The
New Zealand
Medical Journal
Journal of the New Zealand Medical Association
Vol 130 | No 1455 | 12 May 2017

A tale of two islands: trauma care in New Zealand

A walking stick in one hand and a chainsaw in the other: patients' perspectives of living with multimorbidity

Rotorua, hydrogen sulphide and Parkinson's disease—A possible beneficial link?

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Coeliac disease and fertility in New Zealand women

Increased use of police and health-related services among those with heavy drinkers in their lives in New Zealand

The New Zealand
Medical Journal
Publication Information
published by the New Zealand Medical Association

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Individuals*	$306	Individual	$426
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ISSN 1175-8716

Impact of a national time target for ED length of stay on patient outcomes

Peter Jones, Susan Wells, Alana Harper, James Le Fevre, Joanna Stewart, Elana Curtis, Papaarangi Reid, Shanthi Ameratunga

The Shorter Stays in ED target was introduced to reduce ED crowding, which is known to have adverse effects on patient care. Although similar targets introduced overseas have not always resulted in the improved quality of care, this study shows that in New Zealand, people waited less time in the ED before they were admitted to hospital after the target. This was associated with a substantial reduction in ED crowding and a reduction in the number of deaths in the ED compared to what was predicted if pre-target trends had continued. Fewer people left the ED before their care was complete and admission rates to hospital did not change substantially. Overall, people spent an average of seven hours less in hospital after they were admitted to a ward, but there was a small (1%) increase in the number of readmissions to hospital at 30 days after the target.

Effect of the Shorter Stays in Emergency Departments time target policy on key indicators of quality of care

Peter Jones, James Le Fevre, Alana Harper, Susan Wells, Joanna Stewart, Elana Curtis, Papaarangi Reid, Shanthi Ameratunga

This study explored the association between the introduction of a mandatory national target for emergency department (ED) length of stay, which was introduced in New Zealand in 2009, and five key indicators of quality of care. We did this study as there is some evidence from overseas that focusing on a process target for the time spent in the ED may divert attention away from other aspects of quality of care. Our study found that more people left the ED within six hours after introduction of the shorter stays in ED target. There was no difference in the quality of care for patients in pain, with severe infections, with heart attacks, with appendicitis and with fractured hips when comparing the outcomes for these conditions before and after the introduction of the target.

New Zealand plastic surgeons' life-time contribution to peer-reviewed literature

Tess Brian, Brandon Adams

The New Zealand Medical Association commits the New Zealand doctor to evidence-based medicine, scholarship, teaching, collaboration and communication. To assess this commitment, one measure, contribution to the peer-reviewed literature, was examined for one group of New Zealand doctors: plastic surgeons. Based on this metric, as a group, but with exceptions and less so in later practice, New Zealand plastic surgeons would seem to demonstrate this commitment.

Survival of Legionella in earthquake-induced soil disturbance (liquefaction) in residential areas, Christchurch, New Zealand: implications for disease

Frances Graham, David Harte

Legionella bacteria is ubiquitous in the environment. This study set out to expand our understanding of the environmental exposure risks to *Legionella* and whether seemingly unrelated environmental factors, such as aerosolised liquefaction-affected soil resulting from the Christchurch earthquakes had the potential to impact on disease prevalence. Liquefaction-affected soil could not contribute directly to the observed increase in legionellosis cases after the earthquakes due to its inability to support growth and survival of the *Legionella* bacteria. Chemical and size analysis of the liquefaction-affected soil showed it consisted of >65%. Silica. The authors propose that inhalation of earthquake associated airborne liquefaction-affected soil can damage lung tissue and cause inflammation. Inflammation and damage could allow opportunistic pathogens, such as *Legionella* bacteria, to more successfully infect the human host.

A walking stick in one hand and a chainsaw in the other: patients' perspectives of living with multimorbidity

Louise Signal, Kelly Semper, Jeannine Stairmand, Cheryl Davies, Elinor Millar, Tony Dowell, Ross Lawrenson, Dee Mangin, Diana Sarfati

Living with multimorbidity (two or more long-term health conditions) is becoming more common in both young and older New Zealanders. It disrupts people's 'normal' lives, posing challenges for many, yet people learn to cope by making changes to much of what they do (eg, eating, activity and employment). Dealing with the health care system for those with multimorbidity can be challenging and people value simple things like good communication and receiving care that is effective and respectful even when they are from a different cultural background to that of their health care provider. Health care system support is needed to help people with multimorbidity manage the challenge of dealing with multiple medications using simple aids such as blister packs. Improvements to the health care system are needed to better serve those people living with multimorbidity, their support people and health care providers, eg, longer consultation times with GP/primary care providers to discuss multiple health issues and medications.

Implementation and effects of Enhanced Recovery After Surgery for hip and knee replacements and fractured neck of femur in New Zealand orthopaedic services

Suzanne Proudfoot, Brandon Bennett, Simon Duff, Julie Palmer

Eighteen district health boards (DHB) have introduced Enhanced Recovery After Surgery (ERAS), a new way of caring for people who need a hip or knee joint replacement or who have a fractured neck of femur (hip). ERAS is a patient-centred care pathway that aims to ensure people are in the best possible condition for surgery, have the best possible management during and after their operation and participate in the best possible rehabilitation after surgery. The National Orthopaedic ERAS Collaborative used collaborative quality improvement methodology to implement ERAS in the DHBs. Compliance with the elements that make up ERAS increased from 33% to 75% for knee replacements, from 31% to 78% for hip replacements and from 29% to 51% for fractured neck of femur. The length of time patients spent in hospital for knee joint replacement fell from 5.4 days to 4.5 days, and for hip replacement from 5.1 days to 4.3 days. ERAS is known to significantly improve surgical outcomes for patients and the cost-effectiveness of care. It has also been found to reduce the surgical death rate.

Enhanced hip fracture management: use of statistical methods and dataset to evaluate a fractured neck of femur fast track pathway—pilot study

Nigel Gilchrist, Kristian Dalzell, Scott Pearson, Gary Hooper, Kit Hoeben, Jeremy Hickling, John McKie, Ma Yi, Sandra Chamberlain, Caroline McCullough, Marc Gutenstein

This paper demonstrates how integration of service components that are involved in fractured neck of femur can be achieved. It also shows how the use of electronic data capture and analysis can give a very quick and easily interpretable data trend that will enable change in practise. Cooperation between health professionals and practitioners can significantly improve the length of stay and the time in which patients can be returned home. Full interdisciplinary involvement was the key to this approach. The use of electronic data capture and analysis can be used in many other health pathways within the health system.

Increased use of police and health-related services among those with heavy drinkers in their lives in New Zealand

Taisia Huckle, Khoon Ching Wong, Karl Parker, Sally Casswell

The findings of this study are the first to show the extent of service use because of others' drinking among the general population in New Zealand. There are considerable numbers of New Zealanders requiring intervention from police or health-related services due to the effects of someone else's drinking. Heavy drinkers place increased burden on police and health-related services, not only because of directly attributable effects but because they impact others.

The cost of major head and neck cancer surgery

Rahul Jayakar, Jenny Choi, Craig MacKinnon, Swee Tan

The cost of major head and neck cancer surgery is unknown. In this study, 245 patients underwent major head and neck cancer surgery over a five-year period at the cost of NZ$5,130,639.00, averaging NZ$20,941.38 per patient. There are many different types of head and neck cancers. The cost of treatment varies depending on the type of cancer. Calculated hospital income merely covered the actual cost of major HNC surgery, which places substantial financial burden on the hospital.

Is high-quality trauma care "business as usual" in New Zealand?

Ian Civil, Siobhan Isles

New Zealand is on the cusp of establishing a world-class trauma system. Many of the building blocks are in place with national and regional guidelines in both the pre-hospital and hospital phases of care established. A dedicated clinical workforce is available in all DHBs and national data is available through the Major Trauma Registry. The greatest threat to achieving high-quality trauma care in New Zealand at this point is governance stability rather than clinical variability. Now is the time to lock the trauma system into a framework not subject to political or bureaucratic whims.

Rotorua, hydrogen sulphide and Parkinson's disease—A possible beneficial link?

Yusuf Ozgur Cakmak

Rotorua city (New Zealand) is known for its 'rotten egg' smell, due to high levels of hydrogen sulphide (H_2S) concentrations emitted from local geothermal vents. Studies have shown H_2S as potentially toxic if too high in concentration. However, research on H_2S on health postulates whether ambient air inhalation levels of H_2S in Rotorua might have a therapeutic role in the management of motor symptoms in Parkinson's disease (PD). An observed beneficial link between chronic H_2S inhalation in PD animal models and improved finger tapping scores in a sample of the Rotorua population, linked to dopaminergic nerve function, is worth investigating further.

A tale of two islands—trauma care in New Zealand

Dominic Fleischer, Christopher Wakeman

It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of Light, it was the season of Darkness, it was the spring of hope, it was the winter of despair, we had everything before us, we had nothing before us, ...” so opens A Tale of Two Cities by Charles Dickens.[1]

The Major Trauma National Clinical Network has published its first report based on data from the New Zealand Major Trauma Registry (NZMTR). However, it is not a report on the state of admitted major trauma across New Zealand. The report contains data only from the three regions that make up the North Island. It provides no insight into the South Island with a quarter of New Zealand's population and more than half of this country's landmass. Christchurch Hospital is the only tertiary level South Island centre to have collected major trauma data over the last year. Major trauma represents only a fraction of admitted trauma, but it has had no means, due to a lack of staff, to enter this data consistently onto the NZMTR. In contrast, every single North Island hospital that admits major trauma submitted data to the NZMTR. Data from Christchurch Hospital suggests that the South Island population have an even greater incidence of major trauma and higher mortality rates with equivalent injuries to those in the North Island.

The established trauma services of the north, especially Auckland and Hamilton with their specialist multidisciplinary trauma teams—including trauma surgical specialists and trauma fellows, trauma clinical nurse coordinators and trauma registry data entry and analysis personnel—have no equivalence in the South Island. The superior trauma care in the north begins even prior to a patient's arrival at hospital. Medically staffed helicopter retrieval services are able to transfuse blood prior to hospital arrival. Yet the greater distances of travel and high trauma incidence suggests such pre-hospital care would be life-saving down south. There appears to be a wide gulf in trauma load, trauma systems, trauma funding and outcomes between the north and the south. The nearest equivalent to a North Island trauma service that a patient admitted with major trauma to a South Island hospital receives may be an encounter with a trauma clinical nurse specialist tasked with data collection, generally with no specific SMO oversight. In the south, patients with multi-system trauma are admitted into a 'best-fit', 'single-organ' surgical specialty or even a medical team. Despite the best of intentions, a lack of expertise in contemporary trauma care, challenges with coordinating multi-system trauma requiring multi-specialty care, difficulties associated with elderly patients with trauma and their medical comorbidities means that there are likely to be differences in the standards of care between the North and South Island centres. Without the commensurate North Island trauma services, their ability to collect all admitted trauma data and enter major trauma data onto the NZMTR, the South Island remains *terra incognita* on the national trauma registry. Possibly, conveniently veiling the wide separation in trauma care and outcomes between the North and South Islands.

In the provision of trauma care the South Island appears to be some 40 years behind the US,[2] nearly 20 years behind Australia[3] and 10 years behind Auckland.[4] In the 1990's, systemic errors in Australian trauma systems were identified as resulting in significant preventable trauma patient deaths.[5] Since the establishment of a state-wide trauma system in Victoria, Australia, there has been a significant reduction in mortality.[6] Cameron concluded that "Such

inclusive systems of trauma care should be regarded as a minimum standard for health jurisdictions".[6] The South Island does not appear to be progressing towards achieving such a minimum standard. Data capture while nascent in the south needs to be swiftly followed by the fundamental components of a trauma service. In the south, medical and nursing staff involved in the care of major trauma patients have waited for years for the local and national support required to enable us to progress to the standard of care available in Auckland and Hamilton. With our higher rates of trauma presentations the Mainland should be the leaders in trauma care in New Zealand. In the current climate of financial frugality there seems little prospect of funding being made available for detailed data collection, data entry onto the NZMTR and trauma care in the south to equal what is available in the north. Despite the substantial evidence from the North Island, Australia and North America that formal trauma services reduce mortality, morbidity and length of stays, the funding deficits faced by the southern and Canterbury DHBs seem insurmountable hurdles to matching the higher standards of trauma care available in the North Island tertiary level centres.

Incentive funding by ACC highlights the discrepancies in available trauma systems and exacerbates the gap between the north and south by disproportionately rewarding the established North Island Trauma Services.

In the South Island we do not feel we are on the cusp of establishing a world-class trauma system nor do we seem to be progressing to a North Island class of trauma system. The fundamental building blocks for a trauma service, which the paper by Civil refers to, have yet to be laid in the south. Any long-term vision to improve trauma care in New Zealand needs to start with bringing the south up to the North Island standard, then together we should aim to match the achievements in trauma care Australians take for granted. But without significant funding injections and high-level stewardship, trauma care in New Zealand will continue to be a tale of two islands, the haves in the north and the have-nots in the south.

Competing interests:
Nil.

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URL:
http://www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2017/vol-130-no-1455-12-may-2017/7236

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Improving outcomes in orthopaedic care

Gary Hooper

Surgical practice is besieged by traditional methods, which, although they may have been intuitively sound, have not necessarily withstood critical analysis. Many of the surgical doctrines have failed the test of randomised clinical trials. Some of us will remember working as the junior doctor on a surgical attachment and knowing that patients needed to be nil by mouth from midnight for the following morning's list, even if they were last on that list. The ramifications of patients being cancelled the next day because they had eaten were often profound and not an experience to be repeated! This surgical practice was "set in stone" and there was no reason to doubt it. It made sense. Brady et al[1] challenged this concept and conducted a systematic review evaluating the effects of different preoperative fasting protocols. They concluded that there was no evidence that this practice was helpful in eliminating the risk of aspiration pneumonitis and that regular sips of clear fluid in fact reduced gastric volumes while improving the patient's hydration.

Enhanced Recovery After Surgery (ERAS) is an evidence-based strategy involving a paradigm shift in perioperative care. It involves preoperative education, enhanced nutrition, avoidance of fasting, restricted use of opioid analgesia, minimally invasive surgery and rapid postoperative mobilisation. This multimodal, multidisciplinary approach has resulted in reducing hospital stays by up to 50% with a similar reduction in complications and fewer readmissions.[2] Apart from the obvious advantage to the patient, this also results in reduced costs to the funder. Several branches of surgery have been active in adopting this practice, in particular colorectal surgery, but its translation to other branches of surgery has been slow.

There are many reasons for the delay in translating evidence-based medicine into surgical practice, but a major one is likely to be the lack of coordinated knowledge translation to the relevant interested providers. Barriers to this knowledge transfer are often centred on a lack of resource, in particular designated staff to ensure that the translation into practice occurs. Proudfoot et al[3] in *"Implementation and effects of Enhanced Recovery After Surgery for hip and knee replacements and fractured neck of femur in New Zealand orthopaedic services"* have been successful in engaging 18 out of 20 of our district health boards (DHBs) to implement this perioperative process to improve outcomes and reduce the length of stay in hospital for some orthopaedic procedures. This has been supported by both the Ministry of Health and the National Orthopaedic ERAS Collaborative. They show, that for total hip and knee replacement, the average length of stay in hospital can be reduced by almost one day by implementing ERAS strategies alone. Last year, approximately 11,000 joints were replaced in public hospitals throughout New Zealand. The national ERAS programme would have saved almost 11,000 hospital bed days with the potential to allow a further 2,444 hips and knees to be replaced; a major saving in a health system under significant pressure. We have seen the projected increase in demand for joint replacement in the next 20 years,[4] which is going to put even more stress on health care providers and hospitals, so any efficiency in the provision of this care needs to be carefully assessed and implemented. This initiative between the Ministry of Health and other health care organisations is to be applauded and should be the catalyst for future collaborations to translate evidence-based medicine into surgical and medical practice.

Unfortunately the same was not true of fracture neck of femur where their hospital stay was unchanged. This is likely to be due to several factors, including the unpredictability of acute injuries and the difficulty to

weight bear these patients early, which is often a prerequisite for early discharge. Our ageing population means that fragility fractures in the elderly will require increasing health resource, and we need to continue to develop strategies to improve the efficiency of this management. Involving multiple provider groups combined with funding agencies (Ministry of Health, ACC) and a collective approach across all DHBs appears to be the best approach for the future.

The recent development of a hip fracture registry across New Zealand and Australia is an important initiative to provide patient and treatment data, which can then be used to improve outcomes. Like the successful and world renowned New Zealand Joint Registry, we are likely to see this combined database provide the evidence base required to improve outcomes for hip fractures. As Proudfoot et al[3] have shown, the implementation of change within major organisations, such as DHBs, is reliant on having adequately resourced and designated personnel to monitor, educate and manage improvement programmes. This ultimately means employing nationally based staff to coordinate such activities across all DHBs. We look forward to the future development of such initiatives to improve the care of these vulnerable patients.

Competing interests:
Nil.

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URL:
http://www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2017/vol-130-no-1455-12-may-2017/7237

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The ‘six hour target’ in New Zealand is associated with reduced mortality and greater efficiency

Mike Ardagh

The introduction of the Shorter Stays in the Emergency Department health target (the six hour target) in July 2009 was a significant development in New Zealand, being the first and only high-level accountability measure for the care of acute (unplanned and urgent) illness and injury. It required district health boards (DHBs) aspire to admit, discharge or transfer 95% of emergency department (ED) patients within six hours of presentation.

It came about after the advocation of clinicians for a meaningful solution to worsening ED and hospital overcrowding,[1,2] eventually leading to a meeting to discuss possible solutions in Wellington in early 2008. When the participants of the meeting were asked what they wanted, a director of a large and troubled emergency department stood up and said, ‘I just want someone to give a shit.’ This laconic, colloquial quote summarised the consequent direction of travel. A major health target associated with acute care would require DHBs give attention to improving acute care in proportion to the attention they were giving to elective (planned) care.[2]

The consequent report to the Minister of Health called: *The Report of the Working Group for Achieving Quality in Emergency Departments,* provided a thorough examination of the problem and its causes, and made a number of recommendations, including the adoption of a high-level health target based around length of stay (LOS) for patients in EDs.

The new government received the report and accepted this recommendation, appointed a National Clinical Director of ED services and endorsed the establishment of a National ED Advisory Group, consisting mostly of doctors and nurses from throughout New Zealand. There was awareness of the English National Health Service (NHS) experience with a four hour ED LOS target and mixed feelings about its utility. Experience in the UK suggested the target sometimes could be achieved without improving patient care, indeed potentially making patient care worse, by truncating care or moving patients through the system inappropriately—“hitting the target, but missing the point”.

In New Zealand, all players—the Minister, the National Clinical Director, the Advisory Group members and clinicians around the country—were determined to use the target to drive improvements in care, and not allow ‘gaming’ of the target, or shifting of the clinical risk outside the ED to other parts of the system. It was to be a tool to encourage genuine, whole of system improvements in care—quality, not blinkered compliance. It was to be owned and policed by clinicians—the clock should not trump good clinical decisions.[3,4,5]

However, it is not easy creating the understanding that most of the necessary steps to achieving the target are outside the ED, consequently getting buy-in from all who need to contribute, and then changing complex, silos of disconnected care into joined up cooperatives of care, primarily honouring the patient travelling through them. Such change takes time, and there was some pressure for DHBs to achieve the target sooner rather than later.

There is a narrow therapeutic window with an intervention of this sort, so that it is pushed hard enough to get movement but not so hard that it drives bad behaviour. To dose the target in this therapeutic window or keep it in the warm Goldilocks Zone of ample encouragement but not too much pressure, a

six hour time period was chosen, rather than four hours. Similarly, it was stated at the beginning and repeatedly to anxious officials that this would, and indeed should, take at least four years to achieve. Finally, it was explicitly owned and navigated by clinicians who preserved the centrality of the 'quality not compliance' principle.

Did it work?

In this issue of the Journal, Peter Jones and colleagues publish two of the papers from their comprehensive Health Research Council funded 'Shorter Stays in the ED National Research Project'. One paper[6] gives a before and after the target picture of process and clinical measures across the whole of New Zealand, and the other[7] drills down to look at more specific measures at four DHBs. The papers have limitations, particularly regarding their abilities to attribute any changes to the target. The authors acknowledge this and other limitations. However, we should acknowledge that their work represents the most significant research into the utility of an ED LOS target ever undertaken. They should be thanked and congratulated for doing it.

The underlying question is whether the six hour target was good or bad. Did it result in delays to some care, because patients were moved promptly out of the ED before getting the care they should have? Did it result in more admissions to hospital wards because the ED did not take the time to enable a good discharge home? Did it result in greater mortality or increased re-presentation rates because patients were discharged from the ED too quickly?

Or, given the pre-target estimate that ED overcrowding was causing hundreds of deaths in New Zealand each year,[2] would the improvements consequent to the target result in reduced mortality?

In their paper *Effect of the Shorter Stays in Emergency Departments time target policy on key indicators of quality of care*[7] Jones and colleagues found that, in the four DHBs they studied, there were no differences to time to treatment for ST elevation myocardial infarction, antibiotics in severe sepsis, analgesia for moderate or severe pain, theatre for fractured neck of femur and theatre for appendicitis. Nor were there any changes to the adequacy of treatment.

However, it is their paper *Impact of a national time target for ED length of stay on patient outcomes*[6] which is most impressive. This is a nationwide observational study of all DHBs able to provide the relevant data (18 out of 20) covering 90% of hospitals nationwide. Despite more presentations and a case mix which is older and with greater urgency (more urgent triage categories) in the post-target period, the improvement in outcomes was dramatic. Of course, there was better performance against the six hour target and ED LOS reduced in general, for all patient types and particularly for those being admitted to a hospital ward (nearly three hours reduction). However, in keeping with the intent of the target to drive whole of system changes, the inpatient LOS reduced also, freeing up an estimated 145,000 bed days across the country in 2012.

There was no significant increase in rates of admission to hospital, suggesting the target was not being achieved by simply admitting more patients. There was no significant change to re-presentation to the ED within 48 hours, suggesting the target was not being achieved by sending people home before they had received adequate care. Prior to the target there was an increasing trend in the proportion of people attending an ED who left before being seen by a clinician other than the triage nurse. There is appreciable clinical risk associated with this group. After the target, the proportion who did not wait was falling again.

Mortality was unchanged among those discharged home from the ED, or those admitted from the ED to a hospital ward, suggesting the target was not being achieved by 'shifting the risk' to areas other than the ED. Most dramatic among their findings was that there was a significant fall in mortality among ED patients, equating to 700 fewer deaths in 2012 than there would have been had pre-target trends continued. This is an extraordinary finding.

The Shorter Stays in the ED health target has been an important and useful intervention in New Zealand health care. However, it is an intervention for a problem which is chronic and progressive. Not only do we need to ensure we keep it in the therapeutic window but we need to do it for life.

Competing interests:
Professor Ardagh was National Clinical Director of Emergency Department Services, with the Ministry of Health New Zealand, from the instigation of the position in 2009, until the end of 2014.

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URL:
http://www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2017/vol-130-no-1455-12-may-2017/7238

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Impact of a national time target for ED length of stay on patient outcomes

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ABSTRACT

AIM: The impact of national targets for emergency department (ED) length of stay (LOS) on patient care is unclear. This study aimed to determine the effect of New Zealand's six-hour time target (95% of ED patients discharged or admitted to hospital within six hours) on a range of quality indicators.

METHODS: A nationwide observational study from 2006 to 2012 modelled differences in changes over time before and after target introduction in 2009. The observed model estimates in 2012 were compared to those predicted if pre-target trends had continued. Differences are absolute values except for morality, which is presented as a relative change.

RESULTS: There were 5,793,767 ED presentations and 2,082,374 elective admissions from 18 out of a possible 20 district health boards included in the study. There were clinically important reductions in hospital LOS (-0.29 days), EDLOS (-1.1 hours), admitted patients EDLOS (-2.9 hours), ED crowding (-26.8%), ED mortality (-57.8%), elective inpatient mortality (-42.2%) and the proportion not waiting for assessment (-2.8%). Small changes were seen in time to assessment in the ED (-3.4 minutes), re-presentation to ED within 48 hours of the index ED discharge (-0.7%), re-presentation to ED within 48 hours from ward discharge (+0.4%) and acute admissions (+3.9%). An increase was observed in re-admission to a ward within 30 days of discharge (1.0%). These changes were all statistically significant ($p<0.001$).

CONCLUSION: Most outcomes we investigated either improved or were unchanged after the introduction of the time target policy in New Zealand. However, attention is required to ensure that reductions in hospital length of stay are not at the expense of subsequent re-admissions.

In May 2009, the Ministry of Health formally announced six national health targets for public hospitals in New Zealand.[1] One of these was the 'Shorter Stays in Emergency Departments' target, stipulating that 95% of patients will be admitted, discharged or transferred from an emergency department (ED) within six hours of arrival.[2] This policy was introduced on the basis of international evidence that suggested an association between ED and hospital crowding and worse outcomes for patients, including an association with increased mortality.[3–6] The causes of ED crowding are multifactorial, but mostly due to delays in the flow of patients requiring admission to hospital acutely from the ED to hospital wards.[7] Long waits for admission to hospital from ED are synonymously termed 'Access' or 'Exit' Block[8] and are a marker of ED crowding.

Time-based ED targets were initially introduced in the UK's National Health Service (NHS) in 2003[9] and have since been introduced both in New Zealand[1] and in Australia.[10] There is debate as to whether or not targets are helpful or harmful,[11] and it is unclear what impact these have on patient care. Some studies suggest better outcomes for patients,[12,13] and others suggest that focusing on a time target for separation from ED has the potential to distort clinical or management priorities, diverting attention from other aspects of care within the system.[14,15]

The Shorter Stays in ED (SSED) National Research Project is a mixed-methods study within public hospital EDs in New Zealand investigating the relationship between the introduction of a time target for the completion of care in ED and the quality

of care in ED and the whole hospital.[16] The project uses a Kaupapa Māori Research approach, with a lens on ensuring that the target did not widen inequities in health outcomes for ethnic groups, especially the indigenous population. There was involvement by Māori as integral members of the research team from the inception to the completion and reporting of the project.[17]

Key research questions for this paper were: Is there any change in clinically relevant outcomes after the target was introduced? And were there different impacts for at-risk ethnic and age groups?

In order to answer these questions, quality indicators were identified from a literature review and stakeholder analysis.[18] The indicators selected were a mixture of process and outcome measures to provide a balanced view of the influence of the target on the quality of care. The primary outcomes were ED and hospital length of stay (LOS) to reflect efficiency of care, with re-presentation to ED and re-admission to hospital to reflect effectiveness of care. For patients admitted to a hospital ward from the ED, the proportion of patients who had an ED LOS more than eight hours prior to admission (Access Block) was used as the measure of ED crowding. Secondary outcomes were mortality, the proportion not waiting to complete care, the time to assessment by a treating clinician in the ED and the rate of admission to hospital and short-stay wards. Other secondary outcomes relating to specific clinical conditions described in the protocol[16] are being analysed and addressed separately.[19,20,21]

Methods

Study design and setting

This was a cohort study in which the rate of change of selected quality of care markers over time was investigated at a national level in New Zealand for three years before and three years after the introduction of the target (the intervention) in July 2009.

Study population

All ED visits and non-emergency (elective) hospital admissions from 1 January 2006 to 31 December 2012 in New Zealand were identified from the central database of the New Zealand Health Information Service (NZHIS). Hospitals without an ED were excluded. The visit date, demographic data and date of death were extracted from NZHIS and then linked to local district health board (DHB) databases holding times for the patient journey (presentation, triage, assessment, admission and discharge times) in each hospital for each event using a unique patient identifier, the National Health Index (NHI) number. In New Zealand when more than one ethnicity for a person is recorded on arrival, ethnicity is defined by DHBs according to a national prioritisation protocol for major ethnic groups in the following order; Māori, Pacific, Asian, New Zealand European and finally all other ethnicities.[22] Duplicate events were identified and removed prior to data analysis. The linked database was used to determine re-presentation and re-admission to any hospital in the country regardless of which hospital was the site of the index visit. A data dictionary was developed a-priori and contains a full description of the data collection process and definitions of all variables. This is available alongside the study protocol, which has been published previously.[16] The definitions of outcomes pertinent to the current study are provided below.

Intervention

The 'Shorter Stays in Emergency Departments' target is a mandatory target that all DHBs were expected to meet from 1 July 2009. The target stipulates that 95% of patients will be admitted, discharged or transferred from an emergency department (ED) within six hours of arrival[2] and was implemented through a wide variety of process, staffing and structural changes at different hospitals from 2009.[23] Although the target was not accompanied by extra funding to DHBs for implementation, it is estimated that changes made to facilitate meeting the target cost in the region of 52 million New Zealand Dollars.[23]

Definitions

For each outcome, a clinically important difference was determined by consensus, as it was anticipated that due to the large number of participants in the study, small differences that may not be clinically important would be found to be statistically significant. This is shown in Table 1 and is an absolute change unless specified otherwise. In the results section, differences are reported if they met the clinically important threshold for the outcome.

Statistical analysis

The data for each of the outcomes was recorded by twelve-month period to avoid the need to model for seasonal changes. As we included all hospitals (rather than a sample of hospitals) and all their data for the time period of interest was included, hospital was included in the analyses as a fixed rather than a random effect. To compare the rate of change in continuous measures pre- to post-target and whether any change was influenced by age or ethnic group, a general linear model was used. The length of time outcomes were transformed (log base e), and the explanatory variables were hospital, ethnic group (Māori, Pacific, Asian, European, Other), age group (categorised as under five years, 5–14 years, 15–24 years, 25–64 years and 65 years and older), deprivation score (NZDep, a standard measure of socioeconomic deprivation used in New Zealand based on small geographic areas of domicile[24]) entered as a continuous variable centred on NZDep 6, year (coded as 1 to 7 for 2006–2012 representing the pre-intervention change over time), whether pre or post the intervention (a binary variable coded as 0 pre 2009, 1 otherwise, representing the step at target introduction) and a variable to measure the change in slope from pre- to post-intervention (coded as 0 pre 2010, 1, 2 or 3 for 2010, 11 and 12 respectively). As the target was a nationwide target, the first interest was the influence on outcomes nationally. Therefore, changes in the total sample from pre to post the target were investigated first. Estimates of the change over time in all of the outcomes of interest were modelled. The slope over time pre-target, the magnitude of the step change at 2009 when the target was introduced and the slope over time post-target were formed. The difference in the modelled estimate in 2012 from that which would have been obtained if the pre-target pattern had continued was determined. We also determined the difference between the modelled estimates for the year 2012 compared to the immediate pre-target year, 2008.

To investigate if changes differed depending on specific demographic factors of interest, the analyses were also run including the two-way interactions of ethnic group or age, with year, pre-post and change in slope. Estimates as above within ethnic group and within age group were obtained. These estimates were for comparative use and were evaluated at the reference values for the covariates (European, age 15–64, NZDep 6 and Auckland hospital). For the binary outcomes, the analyses were the same with the exception that a generalised linear model was used with a binary distribution and a log link. For some analyses where the outcome was rare, the number of age or ethnic groups needed to be reduced. Data were analysed using SAS/STAT version 9·3 SAS Institute, Cary, NY, USA and SPSS version 22, IBM Corporation, Armonk, NY USA using PROC GLM for the continuous outcomes and PROC GENMOD for binary outcomes. The study funder, the Health Research Council of New Zealand, had no role in the conduct or reporting of the study.

Ethical approval for the study was granted by the Multi-regional ethics committee of New Zealand's Health and Disabilities Ethics Committees MEC 10/06/60.

Results

Of 20 eligible DHBs, 18 participated in the study. One DHB did not reply to multiple requests to supply data and the other was unable to provide the required data due to problems with their database. The 18 DHBs manage 25 hospitals providing care for 3.88 million people (91.7% of the population of New Zealand). Over the study period there were 5,793,767 ED presentations and 2,082,374 elective admissions to the participating DHBs.

Table 2 shows the baseline characteristics of the patients presenting to the participating EDs during the study period. There were more presentations over time with a trend towards increasing age and increasing urgency to be seen according the Australasian Triage Scale (ATS). The use of short stay units (SSU) also increased after the introduction of the target, with <5% of ED presentations placed in SSU prior to 2009 compared to almost 13% in 2012. The proportion of inpatient ward admissions changed little, while target performance improved after 2009, although the target threshold of 95% was not met.

Table 3 shows the raw outcome data by year. Table 4 shows how the model estimates of the indicators in 2012 differed

Table 1: Outcome definitions.

Outcome		Clinically important difference	Definition
Emergency department length of stay (ED LOS)		30 minutes	The interval between ED presentation time and ED departure time. The reported ED LOS does not include the time spent in an ED short stay unit (SSU) and is the time reported by DHBs to the MOH for target compliance. An ED SSU provides short-term (usually <24 hour) assessment and/or treatment for specific conditions in order to streamline the episode of care. This can be led by the emergency medicine or inpatient specialists or both. The total ED LOS includes the time spent in SSU. In this study we used total ED LOS as a balance measure to determine whether SSU were being used to 'stop the clock' for target compliance, in which case total ED LOS would not be expected to change (or may increase).
Access block		10%	The proportion of patients who require hospital admission to an in-patient ward from the ED who have a total ED LOS >eight hours. An in-patient ward is an area of the hospital where ongoing secondary care is provided by a named medical or surgical specialist, usually for more than 24 hours.
Hospital length of stay (LOS)		0.25 days	For admitted patients, the interval between presentation to the hospital and discharge from the hospital.
Re-presentation		1%	The proportion of patients who presented to any ED within 48 hours of discharge from either an ED or a hospital ward, excluding arranged inter-hospital transfers.
Re-admission		1%	The proportion of patients who were admitted to any hospital within 30 days of discharge from a hospital ward.
Mortality		10% (relative change)	The proportion of patients who died: *ED patients:* either in the ED or within 10 days of ED discharge. *Admitted patients:* those that died on the ward or within 30 days of ward discharge. Relative change was used for this outcome as the baseline mortality was low and varied depending on whether patients were discharged (<0.5%) or admitted (≈5%).
Did not wait to be seen or to complete assessment in ED (DNW)		1%	The proportion of patients who left prior to completion of their assessment in the ED.
Assess time		15 minutes	The interval between ED presentation and first assessment by a treating clinician (doctor or nurse practitioner).
Admissions		5%	The proportion of patients who were admitted to an inpatient ward.
For all outcomes	**Observed 2012 estimate**	-	The model estimate of the outcome of interest in 2012 .
	Predicted 2012 estimate	-	The model estimate that would have been obtained for 2012 if the pre-target trend had continued.

Table 2: Baseline characteristics of emergency department presentations.

Year		Pre-target			Target	Post-target		
		2006†	2007	2008	2009	2010	2011	2012
N		678,410	747,135	795,761	843,840	885,093	912,053	931,475
Age	Mean (yr)	38·4	38.4	38.7	38.9	38.8	39.0	39.3
Gender	Male	51.9%	51.9%	51.7%	51.4%	51.0%	50.6%	50.5%
Ethnic group	Māori	18.5%	19.3%	19.4%	19.5%	19.4%	19.2%	19.0%
	European	64.0%	63.5%	63.4%	63.4%	63.4%	63.0%	62.5%
	Pacific	8.4%	8.2%	8.4%	8.6%	8.6%	8.9%	9.1%
	Asian	5.2%	5.1%	5.2%	5.5%	5.9%	6.2%	6.7%
	Other	1.6%	1.7%	1.7%	1.6%	1.5%	1.6%	1.6%
	Unknown	2.3%	2.2%	1.9%	1.5%	1.4%	1.2%	1.2%
Deprivation*	1	12.2%	11.7%	11.7%	12.2%	12.2%	12.4%	12.6%
	2	14.0%	13.6%	13.5%	13.9%	13.9%	14.1%	14.2%
	3	17.2%	17.2%	17.7%	18.0%	18.1%	18.3%	18.3%
	4	24.9%	25.6%	25.4%	24.9%	25.1%	25.1%	25.0%
	5	30.5%	30.8%	30.6%	29.9%	29.6%	29.2%	29.0%
	Unknown	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%	0.9%
Mode of presentation	Ambulance	25.1%	22.7%	22.8%	24.8%	26.9%	25.7%	23.4%
	Self	57.2%	55.0%	53.7%	55.5%	58.4%	57.1%	57.1%
	Other	13.1%	17.8%	19.3%	15.4%	10.6%	13.0%	15.4%
	Unknown	4.5%	4.4%	4.3%	4.2%	4.2%	4.2%	4.2%
Referral by	Self	62.2%	64.5%	66.8%	68.4%	68.2%	66.3%	65.3%
	Health provider	31.2%	28.2%	27.4%	27.2%	25.1%	23.7%	23.0%
	Unknown	6.6%	7.2%	5.8%	4.4%	6.7%	10.0%	11.7%
Australasian Triage Scale**	1	0.7%	0.6%	0.6%	0.6%	0.7%	0.7%	0.7%
	2	9.8%	9.1%	9.2%	9.8%	9.7%	10.1%	10.3%
	3	37.9%	37.4%	37.3%	38.1%	38.8%	40.3%	41.3%
	4	39.6%	40.1%	40.1%	39.9%	39.8%	39.0%	39.0%
	5	12.0%	12.8%	12.7%	11.6%	11.1%	9.9%	8.8%
	Unknown	0.3%	0.3%	0.3%	0.2%	0.2%	0.1%	0.1%
Short stay unit admissions		3.6%	3.8%	4.7%	6.2%	7.4%	11.8%	12.9%
Ward admissions		31.9%	30.1%	30.1%	31.3%	31.5%	30.9%	31.4%
SSED target achievement† all patients		82.4%	81.6%	80.6%	81.9%	86.6%	90.9%	92.3%
SSED target achievement† admitted patients		70.7%	67.5%	64.9%	67.1%	74.9%	82%	85.1%

†One hospital was unable to supply data for 2006 so n is smaller for this year. *New Zealand deprivation quintiles by domicile: 1=least deprived, 5=most deprived, **Australasian Triage Scale 1=most urgent, 5=least urgent. Missing data is represented by the 'unknown' category for each variable. There were also 14 cases with age not recorded and 186 with gender not recorded over the study period. SSED=Shorter stays in emergency departments. SSED=Shorter stays in emergency departments. †Target achievement refers to the proportion of ED patients each year that were admitted to hospital or discharged from the ED within six hours of arrival in the 25 study hospitals. The target threshold for achievement was 95%.

from that predicted for 2012 if the pre-target trend had continued and the difference between the estimates in 2012 and those in the year prior to the introduction of the target in 2008. These data are shown graphically in Figures 1A, 1B and 1C. The impact of the target on different ethnic and age groups is shown in Tables 5 and 6 and supplementary material figures.

Hospital LOS

Hospital LOS reduced by 0.29 days (6.96 hours) after the introduction of the target (Table 3). All ethnic and age groups had lower than predicted post-target estimates of hospital LOS than if the rate of change pre-intervention had continued (Tables 4 and 5, supplementary material figures).

Table 3: Raw unadjusted outcome data.

Outcome	**2006** n=678,410	**2007** n=747,135	**2008** n=795,761	**2009** n=843,840	**2010** n=885,093	**2011** n=912,053	**2012** n=931,475
Hospital LOS (days†)	2.67 (1.2, 5.2)	2.74 (1.2, 5.5)	2.77 (1.2, 5.7)	2.65 (1.2, 5.3)	2.49 (1.1, 5.0)	2.40 (1.1, 5.0)	2.34 (1.1, 5.0)
Total ED LOS (hours†) all patients	2.92 (1.5, 5.1)	3.02 (1.6, 5.3)	3·18 (1.7, 5.5)	3.23 (1.8, 5.5)	3.12 (1.7, 5.2)	3.12 (1.8, 5.1)	3.17 (1.8, 5.1)
Total ED LOS (hours†) patients admitted to a ward	4.17 (2.42,6.85)	4.50 (2.67,7.28)	4.75 (2.87, 7.68)	4.68 (2.88, 7.48)	4.35 (2.67, 6.67)	4.33 (2.72, 6.28)	4.38 (2.78, 6.22)
Target reported ED LOS (hours†)	2.85 (1.5, 4.9)	2.95 (1.6, 5.0)	3.07 (1.6, 5.2)	3.07 (1.7, 5.1)	2.97 (1.6, 4.7)	2.83 (1.6, 4.4)	2.85 (1.6, 4.4)
Access block (%)	19.3%	21.3%	23.3%	22.3%	17.5%	16.0%	16.5%
Re-presentation 48 hr (%)	7.8%	8.1%	8.0%	8.0%	8.1%	7.5%	7.0%
from ED discharge	2.2%	2.1%	2.0%	2.1%	2.2%	2.1%	2.2%
from ward discharge							
Re-admission to ward at 30 days (%)	6.5%	6.1%	6.5%	7.2%	7.4%	7.4%	7.9%
Mortality (%)							
In ED	0.124%	0.126%	0.130%	0.102%	0.088%	0.070%	0.068%
Acute admissions	2.47%	2.40%	2.43%	2.36%	2.21%	2.26%	2.11%
Elective admissions	0.527%	0.557%	0.512%	0.399%	0.365%	0.369%	0.358%
ED discharge	0.152%	0.137%	0.143%	0.118%	0.124%	0.133%	0.117%
Ward discharge	1.63%	1.66%	1.65%	1.54%	1.50%	1.53%	1.49%
Time to assessment (minutes†)	33 (13, 74)	36 (14, 81)	37 (13, 86)	37 (13, 88)	37 (13, 88)	38 (14, 88)	40 (15, 91)
Did not wait for or to complete assessment (%)	3.7%	4.0%	4.5%	4.6%	4.7%	4.4%	4.0%
Admission to ward (%)	31.9%	30.1%	30.1%	31.3%	31.5%	30.9%	31.4%

LOS=Length of stay, ED=Emergency department. †Times are medians (interquartile ranges) due to the skewed underlying distributions.

ED LOS

There was a 1.1 hour decrease in the modelled estimate of total ED LOS in 2012 compared to that predicted for all patients and 2.9 for admitted patients (Table 4). All ethnic and age groups had lower estimates of total ED LOS in 2012 than those predicted from pre-target trends. Similarly, the model estimate of target reported ED LOS in 2012 was 1.6 hours less than predicted from pre-target trends (Table 4), and this was also reduced for all ethnic and age groups (Tables 5 and 6, supplementary material figures).

Re-presentation to ED

There was no clinically important change in the rate of re-presentation to ED within 48 hours of ED discharge overall pre- and post-the target (Table 4). The post-target trend was a reduction across all ethnic and age groups (Tables 5 and 6, supplementary material figures). Conversely, re-presentation to ED within 48 hours of inpatient ward discharge increased but also did not reach the clinically important threshold (Table 4).

Re-admission to a ward

The model estimated that re-admissions to a ward within 30 days of discharge in 2012 increased 1.1% over that predicted with continuation of pre-target trends (Table 4). All ethnic and age groups had higher estimates of re-admission at 30 days in 2012 than predicted from pre-target trends, although not all above the clinically important threshold (Tables 5 and 6, supplementary material figures).

Access block (ED crowding)

Access block was increasing prior to the introduction of the target then reduced after the target was introduced (Table 4, Figure 1A). All ethnic and age groups had importantly lower than predicted post-target estimates of access block (Tables 5 and 6). The pattern of change was similar for different groups, although older people were more likely to be subject to access block than younger people (Table 6, supplementary material figures).

Hospital admissions

Admission rates were trending downwards slightly prior to the target, with a step up at the introduction of the target followed by a downward trend thereafter. The net effect was that the model estimate of admission rate in 2012 was higher than predicted. However, the clinically important threshold was not reached and the estimated admission rate in 2012 was similar to that in 2008 (Table 4). The pattern of change post-target was similar across ethnic and age groups (Figure 1A). The difference between estimates of admission rates in 2012 and those predicted from pre-target trends for Pacific Peoples and the 'Other' ethnic group reached the clinically important threshold, while those for Asian, European and Māori ethnic groups did not (Table 5). The model estimates in 2012 were also importantly higher than predicted for adults as the pre-target trend was reducing and there was step-up at target introduction (Table 6, supplementary material figures).

Mortality in the ED

The observed model estimate of mortality in the ED in 2012 was 57.8% lower than predicted by the pre-target trend. This translates to ≈700 fewer deaths in the study population than predicted if the pre-target trend had continued (Table 4). The model estimates were consistent with the raw data, which showed there were 395 fewer deaths in ED in 2012 compared to 2008, a 47.3% relative decrease. The post-target pattern was consistent for all ethnic groups with no statistically significant differences for the change between these groups (Table 5, supplementary material figures). ED mortality also decreased importantly across all age groups, but more so for those under 65 years (Table 6, supplementary material figures).

In-hospital mortality

In-hospital mortality was unchanged for acute admissions, with a downward trend pre-target which continued post-target (Table 4, Figure 1B). There was no difference in the step at target introduction for acute inpatient mortality by ethnic group. However, a difference in the change in slope from pre- to post-target was demonstrated due to variation in the pre-target trends for different ethnic groups (Table 5, supplementary material figures).

For elective admissions the difference between mortality estimated in 2012 compared to that predicted if the pre-target trend had continued was 0.19% fewer. This was a 42.2% relative decrease, or ≈600 fewer deaths than predicted in 2012 if the

pre-target trend had continued. The model estimates were consistent with the raw data, which showed that there were 351 fewer deaths in 2012 vs 2008 (a 30% relative decrease). There was no difference by ethnic groups for this outcome, while there was a difference by various age groups with an increase in mortality for the 5–14 year group, due to a decreasing trend pre-target, which flattened out post-target. This group had the lowest mortality of all groups. Mortality for all other age groups was lower than predicted post-target (Tables 5 and 6, supplementary material figures).

Mortality for discharged patients

There was no detectable influence of the target in mortality for those discharged from ED (Table 4, supplementary material Figure 5) and no difference by ethnic or age groups (Tables 5 and 6) for this outcome. For those discharged from the ward there was a statistically significant reduction in mortality at 30 days that did not reach the clinically important threshold (Table 4). There were differences in the change in slopes pre- and post-target by ethnic and age group. Pacific Peoples and those in the 15-24 year age group had relative increases in mortality post-ward discharge, while other groups decreased (Tables 5 and 6, supplementary material figures).

Time to assessment

Time to assessment did not change importantly in relation to the target, with a 3.4 minute decrease between predicted and observed estimates, with no clinically important differences for different ethnic or age groups (Tables 4–6, Figure 1C, supplementary material figures).

Did not wait

The DNW rate was increasing prior to the target, then dropped after target introduction (Figure 1C). The difference between observed estimates in 2012 was 2.8% lower than predicted by the pre-target trend, which meant that the 2012 estimate was similar to that in 2008 (Table 4). All ethnic and age groups had reductions in estimated vs predicted DNW rates post-target (Tables 5 and 6, supplementary material figures).

Limitations

As this was an observational study, we are unable to attribute causality, and it is possible that factors other than the implementation of the ED target contributed to the observed changes in the outcomes measured, which is a weakness of our study. This is particularly relevant to the observed reduction in elective in-patient mortality as the introduction of two other health targets (improved access to elective surgery and faster cancer treatment) at the same time as the ED target in New Zealand may have impacted positively on this outcome.

Discussion

This study reports the impact of the introduction of the shorter stays in emergency departments target in New Zealand on a balanced suite of quality indicators at a national level. Despite the target threshold not being achieved, we found clinically important reductions in hospital LOS, ED LOS, ED crowding, ED mortality, elective mortality and the proportion of people not waiting to be seen or to complete assessment in the ED. Clinically unimportant changes were seen in time to assessment in the ED, re-presentation to ED at 48 hours from ED or ward discharge, and ward admissions. No change was seen in mortality for acute admissions or patients discharged from either the ED or hospital wards. However, an important increase was observed in re-admission to a ward at 30 days. There were no consistent patterns of difference between major ethnic and age groups for these outcomes, suggesting that the SSED target did not systematically advantage or disadvantage any groups defined by these particular demographic categories.

Although it may not be surprising that a mandatory government target for shorter ED stays resulted in the reduction in the reported ED LOS, the key question is whether such a reduction was also associated with real changes to improve the quality of care. The use of SSU increased markedly after the target was introduced. As SSU admission was a potential 'clock-stopping' device with respect to the target,

Table 4: Model estimates of change in quality of care indicators in association with the introduction of the shorter stays in ED target.[†]

Outcome	Predicted model estimate in 2012[††] compared to actual model estimate in 2012	2012 model estimate compared to 2008 model estimate	P value for change in slope post-target	P value for step at target introduction	Clinically important difference
Hospital LOS (days)	-0.29	-0.34	<0.001	<0.001	0.25
Total ED LOS (hr)	-1.1	-0.2	<0.001	<0.001	0.5
Total ED LOS admitted patients (hr)	-2.9	-0.7	<0.001	<0.001	0.5
Target reported ED LOS (hr)	-1.6	-0.9	<0.001	<0.001	0.5
Access block (%)	-26.8%	-14.2%	<0.001	<0.001	10%
Re-presents to ED at 48 hr (%) *from ED discharge* *from ward discharge*	 -0.7% +0.4%	 -0.8% +0.1%	 <0.001 <0.001	 <0.001 <0.001	1%
Re-admission to ward at 30 Days (%)	+1.0%	+1.1%	<0.001	<0.001	1%
Mortality‡ (%) *In ED* *Acute admissions* *Elective admissions* *ED discharges* *Ward discharges*	 -57.8% -4.1% -42.2% +6.4% -7.4%	 -51.0% -10.6% -29.5% -12.2% -8.9%	 <0.001 0.33 <0.001 0.18 0.97	 <0.001 0.77 <0.001 0.29 0.002	10%
Time to assessment (minutes)	-3.4	+1.8	<0.001	<0.001	15
Did not wait for or to complete assessment (%)	-2.8%	-0.5%	<0.001	<0.001	1%
Admission to ward (%)	+3.9%	+0.5%	<0.001	<0.001	5%

ED=Emergency department. [†]=The target introduced in 2009 was that 95% of people should be either discharged from the ED or admitted to hospital within six hours of presentation to ED. [††]The predicted model estimate is what would have been observed if the pre-target trend had continued. LOS=length of stay, Total=time in ED counting short stay unit time, Target Reported=reported time in ED not counting short stay unit time, [‡]Relative difference for this outcome, all others are absolute differences, hr=hour.

Table 5: Outcomes for different ethnic groups.

Outcome	Predicted model estimate in 2012 compared to actual model estimate in 2012	2012 model estimate compared to 2008 model estimate	P value for difference in step at target introduction for different ethnicities	P value for difference in change of slope after target for different ethnicities	Clinically important difference
Hospital LOS (days)					
European	-0.32	-0.32			
Māori	-0.28	-0.31	0.08	<0.001	0.25 (6 hours)
Pacific	-0.25	-0.52			
Asian	-0.08	-0.35			
Other	-0.22	-0.31			
All total ED LOS (hr)*					
European	-1.38	-0.20			
Māori	-1.00	-0.13	<0.001	<0.001	0.50 (30 min)
Pacific	-0.27	-0.35			
Asian	-0.67	-0.34			
Other	-0.34	-0.21			
Total ED LOS admitted patients (hr)*					
European	-3.4	-0.74			
Māori	-2.2	-0.53	<0.001	<0.001	0.50 (30 min)
Pacific	-1.2	-0.64			
Asian	-1.9	-0.95			
Other	-1.4	-0.49			
Reported ED LOS (hr)**					
European	-1.86	-0.90			
Māori	-1.19	-0.56	<0.001	<0.001	0.50 (30 min)
Pacific	-0.89	-1.03			
Asian	-1.33	-1.05			
Other	-0.86	-0.81			
Access block[†] (%)					
European	-28.7%	-14.7%	<0.001	<0.001	12%
Māori	-29.4%	-13.4%			
Other	-17.4%	-11.9%			
Re-presentation to ED (%) within 48 hours					
from ED discharge					
European	-0.61%	-0.77%			
Māori	-1.13%	-0.94%			
Pacific	-1.04%	-0.85%	0.30	<0.001	1%
Asian	0.72%	-0.25%			
Other	-0.09%	-0.32%			
from ward discharge					
European	0.33%	0.12%			
Māori	0.18%	-0.12%			
Pacific	0.64%	0.28%	<0.001	<0.001	
Asian	0.46%	0.34%			
Other	0.93%	0.56%			
Re-admission to ward (%) within 30 days					
European	0.91%	0.98%			
Māori	0.77%	1.49%	0.26	<0.001	1%
Pacific	2.18%	1.67%			
Asian	4.24%	4.10%			
Other	3.57%	2.97%			

Table 5: Outcomes for different ethnic groups (Continued).

Mortality[‡] (%)					
in ED					
European	-63.51%	-53.6%			
Māori	-43.90%	-49.8%			
Pacific	-63.65%	-40.3%	0.11	0.22	
Asian	87.57%	-21.3%			
Other	125.24%	-50.7%			
Acute admissions					
European	-4.11%	-11.1%			
Māori	-11.66%	-4.7%			
Pacific	26.74%	-6.1%	0.87	0.05	
Asian	-0.10%	-8.1%			
Other	-69.79%	-61.1%			
Elective admissions					
European	-46.4%	-32.6%			
Māori	-39.3%	-30.4%			10% relative change
Pacific	-25.8%	-2.7%	0.69	0.62	
Asian	13.8%	2.9%			
Other	-38.4%	-47.3%			
ED discharges (10 day)					
European	-4%	-12.89%			
Māori	38%	-15.55%			
Pacific	39%	-1.29%	0.81	0.38	
Asian	185%	7.25%			
Other	4234%	214.24%			
Ward discharges (30 day)					
European	-9.61%	-8.9%			
Māori	-6.11%	-10.1%			
Pacific	77.54%	15.3%	0.16	0.02	
Asian	-26.95%	-20.9%			
Other	-74.99%	-70.9%			
Time to assessment (minutes)					
European					
Māori	-6.6	0.7			
Pacific	-0.3	4.1	<0.001	<0.001	15 minutes
Asian	11.2	5.9			
Other	-1.0	1.6			
	-11.3	1.1			
Did not wait (%)					
European	-2.9%	-0.5%	0.61	<0.001	1%
Māori	-2.1%	0.2%			
Other	-4.4%	-1.3%			
Admission to ward (%)					
European	3.4%	0.4%			
Māori	4.8%	1.0%	<0.001	<0.001	5%
Pacific	6.2%	1.3%			
Asian	3.2%	0.9%			
Other	5.8%	-0.6%			

ED=Emergency department, LOS=Length of stay, *Total ED LOS includes time spent in a short stay unit, **Reported ED LOS does not include time spent in a short stay unit, [†]Access block is a wait more than eight hours for ward admission from ED (categories collapsed to enable model to run), [‡]Relative change for this outcome, all others are absolute change. Min=minutes.

Table 6: Outcomes for different age groups.

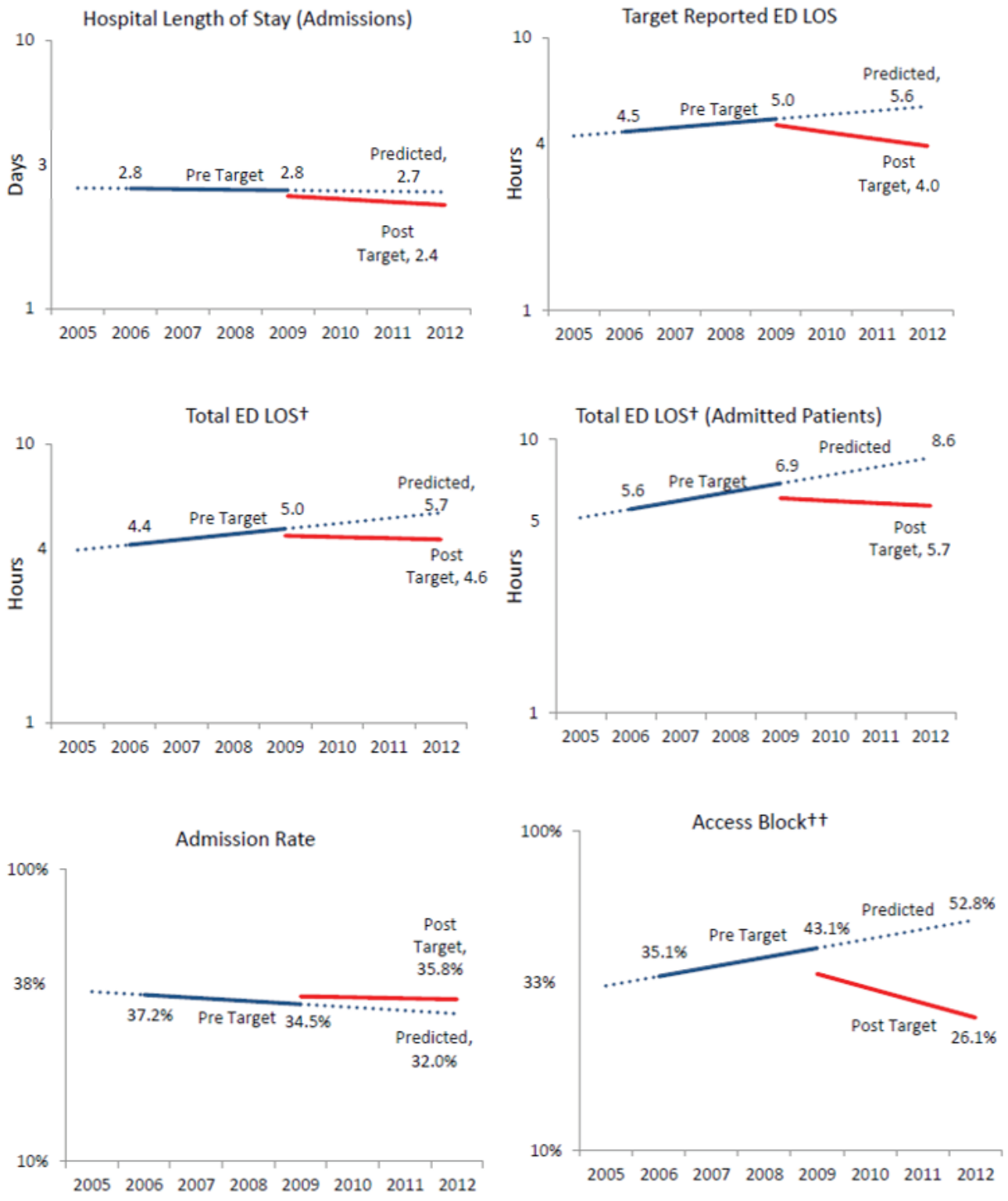
Outcome	Predicted vs estimated in 2012	2012 vs 2008 estimate	P value for difference in step at target introduction for different ethnicities	P value for difference in change of slope after target for different ethnicities	Clinically important difference
Hospital LOS (days)					
<5	-0.16	-0.24			
5–14	-0.29	-0.23	0.001	<0.001	0.25
15–24	-0.13	-0.26			(6 hours)
24–64	-0.23	-0.31			
≥65	-0.73	-0.68			
All total ED LOS (hr)*					
<5	-0.48	0.05			
5–14	-0.61	0.03	<0.001	<0.001	0.50
15–24	-0.66	-0.05			(30 min)
24–64	-1.09	-0.25			
≥65	-2.52	-0.70			
Total ED LOS admitted patients (hr)*					
<5	-0.6	0.29			
5–14	-0.8	0.04	<0.001	<0.001	0.50
15–24	-1.9	-0.63			(30 min)
24–64	-2.9	-0.89			
≥65	-4.3	-1.13			
Reported ED LOS (hr)**					
<5	-0.61	-0.13			
5–14	-0.70	-0.08	<0.001	<0.001	0.50
15–24	-0.94	-0.46			(30 min)
24–64	-1.62	-0.97			
≥65	-3.42	-2.09			
Access Block[†] (%)					
<65	-25.1%	-14.4%	0.24	0.1	12%
≥65	-64.2%	-18.9%			
Re-presentation to ED (%) within 48 hours					
from ED discharge					
<5	0.67%	-0.07%			
5–14	-0.73%	-0.54%	0.02	<0.001	
15–24	-1.54%	-0.84%			
24–64	-0.70%	-0.89%			1%
≥65	-0.57%	-0.67%			
from ward discharge					
<5	0.37%	0.30%	0.23	0.05	
5–14	-0.20%	0.11%			
15–24	0.68%	0.21%			
24–64	0.36%	0.07%			
≥65	0.29%	0.02%			
Re-admission to ward (%) within 30 days					
<5	0.331%	1.53%			
5–14	-0.157%	1.07%	<0.001	<0.001	1%
15–24	2.184%	1.70%			
24–64	1.736%	1.45%			
≥65	0.900%	1.14%			

Table 6: Outcomes for different age groups (Continued).

Mortality‡ (%)					
in ED					
<5	-63.69%	-55.5%			
5-14	-95.98%	-92.4%			
15-24	-94.61%	-89.2%	0.05	0.001	
24-64	-69.82%	-65.4%			
≥65	-41.32%	-36.4%			
Acute admissions					
<5	-53.88%	-34.9%			
5–14	-85.16%	-51.5%			
15–24	-45.28%	-20.3%	0.18	0.43	
24–64	-11.93%	-14.7%			
≥65	-1.00%	-9.3%			
Elective admissions					
<5	-12.6%	5.9%			10% relative change
5–14	122.8%	5.9%			
15–24	-53.2%	-7.7%	0.02	0.18	
24–64	-15.9%	-18.2%			
≥65	-53.9%	-39.3%			
ED discharges					
<5	11%	-23.97%			
5–14	-98%	-18.45%			
15–24	189%	20.32%	0.69	0.26	
24–64	36%	-10.60%			
≥65	-3%	-12.89%			
Ward discharges					
<5	-36.93%	-36.9%			
5–14	-90.61%	-50.6%			
15–24	312.47%	57.3%	0.09	0.04	
24–64	5.87%	-7.6%			
≥65	-10.68%	-8.9%			
Time to assessment (minutes)					
<5	-3.9	0.3			
5–14	-4.0	0.7	<0.001	<0.001	15 minutes
15–24	-6.1	2.3			
24–64	-2.3	2.7			
≥65	-2.7	1.1			
Did not wait (%)					
<5	-3.6%	-0.2%			
5–14	-2.5%	-0.3%	0.15	0.25	1%
15–24	-4.5%	-1.0%			
24–64	-2.7%	-0.6%			
≥65	-0.5%	0.0%			
Admission to ward (%)					
<5	3.9%	0.5%			
5–14	3.0%	0.0%	<0.001	<0.001	5%
15–24	5.1%	1.7%			
24–64	5.3%	1.5%			
≥65	5.0%	-0.2%			

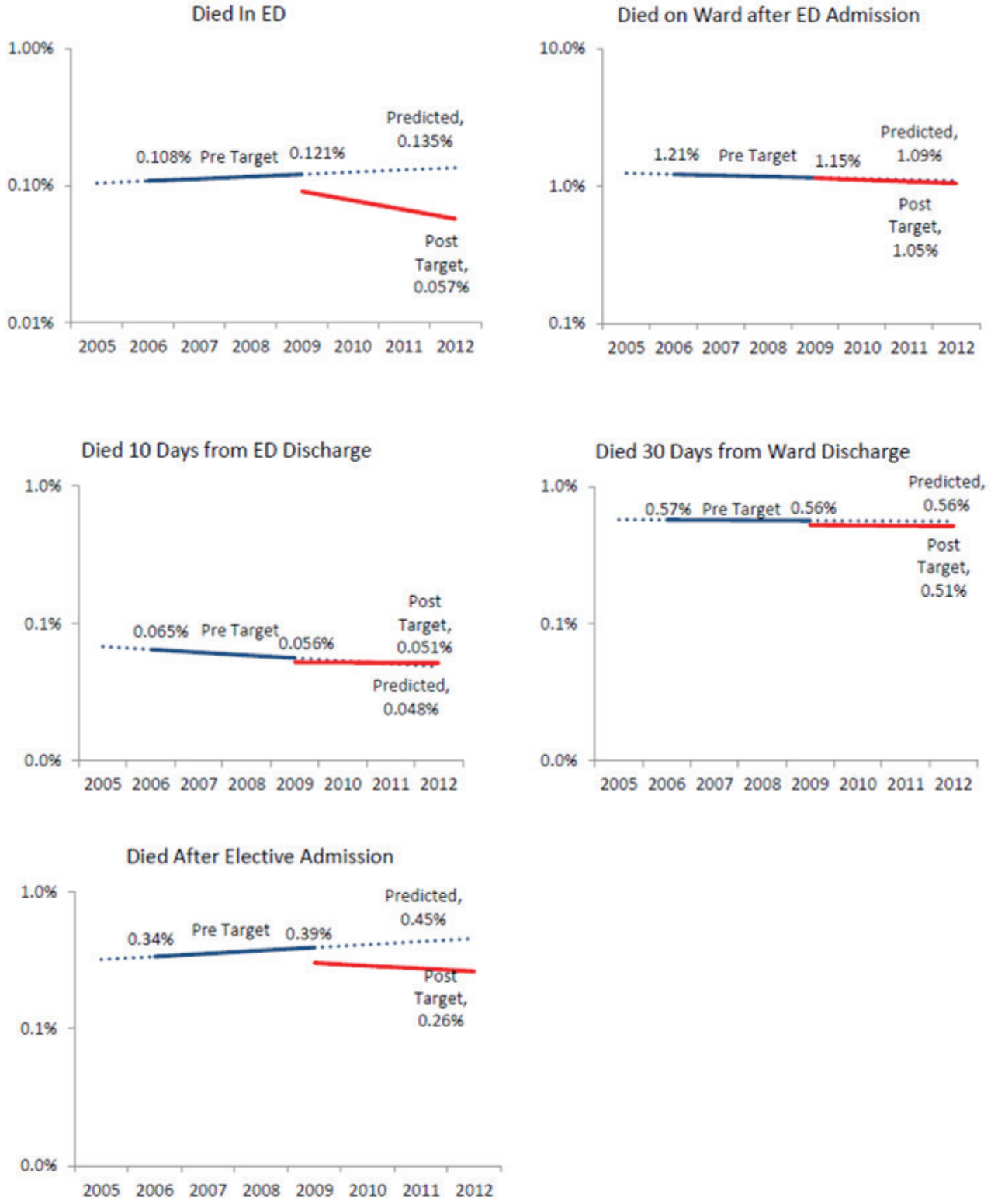
ED=Emergency department, LOS=Length of stay, *Total ED LOS includes time spent in a short stay unit, **Reported ED LOS does not include time spent in a short stay unit, †Access block is a wait more than eight hours for ward admission from ED (age categories collapsed to enable model to run), ‡Relative change for this outcome, all others are absolute change. Min=minutes.

Figure 1A: Model estimates of hospital and ED length of stay, admission rate and crowding (access block).



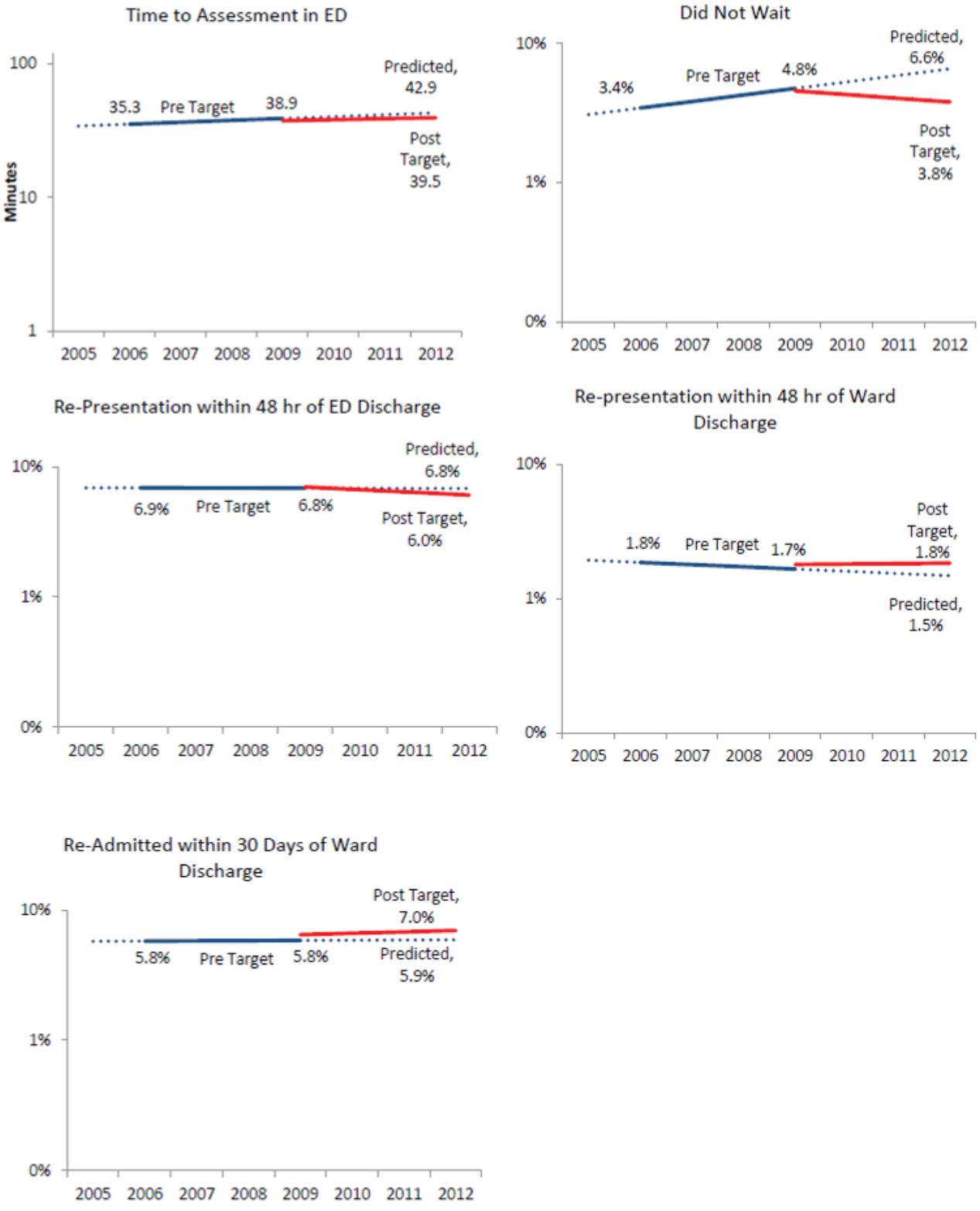
ED=Emergency department. All y-axes are logarithmic scale showing back transformed model estimates. †Total ED LOS includes time spent in a short stay unit. ††Access block is the proportion of patients admitted to a ward who spend more than eight hours in ED.

Figure 1B: Model estimates of mortality in ED, for those admitted to hospital and discharged patients.



ED=Emergency department. All y-axes are logarithmic scale showing back transformed model estimates.

Figure 1C: Model estimates of assessment time, did not wait, re-presentation and re-admission



ED=Emergency department. All y-axes are logarithmic scale showing back transformed model estimates.

we purposefully set out to measure ED LOS both when the time spent in a SSU was counted as ED time (total ED LOS) and when it was not (reported ED LOS). If SSU were used solely to 'stop the clock' for the target then we would expect either no change or an increase in total ED LOS. However, we observed a clinically important reduction in total ED LOS, which is consistent with real improvements in patient flow. Similarly, if SSU was used as a 'holding ward' for patients eventually admitted to a hospital ward, with no real improvements in the efficiency of the admission process, we would expect no change in total ED LOS for admitted patients, however, this group showed the greatest difference between observed and predicted total ED LOS in our study. A reduction in hospital LOS alongside a reduction in ED crowding and marked reduction in ED LOS for admitted patients suggests that the reduction in both reported and total ED LOS we observed may have been due to system-wide changes that facilitated patient flow out of the ED.

Reduced hospital LOS may be expected to result in increased capacity on the wards for admissions, which in turn should reduce ED crowding. Although the reduction in hospital LOS for admitted patients we observed was small for a given patient (≈7 hours per patient admitted), we believe it was clinically important at a national level, as this translates to approximately 145,000 extra bed days available nationally in the post-target period, which would plausibly account for the reduction in ED crowding we observed. This was offset by a small but important increase in re-admission to a ward within 30 days of discharge and a trend towards more ward admissions that was clinically important for adults. It is plausible that these changes may have been the result of early discharges from the ward as a result of pressure to create capacity for new admissions.[25]

The changes in patient flow we observed were associated with a marked reduction in mortality in ED, with a trend towards reduced mortality for acute admissions, with no corresponding increase in mortality for those discharged from ED or a ward and fewer deaths for elective ward admissions. This suggests that the improvement in ED mortality observed was not due to 'shifting deaths' to elsewhere in the system. Furthermore, the improvement in mortality occurred in the face of increasing triage acuity of ED presentations over time, which one would expect to attenuate any improvement in mortality in the post-target period. Previously, it was estimated that ED crowding contributed to 300–500 excess deaths per year in New Zealand[26,27] and size of the reduction in ED mortality in association with reduced ED crowding we observed are consistent with this.

At the inception of this study there was a paucity of research on the benefits and harms of mandatory national targets for ED LOS.[16,28] Subsequent research from the UK in 2012 with respect to the 'four-hour rule' from 15 purposefully selected hospitals showed that ED LOS for admitted patients increased rather than reduced,[29] with no change in mortality within the ED.[30] The authors did not explore whether mortality for those who left the ED (either discharged or admitted) changed in response to the target. The staggered introduction of the UK target in 2004–05 meant that this study captured one true pre-target and one post-target year. Another study of six hospitals in one state of Australia published in 2012, compared the unadjusted mortality for acute admissions in the year of the target introduction to the year after a 'four hour rule' introduction and found a 13% relative reduction in mortality for acute admissions in three out of six hospitals. However, in the year after the target there was also a 10% increase in presentations, which may have diluted the denominator for this outcome. Again, the mortality elsewhere in the system was not reported in this study. In both of these studies the ability to attribute the observed changes to the respective targets is also limited by the short time-frames employed in relation to before and after the intervention, and their conclusions may not be generalisable beyond the small selection of hospitals studied. In contrast, our study spanned seven years to account for secular trends before and after the introduction of the target and included 90% of hospitals nationwide, which are strengths of our study.

Although encompassing a longer time interval (six hours vs four hours) than both the UK and Australian targets, the shorter stays in ED target in New Zealand may have

been more effective at achieving the goal of improved quality of care through reduced ED crowding, despite the target not being reached nationally.[31] This might be due to a six-hour target being more achievable than a four-hour target. Similar to the UK, there was pressure on DHBs to meet the target, which was transferred to clinical staff.[25,28] In New Zealand there was also strong clinical buy-in to the principle of using the target to reduce ED crowding and a determination to not 'miss the point', at least in the emergency medicine community.[26,31]

Conclusion

On the balance of the evidence from this study, the national policy of a six-hour time target of 95% of ED patients being discharged from ED or admitted to hospital did not result in worse care and most likely led to improved care in the emergency department. However, attention should be given to ensuring efforts to discharge patients from in-patient wards are not at the expense of subsequent re-admissions.

Competing interests:
During his time as a research fellow on this study, JLF was also an elected member of one district health board. This potential competing interest was declared to all relevant parties prior to commencing the research activities, and his work was supervised directly by the corresponding author (PJ). The relevant parties and all other authors were satisfied that this potential conflict did not influence JLF's contributions to the submitted work. No other authors have any conflict of interest to declare.

Acknowledgements:
The authors would like to acknowledge Mr Dinesh Kumar for assistance with data management for this study.
The SSED National Research Project was supported by a grant of NZD1,138,000 from the Health Research Council of New Zealand (10–588). Dr Sue Wells was the recipient of a Stevenson Fellowship in Health Innovation and Quality Improvement.

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http://www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2017/vol-130-no-1455-12-may-2017/7239

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Effect of the *Shorter Stays in Emergency Departments* time target policy on key indicators of quality of care

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ABSTRACT

AIM: To determine whether implementation of a national health target called *Shorter Stays in Emergency Departments* impacted on clinical markers of quality of care.

METHOD: A retrospective pre- and post-intervention study from 2006 to 2012 examined quality of care metrics for five different indicators at different sites in relation to the implementation of the target using a general linear model for times to treatment. Explanatory variables included period (pre- or post-target), ethnicity, age, deprivation and severity of condition. Back transformed least square means were used to describe the outcomes.

RESULTS: The times to treatment for ST elevation myocardial infarction; 36.9 (28–49) vs 47.6 (36–63) minutes p=0.14, antibiotics for severe sepsis; 105.9 (73–153) vs 104.3 (70–155) minutes p=0.93, analgesia for moderate or severe pain; 48 (31–75) vs 46 (32–66) minutes p =0.77, theatre for fractured neck of femur; 35.4 (32.1–39.1) vs 32.4 (29.2–36.1) hours, and to theatre for appendicitis; 14.1 (12–17) vs 16.4 (14–20) hours were unchanged after implementation of the target. Treatment adequacy was also unchanged for these indicators.

CONCLUSION: Introduction of the *Shorter Stays in Emergency Departments* target was not associated with any clinically important or statistically significant changes in the time to treatment and adequacy of care for five different clinical indicators of quality of care in Aotearoa New Zealand. For those indicators measured at one site only, it is unknown whether these results can be generalised to other sites.

In May 2009 the Ministry of Health formally announced six national health targets for public hospitals in Aotearoa New Zealand.[1] One of these was the *Shorter Stays in Emergency Departments* target, which states that 95% of patients should be admitted, discharged or transferred from an emergency department (ED) within six hours of arrival.[2] Performance against this target would be reported publicly according to district health board (DHB).

This policy was introduced on the basis of international evidence that suggested an association between ED and hospital overcrowding (reflected by long waits for admission to hospital from ED) and poorer outcomes for patients.[3–6] Time-based ED targets were initially introduced in the UK's National Health Service in 2001,[7] and have since been introduced both in New Zealand[2] and in Australia.[8] There is debate as to whether or not 'Targets' are helpful or harmful,[9] and the effect that time-based targets have upon patient care is uncertain. Some studies suggest better outcomes for patients when such targets were introduced,[10,11] and other evidence suggests that targets may distort clinical and management priorities, diverting attention from clinical care.[12]

The Shorter Stays in ED (SSED) National Research Project is a mixed methods study within New Zealand public hospital EDs, investigating the relationship between the introduction of a time target for the completion of care in ED and quality of care.[13] An important goal was to understand the effect that introducing a process

measure such as an ED length of stay (LOS) target had on other aspects of care for the healthcare consumer. A key research question for this broader project was: *"Is there any change in clinically relevant outcomes after the target was introduced?"*[13]

To explore this research question, a number of clinical indicators of quality of care were identified from a literature review, and a stakeholder analysis process was conducted.[14] The indicators were chosen to cover both ED and hospital outcomes to determine whether target implementation had effects on care quality beyond the ED.

The primary outcomes of interest in this study were the times to thrombolysis for ST elevation myocardial infarction (STEMI), time to antibiotics for severe sepsis, time to analgesia for moderate or severe pain, time to theatre for fractured neck of femur (NOF) and time to theatre for appendicitis. The secondary outcomes of interest were the adequacy of care with respect to each indicator condition; appropriate thrombolysis for STEMI, appropriate antibiotics for the site of infection for sepsis, adequate analgesia for pain, time to theatre <24 hours for NOF and perforated appendix at operation for appendicitis.

Methods

Study design and setting

The overall SSED study has previously been described in detail,[13] and involved all emergency departments across New Zealand. This sub-study was a retrospective, pre- and post-intervention study, which linked administrative data with chart review using the National Health Index number, a number unique to each New Zealand citizen used to record health visits. Four case study site hospitals were selected based on a combination of factors, including: populations with a higher average proportion of Māori people, geographic diversity and initial target performance.[13] There were two urban major referral academic hospitals, one urban district academic hospital and one major regional hospital, serving a combined population of 1.5 million people and a combined annual ED census of 290,000 in 2010.

Selection of participants

All patient visits to the study sites that were recorded in the New Zealand Health Information Service (NZHIS) database from first January 2006 to 31st December 2012 were identified, along with the visit date and demographic data. Data from 2009 were excluded as this was the year in which the target was introduced. Using the random number generator function in Microsoft Excel®, a random sample of visits sufficient to meet the required sample size for each outcome was taken for each of the time periods 2006–08 and 2010–12 (pre- and post-target introduction). For the 'analgesia' outcome, we sample data from all ED presentations nationally. Due to a change in coding practice, NZHIS only supplied data from 1/7/2006 for this outcome. To evaluate the remaining condition specific outcomes the International Classification of Diseases (ICD-10-AM) codes for STEMI, sepsis, fractured neck of femur and appendicitis were used to identify potentially eligible cases at one of the case sites (Table 1). The randomly selected visits were linked to site-specific patient information management systems that included data on the times for each patient journey within a hospital from presentation, triage and assessment, to admission and discharge. Finally, the case notes of the selected visits were reviewed, and the relevant clinical data were extracted by researchers. Prior to data collection a data dictionary that defined each data field and how to classify missing or incomplete data was developed. Smart electronic data extraction forms (Microsoft Excel®) were developed based on the data dictionary.[15] Built-in validation rules were set for cells in the data extraction form to prevent incorrect entries. To avoid bias in selecting and classifying cases, formulas based upon clinical, laboratory and radiological data were used where relevant to ascertain whether patients met the entry criteria. The data extraction forms were piloted prior to data collection, and 15–20% of the data for the specific condition outcomes were independently checked for accuracy by a second data collector who was blinded to the initial data extract. Due to logistic issues, this step was not possible for the eligible records for the analgesia outcome, where data was

collected nationally. Patients were excluded from analysis if the clinical notes were not available or were incomplete, if the patient was transferred from another hospital, if the episode did not involve an ED stay or if the data relevant to the outcome of interest was missing.

Sample size

We determined a clinically important difference in time to treatment for each condition, based on a literature review and expert opinion prior to starting the data collection for these outcomes. Sample sizes were calculated for each outcome to detect this difference, with a power of 90% and an alpha of 0.05, based on the mean and standard deviation (SD) of data piloted at a separate site prior to commencing the study (Table 1).

Analysis

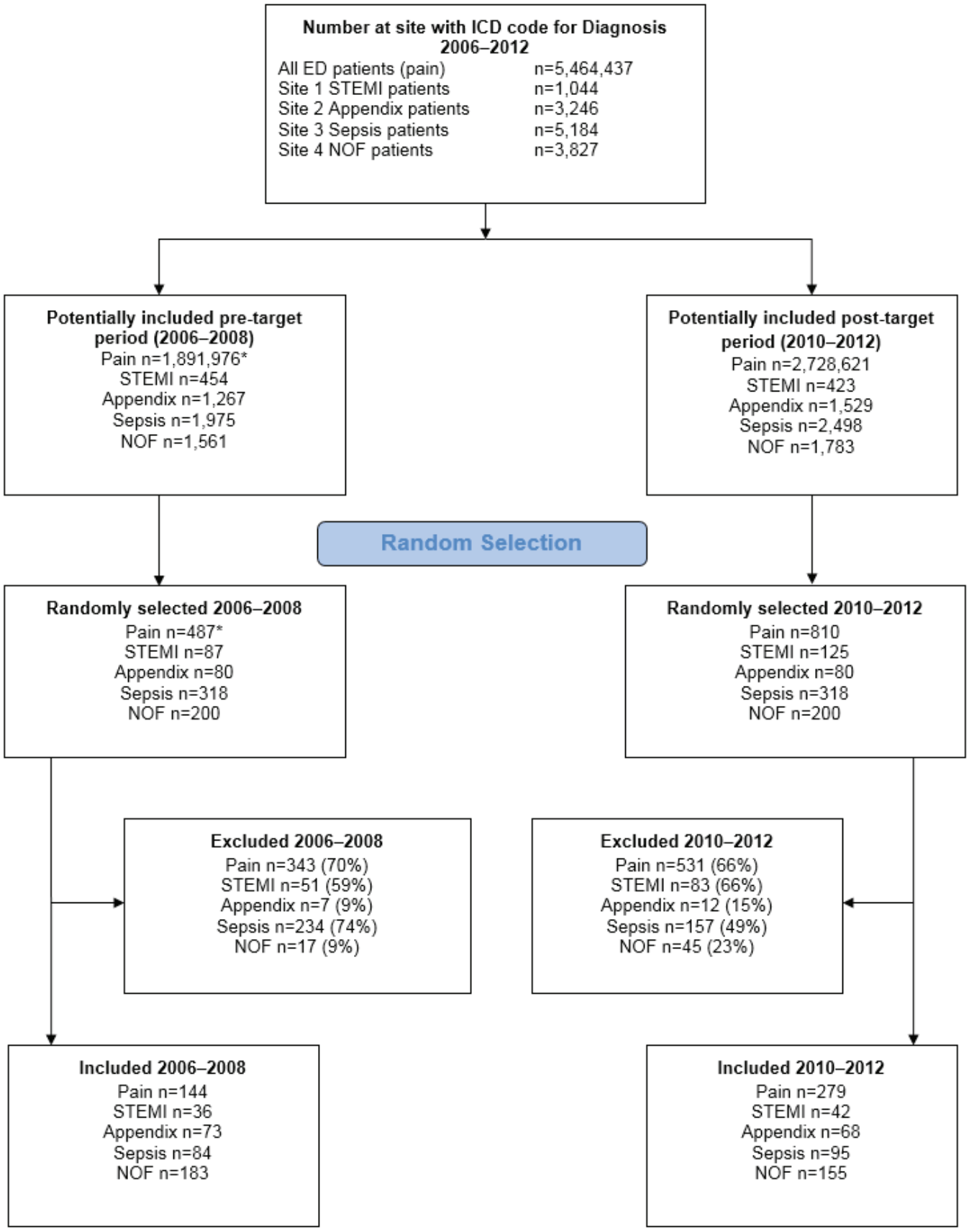
Medians with interquartile range (IQR), means with 95% confidence intervals (95%CI) and proportions (95%CI) were used to describe the data. To investigate changes in treatment times before and after target introduction, a general linear model was fitted with the log of the time plus 0.5 as the outcome. The log transformation was necessary, as treatment time data was skewed. The explanatory variables included were period (pre- or post-target), ethnicity (Māori, Pacific or other), deprivation score (a standard measure of socioeconomic deprivation used in New Zealand based on small geographic areas of domicile[16]), age and severity of condition where appropriate (Pain outcome). Back transformed least square means (LSM) of time were used to describe the effect size.

Table 1: Definitions of outcomes, clinically important differences and sample size requirements.

Outcome	Definition	Clinically important difference*	Total sample size required
Time to antibiotics in severe sepsis *ICD codes* A39 (0–5,8,9), A40 (0–3,8,9), A41 (0–5,8,9), A48 (0,3), A49.9, A42.9, A20.7, A21.7, A22.7, A22.7, A24.1, A26.7, A28.2, A54.8, A32.7, B00.7, B37.7, R57.8, T81 (1,4,42), P36 (0–5,8,9), P37 (2,52)	First antibiotic administration time—presentation time to ED. Severe sepsis = adults aged 18: clinical evidence of infection AND systemic inflammatory response syndrome, AND any of evidence of end-organ dysfunction, hypo-perfusion or hypotension (Surviving Sepsis Campaign definitions[17,18]). Children and adolescents under the age of 18: suspected or proven infection OR a clinical syndrome associated with a high probability of infection, and SIRS, and any of cardiovascular organ dysfunction, acute respiratory distress syndrome, or two or more other organ dysfunctions.[19] Appropriate antibiotics = antibiotic recommended in local guideline for presumed site of infection or cultured organism sensitive to antibiotic given in ED.	60 minutes	230
Time to reperfusion for STEMI *ICD codes* I21 (0,1,2,3,9)	First thrombolytic time—presentation time to ED. STEMI = clinical evidence of myocardial ischaemia and ECG changes indicative of ischaemia: New >1mm ST elevation in two contiguous limb leads, new >2mm ST elevation in two contiguous chest leads, new Left Bundle Branch Block, development of pathologic Q waves, or a new regional wall motion abnormality.[20] No age limit. Appropriate thrombolysis = thrombolysis given for STEMI within 12 hours with no contraindication, or thrombolysis not given where contraindication exists.	15 minutes	50
Time to theatre for fractured neck of femur *ICD codes* S72 (00–05, 08, 10,11)	Operation start time—ED presentation time. No age limit. Adequate time to theatre <24 hours.[21]	6 hours	310
Time to theatre for appendicitis *ICD codes* K35 (0,1,9), K36, K37	Operation start time—ED presentation time. Age >14 years. Appropriateness = proportion of perforated appendix at operation.[22]	12 hours	140
Time to analgesia for patients with moderate to severe pain All ED presentations with pain	First analgesic time—ED presentation time. No age limit. Adequate analgesia = a reduction in pain by 2 points on a 100mm visual analogue scale (or one category on a 4 category scale) and reduced to mild or no pain.[23]	20 minutes	800

ICD = International Classification of Diseases version 10, ED=Emergency Department, STEMI=St Elevation Myocardial Infarction, CT=Computerised Tomography, GCS=Glasgow Coma Scale. SIRS=Systemic Inflammatory Response Syndrome *Based on a literature review and expert opinion.

Figure 1: Case selection and reasons for exclusion.



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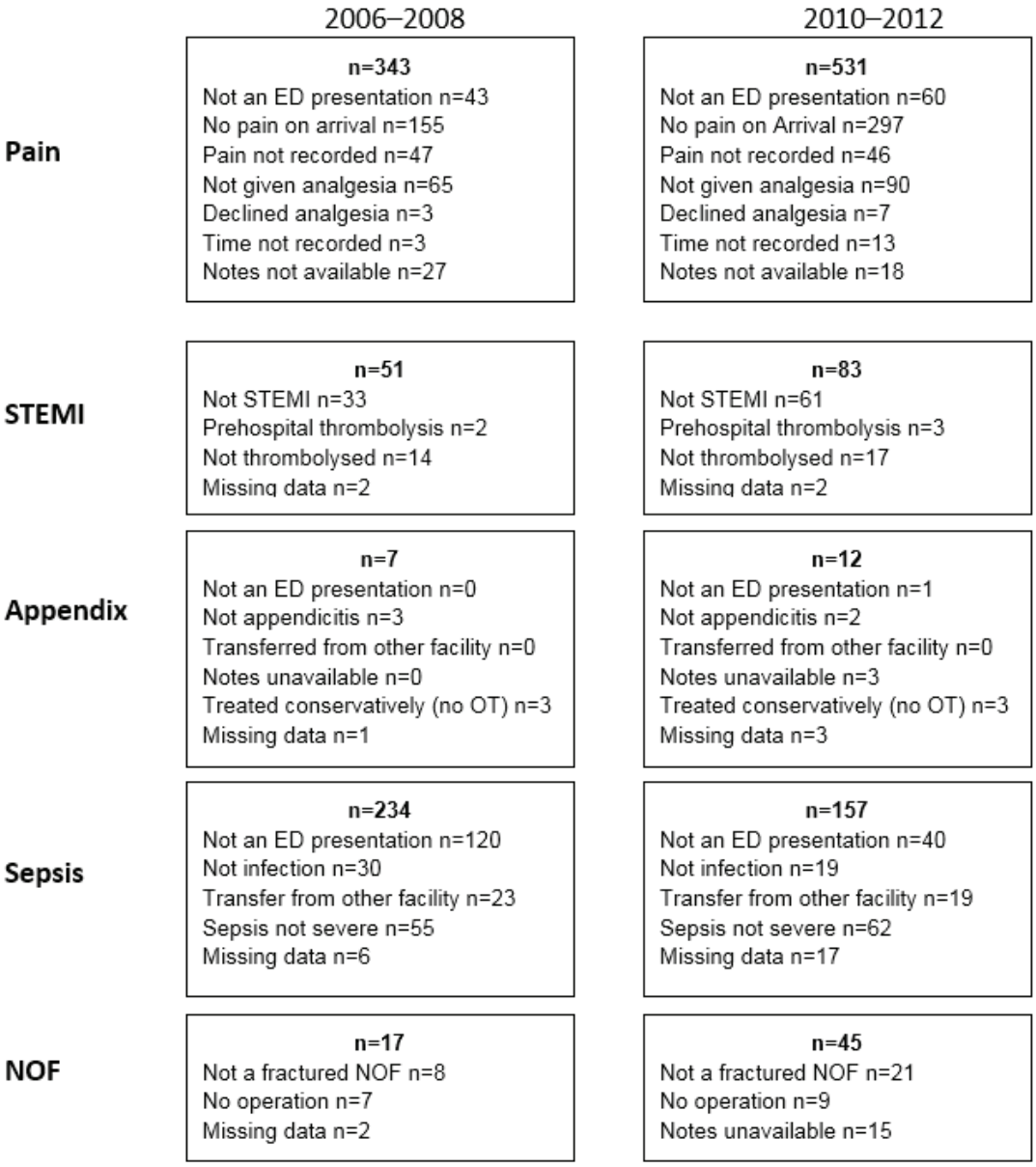
ISSN 1175-8716
www.nzma.org.nz/journal

Figure 1 Continued: Reasons for exclusion.



Key: ED = Emergency Department, STEMI=ST Elevation Myocardial Infarction, NOF=Neck of Femur

*Due to a change in the way coding occurred at NZHIS in 2006, there were fewer visits eligible in the pre-target period for the pain outcome, which starts on 1/7/2006 rather than 1/1/2006.

For the binary outcomes, the analyses were the same with the exception that a generalised linear model was used with a binary distribution and a log link. The explanatory variables included were as above. Unadjusted time-based and descriptive analysis was performed using SPSS v21, Armonk, New York, USA. Multivariable analysis was performed using SAS/STAT version 9.3 SAS Institute, Cary, NC, USA.

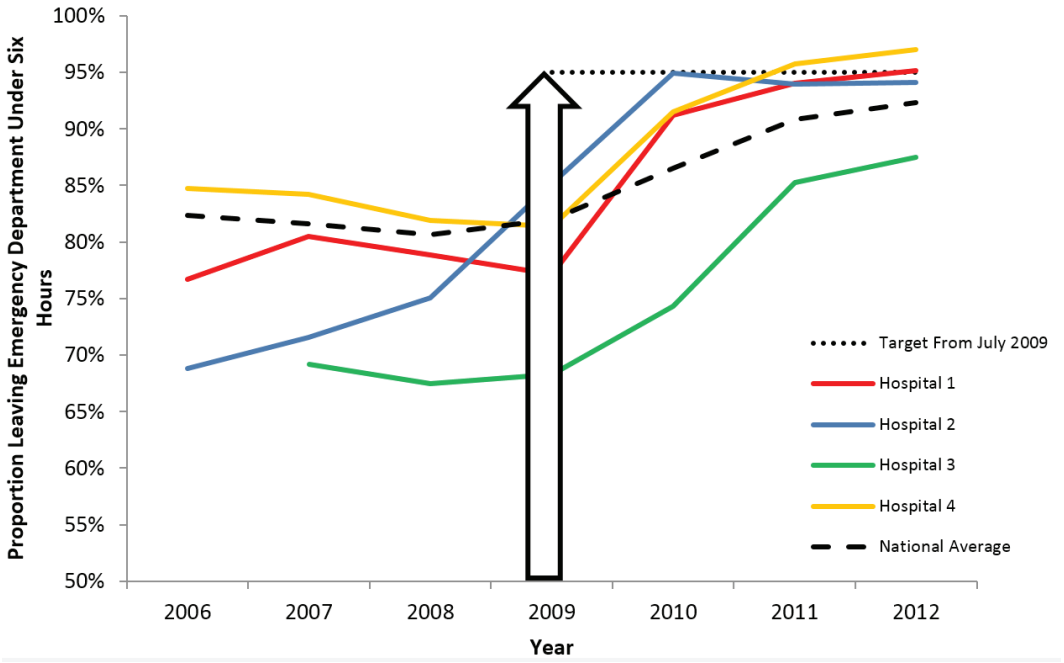
Ethics approval

The Shorter Stays in Emergency Departments National Research Project was approved by the Multiregional Ethics Committee (MEC 10/06/60).

Results

Site specific population samples, case selection and study inclusion are outlined in Figure 1. Fewer patients were available for selection in the pre-target period for the pain outcome due to the data that was supplied by NZHIS starting in July rather than January 2006 (see methods), and fewer visits being selected from 2007 compared to other years (168 compared to ≈269 in the years 2008–2012), the reason for which is unclear. Similar proportions of screened visits were excluded for the pain, STEMI and appendicitis outcomes. More exclusions occurred in the pre-target period for the sepsis outcome

Figure 2: Target performance over time.



due to the initial data request inadvertently capturing cases of neo-natal sepsis, which were not ED visits. Once this was recognised during data collection, the data request for subsequent records was changed to exclude births. There were fewer notes available in the post-target period for the NOF outcome due to patients still under active treatment during the data collection phase in late 2012 and early 2013, and more cases being incorrectly coded as fractured NOF (Figure 1).

The yearly SSED target performance is shown in Figure 2. All sites increased the proportion of patients who left ED within six hours after the target was introduced, although the target threshold was not reached by all hospitals.

The unadjusted median times are reported in Table 2, and the modelled primary outcomes adjusting for the explanatory variables as described in the methods are shown in Table 3. There were no clinically important or statistically significant differences between the pre- and post-target periods for any of the primary or secondary outcomes.

Discussion

This study found that the implementation of the Shorter Stays in ED target was not associated with clinically important or statistically significant differences in the time to treatment or adequacy of care for five acute clinical conditions reflecting care in both the ED and inpatient surgical units in different hospitals. More people left ED within six hours overall, and the median time spent in ED by patients included in the current study either reduced or remained the same after the target was introduced.

Although introduced with a view to reduce unnecessary time patients spend in ED and hence to reduce ED crowding, time targets for ED length of stay have been criticised on the grounds that they may lead to unintended consequences or divert attention away from other aspects of quality of care.[9] Concerns have also been raised by inpatient clinicians about the potential for inappropriate patients to be admitted under their care if sufficient time is not spent differentiating patients in the ED prior to admission. This may lead to

Table 2: Unadjusted primary and secondary outcomes.

Outcome	Overall ED LOS at sites median (IQR) hours		Time to treatment median (IQR)		Treatment adequacy* % (95%CI)	
	Pre	Post	Pre	Post	Pre	Post
Sepsis (†minutes)	4.6 (2.9–6.9)	3.8 (2.4–5.6)	136 (59–199)†	113 (52–217)†	92 (84–97)	90 (82–95)
ST elevation myocardial infarction (minutes)	3.5 (2.0–5.5)	3.1 (1.8–4.7)	27.5 (19–50)†	32 (21–52)†	91 (83–96)	88 (80–92)
Neck of femur fracture (hours)	5.3 (3.1–9.4)	3.7 (1.8–5.6)	34.4 (22–57)	27.6 (20–51)	32 (26–39)	43 (35–51)
Appendicitis (hours)	4.1 (2.7–6.27)	3.4 (2.3–4.8)	14.2 (11–22)	20.7 (10–28)	29 (20–40)	31 (21–43)
Pain (†minutes)	3.0 (1.6–5.1)	2.9 (1.6–4.60)	57.5 (29–126)†	64 (30–138)†	36 (27–47)	44 (38–52)

*Adequacy was defined a-priori as appropriate antibiotics for the site of infection for Sepsis, either thrombolysed or not thrombolysed appropriately for ST elevation myocardial infarction, time to theatre <24 hours for neck of femur fracture, perforated appendix at operation for appendicitis, and adequate analgesia for pain. IQR = Interquartile Range, CI = Confidence Interval† indicates time in minutes (all other times are in hours).

inefficient care or unnecessary resource use on inpatient medical[24] or surgical wards.[25]

Prior research has reported mixed results with respect to ED time targets. New Zealand research using similar methods also found no change in the time to steroids in acute moderate to severe asthma in four hospitals, while the proportion of patients receiving steroids in ED increased.[26] Another study from our group found improvements in the quality of discharge summaries from the ED to primary care in two other New Zealand hospitals.[27] In two Australian hospitals, times to theatre for appendectomy were similar to those we found in their pre-National Emergency Access Target (NEAT) period. However, in the subsequent year, the time to theatre increased to 26 hours in the Australian study.[25] In Ontario, a further study compared the difference in outcomes one year before implementation of ED LOS targets with one year after in hospitals that succeeded in reducing ED LOS versus those that didn't succeed or got worse. The authors reported no difference in the time to thrombolysis for STEMI, time to analgesia or splinting for patients with arm fractures and time to steroids in asthma.[28]

The results from our study alongside others noted above indicate that there

Table 3: Adjusted primary outcomes.

Outcome	Time to treatment Back-transformed least square mean (95%CI)			
	Clinically important difference*	Pre	Post	p
Sepsis (minutes)	60	105.9 (73–153)	104.3 (70–155)	0.93
ST elevation myocardial infarction (minutes)	15	36.9 (28–49)	47.6 (35.7–63)	0.14
Neck of femur fracture (hours)	6	35.4 (32.1–39.1)	32.4 (29.2–36.1)	0.24
Appendicitis (hours)	12	14.1 (12–17)	16.4 (14–20)	0.21
Pain (minutes)	20	48 (31–75)	46 (32–66)	0.77

CI = Confidence Interval *This was determined prior to commencing the study.

is little evidence to suggest that targets focusing on ED length of stay have diverted attention away from other aspects of quality of care in the specific clinical conditions studied. However, whether this represents 'success' with respect implementation of such targets is may depend on the perspective of an observer. An alternative view of this data is that despite apparent ED LOS target 'success', the quality of care did not improve substantially. One reason for this may be a ceiling effect, ie, given good quality of care pre-target, it is difficult to demonstrate a clinically important improvement. This may be a relevant issue in our study, as the baseline times to treatment were reasonable for all outcomes. It is also possible that the reported improvements in ED length of stay targets at our study sites may not have been sufficient to result in important reductions in crowding, as not all of the sites we studied achieved the 95% target threshold. In a secondary analysis, the authors of the Ontario study found that treatment times were faster in the least crowded ED shifts (average ED LOS <4 hours) compared to those in the most crowded ED shifts (average ED LOS >8 hours). This suggests that reductions of around one hour in median ED LOS from a baseline of four hours similar to those we observed may not necessarily result in reductions in ED crowding sufficient to accelerate treatment times. Further research is currently underway to explore how the implementation of the SSED target may have impacted on hospital length of stay, re-presentation to ED, re-admission to hospital, rates of leaving prior to being seen in ED and acute and elective mortality nationally.[29]

Limitations

Due to the number of cases notes required for each outcome and logistic constraints for both the research team and the clinical records departments at the participating hospitals, it was not feasible to measure all outcomes at all sites. We therefore measured different outcomes at different sites so that collectively, we covered a range of quality of acute care indicators in relation to the target, both in the ED and the hospital. For 'pain' and 'sepsis' the estimated sample size was not achieved, weakening the strength of conclusions around the results for these outcomes and increasing the risk of a type II error. However, the observed differences were small even though the estimates were imprecise. As the SSED target was introduced rapidly by the Ministry of Health to all New Zealand public hospitals, we were limited to using a 'pre and post' design rather than a prospective study control sites. Consequently, a causal relationship between the introduction of the target and any differences in quality or lack thereof cannot be assumed because other variables not accounted for by the design may have influenced the outcomes. Retrospective data abstraction involving clinical notes may introduce both selection and measurement bias. In an attempt to minimise bias, notes were selected at random, and electronic data was used wherever possible. Electronic data extraction forms with automated logic checks on individual variables minimised typographical errors. These forms also contained built-in validations, such as formulas which calculated whether or not a given patient met the entry criteria for respective outcomes and additional criteria for severity of condition to reduce subjectivity in these assessments. However, data extractors were not blinded to the objectives of the study, and the collection of time variables meant blinding was not possible with respect to the pre- and post-intervention time periods. Finally, the study results for outcomes measured at single sites may not be generalisable to other settings where the baseline care may differ. It is also possible that quality of care for outcomes that we did not explore may have changed. Importantly, the investigations of these clinical indicators were not powered adequately to explore variations in quality of care between different groups, eg, ethnicity or socio-economic status. This should be the focus of future research.

Conclusion

The introduction of the SSED target was not associated with clinically important or statistically significant changes in the time to treatment and adequacy of care for five clinical indicators of quality of care in Aotearoa New Zealand. For those indicators measured at one site only, it is unknown whether these results can be generalised to other sites.

Competing interests:
During his time as a research fellow on this study, JLF was also an elected member of one district health board. This potential competing interest was declared to all relevant parties prior to commencing the research activities, and his work was supervised directly by the corresponding author (PJ). The relevant parties and all other authors were satisfied that this potential conflict did not influence JLF's contributions to the submitted work. No other authors have any conflict of interest to declare.

Acknowledgements:
The Shorter Stays in ED National Research Project team would like to acknowledge the NZ Emergency Medicine Network for helping with data collection for the outcome of time to analgesia for this study.

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http://www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2017/vol-130-no-1455-12-may-2017/7240

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New Zealand plastic surgeons' life-time contribution to peer-reviewed literature

Tess Brian, Brandon Adams

ABSTRACT

AIM: The New Zealand Medical Association commits the New Zealand doctor to evidence-based medicine, scholarship, teaching, collaboration and communication. To assess this commitment, one measure, contribution to the peer-reviewed literature, was examined for one group of New Zealand doctors: plastic surgeons.

METHOD: Plastic surgeons with a current practising certificate were identified on the New Zealand medical register (April 2016). Scopus database was searched for publications by each.

RESULTS: Sixty-five surgeons authored 541 unique items in 134 journals, generating 8,047 citations. Between medical graduation and specialty qualification, a mean 1.8 items were published per practitioner (range 0–11). Twenty-three practitioners (35.4%) did not publish during this time. Between specialty qualification and the end of 2015, mean number of items published per surgeon was 7.3 (range 0–97). Thirteen (20.0%) surgeons had not published since specialist qualification. The general trend was for surgeons to become less productive with increasing time in practice. Mean surgeon h-index was 4.4 (range 0–26). Four surgeons (6.2%) had not published at any time.

CONCLUSION: As a group, but with exceptions and less so in later practice, New Zealand plastic surgeons would seem to demonstrate commitment to evidence-based medicine, scholarship, teaching, collaboration and communication expected of a New Zealand doctor, as evidenced by peer-review publication.

The 2011 "Consensus statement on the role of the doctor in New Zealand" expresses a commitment to evidence-based medicine, scholarship, teaching, collaboration and communication.[1] This commitment may be demonstrated through development, application and translation of medical knowledge and practice, and by dissemination to colleagues and other professionals.

A desire to contribute evidence and understanding to professional practice is not the only motivation for medical publication,[2] and contribution to peer-reviewed literature is not the only measure of continuing commitment to scholarship, teaching and communication. However, as a lasting and accessible resource, this literature provides a significant metric with which to examine the life-time commitment to these aspects of being a medical practitioner.

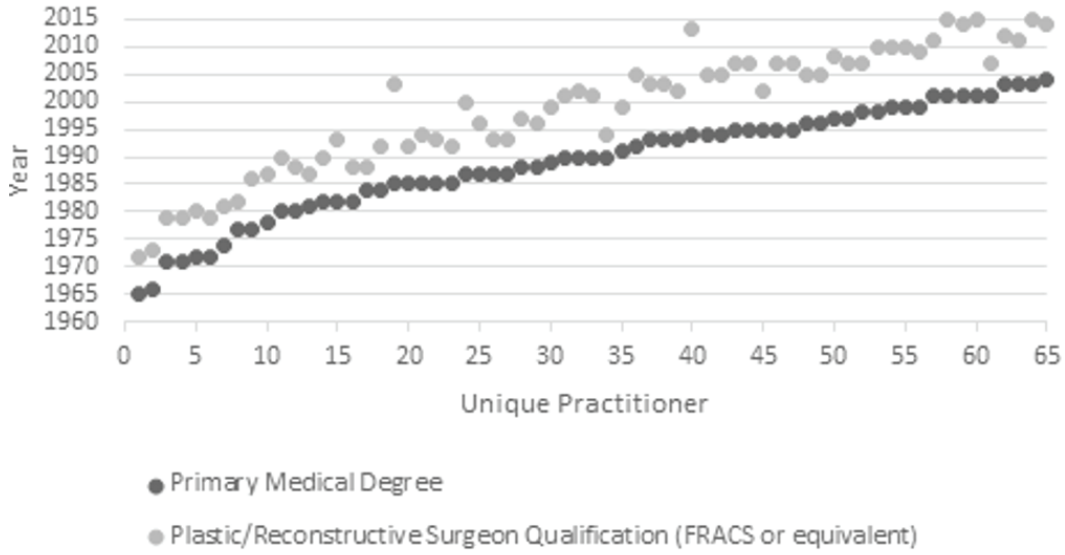
To that end, this paper considers the contribution to the peer-reviewed literature by one group of New Zealand medical practitioners: plastic surgeons.

Method

The Medical Council of New Zealand's medical register was used to identify practitioners with vocational registration in plastic and reconstructive surgery and a current annual practising certificate as of April 2016.

The Scopus database (www.scopus.com) of peer-reviewed literature was searched for publications by each surgeon. Practitioner last names, including previous, current, hyphenated and multiple in combination and separately, were used with first names and their variants (eg, Jonathan/Jon/John), and/or given name initials. When there was

Figure 1: Year practitioner qualifications conferred.



uncertainty as to whether an author was the targeted surgeon, corroboration using ResearchGate (www.researchgate.net) and PubMed (www.ncbi.nlm.nih.gov/pubmed) was undertaken. Author qualifications, institutional affiliation, article topic and publication date were used to adjudicate.

For each unique practitioner, all articles, reviews, case reports, editorials and letters were recorded. Non-peer-reviewed books, chapters and technical reports were excluded. Journal, year and citations were noted for every publication accepted.

Each surgeon's h-index (a measure of both published productivity and citation impact of those publications: an author with an index of *h* has published *h* papers, each of which has been cited in other papers at least *h* times) was calculated.

These data were analysed to examine the professional life-time and pre- and post-specialist qualification contribution of these New Zealand plastic surgeons to the peer-reviewed medical literature.

Results

There were 65 plastic and reconstructive surgeons registered to practise in New Zealand in April 2016 (Figure 1). Eleven (16.9%) were female.

From 1971 through to March 2016, these 65 surgeons authored 541 unique items (Figure 2) in 134 unique journals. The 10 (7.5%) most frequently used journals accounted for 62.3% (337) of the publications (Table 1). Single items appeared in a mix of 77 clinical, research and basic science journals.

Figure 2: Peer-reviewed publications by year.

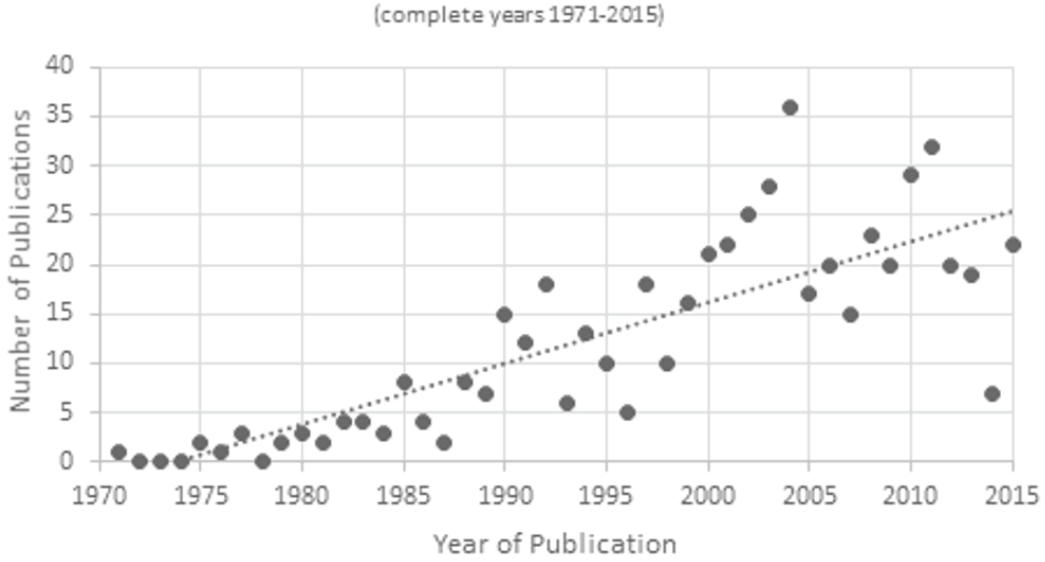


Table 1: Ten journals with most publications by New Zealand plastic surgeons.

Journal	Of 541 Publications	
	Number	Percentage
Plastic and Reconstructive Surgery	75	13.9
British Journal of Plastic Surgery*	55	10.2
New Zealand Medical Journal	39	7.2
Australian and New Zealand Journal of Surgery	34	6.3
Journal of Plastic, Reconstructive and Aesthetic Surgery*	33	6.1
Journal of Craniofacial Surgery	29	5.4
Annals of Plastic Surgery	24	4.4
Journal of Hand Surgery	21	3.9
Burns	18	3.3
Journal of Clinical Pathology	9	1.7

* From 2006, British Journal of Plastic Surgery continues as Journal of Plastic, Reconstructive and Aesthetic Surgery.

Of all publications, 80.2% (434) were original articles and 5.5% (30) were subject reviews. The remaining 14.2% (77) were letters, case reports and editorials. Thirty-two items (5.9%) had a single author. Of these, 14 (43.8%) were letters. Two or more of the 65 surgeons collaborated on 74 (13.7%) publications, of which 60 (81.1%) were original articles or reviews.

The mean number of publications per practitioner was 9.7 (SD 14.3) and the median was six (range 0 to 104: Figure 3). The nine most prolific authors (13.8%) produced 50.6% (274) of the publications. Four surgeons (6.2%) had not published.

During the years between medical graduation and specialty qualification (Figure 1), a mean of 1.8 (SD 2.3) items were published

Figure 3: Peer-reviewed publications per practitioner.

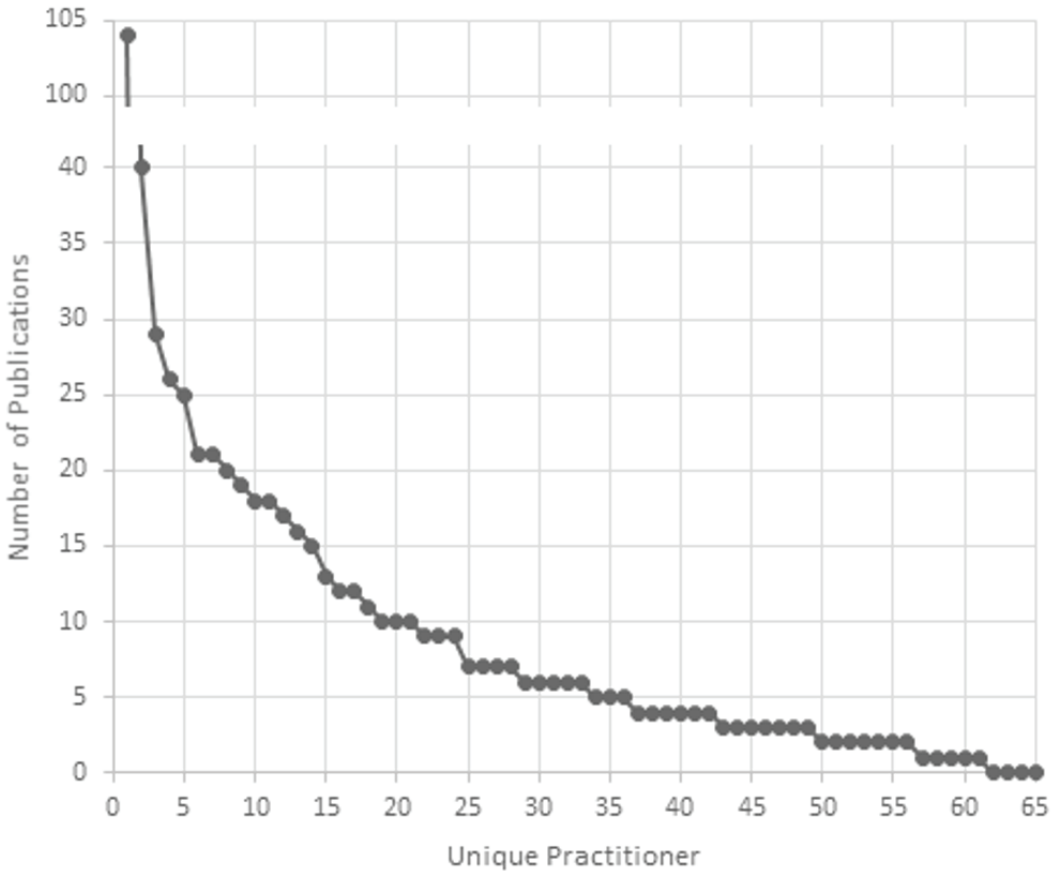
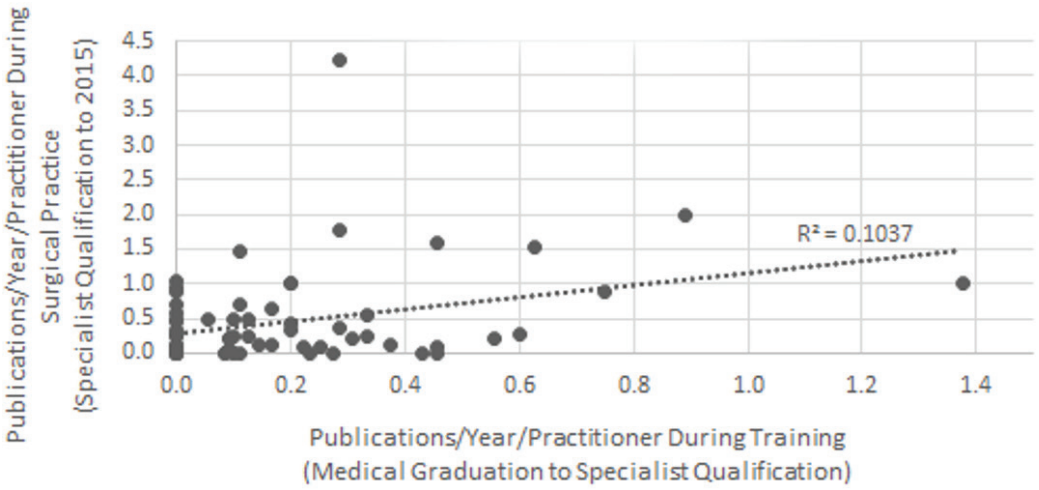


Figure 4: Relationship of pre- and post-surgical qualification publication rates.



per practitioner (range 0 to 11: median 1). Twenty-three surgeons (35.4%) did not publish during this time.

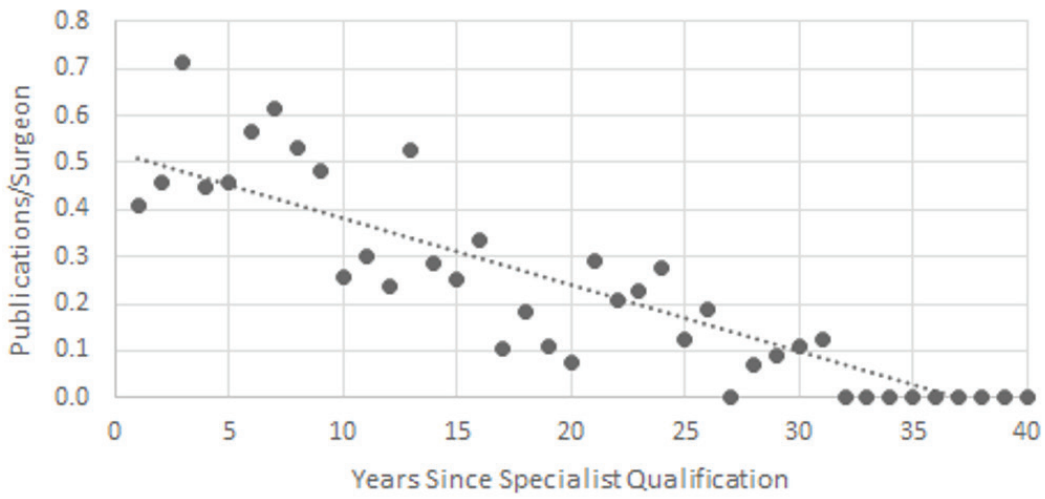
Between specialty qualification and the last full year of consideration, 2015, the mean number of items published per practitioner was 7.3 (SD 13.5), with range 0 to 97, and median of two. Thirteen (20.0%) surgeons did not publish. Four of these had qualified recently, in 2014 or 2015.

The mean number of papers per year per practitioner during surgical training was 0.2 (SD 0.2: range 0.0 to 1.4: median 0.1). Following specialist registration, until the end of 2015, the mean number of publications per year per surgeon was 0.5 (SD 0.7: range 0.0 to 4.2: median 0.2). There was a low positive correlation (Figure 4: Pearson r=0.3, coefficient of determination R^2=0.1) between annual publication rate pre- and post-specialist qualification.

Of all publications produced after specialist registration, 34.4% (175) and 62.4% (317) appeared in the first five and 10 years, respectively. Omitting the outlier practitioner who had a total of 104 publications (Figure 3), 97 of which post-dated specialist registration, the general trend was for surgeons to become less productive with increasing time in specialist practice (Figure 5).

By June 2016, the 541 publications had been cited 8,047 times. Eleven items (2.0%) were referenced on more than 100 occasions (total 1,356 [16.9%]). The most cited article (195 times) appeared in 1986 and described a non-clinical technique. Eighty-two publications (15.2%) were not cited at all.

Figure 5: Publication rate for all surgeons practising each year since specialist qualification.



All surgeons who had published (61 [93.8%]) were cited at least twice. The five most referenced authors (7.7%) accounted for 46.4% (3,731) of all citations.

The h-index for the entire 65-surgeon cohort was 44. The mean h-index per surgeon in the cohort was 4.4 (SD 4.2: range 0 to 26: median 3).

Discussion

This paper uniquely examines the life-time contribution to the peer-reviewed literature by a New Zealand surgical craft group. Its completeness and accuracy are limited by the integrity of the available databases. Errors such as those of author name and attribution, journal and date of publication, and article title and page numbers were common causes of duplication. This poor database entry was overcome as best able by considerable time spent data cleaning before interrogation. However, without approaching all surgeons for lists of publications, the omissions from these databases are unquantifiable.

Another limitation of this study is that those surgeons who had practised over the last 45 years, but were no longer registered to do so in April 2016, were not included in the cohort examined. Therefore, this analysis does not represent the total contribution by New Zealand plastic and reconstructive surgeons to the literature over this period. Instead, it considers the publishing habits of a group of practitioners—some mid-career, others near the beginning or end (Figure 1)—over the continuum of professional lives.

In part, this career distribution of surgeons explains the increasing number of publications per year since the 1970s (Figure 2). Likely other contributors are an increasing number of practising surgeons over this time; an increasing prevalence of research degrees among trainees and surgeons; greater productivity of later qualifying surgeons; the output of a single outlier (Figure 3); and the evolving need to publish to win selection for specialist training.

This cohort of New Zealand plastic surgeons, for whom publication as a trainee and specialist is not compulsory, produced 541 publications. Of these, 434 were original articles. Collaboration resulted in 509 multi-author publications. Their work appeared in 134 different journals, including the locally-influential non-specialty *New Zealand Medical Journal* (Table 1). There had been 8,047 citations, with 11 publications referenced more than 100 times. The mean h-index per surgeon was 4.4, with an h-index of 44 for the cohort. And so, as a group, these plastic surgeons would seem to demonstrate the commitment to evidence-based medicine, scholarship, teaching, collaboration and communication outlined in the consensus statement on the role of the New Zealand doctor.[1]

However, four surgeons (6.2%) had not published at any time during their career (Figure 3). Perhaps more importantly, 13 (20.0%) have not published since specialty qualification. The three who qualified in 2015 may reasonably be exempted from the latter group, having had insufficient time post-qualification to publish during 2015. But, for the remaining 10 surgeons (15.4%), all but two of whom first registered specialist qualifications during 2000–2010, without specific enquiry of them, there is no explanation. Although the correlation between annual publication rate pre- and post-specialist qualification was only low (Figure 4), it may be that more mentored publication during training would help improve subsequent participation.

The general trend is for surgeon publication rate to decline with increasing time in specialist practice (Figure 5). Perhaps a greater ongoing commitment to this aspect of scholarship, teaching, collaboration and communication would occur if continuing professional development programs more generously rewarded publication. This may be important, as the requirement for evidence of continuing professional development increases and the move toward recurrent recertification of medical practitioners gathers pace.

But do New Zealand medical practitioners have an obligation to publish, and to continue to do so over their professional life-time? Surely not if they contribute observation and evidence by other means, such as conference presentation. The obligation in the consensus statement on the role of the doctor is to observe, formulate ideas and hypotheses, test, reflect and communicate, not in the method by which these are disseminated.

Competing interests:
Nil.

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http://www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2017/vol-130-no-1455-12-may-2017/7241

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Survival of *Legionella* in earthquake-induced soil disturbance (liquefaction) in residential areas, Christchurch, New Zealand: implications for disease

Frances Graham, David Harte

ABSTRACT

AIM: To investigate a possible link between liquefaction dust exposure and the noticeable increase in legionellosis cases in response to major earthquakes in 2010 and 2011 that resulted in widespread soil disturbance (liquefaction) in parts of Christchurch, New Zealand.

METHOD: We culture tested liquefaction-affected soil for *Legionell*a spp. in the six months following the first earthquake in 2010. Thirty silt samples were collected randomly from locations within Christchurch's metropolitan area that were affected by liquefaction. The samples were tested to determine the presence of *Legionella* using qualitative and quantitative methods. Liquefaction-affected soil samples from three sites were further subjected to particle size distribution analysis and determination of major oxides. A controlled field study was established using six silt samples and one control (commercial compost), seeded with a wild-type strain of *Legionella bozemanae* serogroup (sg) 1 and persistence monitored over a 60-day period by culturing for the presence of *Legionella*. Dry matter determinations were undertaken so that total *Legionella* could be calculated on a dry weight basis.

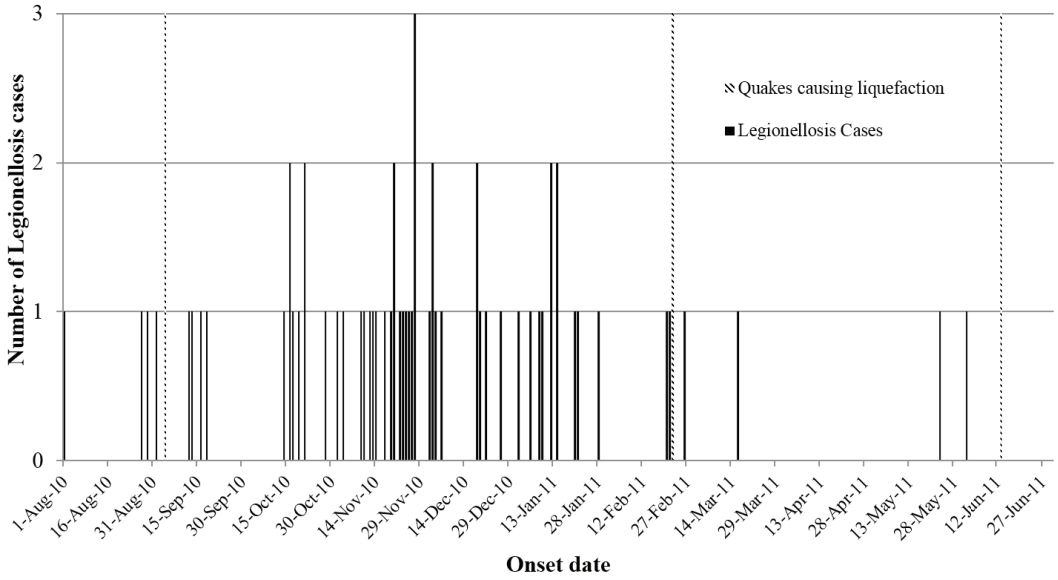
RESULTS: *Legionella* bacteria were undetectable after day one in the silt samples. However, *L. bozemanae* sg1 was detected in the control sample for the entire study period.

CONCLUSION: This study showed that the liquefaction-affected soil could not contribute directly to the observed increase in legionellosis cases after the earthquakes due to its inability to support growth and survival of the *Legionella* bacteria.

Legionellosis is an important notifiable disease often causing sporadic community-acquired pneumonia in New Zealand.[1] The predominant *Legionella* species responsible for disease are *L. pneumophila* and *L. longbeachae*; collectively contributing to greater than 80% of the laboratory-diagnosed cases each year.[1] However, *L. bozemanae* is the second most prevalent *Legionella* species isolated from compost material after *L. longbeachae* in New Zealand, although it is rarely associated with human disease.[1] The Canterbury region (including Christchurch) experiences a high rate of legionellosis relative to the rest of New Zealand.[2]

Active disease surveillance of legionellosis cases is reported annually and showed a step change in the numbers of laboratory-proven cases between 2009 and 2010, with 76 in 2009 and 178 in 2010.[3] Between September 2010 and March 2011, a combination of clinical testing, source tracing and case interviews identified a noticeable increase in compost-associated *Legionella* cases in Christchurch. This was well above the previous 10-year average: in 2009, 13 cases; 2010 52 cases, making a 300% year-on-year increase.[3] Elevated case numbers of legionellosis for the Canterbury region were again observed in 2011 (Figure 1A).

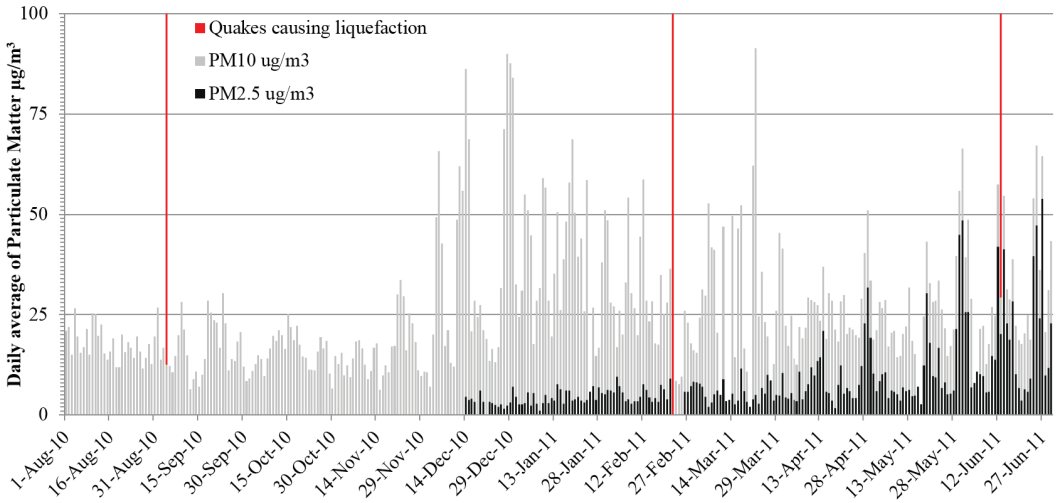
Figure 1A: Number of legionellosis cases in the Canterbury region.



Since legionellosis occurs following environmental exposure and infection, a significant environmental change that may have contributed to the observed increase in legionellosis cases may be the large increase in suspended particulate matter in the ambient air following the earthquakes. Between 4 September 2010 and 13 June 2011, the city of Christchurch was shaken by a series of strong earthquakes, and in particular the devastating 22 February 2011 earthquake, which resulted in 185 fatalities and produced widespread soil disturbance (liquefaction). Several other smaller or more distant earthquakes also produced further liquefaction in parts of the city for the remainder of 2011.[4] One of the most pervasive effects of the earthquakes was the widespread change in the below-ground environment due to liquefaction, with 10 distinct liquefaction episodes occurring between 4 September 2010 and 23 December 2011.[5]

The increased atmospheric $PM_{2.5}$ and PM_{10} (Particulate Matter smaller than 2.5 and 10 micrometres) concentrations was the result of the presence of earthquake-induced soil disturbance (liquefaction) dispersed by the prevailing wind and vehicle movement (Figure 1B). In an attempt to explain the

Figure 1B: Daily concentrations of Particulate Matter (column height) comprising of $PM_{2.5}$ and PM_{10}.



NZMJ 12 May 2017, Vol 130 No 1455
ISSN 1175-8716

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sudden increase in case numbers and in particular the increase in cases in the Canterbury region following the Canterbury earthquake series, we postulate that dust inhalation may have predisposed a case to an invasive infection/disease like legionellosis when exposed to the organism via contact with compost or soil/silt due to damaged lung tissue causing inflammation. Inflammation could allow opportunistic pathogens such as *Legionella* bacteria, to more successfully infect the human host. The scant research in this area has tended to evaluate the potential relationship between dust inhalation and lung inflammation in occupational settings and seasonal climatic events.[6]

Liquefaction was most severe in residential areas located to the east of Christchurch's Central Business District (CBD) as a result of stronger ground shaking due to the proximity of the causative fault, a high groundwater table approximately 1m from the surface and soils with states of high susceptibility and potential for liquefaction.[7] Figure 2 shows areas of different liquefaction severity, which include: (a) moderate to severe liquefaction including sand ejecta, large cracks and fissures in the ground and significant liquefaction-induced impacts on buildings; (b) low to moderate liquefaction with generally similar features as for the severe liquefaction, but of lesser extent and intensity; and (c) minor liquefaction primarily affecting roads.[7]

The earthquakes in Canterbury provided a unique opportunity to investigate a possible causal effect peculiar to *Legionella* and its pathogenesis that we want to explore further. Overseas studies have shown that in the aftermath of a catastrophic earthquake, the immersion in tsunami waters is a risk factor for infection caused by *Legionella* spp.[8] However, very little is known about the microbiological agents that may reside in liquefaction-affected soil or dust. Trials conducted overseas have shown that sterile soil was colonised by the *Legionella* bacteria from the atmosphere within 25 days (the first sampling), however, to date this has never been replicated outside controlled conditions,[9] so as yet it is unclear whether exposure to *Legionella* species in natural soil can lead to disease.[10] Therefore, the key research questions were: (1) whether *Legionella* bacteria is present in the liquefaction-affected soil and (2) if present, how long can *Legionella* survive in the liquefaction-affected soil, following a major earthquake and in turn be a potential exposure route for this pathogen through the inhalation of aerosolised liquefaction-affected soil. The objective of answering these questions was to establish a possible direct link between exposure to the liquefaction soil and the observed elevation in legionellosis cases in the study area following the earthquakes in 2010 and 2011.

Materials and methods

Legionellosis case data collection

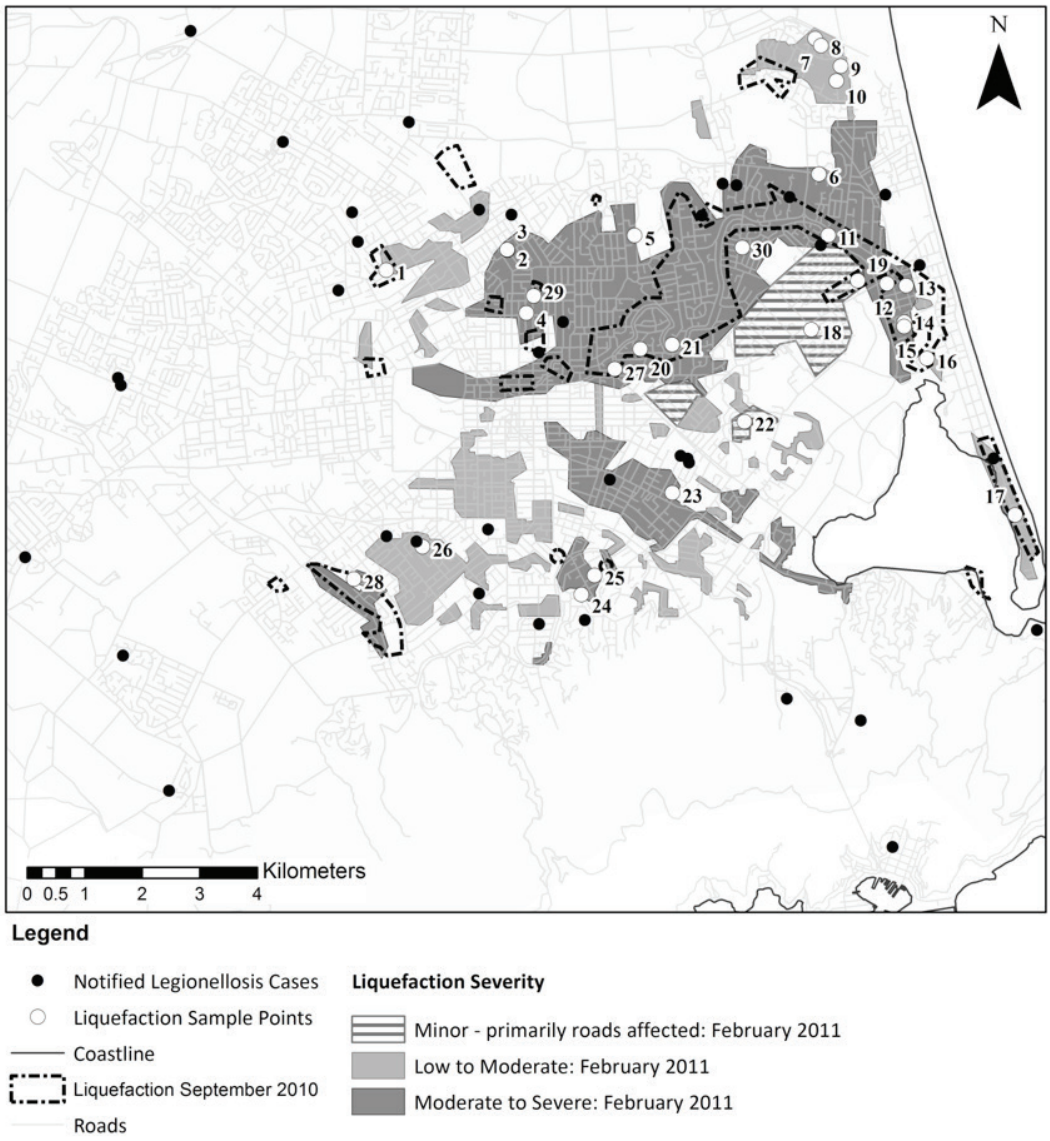
In New Zealand, infections caused by any *Legionella* species are notifiable under the Health Act 1956. All notified laboratory-confirmed cases of legionellosis were obtained from the National Notifiable Disease Surveillance system (EpiSurv), operated and managed since 1996 by the Institute of Environmental Science and Research Ltd (ESR), under contract to the Ministry of Health. The data was accessed to obtain the residential location of all cases between 1 August 2010 and 30 June 2011. Using a geographic information system (GIS), the location of the residential locations were overlaid on the map of the study area (Figure 2).

Sample collection

On 22 November 2011, 30 samples of undisturbed liquefaction-affected soil were collected within the metropolitan area of Christchurch affected by soil disturbance (liquefaction), including areas where there were confirmed cases of legionellosis reported (Figure 2). To ensure objectivity, digitised address points within the liquefaction-affected areas were randomly selected. Using GIS, the location of the sampling sites were overlaid on areas of observed liquefaction, which were based on drive-through reconnaissance that was conducted in the period from 23 February to 1 March 2011.[11]

Liquefaction-affected soil samples of about 250g (dry weight) were obtained from undisturbed sites at a depth greater than 1cm to avoid inclusion of non-silt contaminants using a sterile spoon and placed in plastic bags. Samples were transported in an insulated bin to ESR and stored in sealed plastic

Figure 2: Areas of liquefaction severity and location of notified cases and sampling addresses within the liquefaction area of urban Christchurch.



bags at ambient temperature, in the dark. The material sampled was geographically representative of the liquefaction-affected soil. All 30 samples were cultured on a 90mm diameter plate with Glycine-Vancomycin-Polymyxin-Cycloheximide (GVPC) media by ESR for the presence of *Legionella* in accordance with Steele et al,[12,13] who set out a qualitative test method for testing of potting mixes, composts and other solid matrices for *Legionella* species. A quantitative approach was used measuring the total *Legionella* by plate count. A range of dilutions were plated after acid treatment.

Persistence modelling of *Legionella* in liquefaction soil

To establish if liquefaction soil could sustain the prolonged survival of *Legionella* bacteria, the following experiment was carried out: six liquefaction-affected soil samples (transcending west to east sample—nos. 3, 10, 17, 21, 23 and 26) were randomly selected and seeded with the *Legionella bozemanae* for the persistence modelling experiment. This species is the second most prevalent *Legionella* species isolated from compost material after *L. longbeachae* in New Zealand, and has been

demonstrated to survive in aerosol derived from composted material.[1,14,15] *L. bozemanae* was chosen in the seeding experiment because unlike *L. longbeachae* and *L. pneumophila,* it fluoresces blue under ultra violet (black lamp) illumination. This assists with more accurate and quicker counting of the seeded *Legionella* colonies among mixed bacterial growth on plate culture. The seeded samples and controls were placed outside from 1 November 2012 until 30 March 2013 to mimic ambient climatic conditions. This was because in New Zealand the peak incidence of legionellosis occurs from late spring (November) until autumn (March) and is possibly related to increased gardening activity and use of compost during this period.[1] A compost sample obtained from a commercial supplier in Christchurch that was proven culture-negative for *Legionella* was used as a comparator (control) in the persistence modelling experiment, as compost is known to support the growth and persistence of legionellae.

Due to the limited amount of liquefaction material available for the persistence modelling under field conditions, approximately 200g (wet weight) of sample was placed in free-draining plastic tubs with a diameter of 10cm and a depth of 15cm. The tubs were buried to the top in a gravel bed and placed outdoors at ESR's research facility located at Porirua, Wellington to expose the liquefaction material to normal environmental conditions. At each sampling time point, the whole of the material in each tub was mixed thoroughly and a single 4–6g grab sample was taken for *Legionella* culture testing and dry matter determinations. The 'Day O' samples were collected immediately after the inoculum had been added and tested. Further samples for testing for *Legionella* culture and dry matter determinations were taken on Days 1, 7, 30 and 60. The dry weight measurement of the samples was used when determining the *Legionella* concentration, as this was more accurate than using the wet weight since moisture levels varied significantly between the samples and over the sampling period. Organic matter content (%OM) of the six samples was determined as weight loss on ignition (LOI)[16] by ashing a representative sediment sub-sample at 400°C for four hours.

Silt characterisation: elemental composition and particle size

Particle size distributions in disaggregated samples from the bulk material were determined using a Beckman-Coulter laser diffraction particle size analyser. The samples from the bulk material were dried and sieved to exclude particles >2000µm (2mm) diameter prior to analysis. Gradistat V8,[17] a Microsoft Excel format program, was used to analyse the grain-size data and to determine parameters, such as the percentage of sand, silt and clay, as well as mean and median grain-size, sorting and skewness.

Major oxides were determined using a Panalytical MiniPal-4 X-ray fluorescence (XRF) spectrometer. A fused disk of each sample was made by mixing 1g of sample with 10g of Lithium-Borate flux and melting the powder in an induction furnace at 1100°C. The melt was then poured into a cast and allowed to cool. Each disk was then analysed three times by XRF and an average of the results taken.

Meteorological investigation

For the field experiment, meteorological data for 1 November 2012 to 31 January 2013 was retrospectively accessed from CliFlo, a web-based system that provides access to the National Climate Database, New Zealand's principal repository of meteorological data (http://cliflo.niwa.co.nz/). This system is hosted by the National Institute of Water and Atmospheric Research, a crown research institute. Data (minimum and maximum) temperature, precipitation and relative humidity were sourced from a fixed continuous monitoring station located in metropolitan Wellington.

Microbiological: Preparation of *L. bozemanae* serogroup 1 inoculum

The *L. bozemanae serogroup 1* strain used in this study was a wild-type strain isolated from the same commercial compost brand as the control material. This strain was chosen to avoid using a laboratory-adapted strain. The strain was identified by mip-gene sequence analysis and using commercial DFA reagents. The strain auto-fluoresced bright blue when exposed to black light (UV 660 nm). The *L. bozemanae* strain was sub-cultured onto buffered charcoal yeast extract (BCYE) agar plates (Oxoid)

for three days at 36°C. The plate grown *L. bozemanae* was then used to seed a liquid culture of AYE medium supplemented with BSA (0.5%)[18] and was grown for 48h at 36°C (post-exponential growth phase). The concentration of *L. bozemanae* serogroup 1 in the prepared inoculum was measured by a direct spread plate method: 100µL 10-fold serial dilutions of the final inoculum were cultured on BCYE agar plates and the colonies counted after three days growth at 36°C. The prepared liquid inoculum *of L. bozemanae* serogroup 1 was used to seed each of the liquefaction soil samples and also the 'control compost' material.

Seeding and sampling procedure

All samples used in the study had been previously cultured for Legionellae and were found to be culture-negative. A total of 2.4mL of the *L. bozemanae* inoculum was slowly seeded into each soil sample while undergoing continual stirring to ensure even mixing. The concentration of the *L. bozemanae* sg1 inoculum was determined by 10-fold dilution plating in triplicate from 10^3 to 10^7 and calculated to be $4.08x10^6$ colony forming units (cfu). The concentration of culturable *L. bozemanae* organisms inoculated into each liquefaction sample at time zero and at each subsequent sampling time point was determined by using dilution plating in triplicate at 10^0, 10^1, 10^2 and 10^3. The 'Day 0' samples were collected immediately after the inoculum had been added by taking between 4–6g of the seeded material and cultured for the presence of *Legionella* using the method prescribed in Steele et al.[12] Subsequent samples were collected from each sample on Day 1, Day 7, Day 30 and Day 60, and tested in the same manner. Dry matter determinations were carried out on each sample day so that total *Legionella* concentration could be calculated on a dry weight basis. The concentration of total *Legionella* isolated from each sample at each time point was expressed as the number of *Legionella* colonies growing by plate culture per gram of the original sample using the dry weight determination to correct for the varying moisture content of the sample material.

Results

Microbiological examination of liquefaction silt samples

All 30 liquefaction-affected soil samples were culture-negative for Legionellae. Table 1 shows that a large proportion (80%) of the 30 samples tested had less than 200 microbial (bacterial and fungal) colonies on the plate surface. This was unexpected as the soil samples generally contained high levels of culturable microflora.

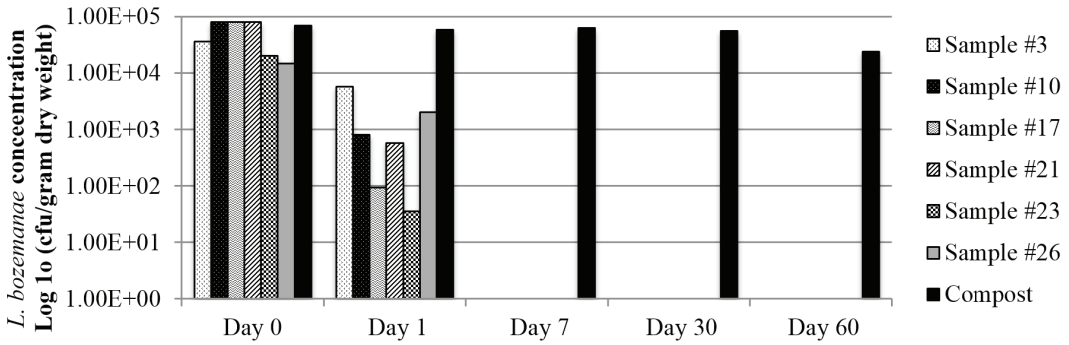
Persistence study using *Legionella*-seeded liquefaction-affected soil

The results for microbial persistence/die-off of *L. bozemanae* in the controlled field experiment are presented in Figures 3A and B. *L. bozemanae* was detectable one day after seeding of liquefaction-affected soil with the bacteria (Figure 3A). For the field samples the moisture content changes depending on precipitation, temperature and wind and varied over the course of the experiment, whereas the dry matter remains constant. The only sample in which the *Legionella* was detected over the full-time course of the field experiment was the seeded commercial compost sample.

Table 1: Microbial growth on GVPC plate medium.

Total (%) number of liquefaction samples (N=30)	Relative microbial growth on GVPC medium (cfu – colony forming unit)	Number of samples from which *Legionella* species isolated
43.3	Low: <50 cfu	None—not detected
36.7	Medium: 51–200 cfu	None—not detected
20	High: ≥201 cfu	None—not detected

Figure 3A: Persistence of *L. bozemanae* in seeded liquefaction-affected soil and compost.



Silt characterisation: elemental composition and particle size

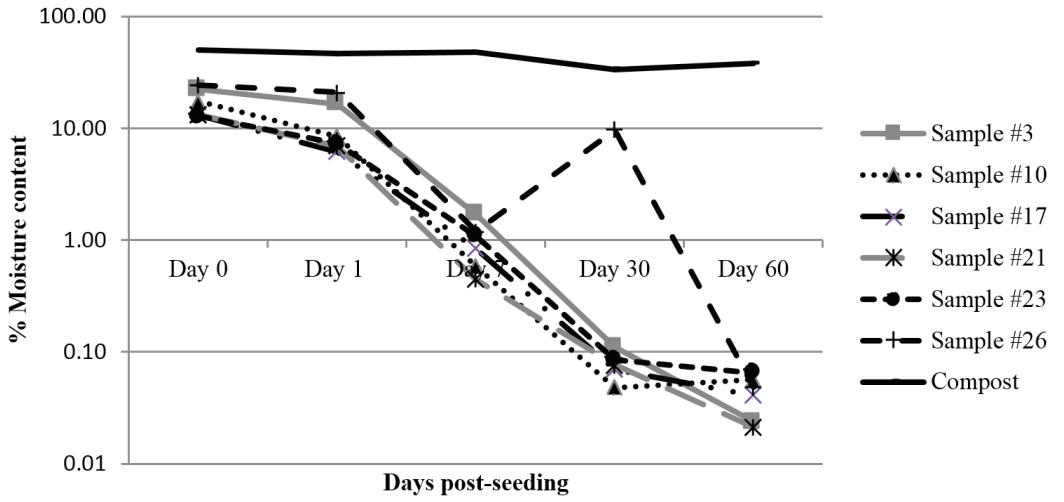
Elemental composition of major oxides present in liquefaction-affected soil is summarised in Appendix 1. Of particular note are the concentrations of silica (SiO_2), which were 72.6%, 76.2% and 76.3% on a mass basis. These results indicate that there is the potential for airborne particulate matter to contain a high proportion of crystalline silica. The analysis also found that 11% of the liquefaction-affected soil was aluminium oxide, which occurs naturally in silicates.[19] The loss-on-ignition results showed low levels of organic carbon in the liquefaction samples, indicating low organic matter.

Figure 4 shows the results of the particle size analysis for sample numbers 10, 21 and 26. The particle size analysis indicated that the liquefaction ejecta were generally very similar to ejected sediment seen elsewhere in Christchurch. Sample No. 26 indicates that the liquefaction ejecta is finer grained than the sand it passes through. Samples Nos 10 and 21 show a well-sorted sand which is very similar to beach sand.

Meteorological investigation

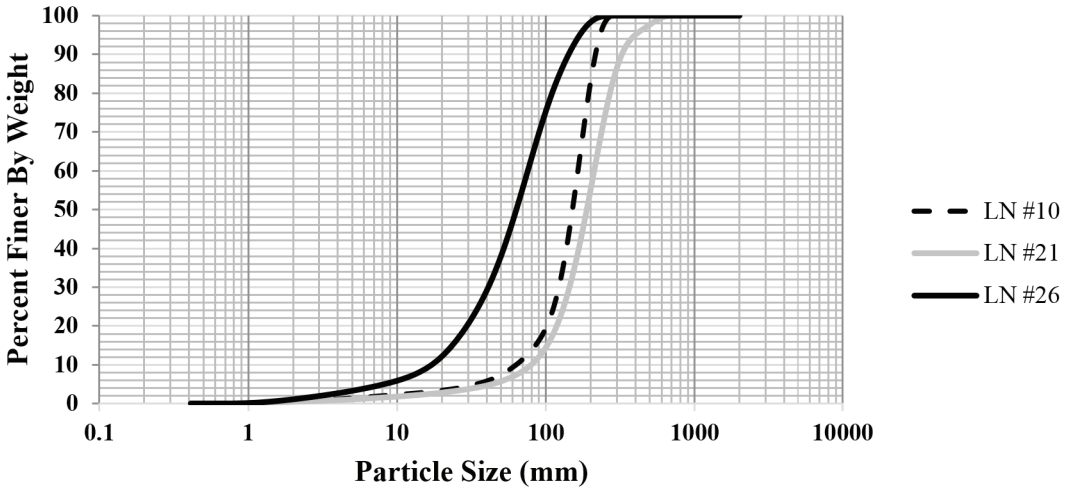
When values for meteorological parameters for the field experiment were compared with a 30-year historical mean, the key finding was that the total rainfall between 1 November 2012 to 31 January 2013 was higher than average (Appendix 2).

Figure 3B: Comparative moisture content over time for the seeded liquefaction-affected soil and compost.



NZMJ 12 May 2017, Vol 130 No 1455
ISSN 1175-8716

Figure 4: Laser particle size analysis results for three liquefaction samples.



Discussion

Difficulties in isolating legionellae directly from natural organic matter in soil and the focus on manufactured composts and potting mixes[20] may account for the paucity of reported investigations of indigenous soil for *Legionella* spp.[13] A series of damaging earthquakes near Christchurch, New Zealand during 2010 and 2011 provided a unique opportunity to study the survival of *Legionella* bacteria in the associated liquefaction silt generated by these seismic events. The interest in investigating liquefaction silt for the presence and persistence of *Legionella* bacteria was an attempt to elucidate a cause for the observed large and sharp increase in the number of *Legionella* infections in Christchurch following the earthquakes. The observed increase in *Legionella* infections closely aligned with an increase in atmospheric PM_{10} concentrations as a result of the aerosolisation of liquefaction-affected silt, especially following the 22 Feb 2011 quake. This points to environmental dust particles being a likely risk factor for legionellosis.[1,21] The increase in case numbers also coincided with a change in the testing algorithm for *Legionella* infection at Canterbury Health Laboratories (CHL) from August 2010 with the introduction of *Legionella* polymerase chain reaction (PCR) testing.[22] These cases dropped significantly after February 2011 with no cases identified between April and June 2011. However, there has been no change in the testing protocol at CHL since September 2010, suggesting the large spike in cases over the summer was related to seasonal factors, compost use or confounding factors such as weather and source material other than liquefaction-affected silt.

During the liquefaction process, subsoil was ejected vertically onto the existing soil surface. When designing our study, one of our primary goals was to develop a snapshot of the effects of earthquake-induced disturbance on the survival of pathogenic bacteria such as *Legionella*. The methods used in this study, while they were capable of detecting 10^3 cfu of Legionellae per gram of liquefaction-affected soil, did not detect any populations from the 30 random samples. A controlled field investigation to demonstrate multiplication of Legionellae in liquefaction-affected soils also gave negative results after Day 1. The inability of the liquefaction-affected soil to retain moisture compared to the compost under the same weather conditions may have contributed to the rapid die-off in the *Legionella* seed (Figure 3B). Moisture retention ability is proportionately linked to the amount of organic matter in the sample. This influences the presence and make-up of the microflora in the silt, and these may be natural hosts for *Legionella* bacteria. It is possible that small numbers of Legionellae in some source material could multiply to form populations of detectable size given that samples were collected in areas where this disease was recorded. The nutritional requirements of the Legionellae dictate that they live communally with other species or as parasites. Indeed, when cultured,

Legionella bacteria require a medium that supplies them with amino acids as their main carbon source as well as fulfilling a specific need for L-cysteine and iron (Fe).[23] Decaying organic matter may support *Legionella* growth, as suggested by earlier studies of aquatic bacterial utilisation of nutrients released by excretion and decomposition of algae.[24] Our study showed that liquefaction-affected soils had low organic matter content consistent with other findings[25] and was nutrient deficient, having low concentrations of exchangeable bases (Fe, Ca, Mg, Na). A study of agricultural land affected by liquefaction following the 4 September 2010 earthquake found the sandy textured soils to have low water-holding capacity.[25] In addition to the chemical limitations of the sandy sediment as a growing medium for supporting the growth of Legionellae, and the possibility of negatively impacting hydrology, there is speculation that soil aeration was also negatively impacted. Because liquefied soil has been known to compress as it dewaters, fine sand may have reduced aeration.[26] This is significant since as aerobes, *Legionella* also require oxygen, either ambient or supplied by the other organisms with which they are associated, hence their preference for air-water surface bio-films.[27]

The hypothesis was developed that liquefaction-affected soil may contain *Legionella*. After all, the ability of *Legionella* to adapt and withstand stressful changes in their environment is well documented. Also, many studies that have demonstrated *Legionella* bacteria can gain a large measure of environmental protection while living within host cells. For example, amoebae have been found to protect the intracellular Legionellae from temperature extremes, saline conditions, increased external osmopolarity,[28] oxygen deprivation, biocides such as 50ppm chlorine from hypochlorite[29] and dehydration. Indeed, when conditions become too dry, the protozoan host cell will encyst and enter a dormant phase to await rehydration, protecting the Legionellae within host cells.[30] It may explain how *L. longbeachae* or *L. bozemanae* (among other species) survives in the non-liquid medium of compost when it dries out.

Amoebal life consists of cycles of encystment and excystment according to available moisture.[31] When encysted, they can survive from months to years, and at any one time in the soil, a good proportion of the population will be encysted.[31] The drier the soil environment, the higher the percentage in this dormant form. The drying out of liquefaction-affected soils may have allowed any *Legionella* present to survive and when the dried soil becomes airborne, pose an infection risk. A limitation of this paper is the lack of testing for the presence of amoebae in the liquefaction soil, which has resulted in a lack of evidence to support this argument.

The low moisture content and the observed relatively low abundance of other culturable microorganisms detected on plate culture, along with the relatively low organic matter in the liquefaction-affected soil all contribute to it not harbouring *Legionella* bacteria and, it can be assumed, a lack of host organisms. In the field experiment where liquefaction-affected soil was deliberately contaminated (seeded) with a heavy inoculum of *Legionella* bacteria, it did not persist for more than one day, contrary to a seeded commercial compost sample exposed to the same conditions. This adds to the evidence that *Legionella* bacteria do not survive adverse environmental conditions readily without the support of host organisms, such as those naturally present in organic material such as compost.

While the persistence of *Legionella* in some matrices can occur due to protection, the exposure of *Legionella* bacteria to sunlight, high temperature and low humidity is likely to inactivate them. The low to non-existent organic content in the liquefaction-affected soil is likely to decrease the presence of *Legionella* hosts. Collectively, this suggests that liquefaction-affected soil that becomes airborne as dust (liquefaction silt dust) is unlikely to represent a frequent exposure route to infectious organisms such as *Legionella*. This observation was consistent with this study's findings that all of the residential liquefaction-affected soil samples analysed did not show evidence of the *Legionella* bacteria.

Chemical and size analysis of the liquefaction-affected soil shows it consisted of >65% silica and between 2–8% (w/w) is <10µm in diameter, of which 30% of the respirable dust was quartz that was less than 10µm

in size (Figure 4). This contributed to the increased number of high-pollution days.[32,33] It is also known that airborne particulates can cause inflammation and increase the risk of respiratory infections.[34,35] We propose that inhalation of earthquake-associated airborne liquefaction-affected soil can damage lung tissue and cause inflammation. Inflammation and damage could allow opportunistic pathogens, such as *Legionella* bacteria, to more successfully infect the human host. Inflammation of the lung epithelial cells results in an influx of macrophages to the site. This may be a similar mechanism resulting in the seasonal increase in meningococcal meningitis seen in sub-Saharan Africa (particles ranging from 0.55 to 7.9µm in size).[6] The inhalation of silica dust is known to increase the risk of lung infections, including pulmonary tuberculosis.[36] It is thought that the inhalation of crystalline silica in inorganic dust including quartz damages the ability of pulmonary macrophages to kill bacteria. This is because crystalline silica has sharp faces rather than the round edges of sedimentary quartz, so the lungs cannot expel the sharp minute crystals and the silica (quartz) is retained in the lungs where it may eventually cause disease due to lung epithelial cell damage and even death.[37] Other studies found that the inhalation of inorganic dust (including quartz) increased mortality from infectious pneumonias, especially lobar pneumonia and pneumococcal pneumonia among construction workers.[38] These factors combine to suggest that dust inhalation could then predispose a case to an infection/disease like legionellosis when exposed to the organism. The scant research in this area has tended to evaluate the potential relationship in occupational settings and seasonal climatic events. Little is known about the relationship between *Legionella* infection and events that result in elevated levels of airborne dust such as aerosolised liquefaction-affected soil following a major earthquake.

Another plausible explanation for the increased notifications might be physical disturbance of the water systems. This may be caused by two different actions. Firstly, by physically shaken and movement of reticulated water lines. Recent studies have shown the presence of *Legionella* and other opportunists in disinfected water distribution systems.[39] Disturbance of such pipelines might cause release of biofilm, and surface attached microorganisms creating a 'pseudo-bloom' of *Legionella* at points of use. Secondly, the ingress of silica-based material such as that generated during the liquefaction event may have caused scouring of the reticulated water system and building water systems.[27] This would also lead to elevated numbers of bacteria being released at point of use. Either or both of these events combined might explain an increase in the cases of water-associated legionellosis immediately subsequent to earthquake events.

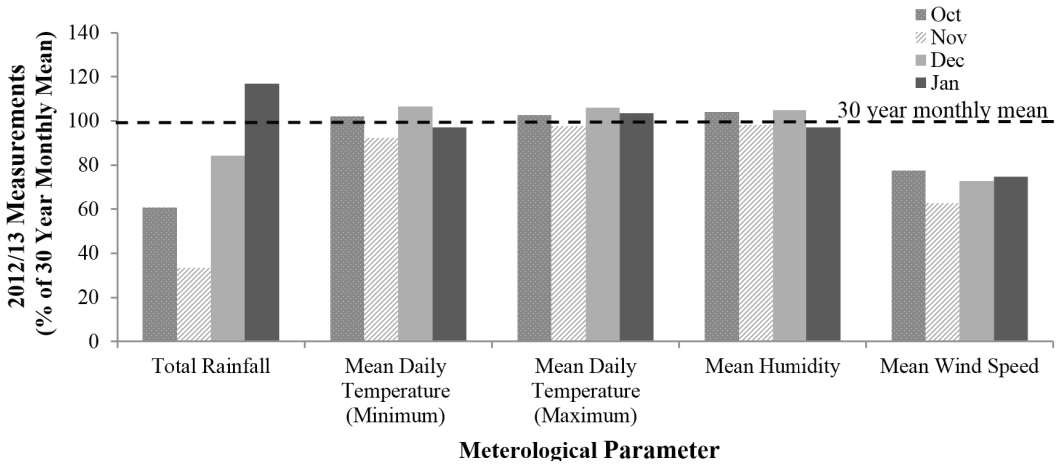
In conclusion, this study set out to expand our understanding of the environmental exposure risks to *Legionella* and whether seemingly unrelated environmental factors, such as aerosolised liquefaction-affected soil resulting from the Christchurch earthquakes had the potential to impact on disease prevalence. No direct causal link between exposure to liquefaction-affected soils/silt and legionellosis was established since no Legionellae were isolated from any samples tested and *Legionella* was shown not to survive in the seeded silt. This does not provide support for the notion that aerosolised liquefaction soil/silt (quartz silica, per se) could be a vector for *Legionella* infection with the methodology followed in this study. Disturbance of and infiltration of liquefaction material into distributions lines cannot be discounted as a possible contributing factor. The contribution of an increased amount of airborne dust on the incidence of legionellosis as a predisposing factor for infection should exposure to the bacteria occur, is still unknown. In addition, the impact of respiratory tract epithelial injury from particulate matter on host susceptibility to opportunistic infections like *Legionella* should be considered. In other words, whether it may reduce immune-system function leading to increased susceptibility to *Legionella*. With careful study design this could add considerably to our understanding of the interactions between environmental events and invasive diseases processes.

Appendix 1: X-ray fluorescence major oxide analyses.

	ChCh 10	Ave of 3	ChCh 21	Ave of 3	ChCh 26	Ave of 3
	Average	2sd%	Average	2sd%	Average	2sd%
SiO_2	76.314	0.239	76.199	0.249	72.554	0.285
TiO_2	0.398	2.527	0.406	1.706	0.482	1.726
Al_2O_3	11.596	0.926	11.716	0.558	13.193	0.523
Fe_2O_3	2.700	0.074	2.553	0.431	3.134	0.327
MnO	0.041	4.878	0.081	1.420	0.044	2.644
MgO	0.778	8.783	0.786	2.701	1.001	15.900
CaO	0.931	2.316	0.954	1.348	1.073	1.456
Na_2O	2.936	2.264	2.876	6.331	3.051	2.503
K_2O	2.394	0.720	2.346	0.323	2.711	0.777
P_2O_5	0.093	7.525	0.098	1.450	0.109	2.794
L.O.I.	1.924	19.545	1.998	17.004	2.745	10.139

LOI = loss on ignition at 1000◦C for one hour.
Results are expressed as weight % on oven dried (110◦C).

Appendix 2: Comparison of meteorological parameters for October–December 2012 and January 2013 with 30 years monthly means (1981–2010), using percentage of the mean.



NZMJ 12 May 2017, Vol 130 No 1455
ISSN 1175-8716

Competing interests:
Nil.

Acknowledgements:
Caroline Fyfe, research assistant, Centre for Public Health Research, Massey University, assisted in the construction of the map using ArcGIS. Alice Graham assisted in the collection of liquefaction samples. Dr Richard Wysoczanski (NIWA), Dr Scott Nodder (NIWA) and Lisa Northcote (NIWA) assisted in the XRF and particle grain-size analyses. Teresa Aberkane, Environment Canterbury assisted in the provision of air pollution data Frances Graham's PhD and this research were supported by the New Zealand Ministry of Health. The analyses, conclusions, opinions and statements expressed herein are those of the authors and do not necessarily represent the views or policy of Environment Canterbury or the New Zealand Ministry of Health. Environment Canterbury and the Ministry of Health do not assume any liability or responsibility for use of or reliance on the contents of this article.

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URL:
http://www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2017/vol-130-no-1455-12-may-2017/7242

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A walking stick in one hand and a chainsaw in the other: patients' perspectives of living with multimorbidity

Louise Signal, Kelly Semper, Jeannine Stairmand, Cheryl Davies, Elinor Millar, Tony Dowell, Ross Lawrenson, Dee Mangin, Diana Sarfati

ABSTRACT

AIMS: Multimorbidity is common, yet there are major gaps in research, particularly among younger and indigenous populations. This research aimed to understand patients' perspectives of living with multimorbidity.

METHODS: A qualitative study of 61 people living with multimorbidity, 27 of whom were Māori and a third aged under 65, from urban and rural regions in New Zealand. Six focus groups and 14 interviews were conducted, recorded, transcribed and analysed.

RESULTS: For many participants, living with multimorbidity disrupted their 'normal' lives, posing challenges in everyday activities such as eating and toileting, working and managing medications. Dealing with the health system posed challenges such as accessing appointments and having enough time in consultations. Cultural competency, good communication and continuity of care from healthcare providers were all valued. Participants had many recommendations to improve management, including a professional single point of contact to coordinate all specialist care.

CONCLUSIONS: Living with multimorbidity is often challenging requiring people to manage their conditions while continuing to live their lives. This research suggests changes are needed in the health system in New Zealand and elsewhere to better manage multimorbidity thus improving patient's lives and reducing costs to the health sector and wider society.

Multimorbidity, the coexistence of two or more health conditions,[1] is a common and growing problem worldwide.[2] While the risk of multimorbidity is higher in those aged 65 years and older, a study of over two million people in Scotland found that the absolute number of those affected was greater in those under 65.[3] Multimorbidity is more frequent and occurs earlier among those living in socioeconomic deprivation, and disproportionately impacts indigenous people.[3,4] People with multimorbidity are the major users of health services, accounting for around two-thirds of healthcare spending.[5] There is a large body of literature documenting the clear associations between multimorbidity and increased risk of hospitalisation, adverse effects of treatment, high healthcare costs, reduced quality of life and higher mortality.[3,5–9] Despite this, there are major gaps in research relating to nearly all aspects of multimorbidity, particularly among younger and indigenous populations.

Research on multimorbidity from a patient perspective has been called for[10,11] and is emerging.[12,13] Patients have an important role in managing their own health needs; however, the 'work' for patients associated with chronic illness management increases significantly with increasing comorbidities, and may exceed the patient's capacity to cope.[3,14] This can be even more challenging when patients' priorities do not align with those of their doctor, with a recent study finding the main healthcare priority of the patient was not represented in the top three priorities of their physician. This

discordance increased with higher levels of patient complexity.[14,15] It is becoming widely recognised that greater coordination of person-centred health services is needed, especially for patients with multimorbidity.[16] Increasing tailored information, education and training, as well as community support, should not be overlooked for this population, with studies suggesting better outcomes for those individuals with the skills, knowledge and confidence to manage their own conditions.[17] A 2010 framework,[18] alongside a more recent education and training programme,[19] suggests a need for more research and an improved evidence base for interventions to benefit people with multiple chronic conditions. This is supported by a recent Cochrane Review, which found only a small number of trials looking at interventions to improve outcomes for people with multimorbidity with mixed results.[1] This research sought to understand patients' perspectives on living with multimorbidity, their views on healthcare and support and what interventions might improve their lives.

The research was conducted in New Zealand where primary healthcare, the gateway to the health system, is largely subsidised by the government, though most adult patients make part-payments for consultations. Secondary services are provided at no direct cost to patients. While pharmaceuticals are heavily subsidized, there are still part-charges for prescriptions. Additional subsidies are available for primary care and pharmaceuticals for those with low and middle incomes, disabilities or high healthcare use.[20]

Methods

This qualitative study took a phenomenological perspective recording and analysing multimorbidity from patients' perspectives.[21] We used a mix of focus groups (6) and interviews (14) to gather data from a large strategic sample, capturing various perspectives from a range of patients with multimorbidity. Focus groups enabled the large sample while interviews included hard-to-reach participants.

Participants

Participants with two or more long-term conditions were recruited through primary healthcare organisations from three regions in New Zealand, from urban and rural locations and a range of socioeconomic and ethnic groups.

A total of 61 people participated in this study, 14 in interviews and 47 in focus groups, 27 of whom were Māori (indigenous). Half of the participants were living with four or more conditions. Similar numbers of men and women participated. Over a third were aged under 65 years. For participant demographics, see Table 1.

Fourteen participants were unable to attend the focus groups due to poor health, difficulty accessing focus groups or availability. They were interviewed individually either at home or work. The focus groups and interviews were audio-recorded and field notes taken. Focus groups lasted ≈90 min and interviews ≈60 min.

Table 1: Participant demographics.

Demographic	Number (%)
Gender (n=61)	
Women	28 (46%)
Men	33 (54%)
Age groups	
Under 50	5 (8%)
51–64	17 (28%)
65–74	20 (33%)
75+	19 (31%)
Location	
Urban	42 (69%)
Rural	19 (31%)
Number of conditions	
2	13 (21%)
3	17 (28%)
4+	31 (51%)
Ethnicity	
Māori	27 (44%)
Pacific	12 (20%)
NZ European	21 (34%)
Other	1 (2%)

Data collection

A semi-structured interview schedule was developed based on findings from previous research[9,22] and with input from both clinical and community Māori (CMOG) advisory groups. Participants were asked about the impact of multimorbidity on their lives, what healthcare and other support they had received, what was positive about it and where it could be improved. At least two researchers participated in each focus group. Audio-recordings were made and transcribed verbatim.

Data analysis

Transcripts were entered into N-Vivo 10. Following careful reading by the research team, thematic analysis was used to identify emergent themes within the text and transcripts coded accordingly. Cross comparison occurred until a coding hierarchy was developed outlining key themes and subthemes within the data. Data on key themes appeared to reach saturation. Initial findings were reviewed by CMOG and were then discussed with the research team until a consensus was reached. Rigor was maintained by independent analysis and multiple coding, triangulation of data analysis and cross comparison of findings.

Ethics

Participants signed consent forms at the beginning of each focus group and interview. Participants agreed to keep the focus group discussions confidential. Transcriptions were numbered to guarantee confidentiality and anonymity. The project was approved by the University of Otago Health Ethics Committee (H14/124)

Results

The results are presented according to the themes that emerged from the data. Participants' quotations are presented in Tables 2 and 3 and briefly in the text.

Living with multimorbidity

What is it like?

When participants were asked about their experience of living with multimorbidity, a wide range of responses were elicited. Some reported that their health conditions did not unduly affect their lives, but for others living with multimorbidity had "taken a lot of the joy of life". For many, they managed their conditions and life simultaneously with, as one man said, "a walking stick in one hand and a chainsaw in the other".

Disrupting normal life

For many, multimorbidity disrupted their 'normal' everyday life and participants frequently reported times when managing their conditions was a struggle. The challenges they faced covered many domains both within the home and outside, including eating, sleeping, toileting and mobility. Some participants reported that their conditions left them feeling fearful of being alone. Participants who worked faced particular challenges and used a range of approaches to address them, including altering their employment conditions (eg, reducing hours) and changing employment. Others stopped working or retired.

Even leaving the house was difficult for some. Many participants reported needing to pre-arrange medications and food requirements, check access to toileting facilities and assess environmental conditions (weather, stairs, safety and resting places) before going anywhere. Participants would also consider their physical ability to determine if they required additional assistance to undertake an activity (eg, a wheelchair).

Coping strategies

While a number of participants described long periods of denying their multimorbidity, others integrated multiple coping strategies into their lives. A positive attitude was important to many. As one person said, "my mantra is every day above ground is a great day". Learning to manage their conditions was important for the majority of participants, who felt their independence was vital.

Care and support

Nearly all participants reported the need for care and support to manage their long-term conditions and prevent further ill-health, identifying psychological, social, spiritual and physical care needs. Participants reported accessing care and support from an array of people, including family and friends, neighbours, the community, healthcare providers and agencies providing social support. Support was provided in a number of different ways,

including emotional, financial and practical support such as transport, gardening and information on disease and treatment. Government support services were essential for many within the study; however, the majority of participants indicated that available services were never fully explained to them, and even if they were, seeking such help was often 'frustrating' with complex application processes.

Managing medications

Managing medications was one of the greatest challenges for nearly all participants. First, remembering to take medications was a key issue, and often a measure of how well people felt they managed their conditions. A number of participants spoke about strategies they used to aid memory, with maintaining a strict routine and taking medications at the same time everyday being mentioned most commonly. Other strategies included writing the medications down, putting medications in an obvious place, setting reminders or alarms and using tools such as 'pill boxes'. Those that used blister packs found them useful to aid memory; however, some participants stated they were not using them because of the additional cost or difficulty opening them. Some participants suggested that their medication became 'easier to forget' when they were 'feeling well'. Second, the number of medications being taken was problematic for many, with one participant saying they felt like a 'chemist shop' and another wishing to have 'one pill for everything'. Some were concerned with the interacting side-effects of their medications. Third, a number spoke about needing to forego basic needs in order to afford their medications.

Participants spoke of skipping medications, primarily due to side-effects and the subsequent disruption on their lives. For example, several participants reported not taking their diuretic when they knew they were leaving the house, as it caused them to be incontinent. Participants discussed stopping medication due to cost, with a few prioritising conditions based upon severity and paying for these medications first. Others stopped medications due to negative side-effects, a lack of understanding about their health conditions and/or their medications, and occasionally distrusting doctors. Some participants expressed the view that they knew themselves and their own bodies better than their health professional did, which resulted in increased self-management through 'trial and error' either with or without the support of a doctor.

The health system

Travel to appointments

Organising travel to healthcare appointments frequently posed logistical challenges for participants, which were often amplified for those living rurally. Participants who were able to drive reported how valuable this was. One participant reported that driving was 'essential' and helped them 'cope'. A small number of participants noted that ageing and their deteriorating health would eventually result in them not being able to drive, ultimately leading to reduced independence and ability to access healthcare.

Participants who were not able to drive often relied on family and friends or the ambulance service, public transport, taxis and drivers from community health providers. For example, one participant reported feeling 'panicked' when organising transport and concerned that she may have 'exhausted' her friends as a source of assistance. Some rural participants talked about the extended journey they faced when trying to access specialist care; at times a whole day's travel to attend a brief appointment. This was more likely to occur if using public transport options, which were reported as 'limited' and at times 'inconvenient'. Other factors such as heavy traffic, driving in unfamiliar areas, length of travel time, parking and the distance to travel from car-park to appointment venue were all raised as a source of frustration and anxiety for people.

Appointments

There were three main issues identified by participants in relation to appointments in primary and secondary care: timely access, provider continuity and duration. First, many participants expressed 'frustration' at having to wait for appointments in their local primary care practice. One person was advised to go to the hospital emergency services if they required medical assistance that day. Another participant was more philosophical, stating "you have to put

up with it", and others mentioned that the lengthy waiting times experienced at local practices were only an issue before you were 'in the system'.

Second, continuity was valued; many participants spoke of their desire to see the same health professional each appointment so that the practitioner knew their medical and personal history. However, this often resulted in increased waiting time for appointments, which in an emergency situation was not an option for many.

Third, a number of participants reported that the time available in a consultation was insufficient. In New Zealand, standard primary care consultations are fifteen minutes. Participants regularly commented that this was not long enough to discuss their complex conditions and their concerns around treatment options. A number of participants spoke about needing to make two appointments if they had multiple concerns to discuss; however, for some this was not a viable option due to the additional cost.

Cultural competence

Māori and Pacific participants' reports of 'mainstream services' (as opposed to culturally specific services) were varied, from complimentary to concern regarding cultural competence. Many Māori participants described their desire for health providers to take a holistic approach, including focusing on spirituality when managing their health. A large number of these participants described using a range of traditional, complementary and alternative medicines and approaches. Some participants stated that cultural differences were the main reason for a poor communication and a lack of rapport with health providers.

Communication

Patient-practitioner communication, or a lack thereof, often influenced how participants managed their multimorbidity. Many participants noted the importance of receiving clear information, or as one person said, "explaining everything", regarding their conditions or medications. Being able to discuss treatment options with health providers and having a trusted practitioner to talk to were highly valued.

Participants frequently mentioned that 'feeling listened to' was a necessary component in patient-practitioner rapport. Some participants felt consultations were 'a waste of time' if their health provider did not appear to be fully engaged with them, for example if they were focused on their computer to write notes. Some participants suggested that at times practitioners dealt with them as an illness rather than as a 'whole person', resulting in a poor relationship.

Integration of care

Navigating through different departments within a seemingly 'siloed' healthcare system was difficult for participants. One participant said she "felt like a jigsaw cut up into pieces". Many spoke about needing to explain their conditions multiple times to different health professionals, and others were frustrated at the conflicting information about medication and treatment options. Many participants valued seeing the same health professional, especially in primary care, where many felt they no longer had a 'family doctor' who knew their personal medical history.

Recommended changes

Participants were asked what changes, if any, they would suggest to health and other services to best support people living with long-term illnesses.

Managing medications: It was suggested by a small number of participants that either subsidised or free blister packs or pharmacy filled pill boxes would be valuable. In one focus group there was support for a wallet-sized medication card recording patients' prescriptions to assist patients to accurately relay their medical information, especially in an emergency situation.

Travelling to appointments: A range of strategies were identified to address the challenge of travelling to appointments, including services being co-located in the community, healthcare appointments being scheduled at convenient times for people travelling from out of town and home-based care, eg, prescriptions being filled and delivered by the pharmacy.

Culturally responsive health workforce: Māori and Pacific participants reported the need for greater representation of Māori and Pacific health workers, with the majority suggesting the need for culturally specific services alongside cultural competency training for mainstream medical professionals. Many Māori also called for a more holistic approach to health.

Better support information: A number of participants suggested that better information regarding social and financial support services was needed.

Consultations suited to those with multiple conditions: While generally the participants were satisfied with the service they received from their health providers, it was commonly suggested that appointment times be extended for people with multimorbidity to allow enough time to fully discuss their conditions. Furthermore, some suggested that health professionals could improve their practice by being seen to focus fully on their patient during the consultation and to attend to their needs as a 'whole person'.

Single point of care: Some participants discussed their desire to have one health professional responsible for all their care, to avoid complications from treatment for their different conditions.

Discussion

Multimorbidity has become 'the most common chronic condition'[5] and the major reason for healthcare expenditure in many countries.[5,24] This qualitative research identified patients' perspectives on living with multimorbidity, and is one of the first to focus on indigenous people. For many participants, multimorbidity disrupted their 'normal' life and created numerous new challenges that they had to learn to manage. Challenges included the activities of everyday life, managing work and, for some, leaving the house. Participants identified multiple coping strategies. As found in other research, the most important for many was a positive attitude.[25,26] Nearly all participants spoke of needing care and support from family and friends to manage their health, a key coping mechanism identified in the literature.[22,25,27,28] Managing multiple medications was a key concern for most, and remembering to take medication was a problem for which many participants identified coping strategies. Participants were also concerned about the side-effects and cost of taking multiple medications, which lead to some participants skipping or stopping their medication in an attempt to self-manage their conditions. These findings on medication concerns were a common theme in the literature.[12,22]

In common with other evidence,[29] participants spoke about the healthcare system. Travelling to appointments was often difficult, especially for those who did not drive and those who lived in rural areas, a finding in keeping with other international studies of chronic illness.[30] The implication for health service planning is clearly to focus on providing the most appropriate number of consultations for effective care, and not to burden patients with multimorbidity with frequent episodic single-illness appointments. Similarly, consultation length and context have been debated in relation to chronic and long-term illness, with a number of responses suggesting including longer consultations.[29,31] Health systems in many OECD countries have identified potential changes in consultation structure to try and accommodate the needs of patients with multimorbidity, though their success will be dependent on the degree to which their structure and function can accommodate change. In New Zealand, primary care consultations usually require a patient co-payment. In recognition of the burden placed on patients with multiple conditions, the government introduced 'Care Plus' where patients get longer consultations with both a GP and practice nurse, free of charge, to provide more coordinated and integrated care.[32] Important themes, including effective communication, longer consultation times and interpersonal continuity of care, are echoed in a recent BMJ editorial on better management of patients with multimorbidity.[29]

Internationally, successful management of multimorbidity demands a specific response to the cultural needs of increasingly diverse populations. In this study, indigenous Māori and migrant participants expressed the need for holistic and culturally competent health services. This could be achieved through an increased focus on cultural competence in healthcare training, including immersion at an early stage and an increased indigenous workforce. A significant increase in Māori medical graduates bodes well.[33] Participants had many recommendations to improve support for people living with multimorbidity. Suggestions for managing multiple medications are supported by a recent systematic review that suggests that fixed-dose combination pills and unit-of-use packaging are likely to improve adherence.[34] Patient-held medication records were recommended, with Whyte[35] finding that they are favoured by patients and effective in assisting recall. A similar study using pictures of medications alongside explanations of their purpose and dose had a significant effect on self-efficacy and adherence.[36] More recently, studies focus on smartphone applications;[37] however, while these applications had a positive effect on recall and enhanced adherence through reminder services, they are limited to those

with the correct types of phone. Better care coordination and home-based care were suggested to avoid the challenges of travel.[38] There are calls for the development of new care coordination interventions for people with multimorbidity.[18,19,22,38,39] Calls for culturally specific services, cultural competence training for staff and a holistic approach to healthcare are other aspects equally supported in the literature.[40–43] Requests for better information about support services need to be addressed, possibly through accessible lay guides and user-friendly application processes. Despite reported high levels of satisfaction, some participants called for changes to healthcare processes, such as more patient-focused care, longer appointment times and having a single health professional for all specialist care, as reported elsewhere.[29,44,45]

The complexity of multimorbidity does not fit naturally within a healthcare system siloed by single diseases. Patients often described feeling overwhelmed by having numerous health services to access, alongside different health professionals and multiple medications. A recent Cochrane review[1] looked at multiple interventions targeted at improving the outcomes of patients with multimorbidity. Of the 18 studies examined, 12 focused on changing the actual organisation of care delivery, either through case management or enhanced multidisciplinary teamwork. The remaining six centred on patient-oriented interventions such as increasing confidence for self-management through various programmes and initiatives.

This research suggests that changes are needed to the way in which healthcare is organised and delivered in order to meet the complex needs of multimorbid patients.

Strengths and weaknesses

All phases of the investigation have been described, and the study followed criteria of quality in qualitative research. In preparing the manuscript, we followed the consolidated criteria for reporting qualitative research (COREQ).[46]

While caution is needed in generalising these findings to other nations, the New Zealand health system has much in common with health services in other OECD countries. Further, the study provides valuable perspectives on multimorbidity in indigenous people and those under 65, populations understudied in this arena. The study highlights the value of focusing on multimorbidity to capture the complexity of multiple, rather than single, conditions. It provides further evidence from a patient perspective about the challenges of this condition and reminds policymakers, funders and providers of the value of gaining patients' voices to identify solutions.

Further research

Future areas of research include triangulating the patients' perspectives with those of health professionals, funders and policy-makers, and undertaking intervention and cost-effectiveness research. The findings are currently being used to inform the development of a national survey, quantifying patients' perceptions of living with multimorbidity.

Conclusions

For many participants, living with multimorbidity disrupted their 'normal' lives, posing challenges in many areas that they needed to learn to manage. These included: coping with everyday activities such as eating and toileting, coping with work and managing multiple medications. Dealing with the health system also poses challenges, such as accessing appointments and having enough time to discuss key issues. Cultural competency, good communication, clear information and continuity of care were all valued. With this in mind, changes to the health system are needed to meet the complex needs of multimorbid patients. Participants in this study have many recommendations including: support to manage multiple medications, longer appointment times especially in primary care, culturally competent health services and one professional to coordinate all specialist care. Changing the siloed health system developed to address a single issue is essential if the challenge of multimorbidity is to be met. Urgent action is needed to reorganise the system in New Zealand and elsewhere so it is 'fit for purpose' to manage multiple conditions effectively and efficiently. This has the potential to dramatically improve the lives of the many people living with multimorbidity, reduce inequity for those living in socioeconomic deprivation and for Māori, enhance the experience of clinicians working with multimorbid patients, and reduce the significant costs to the health sector and wider society.

Table 2: Participants' quotes: living with multimorbidity.

Category	Code	Quote
What is it like?		"I was in denial for several years." (FG3) "You've got to be this close to death before you think 'oh shit, I'd better do something'." (INT1) "Oh we've managed very well. It's the bad look with the walking stick in one hand and a chainsaw in the other, but I still get work done." (FG2) "Sometimes I'm pretty good. Some other times I have trouble walking and puffing away." (FG1) "…it's taken a lot of the joy of life." (FG4)
Disrupting normal life		
Eating		"So I might be at a marae [Māori community centre], and then I've got to leave whatever it is that I'm doing, to get something to eat." (INT11)
Sleeping		"And in the early days I found it very difficult. Because I was told to take the medication in the morning, and I had a full-time job at that stage, and I used to fall asleep—I was a postie—and I used to fall asleep on my run, because the medication would knock me out so much." (FG3)
Toileting		"I might be doing a jig and holding on to everything, and crossing my legs, running ... it's not uncommon for me to turn up at my mum and dad's house, and run in the door and head straight for the toilet. Screaming while I do it." (INT5)
Mobility		"And I've been stuck all sorts of places. And I'm terrified, because it's not like I can ... because I've got walking sticks with me. You can't get outside in the blowing wind and walk with a walking stick." (INT12)
Employment		"So it did really impact upon my work, to such an extent that I was off for considerable amounts of time. And I was making significant mistakes. So then I had to basically leave that work." (INT10)
Leaving home		"And I went off my Furosemide for about three, four months, because I found them to be a nuisance when I go out. I can't go out, and you know, have to stay indoors." (FG1)
Coping strategies		
Positive attitude		"It doesn't really worry me." (FG2)"My mantra is every day above ground is a great day." (FG4)
Learning to manage		"I've learnt to manage things." (INT12) "Once I got to grips with what I had, and how I needed to look after it, everything settled down for me again, back to normal." (INT3) "I do try to manage as best as I can." (FG1) "You live with it." (FG3)
Independence		"So I fight all I can to be independent." (INT12) "But the idea is I think to help yourself while you can. Once you start relying on people, then you find … you fall through that gap." (FG3)
Care & support		"I think there are a number of things. There's the old issue of WINZ [welfare services] not really explaining what's available to people … If you don't ask, then they won't tell. So there's still that. That's always been a problem." (INT9) "… you got to get this piece of paper and that piece of paper and that piece of paper and that piece of paper. Then by the time you go, you don't want ... you just go, 'stuff it'." (FG5)
Managing medications		
Remembering medications		"Sometimes they're a problem [medications] and I have trouble remembering. But yeah, it's about trying to remember". (INT7) "What I would like to see is one pill for everything. No matter how big the pill is, one pill. Get it out the way." (INT9)
Keeping to routine		"But I know pretty well, because I've been like this for fourteen years with the pain sort of thing, so I just know what to take. Sometimes I might be an hour out, but an hour's nothing. But no, I know all about that." (INT12)
Cost of medicines		"I used to live on noodles, home brand noodles. And my son would say; 'where's the food mum?', and I'd say, 'we have to live on noodles, I need my medication'." (INT8) "I put my scripts in last week, but I could only afford to get two things out, which I really needed, but I always keep heaps anyway, just in case I can't afford to get them." (INT15)
Self-management		"So I'm continuing that way, not taking it (a tablet) every day, but I take it every other day. Because I believe that it does help ... I don't feel any pain and that, so it must be working alright." (FG3)
Knowing own body		"Those doctors have got to listen to us because we know that body." (FG4)
Trial and error		"That's about it, really. Just yeah, the mix and match, and the sort of chemistry of trying to get the right drugs." (INT5)

FG= focus group
INT=interview

Table 3: Participants' quotes: the health system.

Category	Code	Quote
Travel to appointments		"The main issue is our transportation there. Because we are not eligible to claim anything, actually." (FG5) "I think that those of us in the urban sense are far luckier than our whānau in the country areas, because they don't have the services that we can access here." (FG6) "… if I wasn't driving, I'd be a dead duck. I really wouldn't be able to cope …. my driving—they're getting very, very tough …" (INT2)
Appointments		
Having to wait for appointments		"The only thing I find coming here is that if you go and make an appointment, they keep ... oh not all the time, but they say oh, he can't see anybody till next week." (FG1)
Wanting to see same health professional		I think there is a problem here … where we are today, we used to have doctors of our own. But going up to the doctor's today, you go up to a different doctor. There's three different doctors." (FG5)
Length of appointments		"My wife had a couple of complaints and she said, 'oh, we're going to the doctor today. We'll talk to him about it.' And she started to talk to him; she said there's this and that. And he said, 'I'm sorry, you've only got fifteen minutes.' (FG4)
Cultural competence		"I tend to discuss only the wee points with my doctor, so we don't have a really good relationship. We're from two different cultures, and we don't like each other." (FG6) "They were Pākehā and I don't think … they were maybe culturally aware." (INT7)
Communication		
Explaining everything		"And for me I was very fortunate, because the people that looked after my diabetes were very good, explaining everything, every step, what was happening and also the medication and all that, which I was quite pleased about that." (FG3)
Discussing options with health professional		"No no, if I'm really happy I can say that to him (doctor). I know if I really don't want to go that way, and I think they suck, I can say that to him. So he is like a buffer." (INT5) "If I've got anything on my mind I've always got someone to talk to." (INT15)
Feeling listened to		"You can tell he's not listening to you. You know, he's either on his machine or doing something." (FG1) "You'd see him looking at his computer and you wonder whether he's listening to you or not." (FG4)
Understanding whole person		"What just keeps coming into my head is, seeing conditions or a person as a whole ... and I suppose they need to upskill, in terms of looking at a person and finding out where else they might be going for appointments or checkups or referrals." (INT5)
Integration of care		"Oh when I go to the GP, he goes 'oh you're seeing the asthma clinic next week. Tell them what's going on'. Or I see the asthma clinic, [they say] 'when are you seeing rheumatoid next?'" (INT4) "… how each doctor has a different opinion on how you should be treated." (FG6) "... everything is siloed, you feel like you're a jigsaw cut up into pieces. The disconnect is the biggest problem." (INT5)
Receiving conflicting information		"And from that disconnect you're getting conflicting bits of information about the same parts of your body, or your condition or your disease, from their interpretation." (INT5) "... you've got the diabetes who are worried about the sugar, but they're not too concerned about the fat intake. And then you have the [other] dietitian who comes in totally different." (INT1)

FG= focus group
INT=interview

Competing interests:
Dr Lawrenson is an employee of the University of Waikato and Waikato District Health Board; Dr Sarfati reports grants from the Health Research Council during the conduct of the study.

Acknowledgements:
The authors would like to acknowledge the participants and thank them for their generosity in sharing their stories to assist others. We would also like to thank our clinical and community advisors. This research was funded by the Health Research Council of New Zealand, Grant No. 14/173.

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URL:
http://www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2017/vol-130-no-1455-12-may-2017/7243

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Implementation and effects of Enhanced Recovery After Surgery for hip and knee replacements and fractured neck of femur in New Zealand orthopaedic services

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ABSTRACT

AIM: The National Orthopaedic Enhanced Recovery After Surgery (ERAS) Collaborative was launched in November 2013 to implement ERAS protocols for hip and knee total joint arthroplasty (TJA) and fractured neck of femur (NOF) in participating district health boards (DHBs) by December 2014. This paper reports on the results.

METHOD: ERAS protocols were developed for hip and knee TJA and fractured NOF. Breakthrough Series collaborative methodology was used to implement the ERAS protocols in 18 DHBs. We collected monthly data on compliance with protocols and average length of stay (ALOS). Data were analysed using run charts and Shewhart control charts.

RESULTS: The national percentage of ERAS components achieved across all DHBs rose from 33% to 75% on the elective knee TJA pathway, from 31% to 78% on the elective hip TJA pathway and from 29% to 51% on the acute fractured NOF pathway. The ALOS for knee TJA reduced from 5.4 days to 4.5 days. The ALOS for hip TJA reduced from 5.1 days to 4.3 days. There was no change in the ALOS for fractured NOF.

CONCLUSION: The National Orthopaedic ERAS Collaborative increased uptake of ERAS protocols across all three pathways and decreased ALOS for the elective pathways among participating DHBs. There was no decrease in ALOS for the fractured NOF pathway. Collaborative improvement methodology can be used successfully to implement orthopaedic ERAS across New Zealand DHBs.

Orthopaedic services in New Zealand traditionally struggle to achieve waiting time requirements set by the Ministry of Health.[1] Furthermore, there is considerable variation among district health boards (DHBs) in intervention rates, length of stay and 28-day acute readmission rates associated with orthopaedic surgical procedures.[1] Demand for orthopaedic services is expected to rise as the population ages.

In 2012, an orthopaedic expert advisory group convened by the Ministry of Health recommended developing a national programme to promote the adoption of Enhanced Recovery After Surgery (ERAS) for hip or knee total joint arthroplasty (TJA) and internal fixation of fractured neck of femur (NOF) in New Zealand DHBs. The members of this group included orthopaedic surgeons, anaesthetists, clinical nurse leaders, orthopaedic nurse specialists and gerontologists.

ERAS comprises an evidence-based, multimodal, patient-centred rehabilitation programme that has been shown to reduce mortality and length of stay in patients having total hip or knee arthroplasty, as well as improving functional outcomes and cost-effectiveness.[2–10]

ERAS can be difficult to implement because it requires all members of a multidisciplinary peri-operative team to adopt a high number of interventions.[11] To our knowledge, there are few studies that describe a methodology for implementing ERAS protocols, and none that use collaborative improvement methodology.[11]

We report on the results of using collaborative improvement methodology to implement ERAS for hip or knee replacement and fractured neck of femur across New Zealand orthopaedic services in the National Orthopaedic Enhanced Recovery After Surgery Collaborative.

Challenges

The New Zealand health system is configured into 20 DHBs. All DHBs deliver orthopaedic services.

New Zealand DHBs had experience of cross-organisational collaborative learning through Target CLAB Zero, a national improvement collaborative to reduce the incidence of central line-associated bacteraemia in intensive care units.[12] However, this experience did not extend to orthopaedic services. Orthopaedic services at each DHB functioned autonomously, and apart from professional development groups only a limited amount of knowledge sharing and process improvement occurred.

In addition, there was no shared database suitable for capturing data on quality improvement measures.

Methods

The aim of the National Orthopaedic Enhanced Recovery After Surgery Collaborative was for all patients needing hip and knee replacement, and all patients with acute neck of femur fracture, to be managed according to ERAS principles by December 2014 in participating DHBs.

The Ministry of Health established a project team and sought improvement advisor expertise from Ko Awatea, a health system improvement and innovation centre with experience in leading national improvement campaigns.

The national project team included a project manager, information management expert, consumer advisor, communications advisor, improvement advisors and a clinical lead. This team managed and advised on the day-to-day operation of the National Orthopaedic ERAS Collaborative by conducting site visits, on-site meetings and teleconferences with local teams from participating DHBs. The national project team used these mechanisms to ensure local teams had adequate support, to mitigate challenges, to provide information and data, and to connect local teams with each other for sharing experiences and approaches to overcoming barriers. In addition, the team developed standardised information booklets and a video for local teams to provide to patients.

Expert clinical faculty led the development and delivery of improvement content, measurement strategies and resources that supported the transformational effort. Expert faculty comprised specialists in orthopaedic ERAS and experts in improvement methodology.

Eighteen DHBs participated in the collaborative and two opted out. Each participating DHB nominated an improvement team comprising a project manager, a clinical lead and frontline staff from disciplines involved in the ERAS care pathway (nurses, anaesthetists and physiotherapists). The two DHBs that opted out did so because they had received funding to adopt ERAS pathways from the Elective Services Productivity Programme prior to the collaborative being established, and were already implementing ERAS using internal quality improvement methods.

The Ministry of Health recruited DHBs to participate through teleconferences and site visits with clinicians and service managers in orthopaedics services. The Ministry also provided partial funding for ERAS to participating DHBs as an incentive.

The intervention

The orthopaedic expert advisory group developed protocols for elective total joint arthroplasty and acute fractured neck of femur. Primary sources of evidence for protocol development were advice from the expert faculty, the *Australian and New Zealand Guideline for Hip Fracture Care* and a how-to guide developed by the Welsh 1,000 Lives Plus campaign.[13,14] Additional secondary sources were also used.[15–18]

For the elective total joint arthroplasty change package, drivers and interventions were grouped into protocols for: primary care; pre-admission; pre-operative; peri-operative; post-operative; discharge and follow-up (Figure 1).

Figure 1: Driver diagram: elective primary total hip and knee joint arthroplasty.

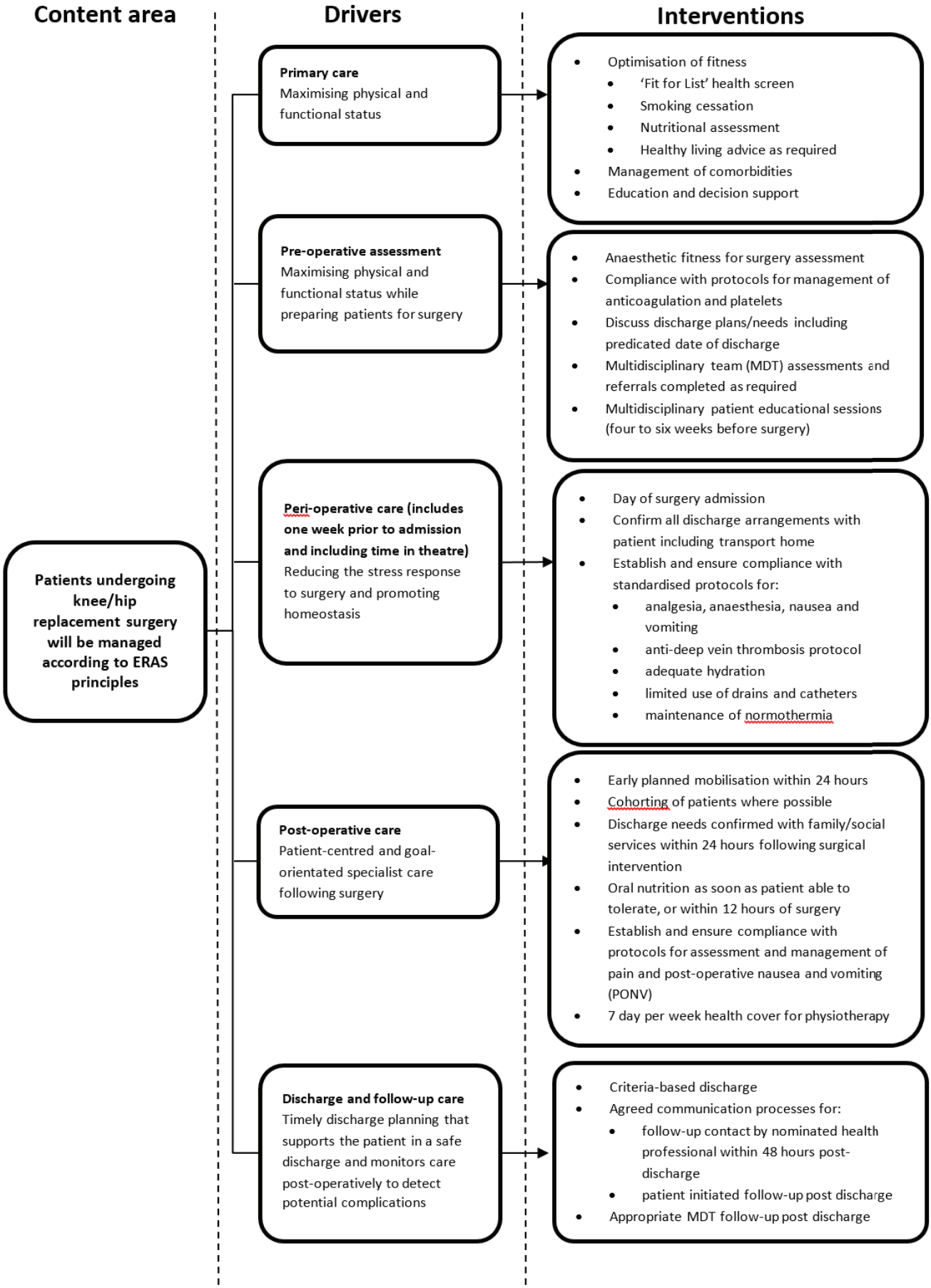
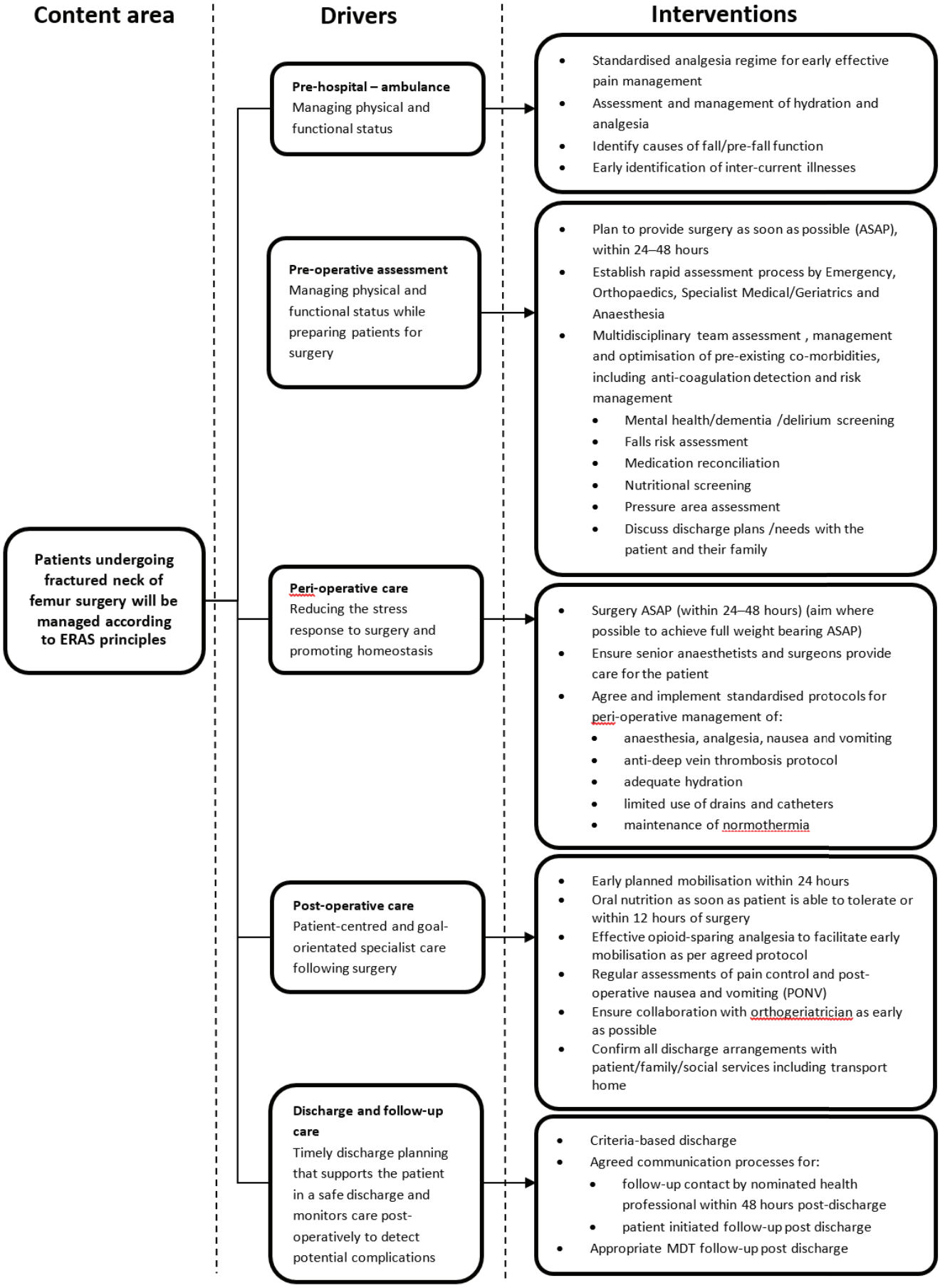


Figure 2: Driver diagram for acute fractured neck of femur.



For the acute fractured neck of femur change package, they were grouped into: pre-hospital and emergency department; pre-operative; peri-operative; post-operative; discharge and follow-up (Figure 2).

We adopted Breakthrough Series Collaborative Model (BTS) methodology as an approach to implementing the change packages.[19] The BTS was structured as learning sessions interspersed with action periods. Improvement teams attended learning sessions every four to six months.

Teams learned how to use driver diagrams and the Model for Improvement at the learning sessions. Driver diagrams provide a visual representation of the factors needed for a system to achieve its aim.[20] Teams used the diagrams as a framework to learn what did and did not improve care. Under the Model for Improvement, teams set specific aims and measures, then develop and test change ideas using plan, do, study, act (PDSA) cycles.[21] Teams applied this model during action periods to adapt change ideas to their local setting.

Learning sessions enabled teams to share experiences and learn from each other, to receive individual and team coaching, and to solve problems.

In between learning sessions, the national project team made site visits and held teleconference calls with teams to monitor progress and provide clinical coaching and feedback.

Measures

We measured practice change by compliance with seven identified ERAS components on the elective hip and knee TJA pathway and five identified ERAS components on the acute fractured NOF pathway (Table 1). We collected and analysed data on compliance with each component. Overall compliance with all components was measured by percentage. Patients who had all components correctly completed were counted as managed according to the ERAS protocol.

Average length of stay was measured for patients undergoing all three types of procedure (Table 1).

Data collection and analysis

Teams collected weekly data on the number of patients managed according to the ERAS protocols. Procedure type, total number of discharges, total length of stay and correct completion of criteria for compliance with the ERAS protocols were collected.

The Ministry of Health commissioned a centralised database to collect and compile data. DHBs submitted data to the database monthly. DHBs were provided with data collection guidelines and were expected to submit their data 10–14 days after the end of each month.

Data were analysed using run charts to detect forms of non-random variation that might indicate a change in performance.[22] Ultimately, data for each individual DHB and all DHBs in aggregate were analysed using Shewhart control charts to further assess whether any improvements in compliance to the ERAS bundle components had been achieved, and the impact on ALOS.

Results

All 18 DHBs reported data on all pathways from November 2013. The majority of DHBs worked on the elective TJA pathway first. All 18 DHBs implemented protocols on the elective TJA pathways in November 2013. DHBs started work on the acute fractured NOF pathway at different times. Most DHBs started work on the NOF pathway after April 2014, some as late as October 2014.

Baseline data on compliance was measured at the start of the collaborative. However, we are able to present earlier data for ALOS because the Ministry of Health collects this data as a performance indicator.

Elective hip and knee total joint arthroplasty

Overall DHB compliance to ERAS components on the elective hip and knee TJA pathway increased for six components (Table 2). The seventh component, Day of Surgery Admission, was already well-established before the collaborative and compliance remained between 90% and 100% throughout the collaborative.

Table 1: Measures, measure definitions and data collection methods for ERAS protocols.

Measure	Collection method	Measure definition
Percentage of patients managed according to the ERAS protocol	Manual	**Elective primary total hip and knee arthroplasty** 1. Pre-op education – The patient received oral and written education regarding the enhanced recovery protocol prior to admission. 2. Pre-op discharge planning – Prior to admission, a predicted date of discharge was given to the patient and discharge needs (such as support, equipment or home adaptations) were explicitly assessed and documented in the patient record. 3. Day of surgery admission – The elective patient was admitted on the day of surgery (ie, the procedure date is equal to the day of admission). 4. Standard anaesthetic and analgesic regimen – A locally agreed standardised anaesthetic and analgesic protocol has been agreed for the procedure that the patient has undergone and the protocol was followed and charted for this patient. 5. Nausea and vomiting protocol – A locally agreed standardised protocol has been agreed for the procedure that the patient has undergone and the protocol was followed and charted for this patient. 6. Mobilisation within 24 hours of surgery – patient was active weight bearing (with appropriate walking aid) within 24 hours from the end of the operation. 7. Criteria based discharge – Standardised discharge criteria have been agreed for the procedure and the protocol was followed and charted for this patient. **Acute fractured neck of femur** 1. Standard anaesthetic regimen – A standardised anaesthetic protocol has been agreed for the procedure that the patient has undergone and the protocol was followed and charted for this patient. 2. Nausea and vomiting protocol – A standardised protocol has been agreed for the procedure that the patient has undergone and the protocol was followed (and charted) for this patient. 3. Mobilisation within 24 hours of surgery – patient was active weight bearing (with appropriate walking aid) within 24 hours from the end of the operation. 4. Criteria-based discharge – Standardised discharge criteria have been agreed for the procedure and the protocol was followed (and charted) for this patient. 5. Patient was operated on within 48 hours of presentation to hospital. Operation start time is within 48 hours of presentation to hospital.
Average length of stay in hospital system	DHB information system extract	**Numerator –** the total bed days from hospital admission to discharge from DHB-funded care in the reporting week. DHB funded care includes not just the hospital stay but also any DHB-funded rehabilitation facility or extended step-down or residential care facility. **Denominator –** the total number of discharges in the reporting week.

Table 2: Summary of compliance to ERAS components on the knee TJA pathway.

Component	Mean percent compliance November 2013 to June 2014	Mean percent compliance July 2014 to November 2014	Percent increase
Standard anaesthetic regime	23%	42%	19%
Standard nausea protocol	0	63%	63%
Mobilisation within 24 hours	20%	70%	50%
Criteria-based discharge	20%	56%	36%
Pre-operative education	51%	65%	14%
Pre-operative discharge planning	40%	80%	40%

Table 3: Summary of compliance to ERAS components on the hip TJA pathway.

Component	Mean percent compliance November 2013 to June 2014	Mean percent compliance July 2014 to November 2014	Percent increase
Standard anaesthetic regime	25%	45%	19%
Standard nausea protocol	5%	62%	57%
Mobilisation within 24 hours	25%	72%	47%
Criteria-based discharge	29%	59%	30%
Pre-operative education	20%	63%	43%
Pre-operative discharge planning	40%	77%	37%

Figure 3: National percentage of ERAS components achieved for elective knee TJA: compliance by week.

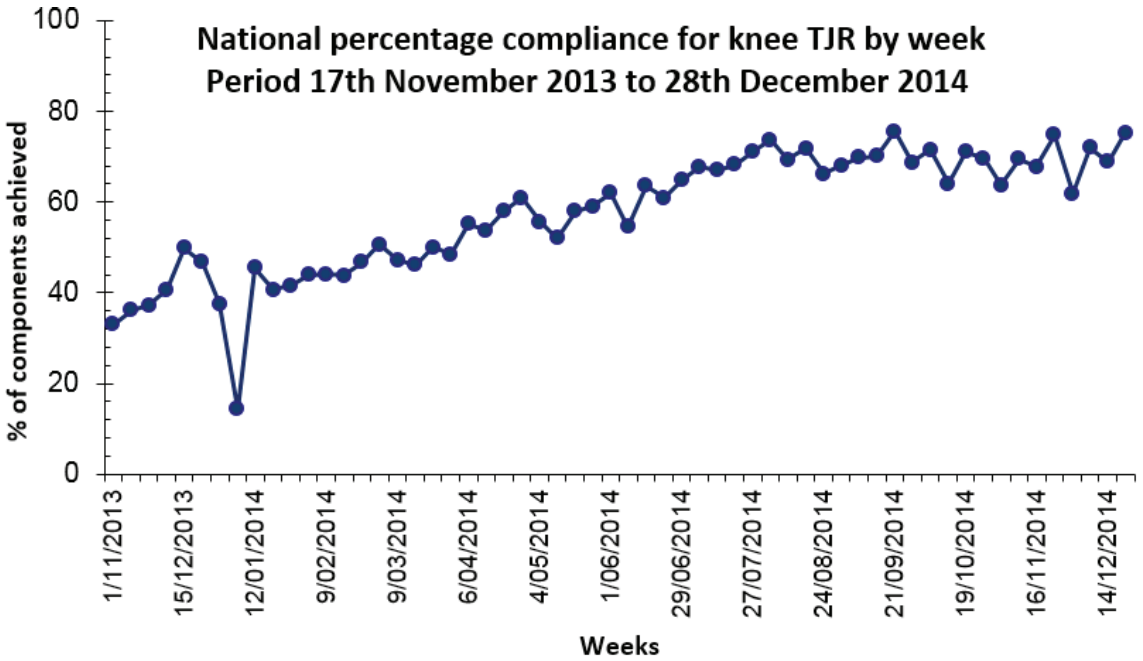
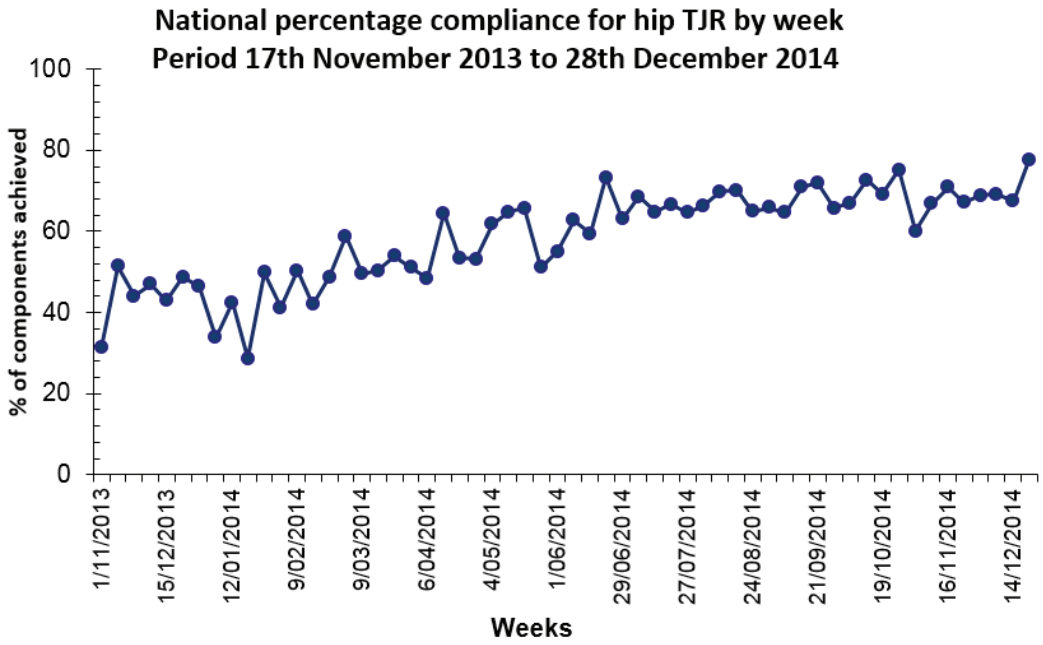


Figure 4: National percentage of ERAS components achieved for elective hip TJA: compliance by week.



The overall percentage of ERAS components that patients received gradually rose to 80% for elective knee TJA (Figure 3).

For hip TJA, the overall percentage of ERAS components that patients received increased to 75% (Figure 4). This is an increase of 44% over a 12-month period.

At baseline, the mean ALOS for knee TJA was 5.4 days. There was a special cause decrease in ALOS before the collaborative started. This can be attributed to burgeoning evidence in support of ERAS and efforts made during 2012 and 2013 to promote the ERAS model of care. This resulted in early adoption of some of the ERAS components by some DHBs. A second special cause decrease was noted for the period of the collaborative, November 2013 to December 2014, indicating a special cause reduction of 0.9 days, from a baseline mean of 5.4 days to 4.5 days (Figure 5). The ALOS at September 2015 was 4.2 days.

Figure 5: Aggregated national ALOS for knee TJA.

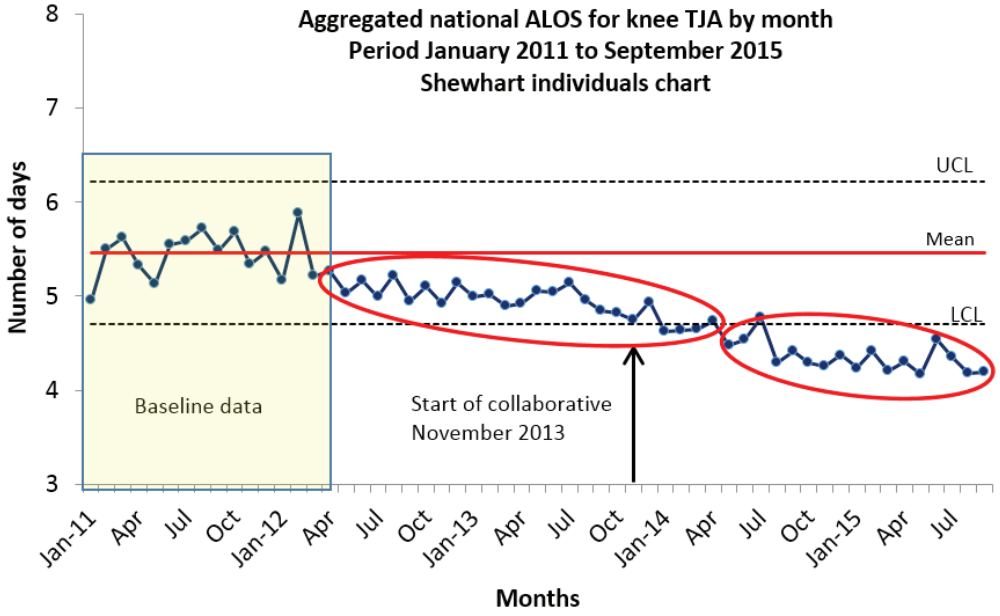
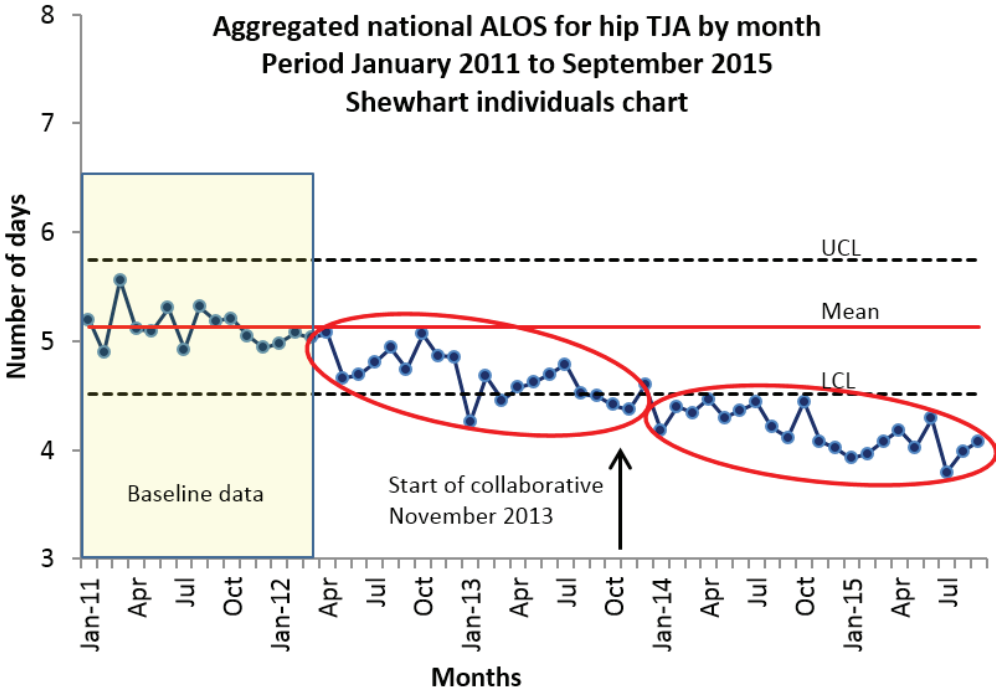


Figure 6: Aggregated national ALOS for hip TJA.



The number of patients who received knee TJA rose from 2,917 for the period January to September 2013, before the collaborative began, to 3,420 for January to September 2014, an increase of 503 cases. From January to September 2015, 3,244 patients received knee TJA. This is less than the 2014 increase but still 327 more cases than in 2013.

For hip TJA, the mean ALOS was 5.1 days at baseline. This reduced to a mean of 4.3 days for the period November 2013 to December 2014, indicating a special cause reduction of 0.8 days. As with knee TJA, there was a special cause decrease in ALOS between April 2012 and September 2013, before the start of the collaborative. The collaborative enhanced the decrease. The downward trend continued after the collaborative ended to a mean of 4.1 days for September 2015 (Figure 6).

The number of patients who received hip TJA rose from 3,138 for the period January to September 2013 to 3,387 for January to September 2014, an increase of 277. There were 3,310 hip TJA patients for the same period in 2015—although less than in 2014, this remains an increase of 172 cases compared with 2013.

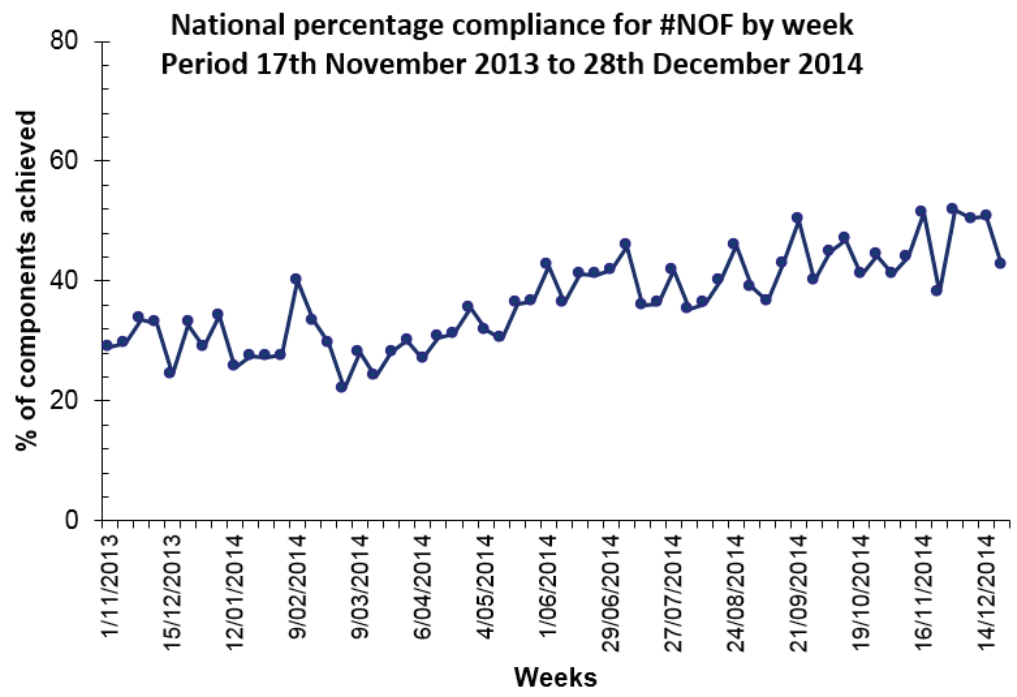
Acute fractured NOF

Overall DHB compliance to ERAS components on the acute fractured NOF pathway increased for all five components (Table 4).

Table 4: Summary of compliance to ERAS components on the acute fractured NOF pathway.

Component	Mean percent compliance June 2014	Mean percent compliance July to December 2014	Mean percent increase
Standard anaesthetic regime	15%	30%	15%
Standard nausea protocol	19%	36%	17%
Mobilisation within 24 hours	23%	33%	11%
Criteria-based discharge	23%	37%	14%
Surgery within 48 hours of admission	72%	80%	8%

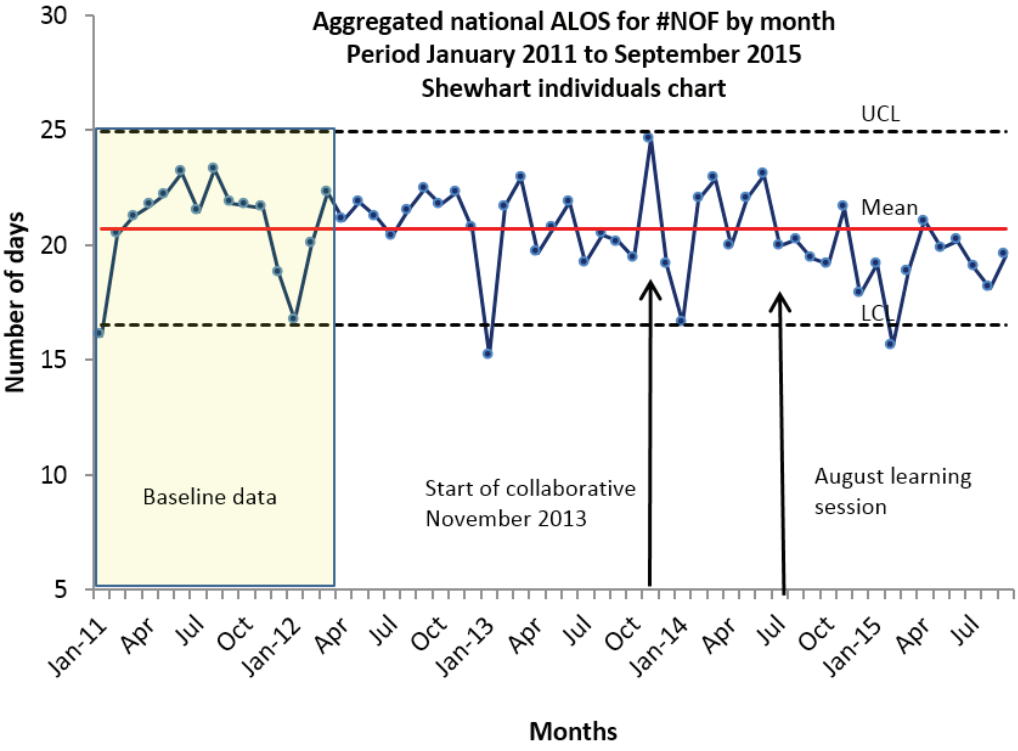
Figure 7: National percentage of ERAS components achieved for fractured neck of femur: compliance by week.



The overall percentage of ERAS components that patients received increased to about 50% (Figure 7). The lower overall percentage increase compared with the elective hip and knee TJA pathways is explained by most DHBs starting work on the NOF pathway after April 2014.

There were no special cause changes detected in the mean ALOS for fractured neck of femur for the period that most participants focused on this acute pathway (April to December 2014). For the period of May to September 2015, the ALOS is below the mean but still does not show any special cause (Figure 8). The decrease in ALOS every January is probably related to reduction in the volume of cases during the holiday period.

Figure 8: Aggregated national ALOS for acute fractured neck of femur.



NZMJ 12 May 2017, Vol 130 No 1455
ISSN 1175-8716

Discussion

The National Orthopaedic ERAS Collaborative shows that collaborative improvement methodology can be used to implement orthopaedic ERAS across New Zealand DHBs.

The collaborative increased uptake of ERAS protocols among all participating DHBs. Overall, compliance increased to 80% for knee TJA, 75% for hip TJA and 50% for fractured neck of femur. Putting these protocols in place increased standardisation across the country. Care became more consistent across DHBs, with less variation in the quality of care and education patients received. Consistent care underlies the improvement in patient outcomes described in the ERAS literature. Studies show that ERAS is associated with important benefits to patients, including better functional outcomes, reduced short-term complication and mortality rates, and reduced length of stay in hospital.[6–8]

The greatest reductions in ALOS were in the elective knee and hip TJA pathways. This compares with results of a study by Christelis et al of patients undergoing elective hip or knee arthoplasty, which showed a reduction in mean length of stay from 5.3 days to 4.9 days for patients in the ERAS phase.[9] Data from the Musculoskeletal Audit in Scotland also shows shorter post-operative length of stay with ERAS protocols.[3] The reduced ALOS increased system capacity, enabling a greater volume of patients to be treated. Although this ALOS reduction of 0.9 days does result in a direct reduction in the number of bed days used for this group of patients, it would be difficult to claim a reduction in bed days used overall for this time period. Bed days saved by this group of patients do not equate to actual bed days saved because the beds are used for patients on the waiting lists for these elective procedures. As noted, there was a volume increase of 780 cases for patients who underwent TJA for hips and knees.

The reduction in ALOS on the elective pathways was sustained after the collaborative ended. However, our findings for the fractured NOF pathway concur with those of Macfie et al, who found no significant difference in length of hospital stay between patients undergoing conventional care and those undergoing care optimised by ERAS protocols.[23] We saw no change in the ALOS for fractured NOF during the period that most DHBs focused on this pathway.

The National Orthopaedic ERAS Collaborative reinforces existing evidence that BTS methodology can be used to implement quality improvement initiatives across multiple DHBs.[12] In the National Orthopaedic ERAS Collaborative, BTS methodology provided a vehicle for change across 18 DHBs regardless of size, demographics of the population, socio-economic climate, organisational culture and previous experience in the implementation of ERAS protocols. DHB teams were able to learn from one another about the application of improvement science, and to share change ideas, clinical expertise and experience. Informal leaders emerged who were able to influence and support those who experienced challenges implementing the protocol related to DHB size, demography, organisational culture or geographical location. For example, the larger DHBs faced the challenge of spreading the protocol across all the required health professionals. In the case of one large DHB, 90 anaesthetists were involved in the agreement and implementation of their protocol. In contrast, the small DHBs were constrained by the number of people available to work on the project, as their absence from day-to-day work could not be covered by other personnel. The ability to share skills, knowledge and resources, and to access support and advice to solve problems, resulted in accelerated adoption, use and proficiency in the protocol.

The National Orthopaedic ERAS Collaborative developed national measurement capability from a quality improvement perspective. Although volume-based data was already being collected by the Ministry of Health, the national database used in the National Orthopaedic ERAS Collaborative was a new database created for quality improvement measures. The database helped teams to stay on target, review their data and identify areas that needed more work.

Another implication of the collaborative is building capability within New Zealand DHBs to apply improvement methodology to address deficiencies in healthcare. It

developed skills in improvement methodology among diverse stakeholders: the improvement team at each DHB included a representative from each discipline involved in the ERAS care pathway, as well as a clinical lead and a project manager.

The successful use of improvement collaboratives across multiple DHBs in differing clinical contexts suggests that the approach could generalise to address other deficiencies in the quality of healthcare.[12] In our experience, multi-DHB improvement collaboratives are feasible where there is an existing body of international evidence for best practice that has already been proven applicable to the New Zealand context through a local pilot at one or more DHBs.

Limitations

In our results, we present ALOS data from before, during and after the collaborative period. ALOS data from the collaborative period was collected weekly. However, data from before and after the collaborative period was collected monthly. For this reason, our results represent all ALOS data monthly. This does not affect the validity of the data, as the monthly data reflects cumulative weekly data.

This collaborative did not include any data collection or analysis on the impact of the day of the week that the surgery occurred.

Conclusion

The National Orthopaedic ERAS Collaborative increased uptake of ERAS protocols among participating DHBs and decreased ALOS on the elective hip and knee TJA pathways. There was no decrease in ALOS for the fractured NOF pathway. Collaborative improvement methodology can be used successfully to implement orthopaedic ERAS across New Zealand DHBs.

Competing interests:
We declare that Ko Awatea was funded by the Ministry of Health to provide improvement advisor expertise for the National Orthopaedic ERAS Collaborative.

Acknowledgements:
We thank the 18 district health boards for their time and commitment in making this programme a success; national clinical lead, Mr Jacob Munro; the clinical leads at each of the DHBs; and Trish Hayward for her invaluable leadership and direction in terms of the writing and editing of this paper. We also thank the Ministry of Health for sponsoring this programme.

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URL:
http://www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2017/vol-130-no-1455-12-may-2017/7244

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Enhanced hip fracture management: use of statistical methods and dataset to evaluate a fractured neck of femur fast track pathway—pilot study

Nigel Gilchrist, Kristian Dalzell, Scott Pearson, Gary Hooper, Kit Hoeben, Jeremy Hickling, John McKie, Ma Yi, Sandra Chamberlain, Caroline McCullough, Marc Gutenstein

ABSTRACT

The increasing elderly population and subsequent rise in total hip fracture(s) in this group means more effective management strategies are necessary to improve efficiency. We have changed our patient care strategy from the emergency department (ED), acute orthopaedic wards, operating theatre, post-operation and rehabilitation, and called it Fracture Neck of Femur Fast Track Pathway. All clinical data and actions were captured, integrated and displayed on a weekly basis using 'signalfromnoise' (SFN) software. The initial four months analysis of this project showed significant improvement in patient flow within the hospitals. The overall length of stay was reduced by four days. Time in ED was reduced by 30 minutes, and the wait for rehabilitation reduced by three days. Overall time in rehabilitation reduced by 3–7 days depending on facility. On average, fast track patients spent 95 less hours in hospital, resulting in 631 bed days saved in this period, with projected savings of NZD700,000. No adverse effects were seen in mortality, readmission and functional improvement status.

Fractured neck of femur has increasing clinical demand in a busy tertiary hospital. Length of stay, co-morbidities and waiting time for theatres are seen as major barriers to treatment for these conditions. Wait for rehabilitation can significantly lengthen hospital stay; also poor communication between the individual hospital management facets of this condition has been an ongoing issue. Lack of instant and available electronic information on this patient group has also been seen as a major barrier to improvement.

This paper demonstrates how integration of service components that are involved in fractured neck of femur can be achieved. It also shows how the use of electronic data capture and analysis can give a very quick and easily interpretable data trend that will enable change in practice.

This paper indicates that cooperation between health professionals and practitioners can significantly improve the length of stay and the time in which patients can be returned home. Full interdisciplinary involvement was the key to this approach. The use of electronic data capture and analysis can be used in many other health pathways within the health system.

In New Zealand, approximately 3,500 people over the age of 50 were hospitalised with a hip fracture in 2013 with the majority being related to falls.[1] The rate of hip fracture increases significantly with age with nearly half of the hip fractures occurring in those aged 85 years or older.[2] Although the incidence appears to be falling, the absolute number of hip fractures is increasing with longer life expectancy.[3]

It appears that the fracture rate is at least 25–50% higher in Europeans than in Pacific Islanders or Māori, but this rate is predicted to equalise with the increasing life span of the Māori and Polynesian population.[4] The care of these patients varies both nationally and internationally.[4] Service provision was initially surgically managed, but has evolved into a shared care model with Health Care of the Elderly Physicians.[5,6] In our centre we established a Fractured Neck of Femur Pathway in 2007,[7] which has significantly improved the outcomes of such patients.[7] Recently, guidelines have been established for both Australia and New Zealand, outlining the standard of care from admission to the emergency department, peri-operative care, operative optimisation, rehabilitation and appropriate discharge from hospital.[1] Experience has shown that this model reduces length of stay and improves cost efficiency.[8] Another recent improvement has been the establishment of a hip fracture registry, which will be able to identify all hip fractures in Australia and New Zealand, to accurately classify them and provide an integrated database for this complex group of patients.[9] Our hospital admits the largest number of hip fractures (>500/year) for a single hospital in New Zealand[10] and has been a leader in the field of innovative management of hip fracture patients. As a tertiary hospital with a large number of acute orthopaedic admissions (4,748 in 2014), evaluation of an effective treatment pathway for these patients has become important to use the finite resources efficiently.

The introduction of a weekly analytical dataset, 'signalfromnoise' (SFN) within our district health board is introducing a new way in which clinical staff working within the patient pathway can clearly and quickly understand the implications of any change in patient management. SFN (proprietary software from Lightfoot Solutions)[11] helps to identify variations, trends and patterns, which allows the assessment of the introduction of change in clinical practice from admission to the emergency department (ED), peri-operative management, rehabilitation and discharge. Previous patient management was independently managed with some information shared between services.

This study presents the initial results of this clinically-led pilot study in the change of the clinical management of hip fracture patients.

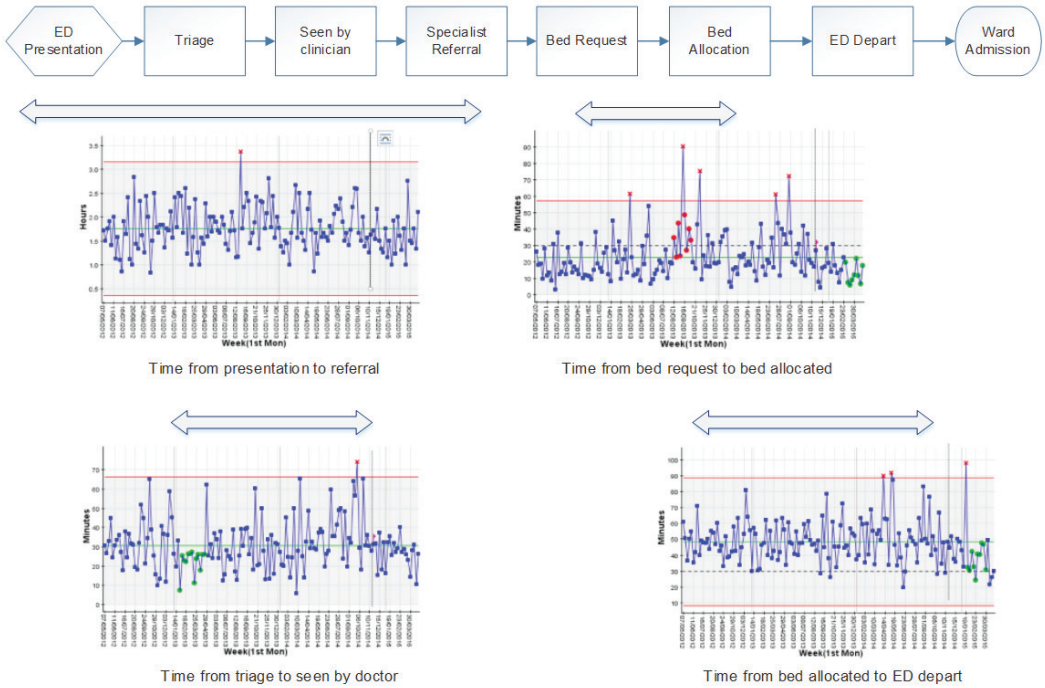
Methods

This fast track pathway was designed to improve the patient journey throughout all phases of their hospital admission from emergency department (ED), the peri-operative process, rehabilitation and planned discharge home. This involved all departments and staff from emergency, acute orthopaedic ward staff, anaesthetic department, surgeons, orthopaedic medicine/rehabilitation service and rehabilitation wards.

The elements of this pathway were mutually agreed by all parties in the period leading up to the introduction of the pathway. Measurement of the effectiveness of this pathway was enabled through the introduction of SFN data visualisation and analysis template that enabled quick and efficient evaluation of all parts of the pathway.[11]

SFN uses the principles of Statistical Process Control (SPC) to analyse and disseminate information about patient flow across the whole healthcare system. It includes a web-based interface that provides users with an 'at a glance' understanding of processes and improvement initiatives (Lightfoot, 2015).[11] SFN uses routine information collected in the district health board (DHB) patient management systems, including ED, operating theatres and inpatients wards. This new information is present in a dashboard format with weekly update and a drop down analysis feature that enables in depth analysis of elements of individual department activities across ED, inpatient wards, operating theatres and rehabilitation wards. Figure 1 shows some of the elements within ED that can be analysed on a week by week basis, giving the ability to quickly change or alter elements of the pathway.

Figure 1: SFN process analysis capabilities.



Patients with hip fracture are usually transported to the ED by ambulance where the ambulance staff often identify the possibility of hip fracture on their arrival in the ED. These patients are rapidly assessed by medical and nursing staff, comorbid conditions identified and treated, analgesia initiated, blood tests performed and x-rays requested. It was observed at an early stage that some patients arrived into a busy ED and concurrent nursing/medical responsibilities could delay care of those patients with hip fracture. The pathway empowered and enabled nursing staff to initiate care and significantly progress the ED phase of the care. Once the hip fracture is identified on x-ray, the orthopaedic team are notified, but further orthopaedic assessment of the patient is carried out once admitted directly to an orthopaedic ward bed. Education was provided early in the course of the new approach and all staff were motivated to provide care according to the pathway and expedite transfer to the orthopaedic ward bed. Fundamental to this improvement was to encourage orthopaedic assessment of the patient on the orthopaedic ward rather than in ED. On admission to the acute orthopaedic ward, every possible attempt was made for the patient to be operated on that day or the subsequent morning.

A system was put in place where the Charge Nurse on the admitting orthopaedic ward would text page the duty anaesthetist as soon as a fast track admission arrived on the ward. For those admissions before 4:00 pm an anaesthetic assessment of the patient would be made regarding suitability for operating theatre first thing the following morning. This enabled any outstanding investigations such as blood tests, chest x-ray, cardiac echocardiography or coagulation studies to be arranged, consultation referrals to be made and medications such as anticoagulants to be stopped (and possibly reversed) in a timely manner. This would then ensure the patient was ready for theatre the next morning, preventing unnecessary fasting of patients and reduced last-minute cancellations with a significant impact on theatre room utilisation. If there were problems identified that would preclude operation the next morning then this information was communicated to the acute orthopaedic team so they could adjust the operating schedule accordingly.

Anaesthesia was provided by an anaesthetic consultant or senior registrar wherever possible, with the technique chosen dependent on both patient factors and anaesthetist's personal preference.

The patients are admitted to an orthopaedic ward that specialises in the management of neck of femur fractures and has dedicated beds for this purpose. Nursing cares are instituted in a standardised fashion.

Registrar assessment (orthopaedic, orthopaedic medicine and anaesthetic) is then undertaken. The confirmation of the diagnosis and exclusion of other injuries or active comorbidities is made, and if present, these are also dealt with at the time of initial admission. Patients are placed on the booking system, 'Scope', and depending on the time on the day of admission, a decision is made regarding fasting status. Generally, the patients receive their surgery in the ensuing day(s) and therefore they are not kept nil by mouth and high-carbohydrate fluids and food commenced.

Pre-operative anaesthetic review and orthopaedic medical reviews are undertaken and any peri-operative risk is identified and mitigated with proactive intervention.

Dedicated time within an acute operating theatre is utilised for neck of femur fractures and priority is given whenever possible to this patient group.

The surgical procedure involves the administration of an anaesthetic, IV antibiotics and patient positioning, and depending on the configuration of the fracture pattern the position varies. For a hemiarthroplasty or total hip replacement, patients are positioned in the lateral decubitus position and generally a lateral approach to the hip is undertaken. This approach is felt to reduce the risk of dislocation by preserving the posterior capsule and careful attention is paid to repairing the vertical incision in the capsule and the gluteal muscles.

For intertrochanteric and subcapital neck of femur fractures treated with closed reduction and internal fixation, a supine position is utilised with the use of a traction table and image-intensifier navigation. A direct lateral approach is made, preservation of the vastus lateralis is attempted and metalware is placed in a fluoroscopic-guided fashion. A drain may be placed and generally, subcuticular dissolvable sutures are used to repair the incision site. Dressings are then applied.

The patients are then transferred to the orthopaedic ward following transfer from recovery, and antibiotics (Cefazolin 2gms) are instituted for two further doses post-operatively. DVT prophylaxis is undertaken and the patients are mobilised early with the assistance of the physiotherapy team. X-rays are taken post-operatively and this is repeated at six weeks to ensure that fracture union is satisfactory and alignment remains acceptable. Patients are reviewed if problems arise in the post-operative period after discharge from hospital.

Rehabilitation

It was agreed that all patients should be suitable for rehabilitation and weight bearing at 48 hours post-operatively. This meant implicitly that these patients would be well enough both medically and surgically to be transferred to the appropriate rehabilitation facility. In Canterbury there are two rehabilitation facilities. The first is a dedicated orthopaedic rehabilitation facility, which manages most of the older people with orthopaedic conditions that require rehabilitation. This unit is situated at another hospital and is integrated within the Department of Orthopaedic Surgery (Orthopaedic Rehabilitation Unit (ORU)). The more medically and cognitively compromised are mostly transferred to another hospital because of the more complex nature of their ongoing medical and social issues and the availability of medical/nursing staff and intensive diagnostic facilities (Older Person's Rehabilitation). The decision as to which institution they are transferred to is made pre-operatively or immediately post-operatively. The rehabilitation process is very similar to those previously described[5] and involves a multi-disciplinary team, which includes nursing, medical, occupational therapists, physiotherapists and social workers. The aim is to get people as independently mobile as possible and return them to their home and facilities or to find appropriate placement should this be needed.

There is small group (<5%) of patients that, because of the complex nature of their fracture and subsequent surgery, are unable to weight bear for mechanical implant and healing reasons. These patients are transferred to another hospital (88kms from our facility) for a period of between two to

six weeks when they undergo orthopaedic review and a decision made to weight bear and then transferred to ORU for rehabilitation but are not included here for analysis. Those who were not fast tracked because of medical/surgical unsuitability were not subject to this analysis but will be in future.

Fast Track study

The Fast Track pilot study began in November 2014 and continued to the end of April 2015. A similar group of patients from the previous three years were used for comparison. All patients admitted with a fracture neck of femur were included except those patients who were younger than 65 years old, had operation times longer than three hours or who ended up in convalescent care or unknown discharge facilities.

The pathway patient flow data were then compared for the following indicators: time spent in the ED, waiting time for theatre, waiting time for rehabilitation, time spent in acute service and time spent in rehabilitation as well as total length of stay. Sub-group analysis was then performed for eligible discharge and/or rehabilitation facilities. Data was also collected on discharge destination, readmissions and functional status, and compared with the pre-pilot study group Australian Rehabilitation Outcome Centre (AROC data).[12] This includes the standardised use of the Functional Independence Measurement tool (FIM™). FIM™ measures 18 items of function, (13 motor and five cognitive). It is scaled from one to seven, with seven being completely independent with a specific activity and one indicating that full assistance is required. It is based on activity over a 24-hour period and guided by observations made by staff over different shifts. Some of the activities include toileting, continence and mobility, etc. The activities are scored giving a functional independence measure (FIM™), which can be used at any stage of the hospital admission to determine progress, discharge destination and goal setting.

Estimated cost per bed day using Total Absorption costing[13] was assessed in the acute and rehabilitation setting. The functional status at discharge was available from AROC data set in only 403 (40%) patients before and 80 (50%) during the trial.

Statistical analysis

Data analysed using SAS 9.3. Wilcoxon Rank Sum test was carried out to assess differences between the two groups. Statistical significance was determined with p-value less than 0.05. Operation types were also compared using Chi-square test. Figures are presented using SPS, which has been adjusted for trend and cyclical variation. Projections of expected volume based on the previous 12-month trends are made from the point of the pilot intervention.

Results

The demography of the patient groups are shown in Table 2, including fracture type and operative intervention.

Table 1: Age, gender, fracture and operation type in before and after fast track patients.

	Before N/989 (%)	**After N/161 (%)**
Age		
Mean (SD)	84 (7.6)	85 (7.5)
Median (IQR)	85 (79 to 89)	85 (80 to 91)
Range	65 to 103	66 to 104
Gender		
Male	266 (26.9)	38 (23.6)
Female	723 (73.1)	123 (76.4)
Fracture type		
NOF, part unspecified	17 (1.7)	1 (0.6)
Intracapsular section of femur	22 (2.2%)	1 (0.6)
Subcaptial section of femur	445 (45.0)	65 (40.4)
Midcervical section of femur	31 (3.1)	4 (2.5)
Base of neck of femur	17 (1.7)	4 (2.5)
Other parts of neck of femur	9 (0.9%)	1 (0.6)
Trochanteric section of femur	22 (2.2%)	4 (2.5)
Intertrochanteric section of femur	35 (3.5)	4 (2.5)
Subtrochanteric	5 (0.5)	2 (1.2)
Shaft of femur	1 (0.1)	0 (0)
Supracondylar	2 (0.2)	0 (0)
Unspecified	361 (36.5)	68 (42.2)
Procedure performed*		
Internal fixation	583 (58.9)	113 (70.2)
Hemiarthroplasty	323 (32.7)	42 (26.1)
Total arthroplasty	83 (8.4)	6 (3.7)

P-values for comparison * <0.05 ** <0.01 *** <0.001

Eighty-four percent of patients were fast tracked from the emergency department to the acute surgical wards, 77% went to a ward designated for these injuries and another 18% were transferred to other orthopaedic beds. A small percentage were transferred to the orthopaedic trauma unit because of co-existing medical/surgical issues.

Sixteen percent were not fast tracked because they were either inter-hospital transfers, young patients with hip fractures and thus treated differently, medically unwell or had been wrongly classified and had peri-prosthetic or sub-trochanteric or pathological fractures. This group was not included in the analysis.

Anaesthetic procedure was not significantly different between pre- and post-fast track groups. General anaesthetic was performed in 68% of the fast track group and 59% of the pre-fast track group, spinal anaesthetic 21% (31% pre) and regional anaesthetic block 3% (4% pre). There were a small number of other anaesthetic procedures that did not significantly differ between groups (ie, femoral/sciatic lumbar plexus blocks).

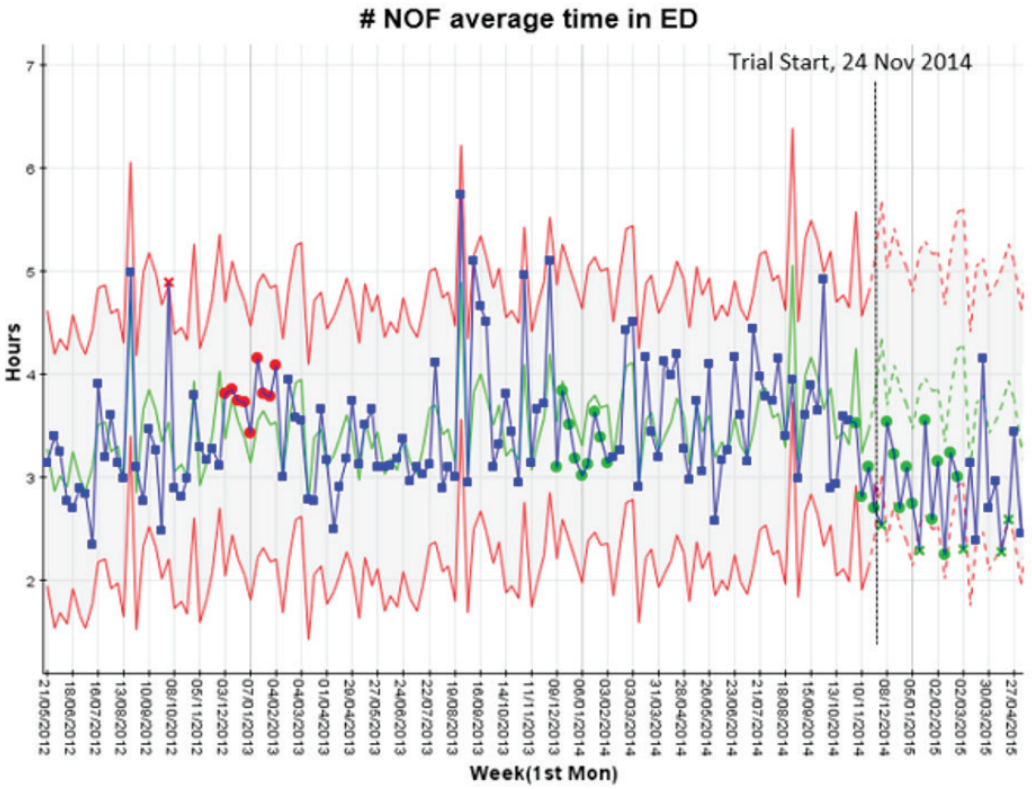
Emergency department

As demonstrated in Figure 2, the average time in the ED compared with the previous year decreased by half an hour (p=0.0001). All facets of the ED process appeared to contribute to this time reduction.

The average wait for theatre decreased by 3.6 hours (p=0.044) and the average time in theatre decreased by approximately 15 minutes (p<0.0001). The comorbidities that affected the wait for theatre are listed in Table 2 and were not different from the pre-study group. The most common was the use of "anti-coagulant like agents" in 17.5% of patients. Only Clopidogrel significantly delayed the time to theatre with an average of 3.35 days. Warfarin was ceased pre-op with a delay of 1.8 days and other agents such as Dabigatran and Dipyridamole had no effect. Aspirin was continued in most patients unless post-operation bleeding was an issue.

The average time to rehabilitation decreased by almost three days (p<0.0001) and was seen in both ORU 2$^{1/2}$ days (p<0.0001) and Older Person's Rehabilitation 3$^{1/2}$ days (p<0.0001). The overall total rehabilitation time decreased by almost seven

Figure 2: Average time in emergency department pre- and post-fast track process.



NZMJ 12 May 2017, Vol 130 No 1455
ISSN 1175-8716
www.nzma.org.nz/journal

Table 2: Co-morbidities of before and after fast track hip fracture patients.

ICD	Before N/989 (%)	After N/161 (%)
G45 – Transient cerebral ischaemic attacks and related syndromes	3 (0.3)	0 (0)
I21 – Acute myocardial infarction	74 (7.5)	11 (6.8)
I26 – Pulmonary embolism	17 (1.7)	0 (0)
I46 – Cardiac arrest	3 (0.3)	0 (0)
I48 – Atrial fibrillation and flutter	106 (10.7)	12 (7.5)
I50 – Heart failure **	73 (7.4)	3 (1.9)
I61 – Intracerebral haemorrhage	2 (0.2)	0 (0)
I62 – Other nontraumatic intracranial haemorrhage	1 (0.1)	0 (0)
I63 – Cerebral infarction	9 (0.9)	1 (0.6)
I80 – Phlebitis and thrombophlebitis	6 (0.6)	1 (0.6)
I82 – Other venous embolism and thrombosis	1 (0.1)	0 (0)
J12 - Viral pneumonia, not elsewhere classified	1 (0.1)	0 (0)
J13 – Pneumonia due to Streptococcus pneumoniae	0 (0)	1 (0.6)
J14 – Pneumonia due to Haemophilus influenzae	2 (0.2)	0 (0)
J15 – Bacterial pneumonia, not elsewhere classified	2 (0.2)	0 (0)
J18 – Pneumonia organism unspecified	65 (6.6)	8 (5.0)
K92 – Other diseases of digestive system	12 (1.2)	2 (1.2)
N17 – Acute kidney failure	60 (6.1)	16 (9.9)

P-values for comparison * <0.05 ** <0.01 *** <0.001

Table 3: Comparison in pathway activities between the before intervention group (n=989, 01/12 → 11/14) and the after intervention group (n=161, 11/14 → 04/15).

	Before		After	
	Mean (SD)	95% Confidence Interval	Mean (SD)	95% Confidence Interval
Average time in ED (hrs) ***	3.46 (1.46)	3.37 to 3.55	2.87 (1.33)	2.66 to 3.07
Average wait for theatre (days) *	1.62 (1.53)	1.52 to 1.71	1.47 (1.42)	1.24 to 1.69
Average wait for rehab (days) ***	7.13 (4.49)	6.85 to 7.41	4.29 (2.63)	3.88 to 4.70
LOS CHCH Hospital (days) **	10.44 (8.39)	9.34 to 11.54	7.13 (4.40)	5.59 to 8.67
Time to rehab ORU (days) ***	6.27 (3.90)	5.88 to 6.66	3.61 (1.90)	3.15 to 4.07
Time to rehab OPH (days) ***	7.84 (4.67)	7.35 to 8.34	4.22 (2.17)	3.66 to 4.79
LOS rehab ORU (days) ***	24.24 (12.41)	22.99 to 25.49	17.46 (6.68)	15.67 to 19.25
LOS rehab OPH (days) *	33.71 (14.20)	32.20 to 35.23	30.43 (14.07)	26.76 to 34.10
Overall LOS **	24.40 (15.06)	23.46 to 25.35	20.48 (13.59)	18.29 to 22.66

P-values for comparison * <0.05 ** <0.01 *** <0.001
Average times in components of pathway—ED = Emergency Department LOS = Length of Stay, ORU = Orthopaedic Rehabilitation Unit, OPH = Older Person's Health, with time related variable and significance.

days (p<0.0001) in ORU but only three days (p=0.048) in Older Person's Rehabilitation. The overall length of stay during the fast track pathway decreased by approximately four days (p=0.0001). Table 3 shows data on wait times and LOS.

The total readmission rate and total orthopaedic admissions remained the same over the course of the study.

Functional status pre- and post-fast track

The average FIM gain was unchanged compared with before (n=403) at 28.9% and during the trial (n=80) at 29.0% (see Figure 3). The missing data was due to incorrect coding status.

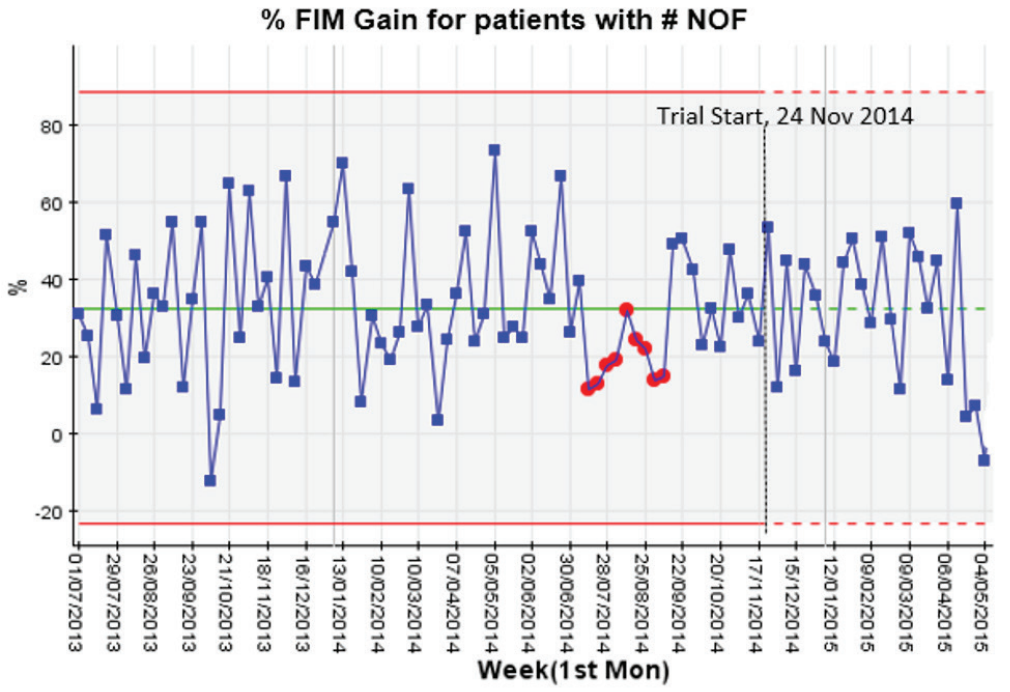
On average, fast track patients spent 95 less hours in hospital, resulting in 631 bed days saved (467 acute bed days and 164 rehabilitation bed days) with a projected annual bed days saving of 1,564 bed days. Using Total Absorption Costing (TAC)[13] the estimated cost per bed day in the acute setting is NZD1,200 and NZD850 in the rehabilitation setting (CDHB, 2015). Therefore, over the trial period the bed days stay equate to a projected saving of NZD699,800 across the whole of care pathway.

Discussion

We have shown that by altering the clinical management of fractured neck of femur patients that present to the ED can be admitted, operated on and undergo rehabilitation prior to discharge resulting in significant reduction in length of stay without compromising the patient.

In the ED, the average time reduced from 3.46 hours to 2.9 hours and although our target was 90 minutes, this is clearly a change in the right direction. This enabled the patient to get to the ward quicker, to be assessed, rehydrated, renourished and if necessary, additional medical and surgical co-morbidities addressed prior to theatre. The average wait for theatre has changed little from 1.62 days down to 1.47 days, and although this is statistically significant, the overall distribution would indicate that this is not clinically significant. This has led to a careful examination into the wait for theatre, including operating theatre assignment and use. Eligibility for transfer to rehabilitation 48 hours after their surgery reduced the time people wait for rehabilitation from 6.27 days to 3.61 days, and of greater importance was the reduced overall rehabilitation

Figure 3: Functional improvement at discharge so far.



	Pre n=403	Post n=80
Average % FIM Gain	28.9%	29.0%

Note: AROC data at time of writing only available for patients discharged from rehabilitation facilities between 1 July 2013 to 23 February 2015 (n=483).

length of stay (from 24.24 to 17.46 days) when patients undergo focused orthopaedic rehabilitation. Although time to transfer to an Older Person's Rehabilitation institution had decreased from 7.84 days to 4.2 days, the overall length stay at this institution continued to be long at 30.43 days (previously 33.71 days p=0.048). Although this study compares a historical group with the current fast track patients, we believe that the groups were comparable as during this pilot study period there was no significant increases in readmissions (<1%), the mortality rate remained stable (6%) and there was also no significant difference in co-morbidities or fracture types, and the functional gains experienced by patients were similar.

By using a statistically-based approach to analysing, interpreting and visually presenting the data, SFN helped to quickly identify that the changes in clinical management were effective. SFN was able to be viewed by staff on a weekly basis, using quantitative clinical measures. In addition, SFN's powerful 'point and click' analytics enabled the users to follow through an assessment into any aspect of the patient pathway in real time using patient data (Lightfoot, 2015).[11] This analysis is a key feature that enabled cross-functional teams to explore the root causes of process issues and to agree on the actions required to improve patient outcomes, therefore creating a high level of engagement with all clinical and non-clinical staff.

The beneficial effects of integration and co-operation through all departments involved in the management of fractured neck of femur was key to the implementation of the process and the results that were obtained. We have used accepted methods of management of hip fracture patients that are laid down by the Australian and New Zealand Guidelines.[1] The clinical management of the patients is not significantly different from previously published work.[1,5] The surgical procedures and anaesthetic methods are not significantly different and are in line with a recent published review on the orthopaedic medical management of the frail older patient.[6,13,15]

To our knowledge this is the only study to have used data integration coupled with significant change in the clinical management of hip fracture patients. Our total length of stay is comparable to other models of care, but ours is a joint model of care with a management of patients that is shared between surgeons and physicians. We have shown, however, that the length of stay of the fast track neck of femur patients can be substantially reduced. We first trialled these models of care in the 1990's[5] and they have been shown by others to be effective in reducing the length of stay[15,16] and post-operative complication rates.[16] The approach to clinician-led hip fracture management, audit and databases has led to substantial improvements in care and survival of older people with hip fractures.[17]

The importance of this pilot study shows that co-operation between departments with the aim of maintaining and improving clinical care but also trying to reduce the length of stay has been beneficial. The key to this outcome has been the rapid acquisition of data via the SFN system that enables early and robust measurement of the effects of change in practice.

The strength of this pilot study shows that the changes can be driven by weekly analysis of routinely collected data, which did not require manual collection of data and did not impact upon clinical time. The acquisition of data enabled the pathway to be monitored and protocols to be changed appropriately. During this pilot study there were no negative indicators, such as increased readmissions, mortality rates, different co-morbidities or change in functional improvement post-operatively. For the patient it meant that they spent an average of 95 hours less in hospital and co-operation between the acute and the rehabilitation setting was clearly beneficial.

The limitations of this study are that it is a pilot study over a 5-month period. The pathway has yet to be tested with larger numbers of patients and the impact of winter. Our work flow is not subject to seasonal change but overall numbers of NOF patients seem to be increasing along with the complexity of fractures and co-morbidities. Our hospital is a large tertiary hospital and the demands on its theatres are considerable. We were unable to make a significant impact in the wait for theatre and this is a limitation of this pilot study. Another limitation is that just under 20% of patients who were not fast tracked have not

been analysed as part of this analysis, and this may impact on the results and conclusions reached. We have not addressed in this paper the impact of community rehabilitation programmes in this group of patients.

The clinical relevance of this paper is obvious. Patients spend less time in hospital, with a reduction in bed days and subsequent financial savings. The integration of the SFN system and the ability to interpret this data quickly and modify the pathway is a significant improvement to patient management.

Of importance, focused orthopaedic rehabilitation produced the greatest reduction in the length of stay and possible benefit to patients, whereas non-orthopaedic focused rehabilitation in another hospital did not show significant reduction in the length of stay. There are many reasons for this, including frailty, co-morbidities and cognitive impairment, but this does signal that targeted orthopaedic rehabilitation should be the focus of any changes to the current system. Better understanding of the impact of frailty on hip fracture patients may help us manage these patients better by focusing our efforts on treating frailty.[18]

The longer waiting list and time for OPH reflected the more complex nature of patients and co-morbidities. This hospital now contributes to the Australian and New Zealand Hip Fracture Registry.

Conclusions

This study has shown with meaningful inter-departmental co-operation and modification of existing guidelines on fractured neck of femur patient treatment resulted in significant reduction in length of stay in all areas. The ED time was significantly reduced, ($p<0.0001$) time to theatre was not improved ($p=0.044$) and time patients had to wait to go the rehabilitation ($p<0.0001$) as well as the time in rehabilitation overall was significantly reduced ($p<0.0001$). Of interest, focused orthopaedic rehabilitation was far more effective than non-focused orthopaedic rehabilitation. The use of the SFN tool to acquire and analyse data has enabled significant improvements to the monitoring on a week by week basis. This is currently undergoing modifications and is an ongoing project.

Competing interests:
Nil.

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http://www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2017/vol-130-no-1455-12-may-2017/7245

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Increased use of police and health-related services among those with heavy drinkers in their lives in New Zealand

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ABSTRACT

AIMS: To report population estimates of service use because of someone else's drinking in New Zealand, investigate whether greater exposure to heavy drinkers relates to greater service use and examine demographic predictors of such service use.

METHODS: A general population survey of respondents aged 12–80 years was conducted in New Zealand. The sample size was 3,068 and response rate 64%. Respondents' use of police and health-related services because of someone else's drinking were measured along with self-reports of heavy drinkers in their lives, demographic variables and own drinking.

RESULTS: Ten percent of New Zealanders reported having called the police at least once in the past 12 months because of someone else's drinking—corresponding to 378,843 New Zealanders making at least one call to police. Almost 7% of the sample, representing 257,613 New Zealanders, reported requiring health-related services at least once for the same reason.

CONCLUSIONS: There are considerable numbers of New Zealanders requiring intervention from police or health-related services due to the effects of someone else's drinking. Further, increased exposure to heavy drinkers among respondents predicted increased service use. Heavy drinkers place increased burden on police and health-related services, not only because of directly attributable effects but because they impact others.

The New Zealand context

New Zealand is a high-income country with over 4.2 million residents and a per capita alcohol consumption, for those 15 years of age and above, of 9.5 litres of absolute alcohol in 2008.[1] Analysis has suggested that in New Zealand, as elsewhere, alcohol is one of the most important risk factors for avoidable injury and mortality in early and middle adulthood, and contributes substantially across the life course.[2] The contribution of alcohol to the burden on health services in New Zealand, such as the emergency department, is high.[3] In 2008, an estimate of the monetary costs of alcohol in New Zealand showed that alcohol cost New Zealand between 3.6 and 4.5 billion dollars.[4]

Consumption differs by age and socio-economic status and contributes to the inequalities found in New Zealand society.[5,6] The impacts of heavy alcohol use go beyond the drinker to those in the drinkers' environment; the health and wellbeing of New Zealanders is lower in those most exposed to heavy drinkers compared to those not exposed.[7]

Alcohol's harm to others

The importance of measuring alcohol's harm to others has received increasing emphasis in the research literature; not only because it's an important way in which the health and wellbeing of individuals may be reduced, but because estimates of alcohol's harm to others is likely to be important

for informing Global Burden of Disease and Injury estimates. Currently, alcohol-attributable fractions measure harm caused to the drinker while estimates of harm to others are excluded, meaning these statistics are underestimates of the total impact of alcohol. A first step is to begin to quantify alcohol's harm to others; effects otherwise described as the "collateral damage", "second-hand effects" or "negative externalities" of drinking.[8]

A number of specific studies have now been conducted assessing alcohol's harm to others. Studies from New Zealand and Australia reported that those with a heavy drinker in their life experienced reduced health and wellbeing.[7,9] In the European Union (EU), very conservative estimates of harm to others (based mainly on drink-driving, homicides and fetal alcohol syndrome) find that between 3% and 4% of the overall alcohol-attributable deaths in the EU are caused by harm to others.[10] In six European countries—Denmark, Finland, Iceland, Norway, Sweden and Scotland—the proportion of the survey respondents experiencing physical harm by a drunken person ranged from 2.6% in Denmark through to 5.7% in Finland.[11]

Service use by those with heavy drinkers in their lives

While some impacts of alcohol's harm to others are known, there are other areas that have been less well investigated, including the burden placed on services because of another's drinking. Where studies are available they have mainly assessed the use of services among those affected by dependent substance users—drug as well as alcohol users[12,13]—and have generally found that family members of dependent substance users utilise health practitioners more frequently or are more frequently hospitalised compared to families without a dependent substance user. A meta-analysis of 24 emergency department studies across 14 countries reported that the perpetrator was suspected to have been drinking in 52.5% of assaults presenting to emergency departments and in 23% in cases had definitely done so.[14] A study in New Zealand by Connor et al[15] showed that more than 62,000 physical assaults and 10,000 sexual assaults occur every year, which involve a perpetrator who has been drinking. Of these, 10,500 incidents required medical attention and 17,000 involved police.

In New Zealand, approximately 30% of police work is alcohol-related.[16] The proportion who have been drinking is similar for those treated for injury in urban hospital emergency departments.[3] However, the burden placed on such services related to another's drinking has not been reported. There are data on those who seek help from health providers to reduce their alcohol use; primary healthcare physicians—general practitioners and counsellors—are those most commonly approached.[17] However, again, how many of those affected by another's drinking who seek help from these sources in New Zealand is not known.

An Australian study assessed service use among those with a heavy drinker in their life among a general population survey sample. This study reported proportions accessing help and the demographic factors and level of harm from others drinking that predicted accessing help in the general Australian population. This study reported that 13% of respondents had called the police because of someone else's drinking and 4.5% had used a health related service in the previous 12 months. Key factors that predicted service use were the level of harm experienced from a drinker (as reported by the respondent), not having a partner and place of residence.[18]

Several factors may play a part in whether people seek help because of someone else's drinking or how often they do so, such as how many heavy drinkers they have in their life or whether they cohabitate with a heavy drinker or not. As such, this study will predict the use of services due to someone else's drinking among the general population based on an exposure to heavy drinkers index. This index has been used previously in work by Casswell et al 2011, and was created to examine the impact of exposure to heavy drinking and is based on an overall measure of numbers of heavy drinkers in the respondents' lives and household. This index has previously appeared to capture aspects relevant to the respondents' lives and/or households,[7] and the value of using it in the current analyses is that it allows for cumulative effects of exposure to heavy drinkers, if any, to be estimated in a respondent's life. Other

factors which may affect service use due to others drinkers may be related to the person affected, such as demographic characteristics or their own consumption of alcohol.

This study, then, reports population estimates of service use because of someone else's drinking in New Zealand, examines demographic predictors of such service use and investigates whether greater exposure to heavy drinkers relates to greater service use.

Methods

Data were collected using an in-house Computer Assisted Telephone Interviewing (CATI) System during 2008/9. Randomly generated landline phone numbers were generated to cover the whole country, and sampled in proportion to the usually resident population aged 12–80 years in the number's area. Telephone coverage in New Zealand was fairly high in 2008: approximately 92% of households had landline telephones. Certain sectors of the population are under-represented among those with access to a landline telephone and these are Māori (the indigenous people of New Zealand), Pasifika and single-parent households.[19,20]All eligible people in the household were enumerated, and one respondent was randomly selected by computer algorithm. Once a phone line had been recognised as a residential line, at least 10 calls were made at different times of the day and days of the week to attempt to reach a respondent. A high level of quality control is ensured by means of interviewer training, ongoing quality checks and supervision to ensure consistency of data collection (for further details see Casswell et al, 2002[21]).

The sample size was 3,068 and response rate 64%. This response rate was calculated using the formula: number of eligible responding/(the number of eligible responding + number of eligible non-responding + estimated numbers of eligible from the unknowns) x 100. Our method of calculating the estimated numbers of eligible from the unknowns is comparable to the AAOPR #3 response rate method (which uses the proportional allocation method to estimate the eligibles from the unknowns). Respondents were eligible if they were aged 12–80 years and had lived in New Zealand for at least 12 months.

The unweighted sample was reasonably representative of the New Zealand population aged 12–80 (Census 2006, see for example[22,23,24]). Weighting was applied to correct for respondent selection probabilities, to weight one of our area strata and to match the survey weights to New Zealand 2006 Census population distributions using Rim Weighting, for groups based on gender, age and ethnicity. Lastly, standardisation to match the weighted sample size back to the initial survey size was undertaken. Mean weight was 0.99 with standard deviation of 0.56.

Full ethical approval for this project was given by the Massey University Human Ethics Committee.

Measures

All measures were asked concerning the previous 12 months.

Heavy drinking associates: Respondents were asked: 'are there any people in your life whom you consider to be a fairly heavy drinker or someone who drinks a lot?' If they said "yes", they were asked to think about the first 'heavy drinker' in their life and state their relationship to that person, and how much of the last 12 months they had lived in the same household as the person. The respondents were then asked to think about the next heavy drinker in their lives. Respondents could report up to 10 heavy drinkers.

Service use because of someone else's drinking: Respondents were asked about use of services because of someone else's drinking, including calling the police and using health services specifically; requiring medical treatment at a general practitioner (GP) or after hours doctor, at a hospital/emergency department or requiring counselling/professional advice. The number of times respondents used these services was asked about; response options ranged from never to daily.

Demographic variables: age, quadratic age (reflecting the non-linear relationship found), gender, ethnicity (European origin; M**ā**ori; Pasifika; Asian), marital status (married/partner; divorced; single), employment status (full time; part time; students; unemployed/sick; retired; parenting), educational achievement (University degree; postgraduate degree;

professional certificate; diploma; trade/technical certificate; secondary certificate; non-secondary certificate) and income (no income; less than NZ$15,000; NZ$15,000–30,000; NZ$30,000–50,000; NZ$50,000–70,000; NZ$70,000 plus).

Respondent's own drinking: was assessed using a within-location beverage-specific measure, which achieves a high coverage of population-level consumption.[21] This obtains frequency and typical quantities consumed in a number of mutually exclusive locations.

Analysis

All statistical analysis was undertaken using SAS (Version 9.2) and significance was declared at $p<0.05$.

Index of exposure to heavy drinkers

An index of respondent's exposure to heavy drinker(s) was derived in order to account for the cumulative effect of exposure where respondents had multiple drinkers in their lives and, if relevant, the time the heavy drinker lived in the household, as previous research has found that heavier drinkers can have greater impacts on others when they live in the same household.[25] Weights were used only to categorise respondents; they were not used in the model itself. For each heavy drinker, weights were assigned 1: not/occasionally living in same household: 1.5: sometimes; 3: half of the time; 4.5: most of the time; 6: all of the time. Weights were summed across all heavy drinkers reported by the respondent and scores were categorised into three groups for analysis. Testing revealed that the weights showed consistency.

Level 0 = No heavy drinkers in life (n=2,173); Level 1 (Weight 1) (n=500); Level 2 = (Weight 1.1–3) (n=237); Level 3 = (Weight 3.1–6) (n=158). Due to lower numbers in Level 3, Level 2 and 3 were combined for analysis.

Analyses of service use

Descriptive analysis was undertaken to determine proportion of respondents who reported using each of the services in the past 12 months at least once. Additionally, the three health services asked about were combined to give an overall proportion of respondents using any of these (at least once). Logistic regression was conducted to predict respondent demographics against any service use in the past 12 months because of another's drinking (yes/no). Respondent's own consumption was also included (typical quantity in a drinking occasion and frequency). A proportional odds model for a univariate ordinal response was used to predict the relationship of exposure to heavy drinkers. Each model controlled for all demographics and the respondent's own consumption (covariates).[26,27]

Results

Proportion of New Zealand population using types of services

Ten percent of New Zealanders reported having called the police at least once in the past 12 months because of someone else's drinking, corresponding to 378,843 New Zealanders making at least one call to police (when converted to a proportion of the total population in 2008 aged 12–80 years). Almost 7% of the sample, representing 257,613 New Zealanders, reported requiring health services at least once for the same reason. Specifically, around 2% required medical treatment from a general practitioner or after-hours doctor, around 2% went to a hospital/emergency department and around 2.5% received counselling/professional advice because of someone else's drinking (Table 1, first column).

Index of exposure to heavy drinkers

The estimates in Table 1 (2nd–4th columns) show that, while controlling for a range of demographic factors and respondents' own consumption, lower exposure to heavy drinkers was not related to "getting medical treatment at a general practitioner or after-hours doctor" or for "getting counselling/professional advice (because of someone else's drinking)", but significant relationships were found for calling the police and going to a hospital/emergency department. Those with lower exposure were 1.4 times more likely to call the police or 1.9 times more likely to have gone to a hospital/emergency department than those with no heavy drinkers in their life because of someone else's drinking.

Significant relationships were found for those exposed to higher levels of heavy

Table 1: Prevalence of service use because of other's drinking, and its prediction by index of exposure to heavy drinkers.

Services	%	Exposure to heavy drinker (level 1) odds ratio	Exposure to heavy drinker (level 2) odds ratio	Linear contrast p-value
Had to call police	10	1.41 (1.01, 1.98)*	2.89 (2.12, 3.93)*	<0.0001
Had to get medical treatment at GP or after-hours doctor	1.8	1.35 (0.64, 2.86)	3.78 (2.08, 6.89)*	<0.0001
Went to a hospital/ emergency department	2.4	1.99 (1.02, 3.88)*	3.74 (2.09, 6.70)*	<0.0001
Got counselling/profes-sional advice	2.6	2.08 (0.93, 4.67)	8.53 (4.65, 15.65)*	<0.0001

drinkers for all variables investigated. Those with higher exposure to heavy drinkers were 2.9 times more likely to have called the police; 3.8 times more likely to have received treatment at a GP or after-hours doctor, 3.7 times more likely to have gone to a hospital or ED and 8.5 times more likely to have received counselling or professional advice because of someone else's drinking (compared to those with no heavy drinkers in their life).

Respondents' own characteristics predicting service use

Table 2 shows how respondents' own characteristics predict whether or not they had used any service (yes/no) because of someone else's drinking in the past 12 months. The findings show that older age, being Māori or Pasifika predicted using services because of someone else's drinking. With regard to income, being in the middle income groups, relatively speaking, predicted service use. Respondent's own drinking—including whether they consumed alcohol in the past 12 months—did not predict ever using a service because of someone else's drinking. Living with a partner also did not predict ever using a service because of someone else's drinking.

Discussion

The findings of this study are the first to show the extent of service use because of others' drinking in New Zealand. In 2008, when the survey was conducted, an estimated 378,843 (or 10%) of New Zealanders made at least one call to the police, and 257,613 (or 6.8%) required a health-related service because of someone else's drinking. These population estimates found in this study are in line with those found in Australia, which is New Zealand's nearest neighbour and which had a relatively similar level of per capita consumption in 2008 (10.32 litres absolute alcohol in Australia compared to 9.5 litres in New Zealand).[1,28] In Australia in 2008, 13% of the population had to call the police at least once in a 12-month period, and 4.5% used a health-related service because of someone else's drinking.[18]

The index we created to examine the impact of exposure to heavy drinking provided an overall measure of numbers of heavy drinkers and co-habitation and appeared to capture aspects relevant to the respondents' lives. This was evidenced by the relationships found in the data, which generally showed that the extent of exposure to heavy drinkers in respondents' lives was related to increased odds of services being utilised because of someone else's drinking.

In this study, those with greater exposure to heavy drinkers (which included cohabitation as one factor) had increased odds of service use. In some cases the odds were relatively large, including for "had to get medical treatment at a general practitioner or after-hours doctor" or "an emergency department/hospital", where respondents were almost four times more likely to have done so compared to those who had no exposure to heavy drinkers in their lives,

Table 2: Logistic regression: respondents' own demographic characteristics and consumption predicting service use.

Parameter	Odds ratios	LCI	UCI	P-value§
Age	1.06	1.01	1.12	0.020
Age in quadratic	0.99	0.998	1.00	0.003
Gender				
Female	B			
Male	0.92			0.494
Ethnicity		0.72	1.17	
European	B			
Asian	0.78	0.51	1.21	0.270
Māori	1.50	1.11	2.04	0.009
Pasifika	1.98	1.34	2.91	0.001
Marital status				
Partner (married/de facto)	B			
Single	0.94	0.70	1.27	0.690
Widowed/divorced/separated	1.29	0.85	1.95	0.230
Current employment status				
Full-time employee	B			
Part-time employee	0.99	0.66	1.47	0.954
Student	1.01	0.60	1.69	0.981
Unemployment or sick/on invalid	1.51	0.85	2.66	0.157
Retired	0.99	0.48	2.05	0.980
Parenting	1.19	0.72	1.95	0.495
Education level				
Did not complete secondary school	0.94	0.59	1.48	0.775
Completed secondary school	1.10	0.75	1.61	0.626
Trade or technical certificate	1.17	0.76	1.79	0.473
Diploma	1.20	0.75	1.92	0.441
Professional qualification	0.69	0.32	1.48	0.338
University degree	B			
Postgraduate degree	1.44	0.92	2.24	0.111
Personal income				
No income	1.26	0.65	2.44	0.495
<$15,001	1.50	0.82	2.72	0.185
$15,001–$30,000	2.11	1.29	3.44	0.003
$30,001–$50,000	1.61	1.02	2.53	0.039
$50,001–$70,000	1.54	0.98	2.43	0.061
$70,001+	B			
Own drinking				
Log of occasion quantity (ml)	1.04	0.88	1.23	0.631
Log of annual frequency	1.04	0.95	1.13	0.417
Drinker				
No	B			
Yes	0.93	0.45	1.90	0.833

B: reference category LCI: confidence interval—lower limit; UCI: confidence interval—upper limit.
§P-value at the 5% level of significance.

"received counselling/professional advice", where those exposed to heavy drinkers were over eight times more likely to have received counselling/professional advice. These findings are consistent with the wider literature showing that co-habitation with a heavy drinker is associated with greater impact.[7,25]

With respect to the respondent's own demographic characteristics: older age, being Māori or Pasifika, and having a higher income predicted using each of the services because of someone else's drinking. Living with a partner did not predict using a service because of someone else's drinking, even though those most exposed to heavy drinkers, as measured by the exposure index that included cohabitation as one aspect, had increased odds of frequency of using each of the services. This could mean that exposure to a greater number of heavy drinkers was more important than the cohabitation aspect of the exposure index. Another possibility is that those harmed by another drinker who is their partner may be less likely to report this.[18]

There is little provision of services directly for family members of others affected by a heavy drinker in New Zealand. Some specialised treatment and harm reduction services are family-inclusive, but there is generally a lack of assessment or intervention for those affected by the drinker.[29] Further, since most heavy drinkers do not receive treatment, only a small proportion of family members and significant others affected are likely reached through specialised treatment services. There are 12-step fellowships for those affected by the heavy drinking of another, eg, Al-Anon and helplines (eg, Alcohol Drug Helpline/Youthline). These were not, however, asked about in the current study.

Exposure to heavy drinkers is related to increased service use by those affected, and this contributes to the cost of running police and health services (which dominate public spending in New Zealand).[8] The cost of alcohol's harm to others to services remains largely hidden, however, as these data are not routinely collected or, if are collected, to the best of our knowledge these have not been utilised to estimate the costs to services in New Zealand. Routine measurement that documents the numbers of those that seek or receive help at services because of the effects of another's drinking, and the service provided, would allow costings in terms of dollars spent by services, and this information would contribute to the policy debate on the extent of alcohol's harm to others and could be taken into account in the alcohol policy making process, ie, translation into practical policy, service delivery and to inform interventions. The study has several limitations. The survey design was cross-sectional, which is a limitation in terms of drawing conclusions about causality. The measure of heavy drinkers was limited to the respondents' self-reports. Not all factors known to be associated with service use could be controlled for. Survey data usually suffer from under-representation of the members of the community most affected due to non-response biases.[30]

Conclusion

There are considerable numbers of New Zealanders requiring intervention from police or health-related services due to the effects of someone else's drinking. Heavy drinkers place increased burden on police and health-related services in New Zealand, not only because of directly attributable effects but because they impact others. Routine measurement of the numbers of those that seek or receive help at services because of the effects of another's drinking, and of the type of service provided, would provide useful data to contribute to the policy debate in the future.

Competing interests:
Nil.
Acknowledgements:
Funded by the Health Research Council of New Zealand.
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The cost of major head and neck cancer surgery

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ABSTRACT

AIM: This study quantified the cost of major head and neck cancer (HNC) surgery.

METHODS: Consecutive patients undergoing major HNC surgery between July 2007 and June 2012 were identified from our head and neck database. Patient demographics, tumour type, site, stage and types of resection and reconstruction, length of stay and surgical complications occurring within six months of initial surgery were retrospectively analysed. The actual cost of initial surgical treatment and hospital income were calculated.

RESULTS: Two hundred and forty-five patients underwent major HNC surgery, most commonly for mucosal squamous cell carcinoma (SCC) and metastatic and/or locally advanced cutaneous SCC. Neck dissection and parotidectomy were the commonest resection procedures and free flaps the commonest reconstructive procedures performed. Forty-two patients developed surgical complications within six months of the initial major HNC surgery. Over the five-year period, surgery cost a total of NZ$5,130,639.00, averaging NZ$20,941.38 per patient, not including costs such as incidentals, while the hospital received NZ$4,976,559.61 averaging NZ$20,229.91/patient. On average, oral cavity cancer, metastatic and/or locally advanced skin cancer, and skull base cancer cost NZ$22,694.72/patient, NZ$17,373.64/patient and NZ$47,295.95/patient, respectively.

CONCLUSION: Calculated hospital income marginally covered the actual cost of major HNC surgery, which places substantial financial burden on the hospital. The anatomic site of the tumour determines the cost of treatment.

Head and neck cancer (HNC) includes cancer arising from the upper aerodigestive tract (UADT; eg, oral cavity, oropharynx and larynx), major salivary glands, nasal cavity, paranasal sinuses, skull base and locally advanced and/or metastatic skin cancer.[1] New Zealand has the 4th highest incidence of oral cavity cancer (OCC) after Melanesia, South-Central Asia and Central and Eastern Europe,[2] and has one of the highest incidence of skin cancer in the world.[3] Metastatic cutaneous squamous cell carcinoma (cSCC) is the most common cancer affecting the parotid in New Zealand and Australia.[4] The incidence of HNC is greater in men, but the delayed and ongoing female smoking epidemic has led to an increased incidence of UADT cancer in women, especially in developing countries.[2]

Mucosal SCC (mSCC) is the commonest UADT cancer.[5] The major risk factors for UADT mSCC are tobacco use and alcohol abuse, which act synergistically.[6,7] They are responsible for 75% of all UADT mSCC in the US.[6] Betel quid chewing remains an important risk factor for oral cavity mSCC in South Asia,[8] while HPV infection has more recently emerged as an important cause of mSCC in the oropharynx, especially in younger patients.[9] Sun exposure in a high risk, predominantly fair-skinned population is the main risk factor for cutaneous malignancies in New Zealand and Australia.[3,10]

Treatment of HNC necessitates a multidisciplinary approach, often involving surgery, radiotherapy (RT) and chemotherapy (ChT). Apart from cancer in the oropharynx, nasopharynx and larynx, surgery remains the mainstay treatment for many types of HNC. It is technically challenging as attempts to attain clear surgical margins often necessitates anatomical and functional loss that affects the quality of life of the patient.[11]

The heterogeneous nature of HNC, its relative rarity and over-lapping involvement of various disciplines in its management

have led to the term 'orphan cancer'. The patient and disease characteristics of HNC in New Zealand have not been well defined. Furthermore, there is a paucity of information on the cost of treatment and the resources needed for the management of HNC, worldwide and especially in New Zealand.[11] Limited information is available on the cost of RT and ChT for HNC.[11] However, no information is available on the cost and resources needed for surgical treatment of HNC in New Zealand.

We retrospectively analysed patient and tumour characteristics using prospectively collected data of patients undergoing major HNC surgery and quantified the cost for surgical treatment.

Methods

Patients

All patients who underwent major HNC surgery at our regional Head and Neck & Skull Base Surgery Service, June 2007–June 2012, were identified from our prospectively maintained head and neck database. Major HNC surgery was defined as local excision of a primary malignancy with neck dissection and/or parotidectomy and/or reconstruction with a regional flap or free flap and/or immediate facial reanimation. Patients who underwent surgery for benign tumours of the head and neck (eg, ameloblastoma of the mandible and pleomorphic adenoma of the salivary glands, and benign orbital or skull base tumours) and/or reconstructive surgery not performed at the time of primary HNC surgery (eg, HNC patients referred for secondary facial reanimation) or for conditions not related to HNC (eg, facial reanimation for Bells' palsy or head and neck reconstruction for congenital anomalies) were excluded.

Data culled from the head and neck database included patient demographics, tumour type, site, stage and resection and reconstructive procedures, the length of stay (LOS), complications that occurred within six months of the initial major HNC surgery and their management including re-admission and return to theatre. Data were supplemented by information collated from patients' electronic records to document the resources needed for their surgical treatment.

Costing methodology

The actual cost of major HNC surgery was estimated by calculating the surgeons' and assistants' time in theatre, theatre time, intensive care unit (ICU) and/or high dependency unit (HDU) hours and inpatient LOS. It excluded all other costs of treatment, such as incidentals (eg, medications and dressing materials) during the inpatient stay, clinic visits, family doctor visits and nursing and allied health support in the community.

In-patient days

An inpatient 'day' was defined as a 24-hour period including an overnight stay. Day surgery was considered to be half an inpatient day. During the admission, the patient's stay in the ICU and/or HDU were also noted and calculated separately. An ICU admission was required for patients who needed ventilation.

Theatre time and surgeons' time

Theatre time was defined as the time between the patient entering and leaving the operating theatre. Surgeons' and assistants' time were quantified as the same as theatre time. Participating surgeons were categorised by specialty and seniority (consultant or registrar).

Our hospital's costing system quantified a bed day in the inpatient ward and ICU/HDU as NZ$502.00 and NZ$2,754.00, respectively. ICU and HDU are an integrated facility within our hospital. The cost for HDU and ICU bed days were considered to be the same according to our costing system. The theatre overhead cost was calculated at NZ$30/minute covering anaesthetic consultant, registrar, technician and equipment, theatre nurses and post-anaesthetic care. The surgeon's time was valued at NZ$2.09/minute, and registrar's time at NZ$1.44/minute. The actual cost of in-patient surgical treatment of HNC was calculated based on the above costing system, excluding other costs such as incidentals.

Surgical complications

All surgical complications that occurred within six months of the initial major HNC surgery and their management, including return to theatre, were recorded. Additional inpatient days to manage these complications were included in the total inpatient days. The costs of treating surgical compli-

cations occurring during the initial surgical admission were included in the total cost of the initial admission. The costs for re-admission were calculated separately. The costs of planned second-stage procedures and treatment of recurrence were also calculated separately.

Hospital income

Patient National Health Identifier and admission date obtained from our head and neck database were provided to our hospital's data analyst, who extracted the individual Diagnosis Related Group per patient from a complex coding system. The coding system provided a Case Weight Disease (CWD) value for each episode and each CWD was multiplied by the 2013 financial year indicator of NZ$4,614.36. This provided the income received by the hospital.

Results

Patients

Two hundred and forty-five patients underwent major HNC surgery during the study period, mostly New Zealand European males (Table 1). The incidence of HNC increased with age peaking in the 8th decade of life (Figure 1). Their smoking status at diagnosis is shown in Table 1.

Table 1: Demographics of patients undergoing major head and neck cancer surgery.

Age: median (range) in years	70 (11–94)
Sex: number (%)	
Male	170 (69)
Female	75 (31)
Smoking status: number (%)	
Smoker	32 (13)
Ex-smoker	101 (41)
Non-smoker	109 (44)
Unknown	3 (1)
Ethnicity: number (%)	
NZ European	200 (82)
Other European	24 (10)
NZ Māori	11 (4)
Other	10 (4)

mSCC with or without metastasis was most common (n=91, 37.1%), followed by locally advanced and/or metastatic cSCC (n=87, 35.5%). There were 20 (8.2%) cases of metastatic malignant melanoma (MM) with or without the presence of a primary tumour at presentation, and nine (3.7%) cases of salivary gland cancer. There were 11 (4.5%) cases of locally advanced basal cell carcinoma (BCC) and two cases of metastatic SCC with unknown primary. The remaining 25 (10.2%) cases consisted a heterogeneous group of rare malignancies (Table 2).

Surgical treatment

HNC resection procedures

Two hundred and sixty-five major HNC resection procedures were performed in 245 patients (Table 3) with curative resection in 240 (98%) patients, including 17 (7%) salvage cases, and palliative resection in five (2%) patients. One hundred and ninety neck dissections (165 patients) were performed, followed by parotidectomy (n=73), glossectomy (n=31), hemi-maxillectomy (n=28), other wide local excision of OCC (n=28), and marginal or segmental mandibulectomy (n=25). These and other resection procedures are listed in Table 3. Thirty-six (14.6%) patients also underwent dental extraction during major HNC surgery and 36 (14.6%) had an elective tracheostomy for resection of oral cavity (n=33), laryngeal (n=1), mandibular (n=1) and maxillary sinus (n=1) cancers.

Major HNC surgery involved plastic and cranio-maxillofacial surgeon in all (100%), dentist or oral and maxillofacial surgeon in 43 (17%), otolaryngologist in 22 (9%), neurosurgeon in 10 (4%), general surgeon in two (1%) and vascular surgeon in one (0.5%) cases.

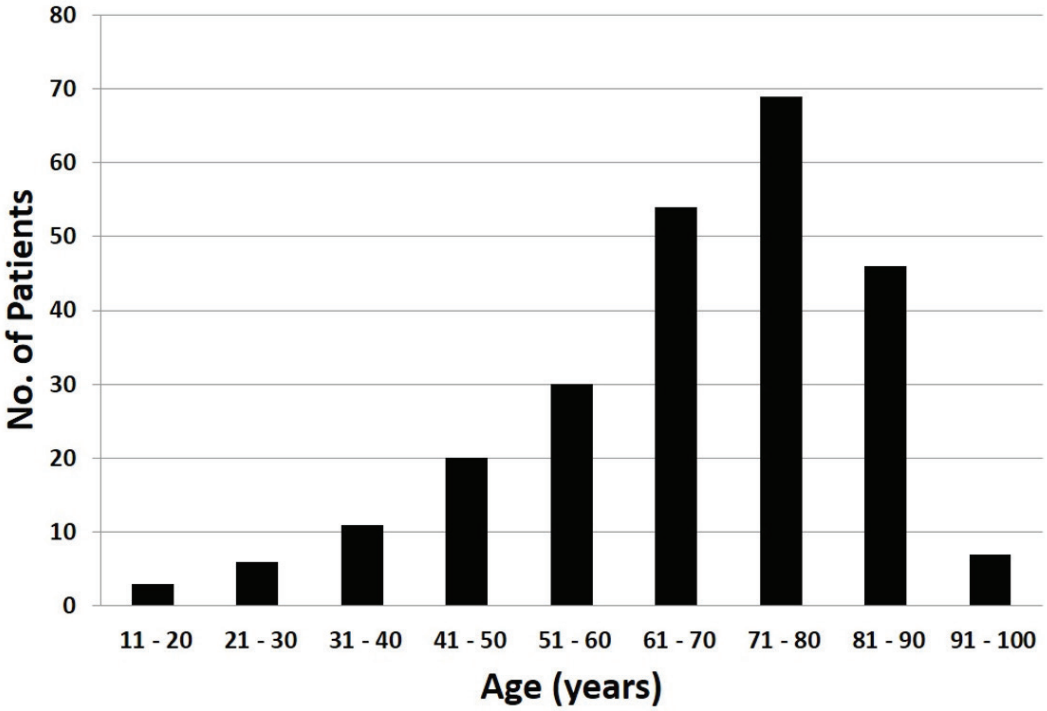
HNC reconstructive procedures

Free (n=88), regional (n=21) or local (n=80) flaps and/or skin grafting (n=6) were performed following major HNC resection in 172 patients. Direct closure was achieved in 73 patients and immediate facial reanimation was performed in 42 patients following sacrifice of facial nerve or its branches.

Theatre time

The average theatre time for major HNC surgery was 357 (range, 58–1,867; median, 318) minutes. The procedure that took

Figure 1: Number and age of patients undergoing major head and neck cancer surgery.



58 minutes was for excision of a locally advanced cSCC on the cheek, including partial parotidectomy and cervicofacial flap repair.

Length of stay

Following surgery, ventilated patients were admitted to ICU, non-ventilated patients requiring intensive nursing care were admitted to HDU, with the remainder admitted directly to the inpatient ward. Average LOS following surgery was eight (range, 1–48; median, 7) days, including ICU/HDU admissions for 112 patients who stayed for a mean of 32.4 (range, 2.1–149.2; median, 23.2) hours.

A 45-year-old female who underwent resection of a retromolar trigone mSCC, including marginal mandibulectomy, ipsilateral levels I-IV neck dissection, free flap reconstruction and elective tracheostomy, became delirious three days post-operatively with deranged liver function tests

Table 2: Types of head and neck cancer in 245 patients.

Histology	Number of patients
Mucosal SCC +/- neck metastasis	91
Locally advanced and/or metastatic cutaneous SCC	87
Metastatic melanoma +/- primary melanoma	20
Locally advanced BCC	11
Metastatic SCC with unknown primary	2
Other mucosal cancer +/- metastasis	10
Salivary gland cancer	9
Sarcoma	6
Lymphoma	2
Metastases from non-HNC	2
Other cancers	5

SCC, squamous cell carcinoma; MM, malignant melanoma; BCC, basal cell carcinoma; HNC, head and neck cancer.

Table 3: Two hundred and sixty-five major head and neck cancer resection procedures in 245 patients.

Resection procedures	No. of procedures
Neck dissection	190[†]
Parotidectomy	73
Superficial	54[‡]
Radical	17
Partial	2
Glossectomy	31
Subtotal	1[§]
Hemi	14
Partial	16
Hemi-maxillectomy	28
Radical	2
Partial/Subtotal	26
Mandibulectomy	25
Segmental	12[‖]
Marginal	13
Other wide local excision of oral cavity cancer	28
Floor of mouth	14
Retromolar trigone	8
Hard palate	4
Buccal mucosal	2
Pharyngectomy	14
Lateral wall	9
Soft palate	5
Tonsillectomy	3
Laryngectomy	2[¶]
Orbital eesection	14
Orbital exenteration	9
Orbital wall resection	4
Enucleation	1
Resection zygomatic arch	4
Lateral skull base	12
Lateral temporal bone resection	8
Mastoidectomy	3
Resection infratemporal fossa	1
Resection anterior skull base	9
Skull resection	13
Full thickness	9
Outer table	4
Submandibular gland resection	2
Rhinectomy	3
Pinnectomy	2
Carotid endarterectomy	1

[†]Unilateral in 140 patients and bilateral in 25 patients; [‡]25 patients had sacrifice of a branch(es) of the facial nerve; [§]As a salvage procedure for recurrent base of tongue SCC following chemo-radiotherapy; [‖]Mandibular condyle was excised in two patients; [¶]One case was of base of tongue SCC extending into the glottis.

due to choledocholithiasis. This patient had a history of poorly controlled epilepsy and type 1 diabetes, suffered a seizure during the admission with persistently low Phenytoin levels and poor diabetic control, and a minor oral wound dehiscence managed conservatively. An ERCP was deferred by the attending gastroenterologist and she was discharged to the Rehabilitation Service and remained in hospital for 48 days.

Patients with mSCC had the longest mean LOS (9.8 days), compared with locally advanced and/or metastatic cSCC (7.6 days). Patients with metastatic MM with or without a primary tumour at presentation had a mean LOS of 5.8 days while those with locally advanced BCC had the shortest mean LOS (4.3 days).

Patients with OCC had a mean LOS of 9.6 days compared to those with skull base tumours (10.2 days). Patients with OCC or skull base cancer had a mean LOS in the ICU/HDU of 37.5 and 42.5 hours, respectively.

Additional in-patient days for patients with surgical complications during the initial admission were included in the LOS of the primary event.

Surgical complications and re-operations

Forty-two (17%) of the 245 patients developed 59 complications within six months of surgery. Of these 38 underwent 51 re-operations acutely during the primary event. There were 14 re-admissions for complications in 13 patients who underwent eight re-operations (Table 4). The total LOS for patients re-admitted with surgical complications was 65 days with a mean of 4.6 days/re-admission.

Second-stage operations and treatment for recurrence

Twenty-five patients underwent 38 second-stage procedures with a total inpatient LOS of 81 (mean, 3.2) days (Table 5). Fifty-eight of the 245 patients developed a recurrence with 32 patients undergoing 39 salvage operations. The total LOS following surgery was 158 days with an average LOS of 4.9 (range, 1–7) days per procedure. Surgical cost estimates for second-stage procedures and for recurrence were calculated separately.

Calculated costs for major HNC surgery

Our surgical costing methodology calculated the total cost during the initial

Table 4: Fifty-nine re-operations for 42 patients who developed complications.

Procedures	Primary admission	Re-admission
Evacuation of haematoma	20	1
Free flap salvage	9	0
Revision of flap (for flap failure)	5	1
Drainage of seroma	11	1
Debridement of flap/wound	2	5
Change of dressing under GA	2	0
Closure of lymphatic leak	1	0
Debulking of flap	1†	0

†Acute debulking of flap to reduce pressure on orbital apex for orbital apex syndrome.

admission for major HNC surgery at NZ$4,567,310.46 over the study period, averaging NZ$18,642.08/ patient. The total cost of second-stage procedures was calculated at NZ$200,873.69, averaging NZ$8,034.94/ patient. The total cost for re-admissions for surgical complications was calculated at NZ$96,126.42, averaging NZ$6,866.17/ patient. The total cost of surgery for recurrence was calculated at NZ$266,328.43, averaging NZ$8,332.71/patient. The total cost for major HNC surgery for this cohort of patients was NZ$5,130,639.00, averaging $20,941.38/patient.

mSCC was the most costly subset with a total cost of NZ$2,139,096.16 (mean, NZ$23,506.57) while cSCC had a total cost of NZ$1,643,242.30 (mean, $18,673.21). These were followed by cutaneous MM (total, NZ$234,112.34; mean, NZ$13,006.24) and BCC (total, NZ$155,361.34; mean, NZ$14,123.76).

OCC had the highest total cost of NZ$2,042,524.51, averaging $22,694.72/ patient. This was followed by cutaneous malignancies (SCC, BCC and MM) with a total cost of NZ$2,032,715.98, averaging NZ$17,373.64/patient. Skull base cancer had the highest average cost of NZ$47,295.95/ patient (total, NZD$425,663.55) (Table 6).

The above calculated costs excluded all other costs of treatment of HNC, such as incidentals (eg, medications and dressing materials) during the inpatient stay, pre-operative work-up, clinic visits, family doctor visits and nursing and allied health support in the community.

Hospital income

In this study only total income from major HNC surgery for the initial admission for the 245 patients was calculated to compare with the actual calculated cost of the surgical treatment accounting for theatre time, surgeons' time, in-patient stay including ICU/HDU admissions. Over this period the hospital income for this cohort of patients was NZ$4,976,559.61, averaging NZ$20,229.91/patient.

Table 5: Second-stage procedures in 23 patients.

Types of procedures	Number of procedures
Division of flap	10
Thinning of flap	21
Brow lift	1
Exchange of gold weight on upper eyelid	1
Insertion of gold weight to upper eyelid	1
Correction of ectropion†	4

†With insertion of a cartilage graft (n=2) and a fascial graft (n=2).

Table 6: Cost of surgical treatment for major head and neck cancer by sub-sites.

Sub-sites	Total cost (NZ$)	No. of patients	Ave. cost (NZ$)/patient
Skin cancer	2,032,715.98	117	17,373.64
cSCC	1,643,242.30	88	18,673.21
cMM	234,112.34	18	13,006.24
BCC	155,361.34	11	14,123.76
Oral cavity	2,042,524.51	90	22,694.72
Lip	205,587.63	14	14,684.83
Oral tongue	530,898.06	22	24,131.73
Floor of mouth	371,239.04	16	23,202.44
Retromolar trigone	228,191.21	9	25,354.58
Buccal mucosa	86,207.41	6	14,367.90
Mandibular alveolus	134,737.92	6	22,546.32
Maxillary alveolus	145,149.12	6	24,191.52
Hard palate	156,584.50	5	31,370.90
Tonsillar fossa	149,221.42	5	29,884.28
Base of tongue†	34,708.20	1	34,708.20
Salivary gland	141,316.57	8	17,664.57
Skull base	425,663.55	9	47,295.95
Nasal cavity	194,537.29	6	32,422.88
Others	293,881.10	15	19,592.08

†Salvage procedure for management of recurrent base of tongue and supraglottic SCC.

Discussion

HNC are a heterogeneous group of malignancies affecting different anatomical sub-sites comprising different histopathological sub-types with different risk factors. Treatment of HNC requires a multidisciplinary approach and multi-modality treatment are often necessary depending on the location, stage and histological type of the tumour, and the patient's general health. Surgery remains the mainstay of treatment for many types of HNC, often requiring adjuvant RT and sometimes ChT.[12]

In 2011, there were 379 cases of OCC and 123 cases of nasal cavity, middle ear and laryngeal cancer in New Zealand.[13] The estimated incidence of cSCC in New Zealand is 118/100,000 with 75–80% affecting the head and neck region[3] and an estimated metastatic rate of 1.9%.[14]

Five-year all-cause mortality for head and neck SCC in the US is estimated at 51.3% with disease-specific mortality of 23.8%.[15] In New Zealand, UADT cancer accounted for 169 deaths in 2011.[13] Smoking and alcohol, that act synergistically, are the main risk factors for UADT cancer.[6,7] Eighteen percent of the New Zealand population currently smoke and 26% consume alcohol 3–4 times weekly.[16,17] Our study identified mSCC as the commonest malignancy reflecting the high rate of UADT cancer in New Zealand.[2,13] New Zealand also has one of the highest incidence of NMSC in the world with cSCC being the second most common.[3] As 75–80% of NMSC affect the head and neck region,[18,19] it is not surprising that locally advanced and/or metastatic cSCC constitutes the second most common HNC in our series.

Elderly New Zealand Europeans are at greatest risk of HNC and we show a peak incidence in the 8th decade of life. Māori have a lower incidence of OCC but higher mortality rates due to poorer access to healthcare and social determinants of health (death adjusted life years of 1.22 *cf* NZ Europeans).[20,21]Quantifying the cost of surgical treatment for HNC is challenging as the management is a continuum spanning in-patient, out-patient and community care involving medical, nursing and allied health components. Many of these patients also require RT and/or ChT. Fully estimating the cost of treatment would require inclusion of the cost of outpatient reviews and investigations, follow-up visits, post-operative surveillance, adjuvant RT and ChT, and hospice care for many patients. Invariably, patients requiring adjuvant RT and/or ChT would incur overlapping costs resulting in difficult cost estimates.

We elected to calculate the cost of surgical treatment during the initial admission and compare this with the income received by the hospital. Most of the cost of major HNC surgery consists of the personnel cost for the operative team, theatre infrastructure and LOS. These variables can be more accurately calculated while the costs of incidentals such as radiology, blood tests, medications and allied health input are difficult to quantify. The calculated hospital income of NZ$20,229.91/patient undergoing major HNC surgery appears to only marginally cover the calculated actual cost of NZ$18,642.08/patient, assuming that the incidentals and other costs are covered by the difference.

The average cost of primary surgical treatment for a HNC was calculated at NZ$18,642.08. If the cost of second-stage procedures, treatment of complications and recurrence are included, the estimated average cost increases to $20,941.38/patient.

Skull base cancer is most costly to treat while metastatic and/or locally advanced skin cancers, especially BCC, are the least costly. The location of the cancer indirectly affected ICU/HDU and inpatient LOS, thereby influencing the overall cost of treatment. Patients with mSCC had the longest LOS and hence the highest average cost, eg, OCC patients were more likely to require a tracheostomy, resulting in ICU/HDU admission and longer LOS.

A French study analyses hospital data of 36,628 HNC patients treated in the public sector over one year and attributes 23% of the annual treatment cost of £6,151–7,673 (NZ$11,164.99–13,927.65) to surgical treatment.[22]Using a micro-costing method based on unit costs determined by resources used for surgery, RT and ChT, a Dutch study of 854 patients analyses the economic burden of HNC, including diagnosis and treatment cost and a two-year follow-up, estimates an average total weighted cost of €21,858.00 (NZ$33,488.20)/patient.[23]

Our analysis of a cross section of patients undergoing major HNC surgery in Central New Zealand, their tumour characteristics and their resection and reconstructive surgical procedures shows that HNC involves substantial financial resources.

Competing interests:
Nil.

Acknowledgements:
We thank Sharon Morse, data analyst, at Hutt Hospital for her assistance in the analysis of the cost of major HNC surgery and hospital income in this study. Jenny Choi was supported by the Summer Student Scholarship at the Gillies McIndoe Research Institute.

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URL:
http://www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2017/vol-130-no-1455-12-may-2017/7247

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Is high-quality trauma care "business as usual" in New Zealand?

Ian Civil, Siobhan Isles

ABSTRACT

New Zealand is on the cusp of establishing a world-class trauma system. Many of the building blocks are in place with national and regional guidelines in both the pre-hospital and hospital phases of care established. A dedicated clinical workforce is available in all DHBs and national data available through the Major Trauma Registry. The greatest threat to achieving high-quality trauma care in New Zealand at this point is governance stability rather than clinical variability. Now is the time to lock the trauma system into a framework not subject to political or bureaucratic whims.

Physical injuries represent a significant burden to society, the healthcare system and the patient. In New Zealand, injury accounts for as much as 8% of total health loss from all causes.[1] Much of this health loss could be prevented or mitigated. The difference in outcomes between optimal and suboptimal care can impact on survival, total cost of care and quality of life in the months and years that follow.

In the early 90's, New Zealand had no effective trauma system, but as a result of a sentinel case and with the input of the Ministry of Health and the Royal Australasian College of Surgeons, a set of national guidelines was developed[2] that had the potential to revolutionise the care of the injured and to ensure best practice was evident throughout the country. Further, the Accident Compensation Corporation (ACC) determined to establish a trauma care pilot in the Central Region to test the basic principles embodied in the national guidelines and see what effect they might have on injury outcomes. Optimism about progress was expressed in a leading article published in the NZMJ at that time.[3]

Despite these promising initiatives, progress was not made. The recommendations of the national guidelines were never enacted in health policy and the ACC Trauma Pilot folded before any outcome could be determined. Our failure to progress the 1990's initiatives was highlighted in another publication in this journal,[4] and ongoing lack of progress brought the issue to a head in 2010.[5]

In 2011, the then National Health Board initiated the development of the Major Trauma National Clinical Network, sponsored by both the ACC and MOH, with the intent to establish a contemporary trauma system in New Zealand. The three initial work streams were to establish a formal trauma structure and system across New Zealand, to establish the New Zealand Major Trauma Registry and to develop consistent guidelines and plans for managing trauma in New Zealand.

The Network has just published its first annual report,[6] which includes data from the three North Island regions, and provides important insights into the overall care of patients and their hospital outcomes. In particular, it shows that the incidence of life-threatening (major) trauma is similar or slightly greater than most of the states in Australia (>40/100,000/year) and that the in-hospital mortality is acceptable (9%) but not as good as contemporary results in both Victoria and NSW. Other initial findings include the fact that over 20% of patients have to be transferred from one hospital to another in the first 72 hours after injury to receive definitive care, and not all hospitals consistently measure blood alcohol

on injured patients, missing an important opportunity to provide injury prevention information.

The activities of the Major Trauma National Clinical Network are providing a window into the quality of trauma care in New Zealand, and in large part the information is reassuring while at the same time showing where trauma care could be improved.

The Major Trauma National Clinical Network has been working to reduce variability within trauma care. The greatest threat to quality in any organisation is variability. The work of the Health Quality and Safety Commission has highlighted this in their promotion of the surgical safety checklist in the operating room and with their other work on hand hygiene and surgical site infection. In trauma care, guidelines are being developed and a national pre-hospital destination policy has been implemented. These will support the delivery of high-quality trauma care by reducing random variation and we hope to see outcome metrics improve.

While clinicians strive to provide high-quality care using best practice guidelines that not only ensure the right patients get to the right hospitals at the right time but also progress through agreed treatment pathways, they are inevitably influenced by the healthcare structure in which they work. The greatest threat to achieving high-quality trauma care in New Zealand at this point is governance rather than clinical variability. As will be evident from the history of trauma system development in New Zealand outlined above, there have been many false starts simply because individuals or structures have changed. Over the last 20 years, various individuals from ministers down to hospital managers have expressed great enthusiasm for trauma care initiatives and have often taken them a way down the track. Sadly, when these individuals change their positions the momentum is lost and new starts have to be engineered. Within large bureaucracies, internal reorganisations are common and the visions developed under previous structures often lost. In Victoria, the trauma care system is defined by legislature and as such is much less prone to changes of direction at political or bureaucratic whims.

New Zealand is on the cusp of achieving a world--class trauma system. We have made significant progress in the last five years to reassure healthcare providers that the quality of trauma care in most situations is good or excellent, but progress has been made before and the momentum lost. It is now time to lock the trauma care system into a structure that is not subject to changes of position or departmental reorganisation.

High-quality trauma care is “business as usual” in most hospitals in New Zealand, but a long-term vision of the system of trauma care and its sponsorship need to be instituted without delay so that the advances made over the last five years are not lost.

Competing interests:
Nil.

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Rotorua, hydrogen sulphide and Parkinson's disease—A possible beneficial link?

Yusuf Ozgur Cakmak

ABSTRACT

AIM: Rotorua city (New Zealand) is known for its 'rotten egg' smell, due to high levels of hydrogen sulphide (H_2S) concentrations emitted from local geothermal vents. Studies have shown H_2S as potentially toxic if too high in concentration. However, some health benefits have been observed at lower concentrations. This article summarises what is known about effects of H_2S on health and postulates whether ambient air inhalation levels of H_2S in Rotorua might have a therapeutic role in the management of motor symptoms in Parkinson's disease (PD).

RESULTS: Chronic H_2S inhalation has been shown to have a protective factor on dopaminergic neurons of animal models of PD. A large-scale survey of long-term Rotorua residents showed no evidence of health detriment nor impairment of cognitive functions. Intriguingly, however, participants in higher H_2S exposures showed a tendency for faster motor response times in a finger tapping test. One of the PD Motor Rating Scale examination tests for PD is finger tapping speed, as this is associated with motor performance. Might it be that relatively high, but safe, H_2S levels in Rotorua could help protect the degradation of dopaminergic neurons associated with PD?

CONCLUSION: An observed beneficial link between chronic H_2S inhalation in PD animal models and improved finger tapping scores in a sample of the Rotorua population, linked to dopaminergic nerve function, is worth investigating further.

High exposure of hydrogen sulfide (H_2S) gas is toxic to the human nervous system, and effects such as necrosis of the cerebral cortex in addition to the basal ganglia have been demonstrated.[1] In ambient air, the respiratory system is the main path for absorption.[2] Toxication reports underline the relationship between H_2S concentrations and related different organ system problems: 1,000,000–2,000,000ppb of H_2S exposure results in immediate respiratory paralysis, 530,000–1,000,000ppb of H_2S causes respiratory arrest, 320,000–530,000ppb of H_2S exposure includes a risk of death as a result of pulmonary oedema, 150,000–250,000ppb of H_2S blocks the olfactory sense and 50,000–100,000ppb can cause serious eye damage. Concentrations of H_2S for eye and respiratory irritation are reported in the range of 10,000–50,000ppb.[1–3]

Hydrogen sulfide intoxications are most often caused by occupational exposure events, up to 100,000ppb. Industrial sites with high risk for potential exposure and associated health problems include Kraft mills and viscose rayon plants, where concentrations are within the range of 3,000–20,000ppb. An accidental release of H_2S in Mexico, Poza Rica, exposed people to concentrations of 1,000,000–2,000,000ppb, and was claimed to be the cause of deaths and hospitalisations.[1,2] The concentration of H_2S occurring naturally in nature is much lower. Most likely, locations for naturally occurring H_2S gas concentrations in ambient air are those near sulfur springs and lakes in geothermally active areas. In a geothermal area, mean concentrations of up to 1,400ppb have been reported.[2] In contrast, maximum clean air concentrations in cities like London are dramatically lower at 0.1ppb.[1,2]

Rotorua city is within an active geothermal region in New Zealand. Exposure analysis in a Rotorua population group demonstrated H_2S concentrations to be only 20.8ppb (mean) for residences and 27ppb

(mean) in workplaces.[4] The highest concentration obtained, 64 ppb, is too low for intoxication levels, but certainly relatively high compared to non–geothermal regions like London (0.1ppb).[1] Overall, ambient air chronic exposure levels in the Rotorua region where 80,000 people live are measured as among the highest in the world.

These relatively high H_2S concentrations in the Rotorua region have been a focus of toxicology research in recent years. One study focused on examining links between asthma and chronic obstructive pulmonary disease (COPD) and H_2S concentrations for 1,204 participants. No evidence of reduction in lung functions or increased risk of COPD was found.[5] Another study surveyed 1,637 long-term adult residents and undertook neuropsychological tests, including visual and verbal episodic memory, attention, fine motor skills, psychomotor speed and mood.[4] Results showed no association between H_2S exposure and cognition. However, a small association was observed between higher H_2S exposure and improved simple reaction time, including finger tapping scores.

Two other observations were made regarding finger tapping scores. Firstly, that better performance was associated with higher H_2S exposure defined as the long-term exposure metric based on maximum exposures at home or work, and secondly that "there was some evidence of an interaction between age and the H_2S exposure metric for tapping with the non-dominant hand and this was in the direction of improved performance by older people associated with higher H_2S exposures".[4]

These associations could have been due to a positive bias effect of multiple testing as suggested by Reed et al, however, other research findings in the literature suggest they might be worth further investigating. There is no data in the published literature that chronic exposure to safe concentrations of H_2S is beneficial to cognitive function of the human brain, but examination of animal studies using PD models as well as indirect evidence in humans, including microbiota differences in PD patients, suggests there may be a biological basis for health benefits related to the prevention of degradation of dopaminergic neurons, associated with PD.

The number of dopaminergic neurons in the brain decreases as Parkinson's disease progresses and in PD animal models, H_2S as a gaseous neurotransmitter has been proven to have protective effects on dopaminergic neuron loss when inhaled.[6] In addition, it has been demonstrated that H_2S as a neuromodulator regulates striatal neurotransmission.[7] In humans, naturally low levels of H_2S gas occur in the body. This gas is synthesized by gut microbiota flora as well by enzymes in tissues where L-cysteine is metabolised, derived from alimentary sources or liberated from proteins in addition to synthesisation from L-methionine.[8] These enzymes are predominantly in nervous system, liver and kidney tissue.[8] Hydrogen sulphide functions as a gaseous neurotransmitter and helps maintain homeostasis of cellular energetics, vascular and anti-inflammatory processes. If certain levels of H_2S are necessary for healthy homeostasis of dopaminergic neurons, it may be that findings from a study on the abundance of a particular H_2S secreting Prevotellaceae, which showed that, relatively, abundance in gut microbiota of PD patients presents an interesting link.[9,10]

It may be that the observation of a small positive association between higher H_2S exposure and improved simple reaction time, including finger tapping scores, was not due to multiple testing (which all participants were subject to) but due to a higher concentration of H_2S in dopaminergic neurons. This is a speculative but tantalising idea that is worth further examining. Presently there is no normalised report for PD diagnosis and progression in Rotorua. Detailed and normalised (including ethnicity, smoking habits, age) survey studies are needed to investigate if there is a statistically significant difference of PD rates and symptom severities of Rotorua residents in comparison to other regions of New Zealand. This research question needs to be carefully developed. Improved finger tapping reports obtained in Rotorua residents exposed to higher chronic levels of H_2S give no clarity to potential benefical effects of H_2S exposure on Parkinson's disease. The PD animal models studies, where eight days of H_2S inhalation showed prevention of neurodegeneration,[6] showed results for acute rather

than chronic exposure, so are limited in relevance to the chronic exposure model that Rotorua provides. However, available knowledge that chronic exposure levels of H_2S inhalation in Rotorua are not harmful and possibly beneficial to motor functions is positive for any further studies that might be proposed to focus on the potential beneficial effects of H_2S on PD. In addition, the potential bottleneck of future studies is to determine the optimal inhalation dosages of H_2S for human PD studies. The H_2S levels in Rotorua (20.8–27ppb) would be the key to overcome the underlined bottleneck of the future human PD studies.

In conclusion, Rotorua with its unique, safe and relatively high concentration of ambient H_2S warrants closer examination to clarify whether there is a definite, positive correlation of inhalation of H_2S on human PD symptoms and pathophysiology.

Competing interests:
Nil.

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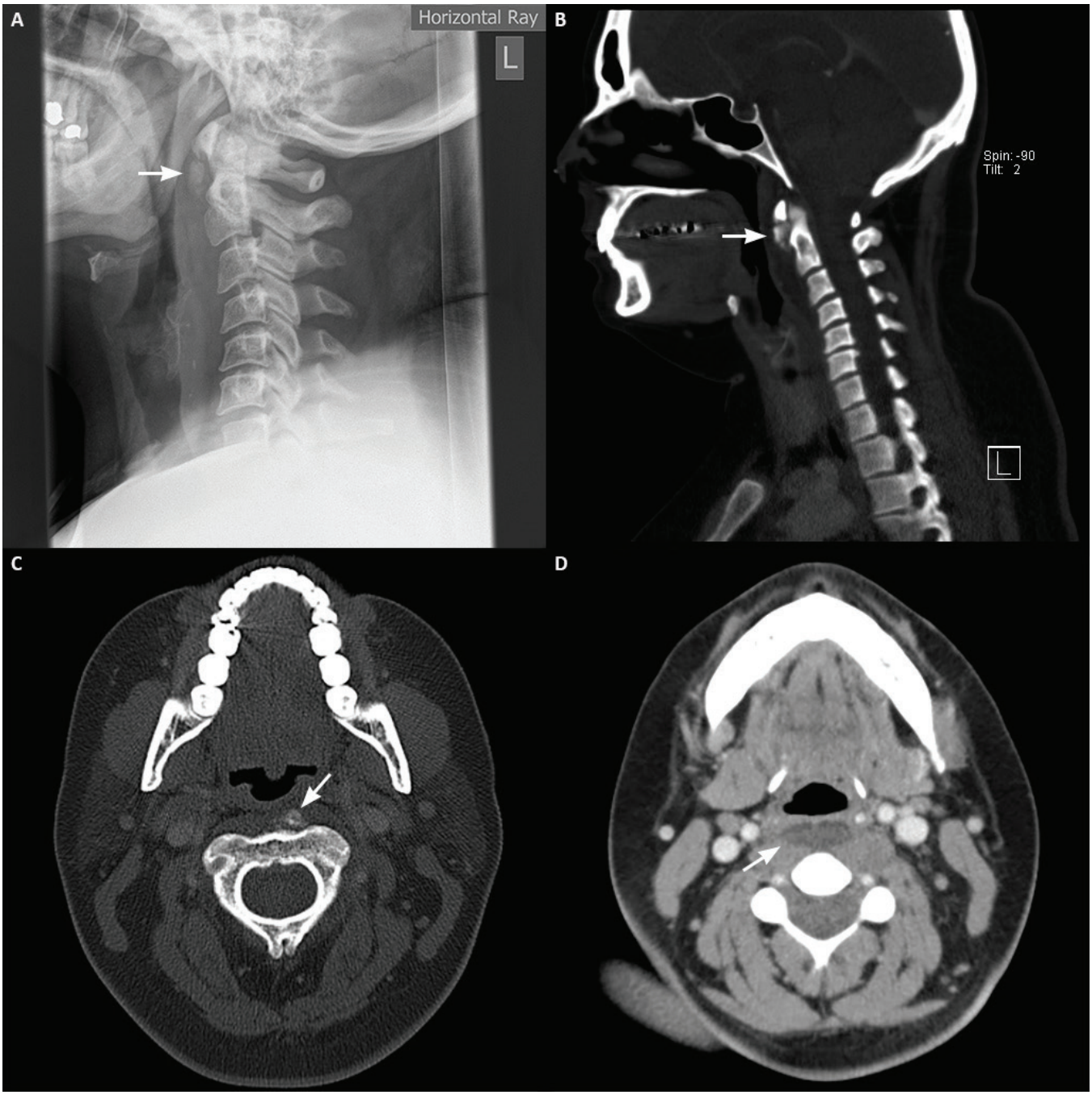
Acute calcific tendinitis of the longus colli muscle

Michael Plunkett, Hugh De Lautour, Adam Worthington

A 35-year-old female presented with a two-day history of severe neck pain and stiffness—particularly on the left—and moderate odynophagia. She had no history of fevers or trauma. She had tenderness on palpation of left cervical paraspinal tissue posteriorly, and marked limitation of cervical spine motion. White blood cell count was 15.5x10^9/L and C-reactive protein was 88mg/L (0–5mg/L). Cervical spine radiograph showed an area of calcification measuring 13x6mm within the prevertebral tissue anterior to C2 (Panel A, arrow) and prevertebral soft tissue swelling superiorly. Computed tomography (CT) of the neck revealed an amorphous focus of calcification within the left longus coli muscle anterior to the C2 vertebral body (Panels B and C, arrows), with associated simple fluid within the prevertebral space (Panel D, arrow).

Acute calcific tendinitis of the longus colli muscle was diagnosed. An oral non-steroidal anti-inflammatory was started and symptoms resolved within 10 days. Acute calcific tendinitis of the longus colli muscle results from asceptic inflammation of the longus colli muscle in the cervical prevertebral space, due to calcium hydroxyapatite crystal deposition.[1] It is benign and self-limiting and presents classically with acute severe neck pain, neck stiffness and odynophagia.[2,3] Inflammatory markers may be raised. Diagnosis may be made on imaging, with CT being the gold standard, showing pre-vertebral soft tissue swelling and amorphous calcification in the longus colli muscle anterior to C1–C2.[2] Treatment is usually with non-steroidal anti-inflammatory medications, with symptoms generally resolving within 1–2 weeks.[3]

Figure 1:



Panel A, lateral radiograph showing calcification anterior to C2 (arrow) with prevertebral soft tissue swelling.
Panels B and C, CT in bone windows showing amorphous calcification within the left longus colli muscle anterior to the C2 vertebral body (arrow).
Panel D, CT in soft tissue window showing simple fluid in the prevertebral space anterior to the C2 vertebral body (arrow).

Competing interests:
Nil.

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A case of confirmed primary hyperaldosteronism diagnosed despite normal screening investigations

Richard Carroll, Alana Gould, Joe Feltham, Simon Harper

ABSTRACT

Primary hyperaldosteronism is a common cause of hypertension in the adult population. We report a case of histologically and biochemically confirmed hyperaldosteronism related to an adrenal adenoma, where initial screening and biochemical tests were potentially misleading. The case highlights the importance of clinical suspicion in the current diagnostic approach to primary hyperaldosteronism.

Mr B (63m) presented with resistant hypertension, diagnosed aged 46, associated with significant hypokalaemia over the past four years. He remained hypertensive (150/90mmHg) despite controlled release metoprolol 47.5mg, felodipine 10mg, losartan 25mg, terazosin 5mg and spironolactone 25mg (all once daily). Serum potassium concentration was 3.9mmol/L (normal range 3.5–5.3) on four tablets of potassium daily (10 tablets per day before spironolactone). After withdrawing spironolactone for six weeks, the plasma aldosterone concentration was 283pmol/L with a plasma renin activity of 0.7nmol/L/hour, giving an Aldosterone Renin ratio (ARR) of 441(normal <750). Other endocrine causes of hypertension were excluded.

An abdominal CT scan excluded reno-vascular causes of hypertension and demonstrated a likely adenomatous 9x12mm left adrenal nodule (Figure 1). On the basis of a significant pre-test probability of hyperaldosteronism (clinical presentation and adrenal nodule), we proceeded to a saline infusion test (SIT) having first withdrawn spironolactone (six weeks), Losartan (four weeks) and metoprolol (two weeks). This test demonstrated an abnormal baseline ARR, but apparent normal aldosterone suppression at four hours (Table 1).

Table 1: Results from a saline infusion test (SIT).

	Plasma aldosterone (pmol/l)	Plasma renin (mIU/L)	Serum potassium (mmol/l)
Saline infusion test A			
Time 0	585	39.3	3.8
Time +240	124	16.7	3.1
Saline infusion test B			
Time 0	575	28.8	3.7
Time +240	392	-	3.5

Aldosterone, renin and potassium concentrations were measured immediately before and after the infusion of 2,000ml of 0.9% saline over four hours while the patient remained seated. 40mmol of potassium was added to the infusion during SIT B. An aldosterone concentration of <140 pmol/L at 4 hours represents normal suppression, while a level >210 pmol/L confirms hyperaldosteronism.

Table 2: Adrenal vein sampling results during ACTH infusion.

	Central/ peripheral	Plasma aldosterone (pmol/L)	Serum cortisol (nmol/L)	Aldosterone: Cortisol ratio
Right adrenal vein	Central	17,900	19,866	0.9
	Peripheral	1,720	565	3.0
Left adrenal vein	Central	310,000	11,888	26.1
	Peripheral	1,500	565	2.7

Central to peripheral cortisol ratios were >5:1 bilaterally confirming appropriate placement of the catheter in each adrenal vein. A left:right adrenal vein aldosterone:cortisol ratio of 29 confirmed lateralisation of aldosterone excess to the left adrenal gland (lateralisation confirmed by a ratio >4:1).

As hypokalaemia had developed during the SIT, this was repeated with potassium added to the saline infusion. On this occasion, post-infusion aldosterone concentrations were clearly inappropriately elevated, confirming a biochemical diagnosis of hyperaldosteronism (Table 1). Mr B proceeded to adrenal vein sampling (AVS), which confirmed lateralisation of hyperaldosteronism to the left adrenal gland, consistent with the radiological findings (Figure 1).

Following stabilisation of blood pressure and potassium concentrations, Mr B underwent left posterior retroperitoneoscopic adrenalectomy without complication. Histological analysis confirmed an adrenocortical adenoma with nodular proliferations of adrenocortical tissue elsewhere in the specimen. At follow up, Mr B has a serum potassium of 4.7mmol/L (no supplements) and a blood pressure of 130/78mmHg on daily Metoprolol 47.5mg and Felodipine 10mg.

Summary

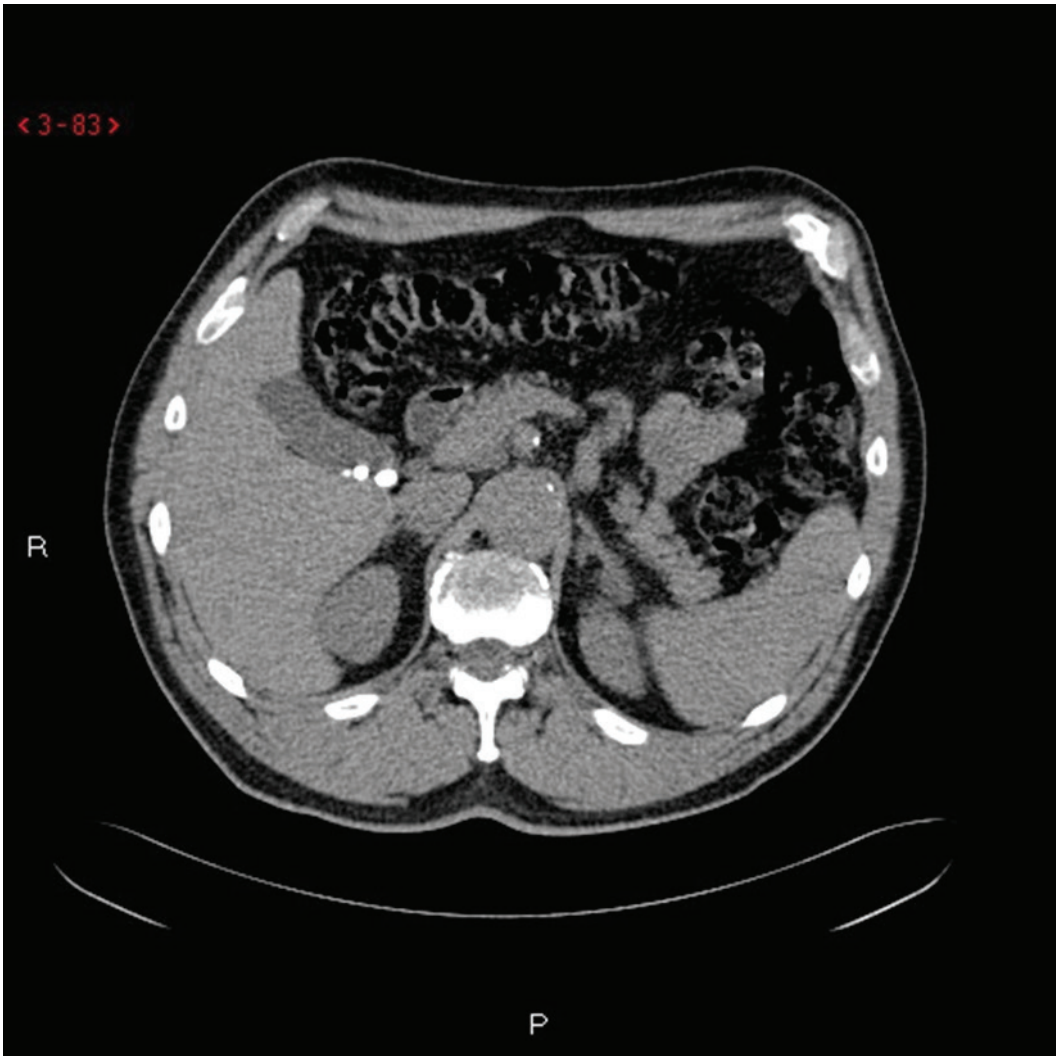
This case illustrates some complexities in the screening for and diagnosis of a common cause of hypertension. Hyperaldosteronism is identified in approximately 6% of cases of adult hypertension, with case detection on the basis of clinical features recommended by recent guidelines (see Figure 2).[1,2] In contrast to historical opinion, hypokalaemia is now known to be present in only a minority of patients with hyperaldosteronism, with normokalaemic hypertension representing the typical presentation.[2] Confirmation of hyperaldosteronism is of value as it provides the opportunity for resection of unilateral adrenal pathology with resultant resolution of hypokalaemia, and significant improvements in blood pressure control[3] and cardiovascular morbidity independent of the degree of hypertension.[4]

In this confirmed case of hyperaldosteronism, it is of interest to consider the initial diagnostic tests. The screening test was normal, dissuading the attending physician of the need to further explore the possibility of hyperaldosteronism. To increase the ease of testing for a common condition, guidelines recommend screening for hyperaldosteronism while the patient is on anti-hypertensive medications bar spironolactone, epleronone and potassium wasting diuretics.[2] However, the concurrent use of interfering medications or dietary sodium restriction may significantly decrease the sensitivity of the ARR for detecting hyperaldosteronism, unless an altered diagnostic cut-off is utilised.[5–7] Thus, a normal screening ARR does not exclude hyperaldosteronism and the result should be interpreted in light of the clinical probability of hyperaldosteronism. Here, a repeat ARR under more stringent test conditions was clearly abnormal.

Hypokalaemia is a potent inhibitor of aldosterone release in health, and potentially also in the context of hyperaldosteronism, falsely lowering the circulating aldosterone concentrations.[8] During the first SIT, potassium concentrations fell significantly, which may have directly lowered the circulating aldosterone concentration. With potassium added to the saline infusion during the second study, normokalaemia was maintained and circulating aldosterone concentrations were clearly inappropriately elevated.

Hyperaldosteronism is a common cause of hypertension. In the context of screening for or confirming biochemical hyperaldosteronism, normal results should not

Figure 1: CT abdomen demonstrating a hypodense lesion measuring 9mm in maximal diameter in the lateral limb of the left adrenal gland. The right adrenal gland and other structures were reported as normal.



necessarily be considered definitive, especially if current medication use is likely to affect the sensitivity of the ARR, or significant hypokalaemia is present. If the clinical picture is suggestive, it may be reasonable to either repeat testing or occasionally pursue a diagnosis of primary hyperaldosteronism despite initial normal tests, after discussion with an endocrinologist.

Figure 2: Endocrine society guidelines for the case detection of primary hyperaldostonerism.[2]

- Blood pressure >150/100mmHg on each of three measurements on different days
- Blood pressure (140/90mmHg) resistant to three conventional anti-hypertensive drugs, or controlled on ≥4 drugs
- Hypertension and spontaneous or diuretic induced hypokalaemia
- Hypertension and an adrenal incidentaloma
- Hypertension and sleep apnoea
- Hypertension and a family history of early onset hypertension or a stroke at <40 years of age
- Hypertensive first-degree relatives of patients with primary hyperaldosteronism

Competing interests:
Nil.

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Unmet need and antenatal care

Ben Gray

The editorial by Matheson and Ellison-Loschman[1] rightly suggest that "more attention must be given to prioritising, measuring and responding to unmet need". Arguably, the most cost-effective screening/public health programme that we use is ante-natal care. In Primary Care we have targets for other screening and public health programmes like cervical screening, smoking cessation and immunisation with sanctions applied if we fail to meet targets. It is remarkable that until recently there has been no similar programme for the provision of ante-natal care. Worse than the lack of a programme is the fact that the Ministry of Health does not routinely provide accurate information on how many women did not receive any or sufficient antenatal care. While there is data on the number of women registered with a lead maternity carer in the first trimester, there is no information on the 30% who had not registered by that time, some of whom had no care.[2] The new Better Public Services target of "90 percent of pregnant women registered with a lead maternity carer (LMC) in the first trimester" is a welcome focus on this problem, but was introduced without adequate consultation with midwives who have major reservations about being able to achieve the target.[3] Many hospitals report difficulty recruiting sufficient midwives, and retention of midwives in the profession has fallen from working for 15 years to only working for six years.[4] It is the hospital midwives who provide care for women who cannot find a community midwife, so this problem should be ringing alarm bells. If we do not count how many women do not receive antenatal care it is entirely plausible that progress towards the minister's target could be made without affecting the numbers receiving no care who should be the first focus of our attention. I have argued elsewhere[5] that there is a fundamental problem with our system of providing antenatal care, but without information on those women who do not access this care it is impossible to respond sensibly.

Competing interests:
Nil.

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Coeliac disease and fertility in New Zealand women

Catherine Rees

During the course of research for a book on coeliac disease (CD), I conducted an online survey among New Zealand women with CD to examine their experiences of fertility, pregnancy and births. Invitations were sent out in November 2016 by Coeliac New Zealand via their email newsletters and Facebook page. Two hundred and sixty women responded to the survey, of whom 200 had biopsy-proven CD. Median age at CD diagnosis was 33 years (range 2–80 years).

Respondents were asked if they had had, or tried to have, a baby before they were diagnosed with CD; 65 had been diagnosed before trying to have a baby, and 133 people were diagnosed after trying to start their family. Two people did not answer this question. Groups were compared using a 2-sample t-test for categorical analysis of proportions. For other variables, a linear regression model or log-linear regression model was used to compare groups, with "diagnosed after trying to get pregnant" as the dependent variable.

Results are shown in Table 1. Women who were diagnosed with CD before trying to become pregnant had a significantly higher number of pregnancies and live births compared with women who were diagnosed earlier, possibly because of differences in age between the two groups. Women diagnosed with CD after starting a family were significantly more likely to have had a miscarriage (45% vs 19%) and had on average more miscarriages per person (1.6 vs 1.2) compared with those who had been diagnosed prior to trying to get pregnant. However, the rate of miscarriage in the two groups was not significant after adjusting for differences in the number of pregnancies (P=0.886). Although a higher proportion of women diagnosed with CD after vs before trying to start a family sought medical advice about conception difficulties, the between group difference was not statistically significant. The group diagnosed with CD after trying to start a family also had a significantly increased incidence of a premature delivery (19.4% vs 3.4%), and the incidence of preterm delivery in late diagnosed women was higher than the New Zealand average of 7.3%.[1] However, after adjustment for between-group differences in the number of pregnancies, the difference in the rate of premature delivery among women diagnosed later vs earlier was of borderline statistical significance (P=0.0678).

This research is limited in a number of ways. First, surveys are subject to recall and response bias, and I did not survey women without CD as a control group. Second, the two groups were not comparable in age, which could have affected pregnancy and miscarriage rates since these are known to be affected by age. Third, the survey did not capture information about the timing of CD treatment in relation to pregnancy. Even assuming that all participants followed the recommended gluten-free diet after their CD diagnosis, it may take years for CD patients to achieve mucosal healing and correction of body composition abnormalities.[2]

Despite these limitations, the findings suggest that undiagnosed CD may contribute to worse pregnancy outcomes. This is consistent with case-control studies showing that pregnancy outcomes can be affected by undiagnosed CD.[3–10] In these studies, undiagnosed CD was most commonly associated with intrauterine growth retardation and low birth weight,[4,5,8,9] and to a lesser extent miscarriage,[3,7,11] whereas diagnosed CD was not.[3,4] According to one study, undiagnosed CD increases the risk of having a small for gestational age infant by 7-fold.[8] Some of the women in this survey had been pregnant before and after their CD diagnosis, and reported having small and early babies before their diagnosis, but bigger babies

Table 1: Pregnancy and birth results in women who were diagnosed with CD before and after trying to start a family.

	Diagnosed with coeliac disease before trying to have children (n=65)[a]	Tried to have children before being diagnosed with coeliac disease (n=133)[a]	P-value
Mean (SD) age at CD diagnosis, years	24.5 (10.8)	38.6 (9.7)	<0.0001
Mean (SD) time to first pregnancy, months	8.2 (16.6)	11.7 (21.6)	0.169
Mean (SD) number of pregnancies per person	1.7 (1.3)	3.3 (2.1)	<0.0001
Had experienced a miscarriage, n (%)	11 (16.9)	59 (45.0)	0.0002
Mean (SD) number of miscarriages per person	1.4 (0.9)	1.6 (1.2)	0.0002
Had consulted a doctor about time taking to get pregnant, n (%)	16 (25.0)	45 (33.8)	0.275
Had undergone or was on waiting list for fertility treatment, n (%)	9 (13.8)	23 (17.4)	0.6637
Mean (SD) number of live births per person	1.2 (1.2)	2.5 (1.4)	<0.0001
Had had a premature delivery,* n (%)	2 (3.4)	25 (19.4)	0.0019
Mean (SD) number of premature births per person	1.0 (0)	1.4 (0.7)	0.449
Mean (SD) gestational age of premature infants, weeks	34.2 (1.8)	33.8 (2.9)	0.267

*Live birth at <37 weeks' gestation.
[a]Percentages are based on the number of responses to a specific question

closer to term after their diagnosis. Based on the previous literature and the current findings in a large cohort of New Zealand women, it would seem prudent to screen pregnant women for CD in New Zealand, especially since CD is particularly common in women of childbearing age,[12] and arguably more prevalent than some of the other conditions which are now part of the standard pregnancy screening panel.

Competing interests:
Nil.
Acknowledgements:
Thank you to Jean Tang at Coeliac New Zealand for her assistance with distributing the survey, Thomas Drain of TRA New Zealand for the statistical analysis and all the women with CD who took the time to complete the survey.
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http://www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2017/vol-130-no-1455-12-may-2017/7253

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Heather Thomson

19 September 1931–1 April 2017

MNZM, Co St J, FNZMA, MB ChB, Dip Obst

Heather Thomson (nee Baillie) was born in Invercargill, 19 September 1931. Brought up in Southland with two older brothers and hard working parents, she decided to become a doctor at the age of nine. She attended Southland Girls High School and became Dux in 1949, achieving third in New Zealand for Scholarship Latin. A hard working and determined student, she went to Otago University in 1950 where she boarded for the next six years at St Margaret's.

Heather was a distinguished medical student; one of only five women in her class of 100, she won the Scott Medal for Anatomy in her third year. Graduating in 1955, she went back to her home town and completed her first house surgeon year at Kew Hospital where she met her husband, Forrester Thomson, a returned serviceman and a pathology registrar.

After they married, Forrester and Heather moved to Mataura where Forrester ran a busy rural practice and Heather gave birth to four girls in quick succession. Forrester's ill health necessitated Heather's early return to medicine. It was in Mataura that 'Dr Heather' started her long association with St John's. Heather spent over 40 years supporting St John's with tutorials and examinations, and her contribution was recognised in 2006 when she was awarded the Office of Dame Commander of the Order of St John.

'Dr Heather' moved to Invercargill, with her four daughters, in 1968 to escape an unstable home situation. Forrester passed away six years later. She spent three months as a house surgeon at Kew Hospital before setting up in what was to be a very busy general practice attached to the family home—normal for the time. She became a

GP anaesthetist and was on call for emergencies, and had regular lists at Kew Hospital and privately at Park Hospital, later to become Southern Cross. She delivered over 3,000 babies during her time in Invercargill.

In 1978, following the controversial passing of the Contraception, Sterilisation and Abortion legislation the year before, she was shoulder-tapped by local MP and Minister, Bryan Talboys to become one of three members of the first Abortion Supervisory Committee. She thoroughly enjoyed her three-year term and it gave her a taste for national medical politics. She was part of the NZMA committee, which took part in maternity negotiations in the 1990's and later became a Fellow of the NZMA.

Heather went on as one of the first doctors to go to China to study acupuncture, and used it for a time in her private anaesthetic practice for post-operative pain relief, but soon discontinued it in favour of more effective methods.

Heather became an Invercargill City Councillor in 1999 and stayed on for three terms. She represented the council on the Southland Heritage and Rural Trust among others and enjoyed her work on the Boards of the Southland Museum and Art Gallery, the Southland Theatre Charitable Trust and as President of the Anderson Park Art Gallery for ten years.

In 2007, Heather was awarded a Member of the New Zealand Order of Merit in recognition of her services to medicine and her local community.

In her spare time, Heather enjoyed going to her holiday house in Arrowtown where she gardened and read books. She was a talented seamstress and later enjoyed painting and making furniture. She travelled widely with family initially and later with friends.

Heather moved to live in Dunedin seven years ago to be close to family and quickly made friends playing bridge and attending lectures at U3A. She was a member of her local church and enjoyed walking her faithful companion Katie around Māori Hill, stopping to talk to anyone and everyone. Heather died suddenly on 1 April 2017 and is survived by her four daughters and seven grandchildren.

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http://www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2017/vol-130-no-1455-12-may-2017/7254

Early death after discharge from emergency departments

The problem evaluated in this study is that many people die soon after being sent home from US emergency departments, and what aspects of patients and hospitals are linked to increased risk?

Data was obtained from the US Medicare programme. Patients with known life-threatening diseases, those receiving palliative care and those older than 90 were excluded from the analysis. Over 10 million patients were involved and apparently 0.12% died within seven days.

Atherosclerotic heart disease was the commonest cause of death. The researchers were unable to determine whether such outcomes were caused by medical error or whether they were preventable.

***BMJ* 2017; 356:j239**

Tight glycaemic control in critically ill children?

Tight glycaemic control targeting a normal blood glucose level has not been shown to improve outcomes in critically ill adults or children after cardiac surgery. Studies involving critically ill children who have not undergone cardiac surgery are lacking.

In this trial, 713 appropriate patients were randomly assigned to one of two ranges of glycaemic control—lower target group (4.4 to 6.1mmol/Litre) or higher target group (8.3–10mmol/Litre). The trial was stopped early owing to a low likelihood of benefit and evidence of the possibility of harm. Patients in the lower target group had significantly higher rates of infection and severe hypoglycaemia.

The researchers concluded that critically ill children with hyperglycaemia did not benefit from tight glycaemic control. No significant differences were observed in mortality, severity of organ dysfunction or the number of ventilator-free days between the two groups.

N Engl J Med 2017; 376:729–41

Subcutaneous methotrexate in patients with moderate to severe plaque-type psoriasis

Methotrexate is one of the most commonly used systemic drugs for the treatment of moderate to severe psoriasis; however, high-quality evidence for its use is sparse and limited to use of oral dosing. In addition, the oral use of methotrexate may be the suboptimal route of administration.

In this randomised trial, 120 appropriate patients were assigned to receive either subcutaneous methotrexate at a starting dose of 17.5mg/week or placebo for the first 16 weeks, followed by methotrexate treatment of all patients up to 52 weeks (methotrexate–methotrexate vs placebo–methotrexate groups). Dose escalation to 22.5mg was allowed after eight weeks if patients had not achieved 50% reduction of their lesions.

The study results suggest that subcutaneous methotrexate has an acceptable safety profile and produces a more rapid and sustained response than that typically seen with oral regimens.

***Lancet* 2017; 389:528–37**

URL:
http://www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2017/vol-130-no-1455-12-may-2017/7255

War Medical Research

June 1917

Stretcher bearers at work in Ploegsteert Wood, World War I. Royal New Zealand Returned and Services' Association: New Zealand official negatives, World War 1914-1918. Ref: 1/2-012915-G. Alexander Turnbull Library, Wellington, New Zealand. /records/22419935

There has arisen out of the tragedy of the great war amazing progress in medical research, so great and wonderful that it cannot be fully comprehended and appreciated in the present troublous times. It is one of the wonders of the war. A glance at what has been done is all that can now be attempted and reveals achievements that must redound to the credit of the medical profession. The well-known fact that antiseptics applied to wounds are more or less damaging to the tissues and incapable of penetrating to deeper recesses, and the frequency of suppuration and gangrene in gunshot wounds in this war, led Sir Almroth Wright, and many other investigators subsequently, to search for improved methods for the purification and healing of wounds. Hypertonic salt solution promoting an outflow of lymph, Dakin's solution and Alexis Carrell's modification of Dakin's solution have caused a transformation in results. Dr. Depage published valuable information in the form of "bacterial charts" of wounds, and statistics showing only two temporary failures in 137 cases in which wounds were closed by suture after preliminary cleansing with Dakin's solution. Valuable researches into the relative value of various antiseptics, in the search for the ideal one, were carried out under the Medical Research Committee of the National Insurance Act at the Institute of Pathology at Middlesex Hospital. It was found for instance, that while iodine in 1 in 10,000 dilution killed cocci in water, a strength of 1 part in 700 was necessary to kill the cocci in serum, but iodine in a strength of 1 part in 3,500 prevents the action of the leucocytes. Dakin's solution in a dilution of 1 in 1,000 killed cocci in serum, but 1 part in 4,000 of Dakin's solution prevented leucocyte activity. After this began the testing of aniline dyes for their antiseptic properties, and flavine was found to be the best. It has great antiseptic power, practically no deleterious effect upon the leucocytes, and is free from irritating effects upon the tissues. Flavine has now been sufficiently tried to show that it very closely approaches towards the ideal of what an antiseptic ought to be.

It is reasonable to conclude that cerebro-spinal meningitis can now be well controlled. It was assuming such large proportions in the earlier stages of the war that every effort was required to find proper measures for preventing its spread. Sir Alfred Keogh, the head of the medical service of the army, adopted the method of what is known as a "mass attack" upon the

problem. He is a man alive to new ideas and new methods, and the line of least resistance is abhorrent to him. It is fortunate for the nation that he neither brooks delay nor half measures. The investigators began with isolation, segregation of contacts, and bacteriological examination. A central laboratory and 37 district laboratories were established, and the best bacteriologists in England were set to work upon the problems. Four types of meningococcus were differentiated, and a polyvalent serum prepared and distributed which reduced the mortality of the disease from 40–60 per cent to 9–13 per cent. Truly, "peace hath her victories no less renowned than war." The final triumph of the "massed attack" was when it was discovered that the problem of the carrier of cerebro-spinal meningitis could be overcome by treatment in an inhalation chamber in an atmosphere laden with steam and chloramine.

To any doctor who had experience of the scourge of dysentery and enteric in the South African War, the progress made in the prevention of these diseases in this war is as amazing as it is joyful. The problem of the carrier in these diseases was at first as baffling as in the case of spotted fever. In the campaign against dysentery the "massed attack" was made not only by medical men, but by botanists, zoologists and other scientists, and none but trained and competent observers were employed. A report stated that "it is almost better that no examination at all should be made than that it should be made by an incompetent or inexperienced person. Examinations made by persons, however skilled they may be in other matters, who have not served their apprenticeship to the actual work itself, possess no scientific value whatever." It was discovered that in 90 per cent of uncured cases of amoebic dysentery by the sixteenth day after treatment by a course of emetine the amoebae re-appeared, although examination was negative during the course of treatment. Dr. Dale then introduced bismuth emetine which was found to be effective in the treatment of acute and carrier dysentery in the great majority of cases.

It is well-known that enteric fever hitherto has caused more deaths in war than shot and shell. It accounted for 20,000 casualties in the Beor War, but nothing like that figure has been reached in this war, where millions of troops are engaged. Inoculation and adequate attention to sanitation have been the cause of this almost miraculous change.

Other triumphs have been the practical eradication of typhus fever in Servia, the discovery of the cause of epidemic jaundice, the investigation of Bilharziosis, of trench nephritis, the bacteriology of the anaerobes, and the causation and prevention of trench foot. Chemical investigation of materials in munition factories prejudicial to health, of poisonous gases and of new drugs have added greatly to the store of knowledge, and in the realm of hygiene attention has been given to the dietaries of workers, the effect of fatigue in industries generally, the suitability of various kinds of industrial work for women, and the prevention and cure of many neurological affections.

In addition to all this there is the colossal work of preparing statistics of the sick and wounded of the army. The cards that are used in this work already weight over fifteen tons.

The effect of these achievements is well summarised in the Times History of the War:—"But it must be pointed out that this scientific work, begun by the army for the army, had a vast effect upon the attitude of the civil population to research. It inaugurated a new conception of medicine; it introduced new methods of attacking and resisting disease; the sure knowledge that by mass attack upon these lines any disease could be mastered and stamped out gained currency. All manner of workers began to demand that army methods should be applied to the problems of home life—the syphilis problem and the problem of consumption. In the Medical Research Committee the British people had an assurance that the good work would be carried on in peace as in war until one by one the fortresses of disease should be assaulted and forced to surrender."

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