Iti noa ana he pito mata / from the withered tree a flower blooms: healthy equitable climate policy in Aotearoa New Zealand

The human and health costs of failure to implement pro-Tiriti and pro-equity health policies: let’s act as if we know this

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Disparities in post-operative mortality between Māori and non-Indigenous ethnic groups in New Zealand

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Disparities in post-operative mortality between Māori and non-Indigenous ethnic groups in New Zealand

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In this study, we looked at nearly 4 million surgical procedures that took place within hospitals around New Zealand between 2005 and 2017. We found that Māori patients (in particular) are more likely to die within 30 days of a procedure compared to European patients. This is probably because of unfair differences in access to the best care when it is needed the most. We believe that we need to pay more attention in the future to how well Māori are accessing surgical care, including “pre-operative” care.

Pre-hospital delays in patients experiencing symptoms of acute stroke or transient ischaemic attack

Karim M Mahawish, Daniel Greenblatt

In our study, knowledge of stroke symptoms was good, but only half of patients thought of stroke as a medical emergency and arrived at hospital early enough to be eligible for specialised emergency treatment. Reasons for delay included not appreciating the significance of their symptoms, transport challenges, or not wanting to be a burden on others or the healthcare system. Patients who called 111 soon after the stroke symptoms started were more likely to receive clot busting medication, meaning a greater chance of recovery. Sudden face/arm weakness or speech disturbance (ie, FAST positive) could indicate a medical emergency. Immediately calling 111 offers the best chance of reducing long term disability.

Clinical and epidemiological characteristics of COVID-19 in Wellington, New Zealand: a retrospective, observational study

Nethmi Kearns, Allie Eathorne, Tessa Luff, Ciléin Kearns, Craig Thornley, Alex Semprini, Richard Beasley, Annette Nesdale

This study looked at the characteristics of COVID-19 cases in the Wellington region during the first wave (1 January 2020 to 1 August 2020). There were 96 cases of COVID-19 with most of them being of European ethnicity and from a high socioeconomic background. The majority of the cases in Wellington were related to travel and seen in those coming into Aotearoa New Zealand from overseas. This study showed that there was no set of “classic” symptoms that could accurately predict infection, and that individuals with COVID-19 had a variety of different symptoms from cough to tummy pain. With New Zealanders following the Alert Level guidelines and other public health advice in 2020, we managed to keep transmission within communities to a minimum and protect the vulnerable.
Ultrasound use in suspected testicular torsion: an association with delay to theatre and increased intraoperative finding of non-viable testicle

Hannah Grace Wright, Hamish John Wright

This ten-year review of testicular torsion cases presenting to Auckland City Hospital from 2007–2017 comprises the largest contemporary Australasian review of testicular torsion. It has the notable findings of ultrasound use being associated with a two-hour delay to the operating theatre and a four-fold increase in intraoperative finding of non-viable testicle. These findings support the notion that ultrasound should not be used in cases where testicular torsion is suspected if it causes a delay in operative management.

Venovenous extracorporeal membrane oxygenation for treating very severe pneumonia in Aotearoa New Zealand: a 16-year experience

André Kübler, Fynn Maguire, David Sidebotham

Extracorporeal membrane oxygenation (ECMO) is a potentially lifesaving treatment for patients with very severe pneumonia who are failing conventional intensive therapies. The Cardiothoracic and Vascular Intensive Care Unit at Auckland City Hospital is a national referral centre for adult ECMO for Aotearoa New Zealand. Over the last 16 years, we have used ECMO for over 130 patients in Aotearoa New Zealand with very severe pneumonia and our outcomes are comparable to large overseas units. Our use of ECMO is broadly in keeping with the geographic and ethnic distribution of the population of Aotearoa New Zealand. However, because Māori and Pacific Peoples have higher rates of pneumonia with more aggressive microorganisms than other New Zealanders (up to three times higher), it is possible that Māori and Pacific Peoples have less access to this potentially lifesaving intervention than other New Zealanders.

A decade of Asian and ethnic minority health research in New Zealand: findings from a scoping review

Annie Chiang, Rachel Simon-Kumar, Roshini Peiris-John

Health research on Asians and other ethnic minority groups in New Zealand is extremely limited. A study of peer-reviewed publications in national and international academic journals identified a total of 115 articles from 2010–2019, a period in which minority ethnic populations in the country grew from 12% to 18%. Of these published studies, the majority focused on the Indian and Chinese populations, whereas there was virtually little research done on smaller demographic groups: for instance, publications on New Zealand's African populations totalled eight, and Sri Lankan, Middle-Eastern and Latin American groups had fewer than five studies each to report. The study also identified a concentration of research in two key areas, cardiovascular diseases and vitamin deficiencies, and demonstrated a glaring gap in evidence across a broader range of diseases and their treatment and management. There is also little research that focuses on the experiences of these groups within New Zealand's health system. Among the suggestions to improve health scholarship for these populations include: better prioritisation of Asian and ethnic minority health in research; the targeted availability of resources such as research grants to undertake research on this population group; better support and systems that enable the conversion of research into publications; and urgent improvements in the training, recruitment and retention of Asian and minority ethnic researchers in New Zealand universities and health research agencies.
Chimeric antigen receptor T-cells in New Zealand: challenges and opportunities

Robert Weinkove, Philip George, Myra Ruka, Tia Huia Haira, Giulia Giunti

CAR T-cell therapy is an emerging form of immunotherapy that works by redirecting a patient's T-cells to recognise and destroy cancer. As a one-off treatment, CAR T-cell therapy can cure some types of blood cancer. New Zealand's first CAR T-cell trial, ENABLE, has involved local manufacture and delivery of CAR T-cells to patients and demonstrates the feasibility of this type of treatment in Aotearoa New Zealand. Māori involvement and consultation will be key to assuring equity of access to CAR T-cell therapies. We believe that Aotearoa New Zealand is in an excellent position to develop and implement this exciting treatment in the future.
The human and health costs of failure to implement pro-Tiriti and pro-equity health policies: let’s act as if we know this

Peter Crampton

AFTER a twenty-year period of relative stability in the health system, we are entering a period of very considerable change. These changes are driven, in part, by a clearly stated desire on the part of government for fairer health outcomes for Māori. We are seeing a number of important new policies and initiatives taking shape in support of that objective, including the establishment of the Māori Health Authority and the structuring-in of formal iwi-partnership boards. The stakes are high. Unfair Māori health outcomes have been widely documented and discussed for decades and, more recently, have been starkly called out by the Waitangi Tribunal in its Hauora report.1 My sense is that amongst many of those working in the health system, there is a mood for change and for action on Māori health outcomes, along with a recognition that changes will mean doing the business of health somewhat differently.

The purpose of this editorial is to draw attention to an innovative analysis commissioned by Waitangi Tribunal claimants in response to a recommendation from the Tribunal that the Crown and the claimants “agree upon a methodology for the assessment of the extent of underfunding of Māori primary health organisations and providers. The methodology should include a means of assessing initial establishment and ongoing resource underfunding since the commencement of the New Zealand Primary Health and Disability Act 2000.” Sapere Research Group were commissioned by the claimants to carry out this work with oversight from an expert advisory group, of which I was a member.

Sapere Research Group’s report2 makes for sobering reading. An overview of the report was provided in a recent newspaper article.3 I wish here to highlight its importance in the context of the current health reforms. The logic of the report is centred around three sets of questions:

• What did Māori primary health organisations receive by way of funding from the time of the implementation of the Primary Health Care Strategy4 in the early 2000s? How much less was this than the actual need for funding? How well was funding distributed according to the patterns of need?

• What would it have taken to implement the Primary Health Care Strategy in a meaningful way for Māori health services? In other words, what was actually required to achieve the promise of the strategy?

• What is the equivalent monetary cost of the health burden experienced by Māori that could have been addressed through proper implementation of the Primary Health Care Strategy?

In brief, some of the answers to these three sets of questions are as follows. First, the cost in dollars for a test population of four Māori primary health organisations indicates that the funding formula, as then used, underfunded those organisations over an 18-year period by between $346 million and $412 million. It is no wonder that a
number of Māori primary health providers were closed or were sold during that time.

Second, estimates were made of the cost of delivering a comprehensive primary health care service to a Māori population, consistent with the vision of the Primary Health Care Strategy. The report notes that if the promise of the strategy had fully come to fruition for Māori, then we would expect government to be investing up to $1 billion per year in Māori primary health organisations.

The answer to the third set of questions is shocking. No one would suggest that dollar values in any way properly reflect the stories of grief and human suffering borne by Māori that lie behind the figures. However, to respond to the recommendation of the Tribunal, the researchers used conventional economic approaches to estimate the dollar-equivalent cost of underfunding and under-provision of primary healthcare for Māori, that is, the cost of poor health and deaths for Māori over an 18-year time period that may be attributable to failed policy implementation. That cost is in excess of $5 billion per annum.

There are, needless to say, limitations of the methodological approach taken by the researchers, some of which are identified in their report. To my mind the significance of this work far transcends debates over methodological details or interpretation of sensitivity analyses. In attempting to quantify the human and economic costs to Māori of failed policy implementation, the authors have focussed an unforgiving spotlight on the critical imperative to implement the current health reforms so that they actually achieve their pro-equity policy objectives for Māori. Looking back over the past twenty years, it is easy to see that the claimants will feel they have a strong case for compensation because of the direct effects of underfunding. Looking forward it is equally easy to see the implications for our health system, and those who govern and manage it, as we move into a period of change and reform. For me, the most important of those lessons concern first power, control and decision-making, and second they concern funding of primary care services. The two points are linked.

The first point speaks to the recognition that, to drive pro-Tiriti and pro-equity changes consistently over the long-term within the context of a complex adaptive system that has entrenched Pākehā power within most of its parts, the exercise by Māori of tino rangatiratanga in governance and decision-making is a foundational requirement, hence the importance of the Māori Health Authority and iwi-partnership boards. The theory here is that Māori decision-makers are far more likely to make pro-Tiriti and pro-equity policy and funding decisions, and the cumulative effect of many such decisions will, over time, lead to improved health outcomes for Māori. The second point is that the primary healthcare funding mechanisms must recognise need for healthcare over and above age and sex, and in particular they must recognise the funding requirements of Māori primary health organisations that serve large concentrations of high-needs people where there is little or no opportunity for internal cross-subsidisation of one set of services by another. I am not convinced that any single funding formula can take account of the funding needs of typical general practices and those of Māori, Pacific and other community-owned primary care organisations at the same time. Special funding mechanisms are required for this latter group of organisations.

The Waitangi Tribunal's Hauora report and this subsequent piece of work commissioned by the claimants provide guiding lights for those designing the system. I urge those responsible for decision-making in the design of the new system to heed the lessons that have been so clearly laid out before us.
Competing interests:
Peter Crampton is a researcher and lecturer at the University of Otago. In 2018 he gave evidence to the 2018 Waitangi Tribunal on alleged failures of the Crown to properly implement its 2001 Primary Health Care Strategy. He was a member of the panel that reviewed the health system on behalf of government (the Simpson report), and in 2020–2021 he was a member of the expert advisory group for the claimants who commissioned an analysis of the costs of underfunding Māori primary healthcare organisations. There was no external funding source for preparing this article. The views, opinions, findings and conclusions or recommendations expressed in this paper are strictly those of the author. The paper is presented not as policy, but with a view to inform and stimulate wider debate.

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REFERENCES
Iti noa ana he pito mata / from the withered tree a flower blooms: healthy equitable climate policy in Aotearoa New Zealand

Caroline Shaw, Annette Bolton, Alex Macmillan, Rhys Jones

It’s hard to say anything about climate breakdown in 2021 that nature isn’t already saying through unprecedented heat waves, bush fires and flooding. The Sixth Assessment Report (AR6) from the Intergovernmental Panel on Climate Change on the physical science of climate change published this year confirms this stark “new normal.” Global temperature has already risen by an average of 1 degree and will continue to increase until at least the mid-century under all emissions scenarios considered. Extreme weather events are occurring more frequently and more severely, and the entire globe is impacted by this. Further updates, including on specific impacts for Aotearoa New Zealand, will be published in the next year.

2021 has also seen unprecedented activity in Aotearoa New Zealand on climate change policy. The Climate Change Commission consulted and published their first report on greenhouse gas emissions (GHGe) reductions targets for Aotearoa New Zealand. These reductions are essential as our contribution to prevent ongoing escalating climate breakdown. The advice outlines the pathway towards net zero emissions by 2050 for Aotearoa New Zealand, setting out stepwise goals for reducing emissions in the next 30 years. The government will be producing a response to the Climate Change Commission report later in mid-2022, which will detail how they will achieve these targets. As part of the preparation for this response, major emitting sectors such as transport have begun to consult on how they will achieve these targets. Other significant actions in climate policy in 2021 include moves towards large companies having to report what climate change might mean for their business and further reform of the emission trading scheme, which creates a domestic carbon price.

The healthcare sector, which is estimated to contribute between 3% and 8% of national GHGe, also continues work on reducing emissions, with upcoming plans for building standards and the phasing-out of fossil fuel energy sources in healthcare facilities. Further work is underway to create a more comprehensive plan to tackle the full range of GHGe from healthcare. They include the large amounts from procurement, pharmaceuticals, medical gases, waste and other devices and products used in healthcare.

Civil society responses to climate change also continue apace; activist work continues despite the pandemic. This includes many Indigenous and youth voices, who feel disenfranchised from the global discussion and have the most to lose. Legal action against agencies and projects perceived as not aligned with meeting emission reduction targets has also moved to the forefront in 2021.

Work also continues on how to adapt to the climate change that has already occurred and will continue until at least mid-century. The Ministry for the Environment has completed a first national climate change risk assessment, which identified a number of risks Aotearoa New Zealand faces from climate change. This risk assessment will be used to develop...
national, and sector specific (including health), adaptation plans outlining what we need to do to respond to those risks.

Although the work outlined here represents a significant effort, it is only the beginning of what is needed. The transformation towards net zero carbon will dominate our society for decades. The timeframe for this work has been urgent for the last three decades; it now warrants a level of response similar to that seen for COVID-19. This will involve listening to scientists, leadership in communicating the case for change, transformative public policy and international co-operation to support our Pacific neighbours.

Why should we care about this work as healthcare professionals? The policy documents being produced by the government on how we will reduce emissions will have profound impacts on health, healthcare delivery and health equity for the next 30 years. This recognises that many of the core drivers of climate change are the same as the determinants of health and health inequity. A substantial body of research locally and internationally confirms that the “right” combination of policies could create substantial health gains while also reducing emissions. Horrocks and Wilson’s paper in this edition of the New Zealand Medical Journal provides a detailed case study of how better policy approaches to the specific issue of diesel vehicles could both reduce GHG emissions as well as improve health. This is an area in which the choices made by the government have caused poor health and climate damage.

Recognising the close links between climate change and health, for the last decade a range of organisations have advocated positioning the response to climate change as being about health. Their rationale is that if climate policies can be related to issues that are of genuine concern to the public (such as health and healthcare), then there is more likely to be support for those policies. However, the paper by Chambers et al in this NZMJ argues that the Climate Change Commission has missed the opportunity to systematically consider and maximise the positive health and health equity impacts in their approach to reducing emissions in Aotearoa New Zealand.

Despite the theory and (some) evidence that emphasising the positive health impacts of action can make people more supportive of climate action, the lack of meaningful reductions in GHG emissions globally suggests this is not enough on its own. The complexity of climate change as a policy issue merits more than just a re- positioning of how we talk about it. There is now a view that academics and health professionals should be taking peaceful direct action, and that activism to preserve the planet is now an ethical imperative for trusted groups in society.

Finally, if we step back for a minute, the question that we should be asking is: Why are we destroying multiple planetary systems? (The destruction of the environment is not limited to climate change. Other ecological crises, such as biodiversity loss, loss of pristine and productive land, particularly forests, and loss and pollution of freshwater, co-exist with climate change.) The answer lies in the dominance of Western European and North American-style capitalist, neoliberal ideologies, which have driven an economic model built on unsustainable exploitation of lands, fossil fuels, Earth systems and Indigenous peoples.

One of the major impediments to an effective response is that we are attempting to address climate change within the same colonial, extractive, market-based framework that created the problem(s). It won’t be enough to make technical adaptations to current systems, and taking such an approach is likely to cause co-harms to population health and health equity. A healthy, equitable and just transition that deals with all the ecological harms being caused, not just GHG emissions, will require a transformation of societal values, including about health. Relational transformation with Indigenous peoples while centring Indigenous knowledge systems, values and leadership will be needed. Population health, Indigenous health and health equity expertise will need to be at the heart of environmental and climate policymaking.

The root causes of concerted government inaction over the last 30 years also need to be exposed and addressed. The vehement and effective resistance to climate policy from powerful industries with the largest
financial interests in the status quo must now be seen as violence against people and nature. As was successfully achieved with the tobacco industry, health professionals must now press for the social license and influence of oil, coal and gas industries to be ended. In Aotearoa New Zealand, the most influential climate policy resistance has come from major firms involved in industrial agriculture. Their actions must be made visible, and they must be held to account for their track record of undermining healthy equitable climate policy.

Climate change and other ecological crises pose an existential threat. They also offer an opportunity to create a healthy equitable society that is not driven by the exploitation of planet and people, but that instead centres the restoration of relationships grounded in Indigenous ways of knowing, doing and being: “Iti noa ana he pito mata/ from the withered tree a flower blooms.”
Competing interests:
All authors are members of Climate Health Aotearoa, a national climate change and health research centre (www.climatehealthaotearoa.org.nz), and OraTaiao the NZ Climate and Health Council (https://www.orataiao.org.nz). Annette Bolton works for ESR and the views expressed in this editorial do not reflect the views of that organisation.

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Disparities in post-operative mortality between Māori and non-Indigenous ethnic groups in New Zealand

Jason Gurney, Melissa McLeod, James Stanley, Diana Sarfati, Doug Campbell, Cheryl Davies, Elizabeth Dennett, Peter Himona, Sarah Jackson, Dick Ongley, Bridget Robson, Juliet Rumball-Smith, Virginia Signal, Jeannine Stairmand, Courtney Thomas, Jonathan Koea

ABSTRACT

AIM: To describe disparities in post-operative mortality experienced by Indigenous Māori compared to non-Indigenous New Zealanders.

METHODS: We completed a national study of all those undergoing a surgical procedure between 2005 and 2017 in New Zealand. We examined 30-day and 90-day post-operative mortality for all surgical specialties and by common procedures. We compared age-standardised rates between ethnic groups (Māori, Pacific, Asian, European, MELAA/Other) and calculated hazard ratios (HRs) using Cox proportional hazards regression modelling adjusted for age, sex, deprivation, rurality, comorbidity, ASA score, anaesthetic type, procedure risk and procedure specialty.

RESULTS: From nearly 3.9 million surgical procedures (876,976 acute, 2,990,726 elective/waiting list), we observed ethnic disparities in post-operative mortality across procedures, with the largest disparities occurring between Māori and Europeans. Māori had higher rates of 30- and 90-day post-operative mortality across most broad procedure categories, with the disparity between Māori and Europeans strongest for elective/waiting list procedures (eg, elective/waiting list musculoskeletal procedures, 30-day mortality: adj. HR 1.93, 95% CI 1.56–2.39).

CONCLUSIONS: The disparities we observed are likely driven by a combination of healthcare system, process and clinical team factors, and we have presented the key mechanisms within these factors.

Around 4.2 million people worldwide die each year within 30 days of a surgical procedure—around a million more deaths than those due to HIV, malaria and tuberculosis combined.1 Within countries, the overall risk of post-operative mortality is strongly related to the type of procedure undertaken,2 the underlying health of the patient undergoing the procedure3 and the quality of available perioperative care.4 Both within and across countries, there is some evidence of increased rates of post-operative mortality for Indigenous patients compared with non-Indigenous, with the most consistent evidence coming from studies that have focused on cardiac procedures.5,6 For example, Native Americans undergoing transcatheter aortic valve implantation (TAVI) were found to be more than seven times more likely to die post-operatively than Whites (adj. odds ratio [OR] 7.2, 95% CI 2.6–20.0). However, our own recent systematic review identified important limitations in the current body of evidence, including major issues with the quality of Indigenous identification and often little or no adjustment for important confounders such as age, comorbidity and deprivation status.7 Studies have generally focused on a single or small set of procedures, leaving large gaps in our knowledge across the range of surgical specialties.

Given the consistent international patterns of worse access to the determinants of good health, impaired access to healthcare and lesser quality of healthcare provided to
Indigenous compared to non-Indigenous populations, it is unsurprising that there are Indigenous disparities in post-operative mortality. However, these disparities are in breach of the United Nations Declaration on the Rights of Indigenous Peoples, which states that Indigenous peoples have both the right to good health and the “right to access, without any discrimination, all social and health services.” In New Zealand, disparities in outcomes for the Indigenous Māori population can be considered a breach of the Treaty of Waitangi, New Zealand’s founding document.

This study aims to address several key gaps in the existing evidence base around Indigenous post-operative mortality. In order to achieve this aim, our objectives were (a) to use New Zealand’s high-quality national-level data to examine the post-operative mortality burden for Indigenous Māori compared to other ethnic groups for a wide range of surgical specialties, adjusting for important confounders, and (b) to provide some explanation of likely drivers of Indigenous disparities in post-operative mortality where they are identified.

Methods
Participants and data sources
Our study cohort included all individuals who underwent a procedure in a New Zealand hospital between 1 January 2005 and 31 December 2017, as recorded on the National Minimum Dataset (NMDS). The NMDS is a record of all publicly funded hospitalisations that occur within New Zealand (a country with universal healthcare), as well as privately funded hospitalisations at those larger private facilities that report to the NMDS. Diagnoses and procedures are coded to International Classification of Diseases (ICD)-10-AM (third edition for this study). We restricted our analysis to New Zealand residents to ensure follow-up for post-operative death. We also excluded patients with an American Society of Anesthesiologists (ASA) physical status score of 6 (ASA score is further defined later in this section).

Patient comorbidity at the start of each admission (see section Variables below) was measured using NMDS data for the prior five-year period. Date of death was defined using the National Health Index (NHI) dataset.

Variables
All variables were derived from the NMDS. Ethnicity data were categorised in the prioritised order of Māori, Pacific, Asian, European or Middle Eastern/Latin American/African/Other (MELAA/Other) to generate mutually exclusive groups.

Ethnicity data collection and recording on the NMDS is guided by ethnicity data protocols in which patients self-identify their ethnicity using a standardised question. Ethnicity data were missing for n=114,095 procedures (2.9% of procedures), with these patients/procedures excluded from further analysis. Patient age at the time of procedure was categorised as <55, 55–64, 65–74 or 75+. Patient sex was categorised as either male or female. Sex data were missing for n=21 procedures (<0.0001% of total procedures). Patient area-level socioeconomic deprivation was based on individuals’ geo-coded residential address, determined by using New Zealand’s 2013 Index of Deprivation (NZDep). NZDep scores were categorised as quintiles from 1 (least deprived) to 5 (most deprived). Missing data prevented attribution of deprivation for n=62,315 procedures (1.6% of procedures). Patient rurality was defined using a modified version of the Urban/Rural Profile Classification (URPC), a categorisation system which allows mapping of residential address data down to three classifications: urban (main urban area + satellite urban area); independent urban area; and rural (all rural areas). Missing data prevented attribution of rurality for n=65,102 procedures (1.7% of procedures).

Patient comorbidity was defined using the M3 Index of multimorbidity. NMDS data from five years prior to admission were coded for the presence of any of the 61 M3 conditions using ICD-10-AM codes, which were then weighted and summed to arrive at the M3 score. M3 scores were categorised as 0, >0–1, >1–2, >2–3 or 3+ for descriptive analysis and included as a splined variable within Cox models with knots at the 0th, 90th and 95th percentiles. ASA physical status score was determined from ICD anaesthesia codes at the time of the procedure and categorised as either 1–2 (healthy or mild/moderate disease), 3 (severe but stable disease), 4–5 (severe...
disease with immediate threat to life) or unknown. Primary anaesthetic type was defined using ICD codes and categorised as general only, regional only or general plus regional (ICD codes: general anaesthetic 9251410-9251499, regional anaesthetic 9250610-9250899). Procedure specialty was determined by mapping procedures to the Australasian College of Health Informatics (ACHI) procedure code “block,” which is organised by anatomical specialty. Procedure risk was established using a modified version of the Johns Hopkins Surgical Risk Classification System, which classifies surgical risk into five categories according to factors including the invasive nature of the procedure and potential for blood loss. In the event that a patient underwent a procedure on more than one system (eg, cardiovascular and respiratory systems) during the same operation, the procedure with the greatest severity (according to the Johns Hopkins Surgical Risk Classification System) was selected as the index procedure. In the event of a “tie” between procedures in terms of severity, the first procedure appearing in the sequential list of procedures within the NMDS was selected as the index procedure.

In addition to stratification by procedure specialty, we selected four individual procedures for closer examination: two cardiovascular procedures (coronary artery bypass graft [CABG] and valve repair), a collection of similar digestive system procedures (small intestine, colon or rectal resection) and a vascular/musculoskeletal procedure (lower-limb amputation). These procedures were chosen because (1) they are common and allowed sufficient data for meaningful comparisons between most ethnic groups, (2) they are frequently related to post-operative death among Māori and (3) they cover several surgical specialities (cardiac, gastro-intestinal and vascular/musculoskeletal).

All analyses were stratified by admission type, which was categorised as either acute or elective/waiting list based on NMDS data. Post-operative mortality was defined as death from any cause recorded within either 30 or 90 days of a procedure.

**Statistical analysis**

Key characteristics of the cohort were described, stratified by ethnicity and admission type, and included count data as well as crude and direct age-standardised rates. We used the 2001 total Māori population as the standard population, which is an Indigenous standard that uses Māori as the target population. Those with missing data (primarily NZDep and rurality, both missing in <2% of the cohort) were excluded from regression analyses (since the models required complete data for all included variables) but were included in descriptive analyses.

We conducted Cox proportional hazards regression modelling to compare the risk of post-operative death, focusing on 30-day mortality. Follow-up was censored if no death occurred within 30 days of the procedure (ie, the end of follow-up); if the same procedure occurred within 30 days of the original procedure (revisions), the first procedure was used as the index procedure and the second (revision) procedure was not included in analyses (mortality after the revision but within 30 days of the initial procedure was counted as a consequence of the initial procedure). Hazard ratios (HR) and their 95% confidence intervals (95% CI) were calculated between ethnic groups for mortality within 30 days, with the majority European ethnic group as the reference. Separate Cox models were conducted for acute and elective/waiting list procedures. For analyses examining combined procedures, models were adjusted for age, sex, deprivation, rurality, comorbidity, ASA score, anaesthetic type, procedure risk and procedure specialty (removed when models were stratified by specialty). Where procedures (eg, CABG) were examined separately, procedure specialty and procedure risk were removed as covariates.

Data management and analysis was performed in SAS v9.4 (SAS Institute Inc., USA), Stata 16 (StataCorp LLC, USA) and Microsoft Excel 2016 (Microsoft Corp., USA). The study received ethical approval from the University of Otago Human Ethics Committee (reference: H18/085). In terms of ensuring the study’s responsiveness to Māori, this study was led by a Māori epidemiologist (JG), supported by Māori academics, clinicians, public servants and community health workers (MM, CD, PH, BR, JS, CT, JK), and situated within an equity-focused research group (the Cancer and
Results

Supplementary Material 1 shows the number of procedures, stratified by covariate. A total of 876,976 acute procedures were performed (age-standardised proportions: 22% Māori, 10% Pacific, 6% Asian, 2% MELAA/Other, 60% European), along with 2,990,726 elective/waiting list procedures (16% Māori, 6% Pacific, 7% Asian, 2% MELAA/Other, 69% European). Our description and interpretation focuses on comparisons between Māori (as the Indigenous peoples of New Zealand) and Europeans (as the majority non-Indigenous population).

Table 1 shows the number and age-standardised rate of death within 30-days of a procedure, stratified by ethnicity, for both acute and elective/waiting list procedures. For all acute procedures combined, the 30-day mortality rate was highest among Māori (age-standardised rate: 1.1/100 acute procedures, European 0.7/100). This pattern of higher mortality rates for Māori compared to European was consistent across procedure specialties (eg, cardiovascular: Māori 3.9/100, European 2.7/100; neurosurgery: Māori 4.7/100, European 3.7/100). Similar patterns were observed for 90-day mortality (Supplementary Material 2). In our fully adjusted model, Māori were 14% more likely to die within 30 days when all acute procedures were combined (adj. HR 1.14, 95% CI 1.09–1.20; Table 2). In comparison to European patients, the chance of post-operative mortality for Māori was 21% higher following an acute cardiovascular procedure (1.21, 95% CI 1.06-1.38), nearly 25% higher following an acute digestive system procedure (1.24, 95% CI 1.13–1.35) and more than 30% higher following an acute musculoskeletal system procedure (1.33, 95% CI 1.20–1.47).

Māori also had the highest rate of 30-day mortality for elective/waiting list procedures combined (adj. HR: 1.35, 95% CI 1.25–1.46; Table 2). Māori were 26% more likely to die within 30 days of an elective/waiting list cardiovascular procedure (1.26, 95% CI 1.07–1.50); more than 30% more likely following a digestive system procedure (1.32, 95% CI 1.14–1.53); 21% more likely following a respiratory procedure (1.21, 95% CI 0.93–1.57); nearly 50% more likely following a urinary procedure (1.49, 95% CI 1.05–2.12); and nearly twice as likely following a musculoskeletal procedure (1.93, 95% CI 1.56-2.39) than European patients.

Individual procedures

We observed strong disparities between Māori and European patients for post-operative mortality following specific procedures (Table 3). Māori undergoing CABG in an acute setting were 71% more likely to die within 30 days (age std. rate: Māori 8.0/100, European 1.0/100; adj. HR: 1.71, 95% CI 1.18–2.48) and 53% more likely in an elective/waiting list setting (Māori 1.9/100, European 0.9/100; adj. HR 1.53, 95% CI 1.10-2.12). Māori undergoing acute valve repair or replacement appeared more likely to die within 30 days (Māori 8.9/100, European 2.8/100; adj. HR: 1.34, 95% CI 0.87–2.08) and also appeared more likely to die in an elective/waiting list setting (Māori 2.0/100, European 0.7/100; adj. HR: 1.39, 95% CI 0.98–1.99), although the confidence limits included small effect sizes and the possibility of no difference. For small intestine or bowel resection, Māori patients were nearly 30% more likely to die within 30 days of an acute procedure (Māori 5.9/100, European 2.5/100; adj. HR: 1.27, 95% CI 1.08-1.50) and 92% more likely in an elective/waiting list setting (Māori 1.5/100, European 0.4/100; adj. HR: 1.92, 95% CI 1.46–2.33). Finally, Māori undergoing acute lower-limb amputation appeared marginally more likely to die within 30 days although the confidence limits again included the possibility of no difference (Māori 5.2/100, European 4.0/100; adj. HR: 1.17, 95% CI 0.95–1.45), but they were more than twice as likely in an elective/waiting list setting (Māori 2.9/100, European 0.8/100; adj. HR 2.04: 95% CI 1.31–3.18).

There was a tendency for the strongest ethnic disparities to occur within the elective/waiting list setting compared to the acute setting.
Table 1: Number and rate of 30-day mortality following acute and elective/waiting list procedures by ethnicity, for both the combined procedures and stratified by procedure specialty. Rates are age-standardised to the 2001 total Māori population.

<table>
<thead>
<tr>
<th>Procedure specialty</th>
<th>Māori</th>
<th>Deaths</th>
<th>Death rate (n/100)</th>
<th>Pacific</th>
<th>Deaths</th>
<th>Death rate (n/100)</th>
<th>Asian</th>
<th>Deaths</th>
<th>Death rate (n/100)</th>
<th>MELAA/Other</th>
<th>Deaths</th>
<th>Death rate (n/100)</th>
<th>European</th>
<th>Deaths</th>
<th>Death rate (n/100)</th>
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<td>Combined procedures</td>
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<td>2.3</td>
<td>0.7 (0.7–0.7)</td>
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<tr>
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<td>169</td>
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<td>3.5 (2.9–4.2)</td>
<td>119</td>
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<td>4 (3–5.2)</td>
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<td>2.6 (1.3–4.5)</td>
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<td>2.7 (2.4–3.1)</td>
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<td>238</td>
<td>2</td>
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<td>5.7 (4.8–6.7)</td>
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<td>0.4 (0.3–0.6)</td>
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<td>1</td>
<td>0.2 (0.1–0.3)</td>
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<tr>
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<td>7</td>
<td>1.9</td>
<td>0.5 (0.2–1.2)</td>
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<td>15</td>
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<td>0.2 (0.1–0.2)</td>
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<td>0.1 (0.1–0.2)</td>
<td>193</td>
<td>0.1</td>
<td>0.1 (0.1–0.1)</td>
<td>61</td>
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<td>0.1 (0–0.1)</td>
<td>4,966</td>
<td>0.2</td>
<td>0.1 (0.1–0.1)</td>
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<tr>
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<td>103</td>
<td>1.4</td>
<td>1 (0.7–1.2)</td>
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<td>1.1</td>
<td>0.8 (0.5–1.1)</td>
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<td>2</td>
<td>1.4 (0.7–2.5)</td>
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<td>0.1 (0.1–0.2)</td>
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<td>1.1 (0.6–1.6)</td>
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<td>1.3 (0.4–2.8)</td>
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<td>0.2 (0.1–0.4)</td>
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<td>0.2 (0–0.7)</td>
<td>233</td>
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<td>0.3 (0.2–0.3)</td>
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<td>0.1</td>
<td>0.1 (0–0.1)</td>
<td>13</td>
<td>0.1</td>
<td>0 (0–0.1)</td>
<td>7</td>
<td>0.1</td>
<td>0 (0–0.1)</td>
<td>666</td>
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<td>0 (0–0)</td>
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<td>0.1 (0–0.2)</td>
<td>9</td>
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<td>0.1 (0–0.3)</td>
<td>2</td>
<td>0.1</td>
<td>0 (0–0.2)</td>
<td>258</td>
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<td>0 (0–0)</td>
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<td>0 (0–0)</td>
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<td>Crude</td>
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<tr>
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<td>1.14 (1.09–1.2)</td>
<td>0.54 (0.5–0.57)</td>
<td>1.03 (0.95–1.11)</td>
<td>0.57 (0.53–0.62)</td>
<td>1.14 (1.04–1.23)</td>
<td>0.53 (0.46–0.62)</td>
<td>1.04 (0.89–1.22)</td>
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<tr>
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<td>1.13 (0.94–1.36)</td>
<td>1.37 (1.13–1.67)</td>
<td>0.71 (0.48–1.07)</td>
<td>0.86 (0.56–1.35)</td>
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<tr>
<td>Digestive system</td>
<td>0.73 (0.67–0.79)</td>
<td>1.24 (1.13–1.35)</td>
<td>0.65 (0.57–0.74)</td>
<td>1.13 (0.99–1.3)</td>
<td>0.43 (0.37–0.51)</td>
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<tr>
<td>Respiratory system</td>
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<td>0.81 (0.62–1.05)</td>
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<tr>
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<td>1.06 (0.92–1.22)</td>
<td>0.85 (0.7–1.04)</td>
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<tr>
<td>Musculoskeletal</td>
<td>0.41 (0.37–0.45)</td>
<td>1.33 (1.12–1.47)</td>
<td>0.33 (0.28–0.39)</td>
<td>1 (0.84–1.18)</td>
<td>0.64 (0.53–0.76)</td>
<td>1.34 (1.12–1.6)</td>
<td>0.45 (0.33–0.61)</td>
<td>1.06 (0.78–1.44)</td>
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<tr>
<td>Urinary system</td>
<td>0.94 (0.73–1.22)</td>
<td>1.04 (0.78–1.38)</td>
<td>0.95 (0.68–1.33)</td>
<td>1.13 (0.78–1.63)</td>
<td>0.49 (0.3–0.8)</td>
<td>0.93 (0.56–1.52)</td>
<td>0.75 (0.35–1.58)</td>
<td>1.45 (0.68–3.09)</td>
<td></td>
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</tr>
<tr>
<td>Other</td>
<td>0.65 (0.56–0.75)</td>
<td>1.09 (0.93–1.27)</td>
<td>0.49 (0.39–0.61)</td>
<td>0.92 (0.73–1.16)</td>
<td>0.36 (0.27–0.49)</td>
<td>1.01 (0.74–1.39)</td>
<td>0.47 (0.28–0.78)</td>
<td>0.93 (0.55–1.58)</td>
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<tr>
<td>Elective/waiting list</td>
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<tr>
<td>Total procedures</td>
<td>1.05 (0.98–1.13)</td>
<td>1.35 (1.25–1.46)</td>
<td>0.86 (0.76–0.96)</td>
<td>1.05 (0.93–1.2)</td>
<td>0.51 (0.44–0.59)</td>
<td>1.01 (0.87–1.17)</td>
<td>0.58 (0.45–0.75)</td>
<td>1.17 (0.91–1.5)</td>
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<tr>
<td>Cardiovascular</td>
<td>1.18 (1.01–1.37)</td>
<td>1.26 (1.07–1.5)</td>
<td>1.07 (0.87–1.31)</td>
<td>1.14 (0.9–1.45)</td>
<td>0.88 (0.66–1.17)</td>
<td>1.02 (0.76–1.37)</td>
<td>1.57 (1.04–2.35)</td>
<td>2.06 (1.37–3.09)</td>
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<tr>
<td>Digestive system</td>
<td>1.15 (1–1.32)</td>
<td>1.32 (1.14–1.53)</td>
<td>1.2 (0.95–1.51)</td>
<td>1.29 (1.01–1.65)</td>
<td>0.53 (0.4–0.7)</td>
<td>1.05 (0.8–1.38)</td>
<td>0.37 (0.21–0.64)</td>
<td>0.83 (0.47–1.46)</td>
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<tr>
<td>Respiratory system</td>
<td>1.12 (0.88–1.43)</td>
<td>1.21 (0.93–1.57)</td>
<td>0.9 (0.6–1.34)</td>
<td>0.86 (0.56–1.33)</td>
<td>0.86 (0.58–1.27)</td>
<td>1.38 (0.93–2.06)</td>
<td>0.93 (0.44–1.95)</td>
<td>1.17 (0.55–2.48)</td>
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<tr>
<td>Neurosurgery</td>
<td>1.57 (1.14–2.15)</td>
<td>0.93 (0.66–1.31)</td>
<td>1.7 (1.05–2.75)</td>
<td>0.97 (0.58–1.63)</td>
<td>0.63 (0.3–1.33)</td>
<td>0.66 (0.31–1.41)</td>
<td>1.29 (0.53–3.13)</td>
<td>1.81 (0.74–4.42)</td>
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<tr>
<td>Musculoskeletal</td>
<td>1.52 (1.25–1.84)</td>
<td>1.93 (1.56–2.39)</td>
<td>0.62 (0.4–0.97)</td>
<td>1.11 (0.7–1.75)</td>
<td>0.56 (0.32–0.97)</td>
<td>0.98 (0.55–1.74)</td>
<td>0.65 (0.31–1.37)</td>
<td>1.38 (0.65–2.9)</td>
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<tr>
<td>Urinary system</td>
<td>1.48 (1.09–2.01)</td>
<td>1.49 (1.05–2.12)</td>
<td>0.41 (0.17–0.98)</td>
<td>0.52 (0.21–1.28)</td>
<td>0.62 (0.32–1.21)</td>
<td>1.09 (0.56–2.15)</td>
<td>0.48 (0.12–1.93)</td>
<td>0.85 (0.21–3.44)</td>
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<tr>
<td>Other</td>
<td>0.83 (0.7–0.99)</td>
<td>1.43 (1.18–1.73)</td>
<td>0.68 (0.51–0.9)</td>
<td>1 (0.74–1.34)</td>
<td>0.39 (0.28–0.55)</td>
<td>0.95 (0.68–1.34)</td>
<td>0.19 (0.07–0.51)</td>
<td>0.43 (0.16–1.16)</td>
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</table>

Table 2: Risk of 30-day mortality between ethnic groups, for both combined procedures and stratified by procedure specialty. Europeans are used as the reference group. Hazard ratios are adjusted for age, sex, deprivation, rurality, comorbidity, ASA score, anaesthetic type and procedure risk. Hazard ratios for combined procedures are additionally adjusted for procedure specialty.
acute setting. For example, Māori undergoing a musculoskeletal procedure in an acute setting were 33% more likely to die in an acute setting (adj. HR: 1.33, 95% CI 1.20–1.47), whereas in an elective/waiting list setting, this disparity increased to 93% (1.93, 95% CI 1.56–2.39).

Disparities for Pacific and MELAA/Other patients (compared to European patients) were broadly similar to those observed for Māori, but with reduced statistical precision due to lower numbers of patients and deaths (Supplementary Material 3). For example, Pacific patients were 30% more likely to die within 30 days of an elective/waiting list digestive system procedure than European patients (adj. HR: 1.29, 95% CI 1.01–1.65), whereas MELAA/Other patients were twice as likely to die following an elective/waiting list cardiovascular procedure (2.06, 95% CI 1.37–3.09).

When examining the impact of each of our modelled covariates on disparities (Table 4), using 30-day mortality comparisons between Māori and Europeans as the exemplar, we observed that adjusting for age increased the magnitude of the disparity and each subsequent covariate attenuated the disparity. The strongest attenuation across procedures occurred when adjusting for deprivation, comorbidity and ASA score.

Table 3: Death within 30 days of selected individual procedures, including numbers of deaths, crude and age-standardised death rate and adjusted hazard ratios (HR) comparing likelihood of death between Māori and European/Other patients. Hazard ratios are adjusted for age, sex, deprivation, rurality, comorbidity, ASA score and anaesthetic type. For brevity, results for Pacific, Asian and MELAA/Other patients are shown in Supplementary Material 3.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>MāoriDeaths</th>
<th>Death rate (n/100)</th>
<th>Hazard ratio (95% CI)</th>
<th>Hazard ratio (95% CI)</th>
<th>EuropeanDeaths</th>
<th>Death rate (n/100)</th>
<th>Hazard ratio (95% CI)</th>
<th>Hazard ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acute</strong></td>
<td></td>
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<tr>
<td>Coronary artery bypass graft</td>
<td>38</td>
<td>6.6</td>
<td>8 (4.6–12.6)</td>
<td>1.71 (1.18–2.48)</td>
<td>192</td>
<td>3.9</td>
<td>1 (0.5–1.9)</td>
<td>Ref</td>
</tr>
<tr>
<td>Valve repair/replacement</td>
<td>31</td>
<td>8.2</td>
<td>8.9 (5.6–13)</td>
<td>1.34 (0.87–2.08)</td>
<td>123</td>
<td>6.5</td>
<td>2.8 (1.5–4.6)</td>
<td>Ref</td>
</tr>
<tr>
<td><strong>Digestive</strong></td>
<td></td>
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<tr>
<td>SI or bowel resection</td>
<td>188</td>
<td>10.4</td>
<td>5.9 (4.6–7.4)</td>
<td>1.27 (1.08–1.5)</td>
<td>1,386</td>
<td>9.1</td>
<td>2.5 (2.1–2.9)</td>
<td>Ref</td>
</tr>
<tr>
<td><strong>Musculoskeletal</strong></td>
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</tr>
<tr>
<td>Lower-limb amputation</td>
<td>152</td>
<td>8.6</td>
<td>5.2 (3.8–6.9)</td>
<td>1.17 (0.95–1.45)</td>
<td>499</td>
<td>7.8</td>
<td>4 (2.9–5.2)</td>
<td>Ref</td>
</tr>
<tr>
<td><strong>Elective/waiting list</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Coronary artery bypass graft</td>
<td>52</td>
<td>3.4</td>
<td>1.9 (0.9–3.4)</td>
<td>1.53 (1.1–2.12)</td>
<td>284</td>
<td>2.3</td>
<td>0.9 (0.5–1.5)</td>
<td>Ref</td>
</tr>
<tr>
<td>Valve repair/replacement</td>
<td>47</td>
<td>3.2</td>
<td>2 (1.2–2.9)</td>
<td>1.39 (0.98–1.99)</td>
<td>305</td>
<td>3.2</td>
<td>0.7 (0.4–1.2)</td>
<td>Ref</td>
</tr>
<tr>
<td><strong>Digestive</strong></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SI or bowel resection</td>
<td>64</td>
<td>3.6</td>
<td>1.5 (0.8–2.4)</td>
<td>1.92 (1.46–2.53)</td>
<td>614</td>
<td>2.1</td>
<td>0.4 (0.3–0.5)</td>
<td>Ref</td>
</tr>
<tr>
<td><strong>Musculoskeletal</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower-limb amputation</td>
<td>36</td>
<td>5</td>
<td>2.9 (1.6–4.8)</td>
<td>2.04 (1.31–3.18)</td>
<td>103</td>
<td>2.6</td>
<td>0.8 (0.4–1.5)</td>
<td>Ref</td>
</tr>
</tbody>
</table>
Discussion

We observed substantial and compelling evidence of ethnic disparities in post-operative mortality across procedures, with the clearest disparities occurring between Indigenous Māori and the majority European population. Māori had higher rates of post-operative mortality across most broad procedure categories, with the strongest disparities seen in elective/waiting list procedures. Disparities for Māori were larger for some procedure specialty groups (cardiovascular, digestive, musculoskeletal) and not apparent for others (neurosurgery). Large disparities were observed for each of the most common causes of post-operative death for Māori, including CABG, cardiac valve repair, bowel resection and lower-limb amputation. The absence of any ethnic disparities in either acute or elective/waiting list neurosurgical procedures may be due to high post-operative mortality from these procedures and the small number of sites and providers of neurosurgical care in New Zealand.

The patterns of disparities observed for Māori were largely mirrored for Pacific and MELAA/Other groups; for example, Pacific peoples appeared more likely to die following a cardiovascular, digestive or musculoskeletal procedure, but not neurosurgical procedures. However, the strength of this evidence was impacted by relatively low procedure numbers and deaths for these groups.

Our observation of substantial disparities in post-operative mortality for Māori is largely in keeping with previous evidence in this context, including our recently published systematic review, which found evidence of disparities in post-operative mortality for Māori across many individual procedures, for Native Americans undergoing some cardiac, bariatric and total knee procedures and for Indigenous Australians undergoing cardiac procedures.

Why do these disparities exist?

Structural factors. Understanding the root cause of disparities in post-operative mortality requires consideration of the structural and systemic differences experienced by Indigenous ethnic groups compared to the European population. These include the ramifications of colonisation, which include institutionalised racism and subsequent structural disparities that impact access to the social determinants of good health. Jones’s theoretic framework for understanding racism suggests three levels: institutionalised, personally mediated and internalised. In the context of perioperative outcomes, institutionalised racism drives disparities by ensuring that the system delivering healthcare privileges non-Indigenous peoples; personally-mediated racism drives disparities through patient stereotyping and differential provision of care; and internalised racism drives disparities by forcing Indigenous peoples to accept these disparities and the conditions from which they arose. In their work on the impact of racism on clinical decision-making, Van Ryn and colleagues illustrated the mechanisms by which healthcare providers impact disparities in treatment, including implicit and explicit beliefs and stereotypes among clinicians that negatively impact on clinical decision-making. In order to maximise the cultural safety of our health system for Indigenous patients, “reflective self-assessment of power, privilege and biases” should occur at each step of the care pathway—right from policy and funding decision-making through to the coalface delivery of clinical care.

Differences in clinical indication and comorbidity. From our analysis, we did observe that some of the disparity in post-operative mortality between ethnic groups could be explained by a greater comorbidity/ASA burden (a marker of perioperative morbidity). These differences are themselves linked to differences in access to the social determinants of good health and have been observed to influence disparities in surgical outcomes between ethnic groups in other international settings, such as the United States. However, it must be noted that substantial disparities remained in our study even after adjusting for differences between groups in these key factors.

Differences in access to best-practice pre-operative care. We observed that there was a tendency for the strongest ethnic disparities to occur within the elective/waiting list setting rather than the acute setting. This may be because of overall poorer outcomes in the acute setting, which
Table 4: Step-by-step adjusted hazard ratios comparing mortality risk between Māori and European patients, adjusted sequentially for demographic, health system and patient-level factors.

<table>
<thead>
<tr>
<th></th>
<th>Māori vs European hazard ratios (95% CI)</th>
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<tbody>
<tr>
<td></td>
<td>Coronary artery bypass graft</td>
</tr>
<tr>
<td><strong>Acute</strong></td>
<td></td>
</tr>
<tr>
<td>Unadjusted</td>
<td>1.73 (1.22–2.45)</td>
</tr>
<tr>
<td><strong>Demographic factors</strong></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>2.29 (1.6–3.26)</td>
</tr>
<tr>
<td>Sex</td>
<td>2.07 (1.44–2.96)</td>
</tr>
<tr>
<td>Deprivation</td>
<td>2 (1.38–2.88)</td>
</tr>
<tr>
<td>Rurality</td>
<td>1.96 (1.35–2.83)</td>
</tr>
<tr>
<td><strong>Health system factors</strong></td>
<td></td>
</tr>
<tr>
<td>Anaesthetic type</td>
<td>1.96 (1.36–2.84)</td>
</tr>
<tr>
<td><strong>Patient factors</strong></td>
<td></td>
</tr>
<tr>
<td>Comorbidity</td>
<td>1.74 (1.2–2.53)</td>
</tr>
<tr>
<td>ASA score</td>
<td>1.71 (1.18–2.48)</td>
</tr>
<tr>
<td><strong>Elective/waiting list</strong></td>
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<tr>
<td>Unadjusted</td>
<td>1.49 (1.11–2)</td>
</tr>
<tr>
<td><strong>Demographic factors</strong></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>2.28 (1.68–3.1)</td>
</tr>
<tr>
<td>Sex</td>
<td>2.17 (1.59–2.95)</td>
</tr>
<tr>
<td>Deprivation</td>
<td>1.97 (1.43–2.73)</td>
</tr>
<tr>
<td>Rurality</td>
<td>1.99 (1.44–2.76)</td>
</tr>
<tr>
<td><strong>Health system factors</strong></td>
<td></td>
</tr>
<tr>
<td>Anaesthetic type</td>
<td>1.99 (1.44–2.76)</td>
</tr>
<tr>
<td><strong>Patient factors</strong></td>
<td></td>
</tr>
<tr>
<td>Comorbidity</td>
<td>1.58 (1.14–2.19)</td>
</tr>
<tr>
<td>ASA Score</td>
<td>1.53 (1.1–2.12)</td>
</tr>
</tbody>
</table>
reduces the opportunity for disparities to occur. Conversely, there are more opportunities in an elective/waiting list setting for differential access to best-practice care prior to surgery to impact on outcomes: this would include disparities in access to prehabilitation and other preparatory care (including primary care of existing conditions). This lack of access is congruent with evidence suggesting that Indigenous peoples, including Māori, have poorer access to primary care than non-Indigenous peoples.40–43 With this in mind, we recommend (a) that further investigation regarding ethnic/Indigenous disparities in access to elective/waiting list care, as well as access to preparatory care including prehabilitation, is undertaken as a matter of priority, (2) that this access is measured and monitored at a national/regional level by ethnicity or Indigeneity on an ongoing basis and (3) that these data are used as quality performance indicators for best-practice care provision within regions and hospitals.

Differences in access to best-practice surgical care. The inverse care law states that, in spite of having greater need, socially disadvantaged peoples receive less (and lower-quality) healthcare.44 Furthermore, the disproportionate care law states that those at a social disadvantage may receive relatively more healthcare than other groups due to increased disease burden, but this care is of poorer quality and still insufficient quantity.45 In New Zealand, there is evidence that Māori wait longer for treatment, and that when treatment is provided, it is of poorer quality than that delivered to non-Māori ethnic groups.46 For example, we have previously observed in the context of stomach cancer treatment that Māori patients were less likely to have their resection performed in a main treatment hub and less likely to have a specialist upper-gastrointestinal surgeon perform their gastric resection, even when the surgery was carried out in a major urban centre.47 Findings in the New Zealand context echo those from other regions: a systematic review of racial disparities in surgical care and outcomes in the United States observed that racial minorities are more likely to be treated in low-volume hospitals or by lower-quality surgeons.39 Therefore, the disparities in post-operative mortality that remain after the data are adjusted for factors such as comorbidity and deprivation may, at least partially, reflect differences in the quality of surgical care received by Māori patients compared to European patients. We recommend the centralised, ongoing audit of surgical outcomes for Indigenous (and other minority) patients as a rolling measure of quality performance, to help highlight the extent of disparities within a given country or region and to guide change in those areas where inequities are identified. The recent announcement of the creation of the Māori Health Authority may provide the opportunity for such ongoing quality performance measurement and an impetus for the systemic changes required to improve outcomes for Māori. As Koea and Ronald noted in a recent systematic review, Indigenous patients deserve to be treated by a highly skilled, culturally competent (ideally Indigenous) workforce operating within a surgical care and broader health system that is working with Indigenous communities to review and govern care for their people.48 The disparities in post-operative outcomes outlined in this study add further urgency to these needs.

Strengths and limitations

This study contributes to a growing body of evidence of international Indigenous disparities in post-operative mortality across Eurocentric healthcare systems. To date, the evidence base has been dominated by studies that have been underpowered, that have poorly articulated methods of identifying Indigenous populations and that have focused on a limited sample of surgical procedures.7 Our study addresses these limitations and provides evidence of ethnic disparities across a wide range of procedure types. Despite this, there remain several important gaps in our knowledge that warrant further research.

This study focused on measuring post-operative mortality, but it is also important to look at the extent of disparities that may exist for other post-surgical outcomes, such as post-operative morbidity, readmission, functional status and quality of life. Further research should also examine outcomes for those declined surgery, where disparities in outcomes might assist us to understand
and remedy any bias in the surgical prioritisation and selection processes.

Although we are confident in the quality of our national-level data, we may have incompletely adjusted for the impact of severity of illness at time of surgery with our adjustments for comorbidity and ASA score (the latter having a high proportion of missing data). More severe illness at the time of surgery for Māori is a likely contributor to the larger disparities we see in elective/waiting list compared to acute procedures. Greater severity of illness for Māori may result from delays in diagnosis through poorer access to primary care alongside delays to surgery compared to Europeans, who may also be better positioned financially to bypass the public healthcare system and engage with private health providers.

**Conclusions**

In a national study of nearly 3.9 million surgical procedures, we observed substantial evidence of ethnic disparities in post-operative mortality across procedures, with the clearest disparities occurring between Indigenous Māori and the majority European population. Māori were observed to have higher rates of 30- and 90-day post-operative mortality across most broad procedure categories, with this disparity strongest for elective/waiting list procedures. This evidence provides a robust reinforcement for international findings from our recent systematic review of this topic.7 Our observed disparities are likely driven by structural factors including institutional racism acting through a combination of healthcare system, process and clinical team factors. As a starting point, we recommend that ethnicity/Indigeneity-stratified monitoring and reporting of access to elective/waiting list procedures, as well as access to pre-operative care, is incorporated into surgical care at a systems level, as part of ongoing quality assurance processes.

**Funding statement**

This study was funded by the Health Research Council of New Zealand (HRC reference # 18/037).

**Data sharing statement**

The data for this study were provided by the New Zealand Ministry of Health (reference number: 2018-0452) following ethical approval, and may be available to other researchers who meet data access requirements. Code for data processing and analysis is available from JG upon request.

**Ethical approval statement**

The study received ethical approval from the University of Otago Human Ethics Committee (reference: H18/085).

**Supplementary material**

- Supplementary Material 1: Number of procedures by covariate, separately for acute and elective/waiting list procedures. Apart from age profile, all other percentages are age-standardised to the 2001 total Māori population.
- Supplementary Material 2: Number and rate of 90-day mortality following acute and elective/waiting list procedures by ethnicity, for both the combined procedures and stratified by procedure specialty. Rates are age-standardised to the 2001 total Māori population.
- Supplementary Material 3: Death within 30 days of selected individual procedures, including numbers of deaths, crude and age-standardised death rate for Pacific, Asian and MELAA/Other ethnic groups, as well as hazard ratios (HR) comparing likelihood of death between European/Other patients and other ethnic groups. Results for Māori and European groups are shown in Table 3.
Competing interests:
Dr Ongley is Chair of the Perioperative Mortality Review Committee for HQSC.
Dr McLeod reports grants from HRC during the conduct of this study.

Acknowledgements
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Pre-hospital delays in patients experiencing symptoms of acute stroke or transient ischaemic attack

Karim M Mahawish, Daniel Greenblatt

ABSTRACT

AIM: Delays in seeking help following stroke or transient ischaemic attack (TIA) are associated with worse outcomes and missed treatment opportunities, including stroke reperfusion therapy. This study aims to discover the reasons for these delays.

METHOD: Patients admitted with stroke or TIA were eligible for inclusion. In Part A, we collected demographic data and particulars at the time of symptom onset, with data dichotomised into early (<4.5 hours) or late (≥4.5 hours) presentation times. In Part B, we collected qualitative data on cognitive factors that led to delayed admission. A standardised questionnaire was used to collect the data.

RESULTS: One-half of 41 patients presented early. Living closer to hospital (36.4 vs 54.4 km, \( p=0.036 \)) and early contact with healthcare services (37 vs 1,382 minutes, \( p=0.001 \)) were associated with early presentation; contact with emergency services within 15 minutes of symptom onset was significantly associated with treatment with thrombolytics \( (p<0.001) \). Neither patient awareness of acute stroke symptoms, having a partner present nor a history of prior stroke were associated with early presentation \( (all \ p>0.05) \). Themes associated with delays included: difficulty understanding symptoms, personal beliefs, minimising symptoms, the influence of others and fulfilling prior responsibilities.

CONCLUSIONS: The findings of this study provide important insights that could help healthcare organisations introduce strategies to help improve access to organised stroke services.

In New Zealand, stroke is the third leading cause of death and the primary cause of adult disability.\(^1\) Around 8,000 New Zealanders experience a stroke each year, and many will either die or lose the ability to care for themselves one year after the event.\(^2\) Although early hyperacute therapies such as thrombolysis and thrombectomy are associated with improved patient outcomes,\(^3,4\) benefits are also seen with other early interventions, including early anticoagulation for patients with atrial fibrillation,\(^5\) early transient ischaemic attack (TIA) assessment and management,\(^6\) early dysphagia screening after stroke\(^7\) and early intensive lowering of blood pressure and reversal of antithrombotic medication in patients with intracerebral haemorrhage.\(^8\) National and regional efforts such as regular audit, service model changes, public FAST campaigns and the introduction of telestroke have improved public awareness of stroke and a number of acute treatment metrics.\(^9,10\) However, despite these initiatives, there are delays in presentation to hospital following stroke in most New Zealand district health boards (DHB). For instance, thrombolysis rates for acute ischaemic stroke have plateaued at around 10–15%, largely due to delays in seeking help.\(^11\) This study aims to identify the factors that lead to time delays in seeking help when stroke symptoms arise.

Design and methods

A prospective cross-sectional study of patients admitted with stroke or TIA was conducted at Palmerston North Hospital, a medium-sized hospital serving a population of 172,930 with approximately 360 stroke admissions per annum. Our institution provides a 24/7 on-site thrombolysis service with input from telestroke and thrombectomy services from Capital
and Coast DHB within the conventional window due to lack of perfusion imaging. Between 24 November 2020 and 8 January 2021, convenience sampling was used to enrol consecutive patients into the study. Inclusion criteria were (1) acute stroke or transient ischaemic attack (defined as an acute, focal neurologic deficit without alternative cause with supportive imaging findings) and (2) patient requires hospitalisation, which at our institution includes all acute strokes, or TIA with high-risk features (defined as concomitant atrial fibrillation, known carotid stenosis, anticoagulant therapy or an ABCD2 score ≥4 (Age ≥ 60 years (+1), blood pressure ≥140/90 mmHg (+1), clinical features (+1 or 2), symptom duration (+0-2), diabetes (+1)). Exclusion criteria were (1) any diagnosis other than stroke/TIA, (2) in-hospital onset of stroke symptoms and (3) incapacity to answer the structured questionnaire and no witness available in the pre-hospital phase available to answer the structured questionnaire. We obtained informed consent prior to enrolment in the study.

One research medical student collected data on the pre-hospital phase by using health records and conducted in-person or phone interviews with all patients or eyewitnesses admitted during the study period. Two methodologies (Part A and Part B) were used.

Part A
A standardised questionnaire and health records were used to collect quantitative data on demographics, the time and location of stroke onset and the first medical assistance sought. Questions were also asked to determine the level of stroke symptom awareness. Data on response times by pre-hospital and hospital services were also recorded.

Part B
Qualitative data was collected on patient perception and understanding of their symptoms, the factors that influenced their decision to seek help and the mode and urgency of seeking help.

Statistical analysis
Descriptive and inferential statistics were used. Categorical variables were described as frequencies and percentages, and numerical variables were described as mean and standard deviation or median and interquartile range. For inferential statistics, the association between categorical variables were determined using Fisher’s exact test, and for numerical variables, mean difference was determined using independent t-test. A p-value <0.05 was used for statistical significance. The association between each variable and hospital arrival within or after 4.5 hours was also investigated. This time window was chosen as it is the standard cut-off for hyperacute therapy. A time of ≥ 4.5 hours was used to define prehospital delay for the purposes of this analysis.

Ethical approval
The study protocol was received ethical approval from the New Zealand Northern Regional Health and Disability Ethics Committee and was endorsed by the Māori Research Review Group, Pae Ora Paíaka Whaiora Hauora Māori Directorate, at MidCentral DHB.

Results
A total of 56 patients were assessed for eligibility during the recruitment period. Overall, 41 patients satisfied the inclusion/exclusion criteria and agreed to participate. Reasons for exclusions are demonstrated in Figure 1.

Part A
The mean age of patients was 70 years (range 33–94), with equal representation of both sexes. Twenty-two patients (53.7%) arrived within 4.5 hours of stroke onset. The mean National Institutes of Health Stroke Scale (NIHSS) on admission was 4, and most patients (91.4%) were functionally independent pre-stroke (Modified Rankin Scale ≤2). The majority of patients (82.9%) identified as being of New Zealand European ethnicity and 5% identified as Māori. The most prevalent vascular risk factor was hypertension (58.5%), followed by diabetes (31.7%). Almost one-quarter of patients had three or more vascular risk factors. Twenty-eight patients had a final diagnosis of ischaemic stroke (68%), three haemorrhagic stroke (7%) and 10 TIA (24%). A summary of patient characteristics is presented in Table 1.

The mean overall delay between stroke onset and first contact with a health professional was 11 hours. Patients who presented
to hospital within 4.5 hours had a mean symptom onset to first healthcare contact time of 37 minutes compared with 23 hours for patients who presented outside 4.5 hours (p=0.036). These findings are summarised graphically in Figure 2.

Overall, 23 patients called the ambulance as their first point for help, and these patients were significantly more likely to arrive in hospital within 4.5 hours (p=0.009). Thirteen patients called the ambulance within 15 minutes of symptom onset and these patients were more likely to arrive to hospital within 4.5 hours (p=0.001) and were significantly more likely to receive thrombolysis (p<0.001). Seven patients used primary care as their first contact, and in these patients the mean time from symptom onset to hospital arrival was 28 hours. Patients with higher NIHSS scores on admission were more likely to present within 4.5 hours. However, this did not meet statistical significance. Interestingly, living with others, the presence of the partner at the time of stroke or having had a prior stroke were not associated with early presentation to hospital. Finally, patients arriving within 4.5 hours had a shorter mean travel distance to hospital than those with delayed admission. (36.36 vs 54.4 km, p=0.036).

Awareness of stroke symptoms
We did not observe a significant association between knowledge of stroke symptoms or FAST awareness and arriving within 4.5 hours. Sixteen patients reported knowing their symptoms were caused by a stroke, but only 12 of these arrived within 4.5 hours (not significant). Most participants could identify aphasia, diplopia/blurred vision and hemiparesis/paresthesia as stroke symptoms (82.9%, 78% and 90.9%, respectively). Only 39% of our patients could identify sudden blindness in one eye as a stroke symptom. The majority of patients correctly excluded chest pain, shooting pain in the arm, joint pain and sudden nose bleeds as stroke-specific symptoms. However, 73.2% and 63.4% of our patients incorrectly identified dizziness and headaches as stroke specific symptoms, respectively. The ability to identify any one stroke symptom was not significantly associated with arriving within 4.5 hours. Patient stroke symptom awareness is summarised in Table 2.

Ambulance response
The mean time between emergency call to arrival at the scene was 14 minutes, and the mean time from arrival of ambulance to departure for hospital was 21 minutes. The mean time delay between departure

Figure 1: Consort diagram showing how patients were enrolled.
Table 1: Baseline characteristics.

<table>
<thead>
<tr>
<th></th>
<th>N (%)</th>
<th>Hospital arrival &lt;4.5 hrs. N (%)</th>
<th>Hospital arrival ≥4.5 hrs. N (%)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male sex</td>
<td>20 (48.8)</td>
<td>10 (43.5)</td>
<td>10 (55.6)</td>
<td>0.443a</td>
</tr>
<tr>
<td>Age (years) mean (SD)</td>
<td>70 (14.4)</td>
<td>71.27 (16.9)</td>
<td>68.21 (11.9)</td>
<td>0.541b</td>
</tr>
<tr>
<td>Unemployed</td>
<td>28 (68.3)</td>
<td>17 (73.9)</td>
<td>11 (61.1)</td>
<td>0.382a</td>
</tr>
<tr>
<td>NZ European ethnicity</td>
<td>34 (82.9)</td>
<td>19 (82.6)</td>
<td>15 (83.3)</td>
<td>1.00c</td>
</tr>
<tr>
<td>Married as a civil status</td>
<td>23 (56.1)</td>
<td>11 (47.8)</td>
<td>12 (66.7)</td>
<td>0.084c</td>
</tr>
<tr>
<td>Living together as a living condition</td>
<td>30 (73.2)</td>
<td>14 (60.9)</td>
<td>16 (88.9)</td>
<td>0.075c</td>
</tr>
<tr>
<td>Partner present at the time of symptoms onset</td>
<td>17 (41.5)</td>
<td>8 (34.8)</td>
<td>9 (50)</td>
<td>0.941c</td>
</tr>
<tr>
<td>Physically active at the time of stroke onset</td>
<td>25 (61)</td>
<td>12 (52.2)</td>
<td>13 (72.2)</td>
<td>0.535c</td>
</tr>
<tr>
<td>High school is the highest educational achievement</td>
<td>28 (68.3)</td>
<td>15 (65.2)</td>
<td>13 (72.2)</td>
<td>0.552c</td>
</tr>
<tr>
<td>Preadmission mRS ≤2</td>
<td>32 (91.4)</td>
<td>17 (85)</td>
<td>15 (100)</td>
<td>0.244c</td>
</tr>
<tr>
<td>Admission NIHSS (SD)</td>
<td>4 (4)</td>
<td>4.35 (5)</td>
<td>3.22 (2)</td>
<td>0.364c</td>
</tr>
<tr>
<td>Shortest route on between stroke location and stroke centre in kilometres (SD)</td>
<td>36.38 (22.01)</td>
<td>54.40 (57.01)</td>
<td>0.036b</td>
<td></td>
</tr>
<tr>
<td>Ambulance/call 111 is the primary kind of help sought</td>
<td>23 (56.1)</td>
<td>17 (77.3)</td>
<td>6 (31.6)</td>
<td>0.009a</td>
</tr>
<tr>
<td>Relatives made the call</td>
<td>17 (41.5)</td>
<td>7 (31.8)</td>
<td>10 (52.6)</td>
<td>0.147a</td>
</tr>
<tr>
<td>Paramedics contacted within 15 minutes of symptom onset</td>
<td>13 (31.7)</td>
<td>12 (54.5)</td>
<td>1 (5.3)</td>
<td>&lt;0.001c</td>
</tr>
<tr>
<td>Palmerston North hospital as first healthcare organisation the patient was taken to</td>
<td>33 (80.5)</td>
<td>21 (95.5)</td>
<td>12 (63.2)</td>
<td>0.031c</td>
</tr>
<tr>
<td>Delay between stroke onset and first healthcare contact in minutes mean (SD)</td>
<td>37.24 (43.42)</td>
<td>1382.28 (1388.94)</td>
<td>0.001b</td>
<td></td>
</tr>
</tbody>
</table>

**Medical history**

<table>
<thead>
<tr>
<th></th>
<th>N (%)</th>
<th>Hospital arrival &lt;4.5 hrs. N (%)</th>
<th>Hospital arrival ≥4.5 hrs. N (%)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>24 (58.5)</td>
<td>12 (52.2)</td>
<td>12 (66.7)</td>
<td>0.350a</td>
</tr>
<tr>
<td>Diabetes</td>
<td>13 (31.7)</td>
<td>6 (26.1)</td>
<td>7 (38.9)</td>
<td>0.382a</td>
</tr>
<tr>
<td>Previous stroke</td>
<td>9 (22)</td>
<td>3 (13)</td>
<td>6 (33.3)</td>
<td>0.119a</td>
</tr>
<tr>
<td>Ischaemic heart disease</td>
<td>8 (19.5)</td>
<td>5 (21.7)</td>
<td>3 (16.7)</td>
<td>0.716c</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>4 (9.8)</td>
<td>3 (13)</td>
<td>1 (5.6)</td>
<td>0.618c</td>
</tr>
<tr>
<td>Hyperlipidaemia</td>
<td>9 (22)</td>
<td>5 (21.7)</td>
<td>4 (22.2)</td>
<td>0.97c</td>
</tr>
<tr>
<td>Ex-smoker</td>
<td>27 (65.9)</td>
<td>14 (60.9)</td>
<td>13 (72.2)</td>
<td>0.881c</td>
</tr>
</tbody>
</table>

*a Chi Square test.
*b Independent t-test.
*c Fisher’s exact test.
*mRS: Modified Rankin Scale.
*NIHSS: National Institutes of Stroke Scale.
Figure 2: Delays in patient response. Time from stroke onset to first call for help and time from stroke onset to hospital arrival.

Table 2: Stroke awareness.

<table>
<thead>
<tr>
<th></th>
<th>N (%)</th>
<th>Hospital arrival &lt;4.5 hrs N (%)</th>
<th>Hospital arrival ≥4.5 hrs N (%)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient first realised that there was something a miss</td>
<td>26 (63.4)</td>
<td>16 (69.6)</td>
<td>10 (55.6)</td>
<td>0.466c</td>
</tr>
<tr>
<td>Know what stroke is/aware of FAST</td>
<td>36 (87.8)</td>
<td>20 (87)</td>
<td>16 (88.9)</td>
<td>1.00b</td>
</tr>
<tr>
<td>Know the symptoms could be caused by a stroke</td>
<td>16 (39)</td>
<td>12 (52.2)</td>
<td>4 (22.2)</td>
<td>0.051a</td>
</tr>
<tr>
<td>Expressive and receptive aphasia is a stroke symptom</td>
<td>34 (82.9)</td>
<td>20 (87)</td>
<td>14 (77.8)</td>
<td>0.816c</td>
</tr>
<tr>
<td>Sudden diplopia or blurred vision is a stroke symptom</td>
<td>32 (78)</td>
<td>19 (82.6)</td>
<td>13 (72.2)</td>
<td>0.429a</td>
</tr>
<tr>
<td>Sudden hemiparesis or paresthesia in face, arm or leg is a stroke symptom</td>
<td>39 (95.1)</td>
<td>21 (91.3)</td>
<td>18 (100)</td>
<td>0.495c</td>
</tr>
<tr>
<td>Sudden blindness in an eye is a stroke symptom</td>
<td>16 (39)</td>
<td>10 (43.5)</td>
<td>6 (33.3)</td>
<td>0.626c</td>
</tr>
<tr>
<td>Dizziness is a stroke symptom</td>
<td>30 (73.2)</td>
<td>16 (72.7)</td>
<td>14 (73.7)</td>
<td>0.023a</td>
</tr>
</tbody>
</table>

a Chi Square test.
b Independent t-test.
c Fisher’s exact test.
of ambulance to arrival at hospital was 38 minutes. This is shown graphically in Figure 3.

**Hospital response**

Seven patients received thrombolysis (thrombolysis rate 25%). In these patients, median door to CT time was 32 minutes, and door to needle time was 57 minutes. Of the remaining 15 early presenters, reasons for not administering reperfusion therapy included: non-disabling symptoms and low NIHSS (10), absolute contraindication (1) and diagnostic uncertainty (4). Nineteen patients had delayed presentation.

**Part B**

Five main themes were identified as being important contributors to delays in help seeking at the time of stroke: difficulty making sense of symptoms, personal beliefs, dismissing/minimising symptoms, the influence of others and fulfilling prior commitments and responsibilities. Each of these themes will be explored in turn.

The majority of patients could not make sense of the symptoms they were experiencing. At symptom onset, patients noted that something was amiss. Some had characteristic severe stroke symptoms (eg, hemiparesis), and others experienced more subtle features, such as feeling “brain-muddled” or “out of it.” Patient 18 (83F, 2 hours), acknowledged that she “knew something was wrong, because I couldn’t move my right-hand side, and it wasn’t going away. What I used to do before (stretch out shoulder) wasn’t working, so I was thinking it was more serious.” Patient 36 (68M, 11 hours) “woke up feeling strange and weak on my right side, I took my blood pressure which was really high. So, I thought it was just due to my blood pressure. So, I just took my morning medications and hoped it would go down like it normally does.” Patient 14 (37M, 15 hours) dismissed the possibility of a stroke since, as they put it, “I wasn’t thinking of a stroke because I thought it is not for young people.”

Another theme that contributed to delays in hospital arrival were personal beliefs about seeking help. Some patients had reservations about depending on others, perceived medical services negatively or thought healthcare services should be reserved for more serious events than those experienced. Patient 41 (79F, 18 hours):

*Figure 3: Ambulance response.*
“I’m not really good at depending on other people, and so I kind of just got on with and dealt with it myself. I should be at a stage where I should ask for help more.”

Patient 40 (64F, 19 hours): “I have no trust in medical persons and establishment/government officials. I’m more inclined to fix things myself.”

Patient 6 (67M, 11 hours): “I don’t like wasting people’s time, got to be pretty sure that I need help, normally family will look after me, I’ve been raised to think that there’s always someone worse off than you, so I didn’t want to take ambulance away from someone else, especially from my area.”

Patient 16 (73F, 53 hours) said, “I wasn’t feeling I was sick enough to get an ambulance. The ambulance, in my mind was always thought of as the last and best effort. I would be embarrassed if they came, because they probably would have thought my symptoms weren’t bad enough,” and reflecting on her experience further, continued: “I think now, I would call the ambulance at a drop of a hat, because they made me feel safe and not like I was overreacting.”

A prominent theme that caused pre-hospital delay was minimising symptoms, with many patients feeling that the severity of their condition did not meet their perceived threshold which would warrant a call to emergency services. Patient 25 (87M, 43 hours): “I was reluctant to call the panic button, because I didn’t think it was critical and I had an appointment with my GP after the weekend.” However, this patient reported that he had contacted ambulance services soon after symptom onset and, unconventionally, the advice reinforced his decision to wait and see his general practitioner in the morning.

One theme that had varying effects on patients’ decisions to seek help was the influence of other people. Many patients sought advice, validation or a second opinion before contacting health services. In others, eyewitnesses identified stroke symptoms. Patient 1 (55M, 7 hours): “I didn’t have reception to talk to anyone, my symptoms were easing sometimes and I wasn’t sure it was a stroke. I knew my wife was coming home after work, and so I waited for her to see what she thought and help me get in.”

Patient 41 (79F, 18 hours): “It was lucky my brother called, because he heard the slurred speech and encouraged me to get help, because he thought it was a stroke. I thought he might have been overreacting because I had been like this before.”

There were a number of patients whose partners or relatives discouraged calling emergency services. Patient 34’s (72F, 35 hours) husband advised: “Just go to sleep and it will get better in the morning like it did last time with your mini stroke.”

Patient 14 (37M, 15 hours) noted that his partner didn’t call earlier because “there wasn’t any bleeding or loss of consciousness, so I didn’t think it was an emergency to call.”

Finally, some patients prioritised prior commitments and responsibilities over seeking help for stroke symptoms, or delayed seeking help because they had upcoming healthcare appointments. Patient 10 (63F, 13 hours): “You look for excuses when you don’t want to come into the real world. I checked on the cat first, first called boss and told them to look after cat and that I think I’ve had a stroke. Don’t know if I was choosing to ignore it, or don’t want to bother people.”

Patient 20 (86M, 4 hours): “[I] was hoping symptoms would just go away and I could focus on driving to get wife to hospital for her appointment.”

Discussion

This study investigated the health-seeking behaviour of patients experiencing stroke symptoms, with a particular focus on the factors that lead to time delays in seeking help. Only 16 patients recognised their symptoms as potentially being attributable to stroke, and only 12 of these patients presented within 4.5 hours of onset. Both our quantitative and qualitative data suggest that the decision to seek timely help is complex and multi-factorial.

The main factors causing significant delays in presentation to hospital included being a longer distance from hospital, delays in contacting health services and the five themes identified in the qualitative analysis.

Geographical distance

We found an inverse relationship between distance from hospital and the likelihood of arriving within 4.5 hours. This highlights the challenge faced by rural communities. Reasons for delays include increased travel time, a lack of access to transportation and
concerns over utilising the limited local ambulance service for fear of depriving others who may be in more need.

**Delay to seeking emergency help**

Patients with an early first call to emergency services for help were significantly more likely to arrive early and receive reperfusion therapy, whereas those whose first contact was primary care experienced significant delays. This finding is consistent with other studies\(^{12}\) that associated face-to-face visits with family doctors with increased prehospital delay and decreased likelihood of receiving reperfusion therapy.

We identified five major themes that contributed to delays in presentations to hospital. We discovered that patients had good insight of stroke symptoms and the majority reported familiarity with the FAST campaign and knowing what a stroke was. However, patients' ability to apply this knowledge to their own stroke symptoms was low. Reasons for this include, firstly, that having knowledge or awareness of stroke does not automatically translate into recognition of symptoms, and secondly, that cognitive function may be impaired in acute stroke; several of our patients describe some degree of confusion during the acute episode. Further, we found that almost half of patients did not consider stroke to be a medical emergency or think that emergency medical services should be contacted when stroke symptoms are minor. Some patients were not aware of the hyperacute treatments available.

**Emergency services**

We found that pre-hospital emergency services were extremely efficient at prioritising and responding to patients with stroke symptoms and transporting them to hospital. Hospital arrival to initial reperfusion therapy, more commonly referred to as “door to needle” time, is widely acknowledged to represent a stroke centre's efficiency. Our door to needle time met the New Zealand target (less than 60 minutes in 80% of patients)\(^{1}\) and is comparable to the performance of other international stroke centres.\(^{13,14}\)

**Limitations**

Our study did have some limitations. We had relatively low numbers of study participants, which limited the ability to draw further conclusions and associations. Patients with severe strokes were under-represented, due to their inability to complete the interview, no eyewitnesses of the event or consent to participate being withheld. This study was conducted in a single centre, limiting the generalisability of our results. Finally, we had a disproportionately low representation by Māori and Pacific peoples, ethnicities associated greater morbidity and mortality from stroke compared with other ethnic groups.\(^{15}\)

**Conclusion**

This novel study identified a number of factors and themes that led to delays in patients with stroke symptoms seeking help. The findings of this study confirm that the most common reason for not receiving reperfusion therapy was prehospital delay. This study highlights gaps in the public's awareness of stroke symptoms and the necessity of urgent treatment, and misgivings on the use of healthcare services. These factors should be addressed in future public health campaigns and by healthcare providers.
Competing interests:
Nil.

Acknowledgements:
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REFERENCES
Clinical and epidemiological characteristics of COVID-19 in Wellington, New Zealand: a retrospective, observational study

Nethmi Kearns, Allie Eathorne, Tessa Luff, Ciléin Kearns, Craig Thornley, Alex Semprini, Richard Beasley, Annette Nesdale

ABSTRACT

AIMS: To review the demographic and clinical characteristics of confirmed COVID-19 cases within the Greater Wellington Region (GWR).

METHODS: A retrospective, observational study of all 96 confirmed COVID-19 cases in the GWR. The primary outcome was time taken from onset to complete resolution of symptoms. Secondary outcomes were the epidemiological and clinical characteristics of cases.

RESULTS: The mean (SD) time from symptom onset to complete resolution was 19.1 (1.1) days. The mean (SD) age was 43.1 (16.9). 51% were male. The majority were of European ethnicity (84%), resided in the top five decile neighbourhoods (76%) and had travelled to New Zealand (69%). The mean (SD) time from onset of symptoms to obtaining RT-PCR testing results was 5.3 (0.4) days. The most common symptoms at onset were cough (36%), sore throat (22%) and fatigue (21%; the overall most common symptoms were cough (65%), sore throat (43%), headache (43%) and fatigue (42%); many symptoms were late manifestations. The most common co-morbidity reported was asthma (20%), with no reported exacerbations. The rate of secondary infections within households was 0.05 per primary infection.

CONCLUSION: The demography of COVID-19 cases reflected the imported nature of cases. The clinical presentation of COVID-19 was highly variable and there were no particular symptoms that could accurately predict infection.

The COVID-19 pandemic has constituted a Public Health Emergency of International Concern, with New Zealand having reported its first case of COVID-19 on 26 February 2020. While clinicians, researchers and authorities have been characterising the nature of COVID-19, the majority of data on COVID-19 has been limited to patients presenting or admitted to hospital and intensive care, which provides invaluable data on disease progression in severe disease, but it only represents a minority of cases. It is estimated that 80% of confirmed COVID-19 cases experience a mild course of disease and therefore are likely to be managed in the community.

The lack of knowledge surrounding the time-course, duration and progression of COVID-19 in mild cases poses challenges not only to those immediately affected, but also to the public health services charged with developing guidelines for the management of confirmed mild cases in the community. It is therefore imperative that the progression of disease at the milder end of the spectrum is explored to fill this gap in knowledge.
New Zealand's burden from COVID-19 has been markedly lower than all other comparable Organisation for Economic Co-operation and Development (OECD) nations, with a lower rate of cases, related hospital admissions and deaths. New Zealand managed to eliminate COVID-19 (defined as an absence of transmission in the community for at least 28 days) for 102 days prior to the “second wave” that surfaced in Auckland in August 2020. The Greater Wellington Region (GWR), where this study was undertaken, remained free of community transmission until the recent outbreak in August 2021.

A combination of geographic isolation, early border restrictions, nationwide lockdown, managed isolation and widespread testing has meant that New Zealand's epidemic curve plateaued at a significantly earlier date from the first confirmed case compared to many other nations. The smaller number of cases prevented an overwhelmed health sector and appropriate testing and contact tracing measures were able to be undertaken in a transparent and systematic way.

In this community-based review of all confirmed cases of COVID-19 within the GWR, we report the demographic and clinical characteristics of COVID-19 cases. With the recent publication of the comprehensive national epidemiological study of all COVID-19 cases in New Zealand, we have focused on the data that complements the national study. This includes information on the time course of disease from onset to resolution, the difference in symptoms at onset versus throughout the disease, the frequency of exacerbations of asthma, the rates of secondary infection within households and the countries from which cases were imported.

Methods

This was a retrospective, observational study of confirmed COVID-19 cases managed in the community by the Regional Public Health Unit (RPH) in the GWR between 1 January and 1 August 2020. The GWR consists of three district health boards (DHBs), Capital and Coast DHB, Hutt Valley DHB and Waitemata DHB, serving a population of 506,814 (10% of New Zealand's population). A confirmed case of COVID-19 was defined as one with laboratory definitive evidence. Given the evolving nature of the pandemic, there was no pre-determined sample size. All confirmed cases were included in the analysis.

Ethics approval

This study was approved for conduct with a waiver of patient consent by the New Zealand Northern B Health and Disability Ethics Committee (reference 20/NTB/109). The request for waiver of consent was granted by the Ethics Committee as the study aimed to re-use existing data that have already been collected and were also in line with the privacy law criteria.

Patient and public involvement

Neither patients nor the public were involved in the design, conduct, reporting or dissemination plans of our research.

Data

The list of confirmed cases was obtained from New Zealand's national notifiable disease surveillance database, EpiSurv. Data relating to cases were collected from existing patient records held by the RPH and three DHBs. As part of daily monitoring, RPH staff contacted all cases daily by phone to ascertain self-reported symptoms, duration and resolution. Data on co-morbidities and smoking status were included if they were recorded in existing RPH/DHB records. All available data were analysed and missing data were not imputed. Data were entered directly into the REDCap database—a secure, United States Health Insurance Portability and Accountability Act 1996 (HIPPA)-compliant web-based application, hosted and supported by the Medical Research Institute of New Zealand (MRINZ).

Bias

This was a retrospective study collecting existing data and therefore susceptible to potential information bias and missing data.

Statistical methods

Data descriptions for continuous and ordinal variables are mean and standard deviation (SD), median and inter-quartile range (IQR) and minimum (min) to maximum (max). Data descriptions for categorical variables are by counts and proportions expressed as percentages. Data descriptions for survival data are by Kaplan-Meier survival curves and estimates of 25th, median and 75th percentiles of survival.
Table 1: Definition of variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnicity</td>
<td>As per EpiSurv and reported as Prioritised output using Level 1 codes defined by the Ministry of Health.</td>
</tr>
<tr>
<td>Occupation</td>
<td>As per EpiSurv and classified at Level 1 of the Australian and New Zealand Standard Classification of Occupations (ANZSCO).</td>
</tr>
<tr>
<td>Deprivation</td>
<td>The NZDep(^{18,19}) is an area-based measure of socioeconomic deprivation in New Zealand based on a composite score for each meshblock (smallest geographical area defined by Statistics New Zealand) determined using EpiSurv data.</td>
</tr>
<tr>
<td>Likely source of infection(^{20})</td>
<td>1. Imported cases: cases with a reported history of international travel within 14 days of onset.</td>
</tr>
<tr>
<td></td>
<td>2. Imported related cases: cases that had a reported link (close contact or epidemiological link) to an imported/overseas acquired case.</td>
</tr>
<tr>
<td></td>
<td>3. Locally acquired cases, epidemiologically linked: cases that had a reported link (close contact or other epidemiological link) to a locally acquired case with unknown source.</td>
</tr>
<tr>
<td></td>
<td>4. Locally acquired cases, unknown source: cases that had no reported history of international travel within 14 days of onset and no recorded epidemiological link to a source case.</td>
</tr>
<tr>
<td>Resolution of symptoms</td>
<td>The date on which a case had been asymptomatic (absence of acute symptoms) for the preceding 48 hours.</td>
</tr>
<tr>
<td>Severe exacerbation of asthma</td>
<td>Presentation to an emergency department or other hospital unit during the 28-day period from onset of symptoms.(^{21}) Admission was defined as hospitalisation for at least four hours.</td>
</tr>
<tr>
<td>Severe exacerbation of chronic obstructive pulmonary disease (COPD)</td>
<td>Presentation to an emergency department or other hospital unit during the 28-day period from onset of symptoms.(^{22,23}) Admission was defined as hospitalisation for at least four hours.</td>
</tr>
<tr>
<td>Secondary household infection</td>
<td>If a household member living with a confirmed COVID-19 case, received a diagnosis of COVID-19 within 14 days of the initial household member getting unwell, this was defined as secondary household infection.</td>
</tr>
</tbody>
</table>
Data descriptions for count data are by rates and total counts in relation to observation time and/or primary infections. Kaplan-Meier plots of survival were used to determine time to resolution of symptoms and recovery. SAS version 9.4 was used.

**Results**

**Baseline characteristics**

All 96 confirmed cases of COVID-19 in the GWR during the study period were included in the analysis. Ninety-four cases presented to either their general practitioner or a community-based assessment centre (CBAC) for testing following onset of symptoms. Two cases were tested as part of the managed isolation exemption protocol.

The mean (SD) age of cases was 43.1 (16.9). Fifty-one percent were male and the majority were recorded as being of European ethnicity (84%) (Table 1). Forty-three percent of cases were employed in professional and managerial jobs, 25% lived in decile 1 areas (the least deprived 10% of areas in New Zealand) and 9% were healthcare workers.

**Clinical characteristics**

Of the 96 cases, one was asymptomatic and not been included in this analysis. The most common symptoms at onset were cough (36%), sore throat (22%), fatigue (21%) and fever (19%), and the most common symptoms overall were cough (65%), sore throat (43%), headache (43%) and fatigue (42%) (Figure 1). Approximately two-thirds of cases experienced two or more of the four most common symptoms during their illness, and only five cases experienced all four most common symptoms. Myalgia and altered sense of smell and taste were each experienced by approximately a third of cases. Gastrointestinal upset was a late onset manifestation accounting for only 1% of symptoms at presentation; but over time, 16% of cases developed diarrhoea and 10% of cases vomiting or nausea. Eleven cases had a recrudescence of symptoms and all but one tested negative on repeat testing. The mean (SD) time taken from onset of initial symptoms to obtaining RT-PCR testing results was 5.3 (0.4) days.

The mean (SD) time taken from onset of symptoms to resolution of acute symptoms was 19.1 (1.1) days (Figure 2) with 75% of cases reaching complete resolution in 23 days (95% CI: 19 to 32) after onset.

Seven of the 12 cases that presented to hospital were admitted. Two of these admissions were from aged residential care facilities. The mean (SD) length of stay in hospital was 11.4 (4.6) days. The majority of admissions (71.4%) were in males and had a mean (SD) age of 63.23 (21.3). Two of the admitted cases who were within the 76–85 age group died in hospital.

The most common co-morbidity reported was asthma (19.8%), followed by cardiovascular disease (15.6%), malignancy (6.3%) and liver disease (2.1%). There were no severe exacerbations of asthma or COPD.

Data on obesity was poorly reported, with six cases having obesity recorded in their medical records. Seven cases (10.9%) were active smokers and 14 (21.9%) were former smokers.

**Source of Infection**

The majority of COVID-19 infections (69%) were in people who travelled to New Zealand from overseas via international flights (Figure 3). Two cases were linked to a cruise ship. The most common country of origin of imported cases was the United Kingdom (n=28, 42.4%), followed by United States of America (n=17, 25.8%). Two additional cases were related to imported cases, and 25 infections (26.0%) were locally acquired and epidemiologically linked. Three cases (3.1%) had no identifiable source of infection. The rate of secondary infections within households was low, at 0.05 secondary infections per primary infection.

**Discussion**

In this study we explored the clinical and epidemiological characteristics of consecutive COVID-19 cases in the community. The mean time from symptom onset to resolution of acute symptoms was 19 days, with a tail in which the duration of symptoms lasted at least six weeks. The majority of cases were middle aged, European descent, higher socioeconomic background and related to travel, which mirrored the characteristic of cases in the national study, and therefore our data are likely to representative of the New Zealand COVID-19 cases.

The ethnic make-up of the Wellington cases is of interest as Māori have histor-
Figure 1: Symptoms of COVID-19 cases at presentation and during the course of illness.
Figure 2: Kaplan-Meier curve showing time taken from onset to resolution of acute symptoms.

Figure 3: Map of entry route for imported COVID-19 cases, Wellington, New Zealand.
Table 2: Baseline characteristics of COVID-19 cases.

<table>
<thead>
<tr>
<th>Variable (N=96)</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex: Female</strong></td>
<td>47 (49.0)</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
</tr>
<tr>
<td>0–19</td>
<td>4 (4.2)</td>
</tr>
<tr>
<td>20–39</td>
<td>40 (41.7)</td>
</tr>
<tr>
<td>40–59</td>
<td>36 (37.5)</td>
</tr>
<tr>
<td>60–79</td>
<td>15 (15.6)</td>
</tr>
<tr>
<td>80 and above</td>
<td>1 (1.0)</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
</tr>
<tr>
<td>Māori</td>
<td>7 (7.3)</td>
</tr>
<tr>
<td>Pacific Peoples</td>
<td>2 (2.1)</td>
</tr>
<tr>
<td>Asian</td>
<td>5 (5.2)</td>
</tr>
<tr>
<td>Middle Eastern/Latin American/African</td>
<td>1 (1.0)</td>
</tr>
<tr>
<td>European</td>
<td>81 (84.4)</td>
</tr>
<tr>
<td><strong>Occupation</strong></td>
<td></td>
</tr>
<tr>
<td>Managers</td>
<td>12 (12.5)</td>
</tr>
<tr>
<td>Professionals</td>
<td>29 (30.2)</td>
</tr>
<tr>
<td>Technicians and trades workers</td>
<td>6 (6.3)</td>
</tr>
<tr>
<td>Community and personal service workers</td>
<td>9 (9.4)</td>
</tr>
<tr>
<td>Clerical and administrative workers</td>
<td>7 (7.3)</td>
</tr>
<tr>
<td>Sales workers</td>
<td>3 (3.1)</td>
</tr>
<tr>
<td>Machinery operators and drivers</td>
<td>3 (3.1)</td>
</tr>
<tr>
<td>Labourers</td>
<td>4 (4.2)</td>
</tr>
<tr>
<td>Retired</td>
<td>7 (7.3)</td>
</tr>
<tr>
<td>Student</td>
<td>5 (5.2)</td>
</tr>
<tr>
<td>Unemployed</td>
<td>11 (11.5)</td>
</tr>
<tr>
<td>Healthcare and support workers</td>
<td>9 (12.3)</td>
</tr>
</tbody>
</table>
Table 2: Baseline characteristics of COVID-19 cases (continued).

<table>
<thead>
<tr>
<th>Variable (N=96)</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>New Zealand Index of Deprivation decile</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>24 (25.0)</td>
</tr>
<tr>
<td>2</td>
<td>17 (17.7)</td>
</tr>
<tr>
<td>3</td>
<td>15 (15.6)</td>
</tr>
<tr>
<td>4</td>
<td>12 (12.5)</td>
</tr>
<tr>
<td>5</td>
<td>5 (5.2)</td>
</tr>
<tr>
<td>6</td>
<td>9 (9.4)</td>
</tr>
<tr>
<td>7</td>
<td>9 (9.4)</td>
</tr>
<tr>
<td>8</td>
<td>5 (5.2)</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>
cally fared poorly in pandemic respiratory illnesses compared to New Zealand Europeans, with higher rates of death and hospitalisations. This study found that, during the first wave, Māori comprised only 7% of Wellington cases (with no deaths) and 8% of cases across New Zealand, which contrasts with the national Māori population of 16.5%. This has been attributed to the higher rate of European New Zealanders returning with COVID-19 infection from overseas.

Consequently, only 24% of Wellington cases were in the lower five deciles. The New Zealand Index of Deprivation considers the “living space” (number of people living in equivalised households below a bedroom occupancy threshold). The majority of cases that were in less deprived areas, and therefore in less crowded housing, could have arguably been able to isolate better and result in the reduced household transmission of 0.05 secondary infections per primary infection. A strong public health mitigation framework with timely lockdowns, early border restrictions, mandatory quarantine of international arrivals and clear communication of risk, as seen in Wellington and in New Zealand overall during the first wave, minimised transmission from arriving travellers to vulnerable communities.

The mean age of COVID-19 patients (43.1 years) was similar to that of the positive community cases in Reykjavik, Iceland (44.4 years). However, our hospitalised cases tended to be younger (63.2 years) compared to other hospital COVID-19 cohorts in the United Kingdom (73 years), but both deaths occurred in the 76–85 age group. This was in keeping with the mean age of 81.5 years among the 22 COVID-19 deaths nationally. Increasing age has been associated with increased risk of mortality with people aged 80 or over having a more than 20-fold-increased risk compared to 50–59-year-olds. Our hospitalised cases also had a longer length of stay (11.4 days) compared to the median five days of hospital stay in countries outside China. China had a median length of stay of 14 days. Wellington's longer stay may have been in part due to availability of beds and the system not being under pressure from COVID-19.

The frequency of symptoms in COVID-19 cases in Wellington were similar to those exhibited by positive community cases across New Zealand and Iceland. In Wellington, the most common symptoms overall were cough (65%), sore throat (43%), headache (43%) and fatigue (42%). Fever (36%) and dyspnoea (27%) occurred less commonly than in hospital cases, which probably reflected the differences in severity of disease. Anosmia (36%) and ageusia (33%) were more prevalent in the Wellington cohort compared to those who reported either anosmia or ageusia (2.2%) in the Icelandic cohort. In many cases, specific symptoms such as dyspnoea, rhinorrhea, diarrhoea, nausea and vomiting were late manifestations of the illness. Although this study lacks a control group to determine the predictive value of symptoms, our findings suggest that there was no characteristic symptom or cluster of symptoms that could predict COVID-19 infection, which is consistent with analyses of other studies.

There was only one asymptomatic case in this study. New Zealand guidelines required individuals to be symptomatic in order to be tested in the community at this time. However, during the study period, individuals who arrived at the border and were exempted from mandatory quarantine underwent testing regardless of symptoms, resulting in the identification of our only asymptomatic case. Asymptomatic persons may have accounted for approximately 40% to 45% of COVID-19 infections, with possible transmission for extended periods, perhaps longer than 14 days. In the Icelandic cohort, 43% of those aged ten years and older had no symptoms at testing. In an Italian sample, 42.5% of those who tested positive had no symptoms at testing and never developed any symptoms. These studies showed that the symptom profile of COVID-19 was inconsistent and variable and that the testing of asymptomatic persons represented an important approach in population surveillance.

A limitation of this study is that, for the majority of cases, the source of the infection was from overseas, yet socioeconomic/deprivation data were based on their local address in New Zealand. Confining the study to confirmed cases and excluding probable cases is also a limitation, as some
probable cases may have been confirmed if they had been tested. The strengths of this study include the collection of standardised data from consecutive cases in a population where extensive contact tracing occurred as part of the public health response.

This study of community cases has illustrated that the profile of symptoms in COVID-19 was highly variable and there was no particular symptom(s) that could accurately predict infection. The overall make-up of Wellington cases being of European descent and higher socioeconomic background and related to travel, in combination with public health measures, meant that there was minimal community transmission in Wellington, which protected vulnerable communities.

Competing interests:
Prof Beasley reports grants and personal fees from Health Research Council outside the submitted work.

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URL:

REFERENCES


Ultrasound use in suspected testicular torsion: an association with delay to theatre and increased intraoperative finding of non-viable testicle

Hannah Grace Wright, Hamish John Wright

ABSTRACT

AIM: Testicular torsion is a surgical emergency and delayed operative management can negatively impact fertility. The aims of this study were to establish patterns of ultrasound use, correlate ultrasound and intraoperative findings and determine the impact of ultrasound on admission-to-operation time in patients undergoing scrotal exploration for suspected torsion.

METHOD: All adult patients who underwent acute scrotal exploration for suspected torsion between 2007 and 2017 at Auckland City Hospital were included (n=316). Clinical notes were reviewed for demographic and clinical data. Admission-to-operation time was compared between patients who had a formal ultrasound and those who did not.

RESULTS: Ultrasound was performed in 153/316 (48.4%) patients. Ultrasound sensitivity and specificity for torsion was 97.8% and 52.9% respectively. Median admission-to-operation time was 106 minutes for patients who did not have an ultrasound and 225 minutes for those who did (excluding those with missed torsion on ultrasound) (p=<0.0001). Non-viable testicle was identified intraoperatively in 11/163 patients (6.7%) who did not have an ultrasound, and in 42/122 (34.4%) of those who did (excluding those with missed torsion on ultrasound) (p=<0.0001).

CONCLUSION: Ultrasound is a sensitive test for testicular torsion but associated with an average two-hour delay to theatre and a higher rate of intraoperative finding of non-viable testicle in this centre.
to result in reduced size and abnormal morphology of the affected testicle, as well as reduced endocrine and exocrine function. One study found that the degree of testicular atrophy following testicular torsion and orchidopexy was significantly correlated with the duration of pre-operative pain. Extensive apoptosis can also be seen in the germinal epithelium of the contralateral testicle in torsion, which may be due to trauma to the blood–testis barrier from apoptotic activating factors released, and may contribute to infertility. Therefore timely de-torsion and restoration of blood flow is the key determinant of fertility preservation.

Clinical history and examination are the mainstays in diagnosis of testicular torsion. Classical examination findings include exquisite testicular tenderness, high-riding testicle, swollen testicle and/or absent cremasteric reflex. The lead differential diagnoses include inflammation from epididymitis or orchitis. Other common differential diagnoses include torsion of testicular or epididymal appendage, cellulitis, tumour, hernia or hydrocele.

Ultrasound is a diagnostic tool used to differentiate causes of scrotal pain. Sensitivity and specificity of colour flow Doppler ultrasound in detecting testicular torsion are estimated to be 88.9%–89.9% and 98.8% respectively, with a false-positive rate of 1%. However, formal ultrasound can delay definitive management in a time-critical situation and lead to worse outcomes. This delay has been associated with worse outcomes in patients with pain longer than eight hours. Point-of-care ultrasound by trained emergency department physicians is a demonstrably accurate technique for diagnosis of scrotal pathology and has the potential to streamline patient disposition.

This study reviewed adult patients who underwent acute scrotal exploration for suspected torsion at Auckland City Hospital. Patterns of formal ultrasound use were previously unknown in this patient group. The aim was to establish patterns of ultrasound use, correlate ultrasound and intraoperative findings and establish the impact of ultrasound on admission-to-operation time.

Method

All patients who underwent acute scrotal exploration between 1 January 2007 and 31 December 2017 at Auckland City Hospital were identified through the hospital coding system and operating theatre records. Auckland City Hospital provides the regional acute urology service to the Auckland region (total population 1,737,830). There were no exclusion criteria. Patients under 15 years of age are served by the paediatric surgical service of the adjacent children's hospital, and therefore were not included in this study. A de-identified database accessible to the two investigators was created using patient demographic and clinical data sourced from online hospital records. These hospital records included admission and discharge records, theatre documentation, operation notes and ultrasound reports. Demographic data collected included age and ethnicity. Clinical data included side of testicle affected (left or right), admission-to-operation time, intraoperative findings, duration of operation and duration of admission. Whether or not the patient had a formal pre-operative ultrasound scan was documented, along with the time between admission and ultrasound and reported ultrasound findings. A formal ultrasound was one performed by a qualified sonographer and reported by a radiologist. We did not include bedside ultrasound studies. Ultrasound and intraoperative findings were correlated. Admission-to-operation time was compared between patients who had an ultrasound scan and those who did not. Admission-to-operation time was defined as time between arrival at Auckland City Hospital and arrival in the operating theatre. The database was created using Microsoft Excel (Microsoft Corporation 2011, Washington, USA), and patient groups were compared using Pearson's chi-squared test.

Results

The total number of patients who underwent scrotal exploration at Auckland City Hospital between 1 January 2007 and 31 December 2017 was 316.
Patient demographic and clinical data

The median patient age was 18 years (range 15–59). The largest ethnic group was New Zealand European (144/316, 45.6%), followed by Indian (38/316, 12.0%) and Pacific Island (37/316, 11.6%). Median theatre time was 65 minutes (range 27–130). Median duration of admission was 0.93 days (range 0.2–3). Demographic data are summarised in Table 1 and clinical data in Table 2. Intraoperative findings were normal in 27/316 patients (8.5%). Testicular torsion with viable appearance was found in 183/316 patients (57.9%) and testicular torsion with non-viable appearance in 84/316 patients (26.6%). Findings consistent with intermittent torsion were reported in 13/316 patients (4.1%). Table 3 summarises the intraoperative findings for all patients.

Table 1: Demographic data for all study patients.

<table>
<thead>
<tr>
<th>Data</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years (range)</td>
<td>18 (15–59)</td>
</tr>
<tr>
<td>Smoker</td>
<td>34/316 (10.7%)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
</tr>
<tr>
<td>New Zealand European</td>
<td>144/316 (45.6%)</td>
</tr>
<tr>
<td>Indian</td>
<td>38/316 (12%)</td>
</tr>
<tr>
<td>Pacific Island</td>
<td>37/316 (11.7%)</td>
</tr>
<tr>
<td>Asian</td>
<td>30/316 (9.5%)</td>
</tr>
<tr>
<td>Other European</td>
<td>27/316 (8.5%)</td>
</tr>
<tr>
<td>Māori</td>
<td>26/316 (8.2%)</td>
</tr>
<tr>
<td>Other</td>
<td>14/316 (4.4%)</td>
</tr>
</tbody>
</table>

Table 2: Clinical data for all study patients.

<table>
<thead>
<tr>
<th>Data</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-operative ultrasound performed</td>
<td>153/316 (48.4%)</td>
</tr>
<tr>
<td>Median theatre time (minutes) (range)</td>
<td>65 (27–130)</td>
</tr>
<tr>
<td>Median admission duration (days) (range)</td>
<td>0.93 (0.2–3)</td>
</tr>
<tr>
<td>Right-sided testicle affected</td>
<td>151/288* (52.4%)</td>
</tr>
</tbody>
</table>

*Total number of patients with finding of abnormal testicle.

Ultrasound

Pre-operative ultrasound was performed in 153/316 patients (48.4%). Testicular torsion with viable appearance was reported in 108/153 patients (70.6%). Testicular torsion with non-viable appearance was reported in 32/153 patients (20.9%). Findings consistent with intermittent torsion were reported in 2/153 patients (1.3%). The following findings were each reported in 1/153 patients (0.7%): epididymo-orchitis, torsion of the epididymis, torsion with epididymitis and infarcted testis without torsion. Normal testicular appearance was reported in 7/153 patients (4.6%).

The median admission-to-operation time was 106 minutes for patients who did not have an ultrasound, and 280 minutes for all patients who did (p<0.0001). When
patients who had an ultrasound with finding of missed torsion were excluded from the ultrasound group, the median admission-to-operation time was 225 minutes. The difference between this group and the group who did not have an ultrasound remained significant (p=<0.0001).

Those with missed torsion diagnosed on ultrasound had a much longer median admission-to-operation time than those with all other ultrasound findings (1,046 minutes vs 230 minutes, p=<0.0001). In missed torsion, the testicle becomes non-time-critical. These data are summarised in Table 4.

The rate of intraoperative finding of non-viable testicle was significantly higher in the ultrasound group than in the group who did not have an ultrasound (42/122, 34.4% vs 11/163, 6.7%, p=<0.001) when patients with ultrasound showing missed torsion were excluded. Of the patients who did not have an ultrasound, 17/163 (10.4%) had normal testicles intraoperatively, compared with 10/153 (6.5%) of those who had an ultrasound (p=0.22).

Table 3: Summary of intraoperative findings.

<table>
<thead>
<tr>
<th>Intraoperative finding</th>
<th>All patients</th>
<th>No pre-operative ultrasound</th>
<th>Pre-operative ultrasound</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>27/316 (8.5%)</td>
<td>17/163 (10.4%)</td>
<td>10/153 (6.5%)</td>
<td>0.22</td>
</tr>
<tr>
<td>Torsion—viable</td>
<td>183/316 (58%)</td>
<td>120/163 (73.6%)</td>
<td>63/153 (41.2%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Torsion—non-viable</td>
<td>84/316 (26.6%)</td>
<td>11/163 (6.7%)</td>
<td>73/153 (47.7%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Torsion—non-viable</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(excluding those with ultrasound diagnosis of missed-torsion)</td>
<td>53/285 (18.6%)</td>
<td>11/163 (6.7%)</td>
<td>42/122 (34.4%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Intermittent torsion</td>
<td>13/316 (4.1%)</td>
<td>11/163 (6.7%)</td>
<td>2/153 (1.3%)</td>
<td>0.01</td>
</tr>
<tr>
<td>Testicular/epididymal appendage torsion</td>
<td>8/316 (2.5%)</td>
<td>4/163 (2.5%)</td>
<td>4/153 (2.6%)</td>
<td>0.92</td>
</tr>
<tr>
<td>Other</td>
<td>1/316 (0.3%)</td>
<td>0/163 (0%)</td>
<td>1/153 (0.65%)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>316</td>
<td>163</td>
<td>153</td>
<td></td>
</tr>
</tbody>
</table>

Table 4: Median admission-to-operation time.

<table>
<thead>
<tr>
<th>Median admission-to-operation time (mins) (range)</th>
<th>Total</th>
<th>No pre-operative ultrasound</th>
<th>Pre-operative ultrasound*</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>145 (30–3503)</td>
<td>106 (42–2625)</td>
<td>225 (30–3503)</td>
<td>&lt;0.0001</td>
<td></td>
</tr>
</tbody>
</table>

*Excluding those with ultrasound finding of missed torsion.
Ultrasound sensitivity and specificity for torsion was 97.8% and 52.9%, respectively. The positive predictive value was 94.3% and the negative predictive value was 75%.

Discussion

This study describes the pattern of ultrasound use in suspected testicular torsion in New Zealand’s largest metropolitan area over a 10-year period. It provides a valuable insight into the impact of formal ultrasound on time to re-establishing testicular perfusion in the operating theatre.

In this cohort of patients, ultrasound was shown to be a sensitive test for testicular torsion with a high positive predictive value. Ultrasound sensitivity was higher, but specificity lower, than quoted in the literature. Approximately half the patients who underwent acute scrotal exploration had a pre-operative ultrasound. Ultrasound was associated with an average two-hour delay to theatre and a four-fold higher intraoperative finding of non-viable testicle, when patients with pre-operative ultrasound diagnosis of missed torsion were excluded.

The onset of ischaemia, as indicated by the onset of pain, will precede hospital admission by a variable duration. The duration of ischaemia prior to admission was not evaluated in this review, but it is important to consider the total ischaemic time as further delays to reperfusion are additive and may have critical impact in preserving testicular structure and function. The four-fold increase in intraoperative finding of non-viable testis in the ultrasound group, even when those with ultrasound diagnosis of missed torsion were excluded, is a concerning association. This is the outcome that timely surgery aims to avoid. Conversely, the low rates of normal testicular findings intraoperatively in both the ultrasound and non-ultrasound groups indicate a relatively high threshold for operative management.

This study only included patients who underwent scrotal exploration, so no comment can be made on the number of operations avoided by negative ultrasound. Therefore neither the utility of ultrasound in patients with low pre-test probability of testicular torsion, nor the rate of false negatives, was assessed. Scrotal exploration has inherent risks of bleeding, infection, chronic pain and injury to scrotal structures. Striking the correct balance between avoiding unnecessary surgery and achieving timely surgery to improve outcomes can be challenging. There was no statistically significant difference in rate of intraoperative finding of normal testicles in patients who had a pre-operative ultrasound compared to those who did not.

This hospital did not have a protocol for when to request an ultrasound for a patient presenting with scrotal pain. This decision was at the discretion of the treating clinician. Therefore a possible source of bias in this study was a lack of consistency in indication for scrotal ultrasound.

This series shows ultrasound to be a highly sensitive test in diagnosis of testicular torsion, making it a valuable tool if obtained in a timely manner. Results show an associated delay to theatre when ultrasound is performed (median), but this delay was not implicit: shortest time from admission to theatre in the ultrasound group was 30 minutes, compared to 42 minutes in the non-ultrasound group.

The descriptive retrospective study by Blavais et al described a high sensitivity of emergency physician-performed bedside ultrasound in patients presenting with acute scrotal pain that did not interfere with time to formal ultrasound or theatre. If ultrasound could be performed in a more timely manner, there may still be a role for ultrasound in this setting. However, timely ultrasounds can be constrained by real-world demands on radiology services, particularly after hours, and emergency department clinical demands.

Although ultrasound is a sensitive test for diagnosing testicular torsion, in this centre it was associated with a significant delay to definitive operative management and a higher prevalence of non-viable testes. But this relationship cannot be deemed causative. Testicular torsion is a time-critical pathology where delay to theatre can have an irreversible detrimental effect on fertility. The findings of this study support the notion that ultrasound should not be used as a diagnostic tool when testicular torsion is the likely pathology if it will cause more than a trivial delay in time to theatre.
Competing interests:
Nil.

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hanniegrace@gmail.com

URL:

REFERENCES
Venovenous extracorporeal membrane oxygenation for treating very severe pneumonia in Aotearoa New Zealand: a 16-year experience

André Kübler, Fynn Maguire, David Sidebotham

ABSTRACT

AIM: We sought to describe the aetiology, demographics and outcomes of patients with pneumonia undergoing venovenous extracorporeal membrane oxygenation (VV-ECMO) in Aotearoa New Zealand.

METHODS: Retrospective observational study.

RESULTS: Between January 2004 and August 2020, 133 patients underwent VV-ECMO for pneumonia. This VV-ECMO cohort is representative of the geographic and ethnic distribution of the population of Aotearoa New Zealand. Six-month survival was 85/133 (64%). A primary viral aetiology was identified in 63/133 cases (47%) with bacterial co-infection present in 34/63 viral pneumonias (54%). Primary bacterial pneumonia was identified in 48/133 cases (36%). Twenty-three (17%) of 133 patients developed necrotising pneumonia. The most commonly identified microorganisms were influenza A, Staphylococcus aureus and Streptococcus pneumoniae. Infection with Staphylococcus aureus or Streptococcus species was strongly associated with necrotising pneumonia (OR 10.18, 95% CI 3.52–37.13, P<0.0001). Necrotising pneumonia was more common in Māori and Pacific Peoples than in other ethnic groups (OR 3.08, 95% CI 1.16–7.96, P=0.02).

DISCUSSION: Outcomes from VV-ECMO for pneumonia in Aotearoa New Zealand are comparable to large international series. Although the use of VV-ECMO was matched to the ethnic distribution of the population of Aotearoa New Zealand, Māori may have reduced access because they have higher rates of pneumonia than non-Māori.

Pneumonia is the fourth leading cause of death worldwide.¹ In Aotearoa New Zealand, 672 deaths were attributed to pneumonia in 2018, and pneumonia was recorded as the cause of death in 0.77% of deaths in the 15–65 age group between 2015 and 2018.² The population of Aotearoa New Zealand is composed of multiple ethnicities, including European (62%), Māori (14%) and Pacific Peoples (7%).³ Māori and Pacific Peoples have worse medical outcomes than Europeans, primarily due to socioeconomic disparities.⁴ The rate of pneumonia is three times higher among Māori than non-Māori.⁴

Data on the aetiology of pneumonia in Aotearoa New Zealand are limited. A 2001 study in Christchurch and Waikato found that Streptococcus pneumoniae (14%), Haemophilus influenzae (10%), influenza A virus (7%), Legionella sp. (4%) and Mycoplasma pneumoniae (3%) were the most common causes of community-acquired pneumonia.⁵ A 2008 study demonstrated viral diagnoses in 29% of patients, with rhinovirus and influenza A being the most common causative agents.⁶ Sixteen percent of patients had polymicrobial infection, which was associated with worse outcomes.

Venovenous extracorporeal membrane oxygenation (VV-ECMO) is a widely accepted supportive therapy for patients with very severe pneumonia who have
a high (>50%) chance of dying despite conventional mechanical ventilation. We have previously described the physiology and cannulation options for VV-ECMO.8,9 Briefly, blood is drained from the inferior vena cava, passed through a membrane oxygenator and returned to the right atrium. In the right atrium, oxygenated blood from the extracorporeal membrane oxygenation (ECMO) circuit mixes with the patient’s systemic venous return and passes to the left heart via the pulmonary artery. Adjusting the blood flow though the ECMO circuit controls the patient’s arterial oxygen tension and adjusting the sweep gas flow in the membrane oxygenator controls the patient’s arterial carbon dioxide tension. Circuit blood flow and sweep gas flow of 3–8L/min can usually achieve satisfactory gas exchange, even in the absence of native pulmonary function. VV-ECMO confers two benefits in patients with acute respiratory failure. First, ECMO supports gas exchange until pulmonary function recovers. Second, ECMO allows resumption/initiation of lung protective ventilation, minimising ventilator-associated lung injury.

The Cardiothoracic and Vascular Intensive Care Unit (CVICU), Auckland City Hospital, is the national referral centre for adult ECMO in Aotearoa New Zealand. Patients referred for consideration of VV-ECMO are evaluated on a case-by-case basis according to publicly available guidelines.10 VV-ECMO is appropriate for patients with potentially reversible lung disease who are failing mechanical ventilation. Suitable patients are assessed as likely to survive prolonged intensive care unit (ICU) stay and return to a quality of life acceptable to that patient.

ECMO is an expensive therapy and has an opportunity cost to other users of healthcare resources. There is also substantial financial and emotional cost to patients and their families inherent to the transfer to Auckland and prolonged ICU stay.

We reviewed our experience of VV-ECMO for treating patients with pneumonia to assess whether the service was effective, equitable and met the needs of the people of Aotearoa New Zealand. In particular, we wanted to know whether the outcome from ECMO was different for Māori and Pacific Peoples compared to other New Zealanders. Based on our clinical suspicion of poor outcome from VV-ECMO in patients with necrotising pneumonia, we assessed the outcome in this sub-group compared to other patients.

The case series largely predates the COVID-19 pandemic (and to date no patients with SARS-CoV-2 have been treated with VV-ECMO in Aotearoa New Zealand) but includes a number of patients treated during the H1N1 influenza A pandemic.

Methods

Following approval by the Auckland District Health Board Research Office, we reviewed the medical records and our in-house database of patients receiving ECMO in CVICU for suspected pneumonia between January 2004 and August 2020. Patients receiving venoarterial ECMO or VV-ECMO for reasons other than pneumonia were excluded. Data extraction was done by two authors (FM, AK).

Demographic data, along with the indications, duration and outcome from ECMO, were recorded. Microbiological and radiographic imaging results were reviewed. Necrotising pneumonia was defined by computed tomographic (CT) evidence of non-perfusion, liquefaction or cavitation of lung parenchyma.

Cause of death was defined as the primary reason for discontinuing ECMO or intensive therapies, as documented in the clinical notes or on the death certificate. Deaths occurring during or immediately following discontinuation of ECMO were recorded as a “death during ECMO.” Deaths occurring after successful weaning from ECMO were recorded as a “death after ECMO.”

The causative microorganism was defined as the virus or bacterial species identified prior to or within one week of hospital admission. In cases where both bacteria and viruses were identified, the virus was considered the primary infection and the bacteria considered a secondary infection. Bacterial infections were defined by a positive culture from either respi-
ratory secretions or blood. Additionally, in the case of *Streptococcus pneumoniae* (*S. pneumoniae*), a positive urinary antigen was considered diagnostic for infection. Viral infections were defined as a positive polymerase chain reaction assay from respiratory secretions.

Summary data were calculated using Excel (Microsoft Corporation, Redmond, Washington, USA). Statistical analyses were done in GraphPad Prism v 9.02 (GraphPad Software Limited, San Diego, California, USA). The relationship between infection with *Staphylococcus aureus* (*S. aureus*) or *Streptococcus* species and the development of necrotising pneumonia was investigated using logistic regression. Similarly, the relationship between Māori and Pacific Peoples ethnicity and the development of necrotising pneumonia was investigated using logistic regression. Predictors of six-month survival were evaluated using both simple (univariate) and multivariate logistic regression. Predictors were chosen based on clinical interest and previously identified risk factors for poor outcome, and comprised (1) age, (2) Māori and Pacific Peoples ethnicity, (3) infection with *S. aureus* or *Streptococcus* species and (4) the presence of necrotising pneumonia. In all cases, *P*<0.05 was considered statistically significant.

### Results

Between January 2004 and August 2020, 133 patients underwent VV-ECMO for presumed pneumonia, of whom 76/133 (57%) were male and 131/133 (98%) were under 65 years old. The median age was 39 years (interquartile range [IQR] 27–52 years), with an even distribution across ages groups (Table 1).

Approximately one-third of patients were from the greater Auckland area (Auckland, Counties Manukau and Waitāmatā), with Canterbury, Waikato and Capital and Coast district health boards (DHBs) each contributing approximately 10% of patients (Table 2).

Median duration of ECMO support was 246 hours (IQR 150–426 hours). Six-month survival was 85/133 (64%), with 40/48 deaths (83%) occurring during ECMO (Table 3). Eighty-five (91%) of 93 patients who were successfully weaned from ECMO were alive at six months, with all survivors discharged from hospital. Death was predominantly due to non-recovery of lung function 17/48 (35%), sepsis 17/48 (35%) and neurological dysfunction 8/48 (17%). For non-survivors, the median time to death was 367 hours (IQR 139–689 hours). Survival by sub-groups is summarised in Table 3. Over half of patients had a pre-existing co-morbidity and 41/133 (31%) had a history of current

### Table 1: Demographics.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
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<td></td>
</tr>
<tr>
<td>Male</td>
<td>76</td>
<td>57</td>
</tr>
<tr>
<td>Female</td>
<td>57</td>
<td>43</td>
</tr>
<tr>
<td>Total</td>
<td>133</td>
<td></td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;16</td>
<td>6</td>
<td>4.5</td>
</tr>
<tr>
<td>16–29</td>
<td>34</td>
<td>25.6</td>
</tr>
<tr>
<td>30–49</td>
<td>53</td>
<td>39.8</td>
</tr>
<tr>
<td>50–65</td>
<td>38</td>
<td>28.6</td>
</tr>
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<td>&gt;65</td>
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<td>1.5</td>
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</tbody>
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Table 1: Demographics (continued).

<table>
<thead>
<tr>
<th>Ethnic groups</th>
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</tr>
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<tbody>
<tr>
<td>European</td>
<td>78</td>
<td>59</td>
</tr>
<tr>
<td>Māori</td>
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<td>18</td>
</tr>
<tr>
<td>Pacific Peoples</td>
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<td>6</td>
</tr>
<tr>
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<td>19</td>
<td>14</td>
</tr>
<tr>
<td>MELAA</td>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>Other ethnicity</td>
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<td>1.5</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
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<td></td>
</tr>
<tr>
<td>African</td>
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</tr>
<tr>
<td>Asian NFD</td>
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<td>0.8</td>
</tr>
<tr>
<td>Chinese</td>
<td>6</td>
<td>4.5</td>
</tr>
<tr>
<td>Cook Island Māori</td>
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<td>3.0</td>
</tr>
<tr>
<td>Fijian</td>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>Indian</td>
<td>9</td>
<td>6.8</td>
</tr>
<tr>
<td>Māori</td>
<td>17</td>
<td>12.8</td>
</tr>
<tr>
<td>Middle Eastern</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>Niuean</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>New Zealand European</td>
<td>74</td>
<td>55.6</td>
</tr>
<tr>
<td>New Zealand Māori</td>
<td>3</td>
<td>2.3</td>
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<tr>
<td>Other Asian</td>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>Other European</td>
<td>4</td>
<td>3.0</td>
</tr>
<tr>
<td>Samoan</td>
<td>3</td>
<td>2.3</td>
</tr>
<tr>
<td>South East Asian</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>Tongan</td>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>Unknown</td>
<td>2</td>
<td>1.5</td>
</tr>
</tbody>
</table>

MELAA: Middle Eastern/Latin American/African.
or prior smoking. Survival was similar for patients with co-morbidities (Table 3).

Viral pneumonia occurred in 63/133 patients (47%), with influenza A and B being the most common causative agents (Table 4). Pandemic H1N1 was identified in 27/47 influenza A cases (57%). Thirty-four of 63 patients (54%) with viral pneumonia had bacterial co-infection. In the majority of cases, bacterial co-infection was with *S. pneumoniae*, *S. aureus* or both. Primary bacterial pneumonia occurred in 48/133 patients (36%), with *S. aureus*, *S. pneumoniae* and *Legionella* sp. accounting for 13/48 (27%), 12/48 (25%) and 8/48 (17%), respectively (Table 4). A total of 28 patients had infection with *S. aureus*, either as a primary or secondary infection; in six of these cases (21%), the infection was due to methicillin resistant strains. In 19/133 cases (14%), no causative microorganism was identified, and the diagnosis of pneumonia was made clinically.

Seventy-eight of 133 patients (59%) underwent pulmonary CT imaging, of whom 23 (30%) had evidence of lung necrosis. Eleven of 23 patients (47.8%) with necrotising pneumonia were alive at six months. Primary or secondary bacterial infection was identified in all but two cases of lung necrosis, with the most common causative microorganisms being *S. aureus* (14/23, 61%) and *S. pneumonia* (6/23, 26%). Infection with *S. aureus*, *S. pneumoniae* or

**Table 2:** Referring district health board.

<table>
<thead>
<tr>
<th>Region</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auckland</td>
<td>21</td>
<td>15.8</td>
</tr>
<tr>
<td>Bay of Plenty</td>
<td>10</td>
<td>7.5</td>
</tr>
<tr>
<td>Canterbury</td>
<td>11</td>
<td>8.3</td>
</tr>
<tr>
<td>Capital and Coast</td>
<td>12</td>
<td>9.0</td>
</tr>
<tr>
<td>Counties Manukau</td>
<td>14</td>
<td>10.5</td>
</tr>
<tr>
<td>Hawke’s Bay</td>
<td>3</td>
<td>2.3</td>
</tr>
<tr>
<td>Hutt Valley</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>Lakes</td>
<td>6</td>
<td>4.5</td>
</tr>
<tr>
<td>MidCentral</td>
<td>5</td>
<td>3.8</td>
</tr>
<tr>
<td>Nelson Marlborough</td>
<td>3</td>
<td>2.3</td>
</tr>
<tr>
<td>Northland</td>
<td>5</td>
<td>3.8</td>
</tr>
<tr>
<td>South Canterbury</td>
<td>3</td>
<td>2.3</td>
</tr>
<tr>
<td>Southern</td>
<td>12</td>
<td>9.0</td>
</tr>
<tr>
<td>Tairāwhiti</td>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>Taranaki</td>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>Waikato</td>
<td>10</td>
<td>7.5</td>
</tr>
<tr>
<td>Wairarapa</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Waitematā</td>
<td>13</td>
<td>9.8</td>
</tr>
<tr>
<td>West Coast</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Whanganui</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 3: Survival and cause of death.

<table>
<thead>
<tr>
<th>Survival to</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECMO decannulation</td>
<td>93/133  (69.9)</td>
</tr>
<tr>
<td>CVICU discharge</td>
<td>90/133  (67.7)</td>
</tr>
<tr>
<td>Discharge from hospital</td>
<td>85/133  (63.9)</td>
</tr>
<tr>
<td>6-month survival</td>
<td>85/133  (63.9)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Aetiology of death</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irreversible respiratory failure</td>
<td>17/48 (35.4)</td>
</tr>
<tr>
<td>Septic shock</td>
<td>17/48 (35.4)</td>
</tr>
<tr>
<td>Neurological injury</td>
<td>8/48 (16.7)</td>
</tr>
<tr>
<td>Bilateral pneumothoraces</td>
<td>1/48 (2.1)</td>
</tr>
<tr>
<td>Cardiac arrhythmia</td>
<td>1/48 (2.1)</td>
</tr>
<tr>
<td>Ischaemic bowel</td>
<td>1/48 (2.1)</td>
</tr>
<tr>
<td>Unknown</td>
<td>3/48 (6.3)</td>
</tr>
</tbody>
</table>

S. pyogenes was strongly associated with the development of necrotising pneumonia (OR 10.18, 95% CI 3.52–37.13, P<0.0001). Māori and Pacific Peoples accounted for 44% of patients with lung necrosis but only 24% of the entire cohort (OR 3.08, 95% CI 1.16–7.96, P=0.02).

Univariate logistic regression did not identify significant predictors of six-month survival. Multivariate logistic regression showed necrotising pneumonia was predictive of mortality at six months (Figure 5). However, the area under the receiver operating characteristic curve for the multivariate model was 0.63, indicating nearly 40% of deaths were unaccounted for by the model.

**Discussion**

Here we report the CVICU experience of using VV-ECMO for severe pneumonia over a 16-year period. Prior to 2004, the first year for which we have reliable data, VV-ECMO was used only sporadically in patients with pneumonia. Given CVICU serves as the national referral centre for adult ECMO, it is likely this series represents the great majority of patients treated with VV-ECMO in Aotearoa New Zealand. Our finding of 64% six-month survival is similar to that reported from large international cohorts. Encouragingly, few patients died following successful weaning from ECMO, and patients who survived for six months were all discharged from hospital. Since ECMO is only used in patients at high risk of death with conventional treatment, it is likely our series represents a significant number of lives saved. However, it is important to acknowledge that we do not have information on quality of life or functional status—only that all survivors at six-months were out of hospital.

The cohort treated with VV-ECMO is broadly representative of the ethnic (Table 1) and geographic (Table 2) distribution of the population of Aotearoa New Zealand. One exception is the Auckland DHB, which accounted for 15.8% of cases but represents only 9.9% of the population. Māori and Pacific Peoples represent 21% of the population of Aotearoa New Zealand and accounted for 24% of people on VV-ECMO. However, Māori and Pacific Peoples are more likely to develop pneumonia and are more likely to suffer from severe disease. In this context, our data suggest Māori and...
Table 3: Survival and cause of death (continued).

<table>
<thead>
<tr>
<th>Ethnic group</th>
<th>Survival (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>European</td>
<td>50/78 (64)</td>
</tr>
<tr>
<td>Māori</td>
<td>19/24 (79)</td>
</tr>
<tr>
<td>Pacific Peoples</td>
<td>4/8 (50)</td>
</tr>
<tr>
<td>Asian</td>
<td>9/19 (47)</td>
</tr>
<tr>
<td>MELAA</td>
<td>2/2 (100)</td>
</tr>
<tr>
<td>Other ethnicity</td>
<td>1/2 (50)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age</th>
<th>Survival (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;16</td>
<td>4/6 (66.7)</td>
</tr>
<tr>
<td>16–29</td>
<td>20/34 (55.8)</td>
</tr>
<tr>
<td>30–49</td>
<td>36/53 (67.9)</td>
</tr>
<tr>
<td>50–65</td>
<td>25/38 (65.8)</td>
</tr>
<tr>
<td>&gt;65</td>
<td>0/2 (0)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Co-morbidities</th>
<th>N</th>
<th>Survival (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory*</td>
<td>33/133  (21.8)</td>
<td>19/33 (57.6)</td>
</tr>
<tr>
<td>Asthma</td>
<td>18/133  (13.5)</td>
<td>9/18 (50)</td>
</tr>
<tr>
<td>Other</td>
<td>15/133  (11.3)</td>
<td>10/15 (66.7)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>13/133  (9.7)</td>
<td>10/13 (76.9)</td>
</tr>
<tr>
<td>Psychiatric</td>
<td>18/133  (13.5)</td>
<td>11/18 (61.1)</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>24/133  (18)</td>
<td>16/24 (66.7)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Smoking</th>
<th>N</th>
<th>Survival (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>41/133  (30.8)</td>
<td>26/41 (63.4)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Organ failure</th>
<th>N</th>
<th>Survival (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vasopressor</td>
<td>103/133 (77.4)</td>
<td>66/103 (64.1)</td>
</tr>
<tr>
<td>CRRT</td>
<td>58/133  (43.6)</td>
<td>34/58 (58.6)</td>
</tr>
<tr>
<td>Single organ Failure’</td>
<td>61/133 (45.9)</td>
<td>42/61 (68.8)</td>
</tr>
<tr>
<td>Multi-organ Failure</td>
<td>72/133 (54.1)</td>
<td>43/72 (59.7)</td>
</tr>
<tr>
<td>Presence of necrotic disease</td>
<td>23/133 (17)</td>
<td>11/23 (47.8)</td>
</tr>
</tbody>
</table>

Survival: six-month survival. *Total of asthma and non-asthma groups. +All VV-ECMO patients have respiratory failure.
Table 4: Microbiology.

<table>
<thead>
<tr>
<th>Primary aetiology</th>
<th>N (%)</th>
<th>Co-infection</th>
<th>S. aureus N* (%)</th>
<th>S. pneumoniae N* (%)</th>
<th>S. aureus + S. pneumoniae N (%)</th>
<th>Other co-infection N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viral</td>
<td>63/133 (47)</td>
<td>12/63 (19)</td>
<td>15/63 (24)</td>
<td>3/63 (5)</td>
<td>4/63 (6)</td>
<td></td>
</tr>
<tr>
<td>Influenza A</td>
<td>47/63 (75)</td>
<td>10/47 (21)</td>
<td>5/47 (11)</td>
<td>2/47 (4)</td>
<td>2/47 (4)</td>
<td></td>
</tr>
<tr>
<td>Influenza B</td>
<td>8/63 (13)</td>
<td>1/8 (13)</td>
<td>5/8 (63)</td>
<td>1/8 (13)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adenovirus</td>
<td>3/63 (5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Varicella</td>
<td>2/63 (3)</td>
<td>1/2 (50)</td>
<td></td>
<td>1/2 (50)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cytomegalovirus</td>
<td>1/63 (1.6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human metapneumovirus</td>
<td>1/63 (1.6)</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parvovirus</td>
<td>1/63 (1.6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bacterial</td>
<td>48/133 (36)</td>
<td>1/48 (2)</td>
<td>1/48 (2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>13/48 (27)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Streptococcus pneumonia</td>
<td>12/48 (25)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Legionella longbeachiae</td>
<td>4/48 (8)</td>
<td>1/4 (25)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Legionella pneumophila</td>
<td>4/48 (8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Streptococcus pyogenes</td>
<td>3/48 (6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Klebsiella pneumonia</td>
<td>2/48 (4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mycoplasma pneumonia</td>
<td>2/48 (4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>2/48 (4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>1/48 (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haemophilus influenza</td>
<td>1/48 (2)</td>
<td>1/1 (100)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haemophilus parainfluenza</td>
<td>1/48 (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>1/48 (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fungal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aspergillus sp.</td>
<td>3 (100)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td>19/133 (14)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Not including cases where both S. aureus and S. pneumoniae were isolated—these are counted in the subsequent column. Clinical diagnosis of pneumonia without positive microbiology in written notes, or in local online reporting system.
Pacific Peoples may be underrepresented in terms of VV-ECMO use.

Overall, the VV-ECMO cohort represents a young group of patients with relatively few co-morbidities (Tables 1 and 3), which probably reflects (an appropriate) selection bias against using VV-ECMO in co-morbid patients who have worse outcomes.12

The aetiology of pneumonia in our cohort is similar to that reported for community-acquired pneumonia in New Zealand, with a predominance of influenza A and S. pneumoniae.6,7 The high rate of influenza A is in part due to 27 cases of pandemic H1N1 who required VV-ECMO. One exception to previous New Zealand cohorts and to community-acquired pneumonia in general13 is the high incidence of S. aureus, which was identified in 21% of patients, either as a primary or secondary infection. This finding is unsurprising because S. aureus pneumonia is associated with more severe disease and worse outcomes than pneumonia due to other microorganisms.13 At least in children, S. aureus sepsis is more common in Māori and Pacific Peoples than in Europeans.14 The microbiology of S. aureus in Aotearoa New Zealand is notable for increased prevalence of Panton-Valentine leukocidin producing genes,15 a cytotoxin that causes necrotising pneumonia.16

Necrotising pneumonia was strongly associated with infections due to S. aureus and streptococcal species and was more common in Māori and Pacific Peoples. The association between necrotising pneumonia and S. aureus and S. pneumoniae has long been recognised.17,18 Although necrotising pneumonia is known to be associated a high mortality,17,18 it was only weakly predictive of non-survival in our cohort (Table 5), which probably reflects the relatively small number of patients with this condition and selection bias against offering VV-ECMO to patients with very severe lung necrosis. However, given our clinical concern regarding futility for VV-ECMO in patients with lung necrosis, the fact that nearly half of patients with necrotising pneumonia survived for six months is reassuring.

There are several limitations to this case series. First, and most importantly, the patients included in the series represent a highly selected group. The available CVICU intensivists discuss all patients referred for ECMO and only accept the referral if there is a consensus that ECMO is likely to be beneficial. Older (>65 years) and highly co-morbid patients are typically declined. Second, the decision to discontinue VV-ECMO for futility is complex and includes factors such as the patient’s disease trajectory, their likely post-ECMO functional status and organ function, the wishes of the family, the expressed views of the patient and the opinions of the treating physicians.

<table>
<thead>
<tr>
<th>Table 5: Predictors of six-month survival from logistic regression.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Ethnicity (Māori or Pacific Peoples)</td>
</tr>
<tr>
<td>Infection with S. aureus or streptococcal species</td>
</tr>
<tr>
<td>Necrotising pneumonia</td>
</tr>
</tbody>
</table>

CI: confidence interval.
Such factors impact upon both the duration of VV-ECMO support and overall survival. Finally, over the 16-year period of the study, the data collected, the management of VV-ECMO and the treatment of patients with very severe pneumonia have changed.

Notwithstanding these limitations, we can draw the following conclusions. First, our pattern of VV-ECMO use for severe pneumonia is representative of the ethnic and geographic distribution of the population of Aotearoa New Zealand. Second, our outcomes, which are highly dependent on patient selection, are comparable to that reported in larger, international series. Third, despite our clinical concern, VV-ECMO is an appropriate intervention for selected patients with necrotising pneumonia.

Fourth, the use of and the outcome from VV-ECMO for Māori and Pacific Peoples is comparable to that of other New Zealanders. However, given their higher rates of pneumonia and, particularly, their higher rates of staphylococcal pneumonia, it is highly likely that Māori and Pacific Peoples are underrepresented in terms access to VV-ECMO.

Competing interests: Nil.

Acknowledgements: Dr Alaistair McGeorge for the management of the CVICU clinical database


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REFERENCES


A decade of Asian and ethnic minority health research in New Zealand: findings from a scoping review
Annie Chiang, Rachel Simon-Kumar, Roshini Peiris-John

ABSTRACT

BACKGROUND: Despite the increasing proportion of Asian and MELAA (Middle Eastern, Latin American and African) population groups in Aotearoa New Zealand (collectively referred here as A/EM), research on their health and wellbeing is still nascent. To improve our understanding of health and wellbeing of A/EM groups, including future research needs, a review and synthesis of existing A/EM research in New Zealand is timely.

AIM: To undertake a scoping review of existing research on A/EM health in New Zealand with a view to highlighting key health concerns for this group and identifying the areas where there is a concentration of A/EM research and, concomitantly, where there are gaps.

METHODS: Medline and PubMed databases were searched for quantitative and qualitative studies published between 2010 and 2019 that report on A/EM health and wellbeing.

RESULTS: The scoping review identified 115 (63 quantitative and 52 qualitative) studies. Three thematic areas were identified in the published literature: health conditions, health determinants and health services. The review also highlighted several gaps in the body of published A/EM research.

CONCLUSION: Overall, the evidence base on A/EM health in New Zealand is weak as there is limited information on health conditions and its determinants of minority groups, including their patterns of health service use. The nature and content of A/EM health research requires further substantive development in terms of understanding the health and its determinants of this ever increasing and heterogenous population group.

Asians and MELAA (Middle Eastern, Latin American and African) minority and migrant populations, collectively referred in this paper as “A/EM,” are New Zealand’s most rapidly growing population groups. According to Census 2018, there were approximately 707,600 Asian peoples and 70,000 people identified as MELAA. New Zealand’s A/EM constitute 17.2% of the total population, having grown 11.5% since 1996. A/EM populations are expected to continue to grow by 2% annually, with projections that they will constitute 25% of New Zealand’s population by the year 2038.

Although some researchers have noted the colloquial tendency to use “Asians” to refer to people from East and Southeast Asia, in more formal interpretations in New Zealand, “Asia” refers to regions in the Far East (like Japan and Mongolia) to Afghanistan in the West. Similarly, official descriptions of “ethnic” encompass those who are non-Māori, non-Pacific and non-Pākehā/Anglo-Celtic, covering people from Asia, Africa, the Middle East, Latin America and Continental Europe. Yet in some public health studies, as a recent publication on racism has shown, Asians are considered ethnic along with Māori and Pacific Island communities.

Further, despite the tendency to mark them as a distinct population group, the categories “Asian” and “ethnic minority” are extensively heterogenous in terms of nationality of origin, visa status (citizen, permanent resident, temporary worker, refugee or international student), recency...
and acculturation (from those who have lived in New Zealand for generations to first-generation migrants, and second-generation ethnic young people) and ethno-cultural and linguistic differences. In addition, there are also diversities of social markers such as age, gender, religion, sexuality, ability and socioeconomic position. There are also variations in their settlement patterns, with greater concentrations in urban centres like Auckland, Hamilton and Christchurch. More recently, there has been growing attention to the intersectionality of inequalities within and among this group that call for divergent approaches to equity and fairness.

The size and sheer diversity of A/EM groups mark a growing challenge for New Zealand’s future public health responses. Despite a growing body of scholarship, health research on A/EM is still nascent and, at best, sporadic. Instead, a strategic and future-focused approach to researching their health and wellbeing is urgently needed. As a step towards this goal, a scoping review and a thematic analysis of New Zealand-based A/EM health research published between 2010 and 2019 was undertaken with the following aims: firstly, to highlight key issues in A/EM health and wellbeing that have emerged through existing research, and secondly, to identify the areas where there is a concentration of A/EM research and, concomitantly, where there are gaps. Our study extends upon the work done by Kanengoni, Andajani-Sutjahjo and Holroyd, encompassing a wider range of publication years but focusing more specifically on A/EM communities in New Zealand.

Figure 1: PRISMA flow diagram.
Methods

This scoping review was conducted with the aim of identifying the common themes and gaps in research related to A/EM health. In August 2020, Medline and PubMed databases were searched to identify articles that were published in the 10 years between 2010 and 2019 (both years inclusive). The topic search was open-ended and not restricted to any specific area of health or medicine. Additionally, the ethnicities included in the search terms are all New Zealand ethnic groups that have a population of at least 100 individuals, according to Census 2013. At the time of the search, the equivalent list of ethnicities for Census 2018 was not yet available. In addition, the terms “refugee,” “asylum seeker,” “ethnic minority” and “migrant” were included. The comprehensive search strategy used to search the Medline database is available in Appendix Table 1.

Study selection

Articles were included if they were research studies (a) undertaken in New Zealand and (b) included ethnic minority groups who identify with Asian or MELAA ethnicities, defined as either total response or prioritised ethnicities. Studies were excluded if ethnic minority groups were not clearly identified. For example, “ethnic minority” or “Other” ethnicity were defined as non-European or non-Māori ethnicities. Title and abstract screening for inclusion into the review corpus were conducted by the primary author, and when articles that did not clearly meet the criteria, the primary author consulted the third author. An initial full-text review of select articles was conducted by the primary author, whose decision to include each article was made in conjunction with the other authors.

As shown in Figure 1, a total of 3,224 articles were initially identified. Four hundred and fifteen were duplicates, so 2,809 were selected for screening. Title and abstract screening excluded 2,633 papers. The most common reason for removal of articles at this stage was that they were not relevant to the New Zealand context. This resulted in 176 articles being retrieved for full-text review. From the full-text review, a further 61 articles were excluded as they did not meet the aforementioned criteria.

Data extraction

The review included a total of 115 articles. Each article was reviewed to identify the ethnic groups included in the study, the population group of interest, the broad area of research and the subject of study. Ethnic groups were coded as they appeared in the publication, as were the populations of interest. These data, along with additional details on subject of study, where collated using Microsoft Excel by the first author. Following review and discussion, the authors identified three broad themes that emerged:

- Health conditions
- Health determinants
- Healthcare services

Each author conducted an in-depth analysis of the studies within each theme, using a qualitative thematic synthesis approach. As this was a scoping review, and given the heterogeneity of the fields and methodologies of research, a meta-analysis was not undertaken.

Results

Table 1 summarises the 115 studies selected for review. The publication rate for papers over the past 10 years has ranged from five to 15 papers per year, with the total number of publications peaking in 2014 and 2016. The most studied ethnic groups were Chinese (39.1%) and Indian (33.9%). Broad ethnic groups, such as South Asian, East Asian, Southeast Asian and other Asian, were included in 12.2%, 9.6%, 3.5% and 6.1% of selected studies, respectively. Despite the small number of studies on MELAA groups, their inclusion contributes to the overall picture of immigrant health in New Zealand, and also highlights gaps in research and intervention within these specific small-population groups.

Of the 115 selected studies, 16 focused on health of children or youth and 13 studies focused on the health and experiences of older people. Women's health comprised 16.5% of the selected, whereas only two studies were exclusively on A/EM men. Seven papers identified their participants as migrants. Just four studies focused on former refugees, and these intersected with research on physical health needs of
Table 1: Summary of studies by publication year, ethnicity and population groups and area of research.

<table>
<thead>
<tr>
<th>Year of publication</th>
<th>Number of papers</th>
<th>% of total studies</th>
<th>Publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>12</td>
<td>10.4%</td>
<td>11–23</td>
</tr>
<tr>
<td>2011</td>
<td>6</td>
<td>5.2%</td>
<td>24–29</td>
</tr>
<tr>
<td>2012</td>
<td>10</td>
<td>8.7%</td>
<td>30–39</td>
</tr>
<tr>
<td>2013</td>
<td>13</td>
<td>11.3%</td>
<td>40–52</td>
</tr>
<tr>
<td>2014</td>
<td>15</td>
<td>13.0%</td>
<td>53–67</td>
</tr>
<tr>
<td>2015</td>
<td>9</td>
<td>7.8%</td>
<td>68–76</td>
</tr>
<tr>
<td>2016</td>
<td>15</td>
<td>13.0%</td>
<td>77–91</td>
</tr>
<tr>
<td>2017</td>
<td>14</td>
<td>12.2%</td>
<td>92–105</td>
</tr>
<tr>
<td>2018</td>
<td>10</td>
<td>8.7%</td>
<td>106–115</td>
</tr>
<tr>
<td>2019</td>
<td>11</td>
<td>9.6%</td>
<td>116–126</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ethnic group</th>
<th>Number of papers</th>
<th>% of total studies</th>
<th>Publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indian</td>
<td>39</td>
<td>33.9%</td>
<td>18, 21, 27, 28, 30, 37, 39, 40, 49, 54, 58–60, 62, 68, 74–77, 79, 80, 89, 91–95, 98, 103, 104, 106, 109, 113–115, 118, 120, 121, 126</td>
</tr>
<tr>
<td>South Asian</td>
<td>14</td>
<td>12.2%</td>
<td>12–14, 24, 31, 34, 61, 64, 73, 87, 89, 90, 96, 110</td>
</tr>
<tr>
<td>Korean</td>
<td>13</td>
<td>11.3%</td>
<td>15, 17, 20, 50, 55, 62, 63, 85, 111, 113, 114, 123, 125</td>
</tr>
<tr>
<td>East Asian</td>
<td>11</td>
<td>9.6%</td>
<td>12, 24, 27, 33, 64, 73, 90, 110, 115, 119, 124</td>
</tr>
<tr>
<td>African</td>
<td>8</td>
<td>7.0%</td>
<td>42, 43, 46, 69, 75, 82, 83, 106</td>
</tr>
<tr>
<td>Other Asian</td>
<td>7</td>
<td>6.1%</td>
<td>30, 40, 58, 75, 92, 93, 98</td>
</tr>
<tr>
<td>Filipino</td>
<td>6</td>
<td>5.2%</td>
<td>62, 86, 97, 103, 122, 123</td>
</tr>
<tr>
<td>Southeast Asian</td>
<td>4</td>
<td>3.5%</td>
<td>20, 73, 93, 110</td>
</tr>
</tbody>
</table>
Table 1: Summary of studies by publication year, ethnicity and population groups and area of research continued.

<table>
<thead>
<tr>
<th>Population group</th>
<th>Number of papers</th>
<th>% of total studies</th>
<th>Publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cambodian</td>
<td>3</td>
<td>2.6%</td>
<td>65, 72, 126</td>
</tr>
<tr>
<td>Middle Eastern</td>
<td>3</td>
<td>2.6%</td>
<td>68, 71, 75</td>
</tr>
<tr>
<td>Japanese</td>
<td>3</td>
<td>2.6%</td>
<td>56, 81, 114</td>
</tr>
<tr>
<td>Sri Lankan</td>
<td>3</td>
<td>2.6%</td>
<td>17, 62, 76</td>
</tr>
<tr>
<td><strong>Population group</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Children/youth</td>
<td>16</td>
<td>13.9%</td>
<td>12, 24, 26, 29, 51, 62, 66, 75, 76, 89, 92, 95, 99, 100, 111, 120</td>
</tr>
<tr>
<td>Older Peoples</td>
<td>13</td>
<td>11.3%</td>
<td>11, 22, 41, 50, 63, 86, 97, 113, 114, 117, 122, 123, 125</td>
</tr>
<tr>
<td>Women</td>
<td>19</td>
<td>16.5%</td>
<td>12–14, 24, 30, 31, 34, 38, 40, 43, 44, 55–57, 61, 65, 71, 96, 103</td>
</tr>
<tr>
<td>Men</td>
<td>2</td>
<td>1.7%</td>
<td>54, 87</td>
</tr>
<tr>
<td>Migrants</td>
<td>7</td>
<td>6.1%</td>
<td>26, 29, 32, 44, 107, 108, 116</td>
</tr>
<tr>
<td>Former refugees</td>
<td>4</td>
<td>3.5%</td>
<td>36, 51, 102, 105</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Area of research</th>
<th>Number of papers</th>
<th>% of total studies</th>
<th>Publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mental/psychiatric health</td>
<td>15</td>
<td>13.0%</td>
<td>11, 26, 36, 52, 70, 78, 92, 93, 101, 102, 105, 114, 117, 125</td>
</tr>
<tr>
<td>Settlement experience</td>
<td>11</td>
<td>9.6%</td>
<td>22, 29, 50, 66, 85, 97, 99, 100, 113, 122, 123</td>
</tr>
<tr>
<td>Health practice</td>
<td>9</td>
<td>7.8%</td>
<td>16, 19, 35, 53, 65, 81, 86, 88, 108</td>
</tr>
<tr>
<td>Women's/maternal health</td>
<td>8</td>
<td>7.0%</td>
<td>30, 38, 40, 44, 55, 57, 103</td>
</tr>
<tr>
<td>Sexual health/STIs</td>
<td>7</td>
<td>6.1%</td>
<td>42, 43, 46, 69, 82, 83, 87</td>
</tr>
<tr>
<td>Palliative care</td>
<td>4</td>
<td>3.5%</td>
<td>41, 45, 84, 107</td>
</tr>
</tbody>
</table>
Health conditions

The first overarching theme of the review was health conditions, that is, the specific diseases that were researched in relation to A/EM and the methodologies used in these studies. Cardiovascular disease (CVD) in A/EM is the most common health condition featured in the selected articles. Research in this area largely involved quantitative analyses of the underlying health determinants of the disease or mortality associated with a cardiovascular event. There is also significant interest in understanding association between ethnicity (Indian, in particular) and differential access to medication and treatment.

The high prevalence of macronutrient deficiency, especially of vitamins B12 and D, in South Asian and Middle Eastern groups was another prominent area of interest. Experimental studies demonstrated the benefits of supplementation of vitamin B12 and long-term supplementation of vitamin D in women from these communities, among whom chronic deficiency was especially high. Observational studies described the prevalence of vitamin B12 and vitamin D deficiencies as an outcome of attitudes towards diet and lack of sun exposure.

Diabetes mellitus among A/EM groups was another common condition that was researched. Nutrition research involving Chinese participants included experimental studies of ethnic specific glycaemic responses and found that Chinese individuals were more likely to have increased glycaemic responses compared to European counterparts. This finding, coupled with the traditionally rice-based diet, suggests that Chinese are at an increased risk of developing type-2 diabetes. Quantitative studies found that ethnic diabetics were more likely to experience albuminuria, though less likely to have a lower limb amputation. Both quantitative and qualitative studies on diabetes management found a lack of nutrition knowledge among ethnic communities, though ongoing and supportive care from healthcare providers or support groups were associated with improvements with self-management.

Six studies focussed on obesity and body composition. Of these, four quantitative studies re-examined indexes of body composition and argued for the need for ethnic-specific indexes. Perceptions of body weight and obesity were studied from the perspective of young girls and parents.

Research on health conditions and ethnic communities also included descriptive studies of Paget’s disease, conditions affecting the ocular surface and tuberculosis.

Health determinants

A second theme highlighted health determinants, that is, the causative, risk and protective factors that influence health and wellbeing outcomes in A/EM populations.

Ethnicity, defined as unique phenotypes of minority groups, was a prominent determinant in the studies reviewed. Three studies on vitamin D, type-2 diabetes and dry eye conditions pointed to the higher risk to all Asians compared to European New Zealanders as a result of factors such as darker skin, eye pigmentation and levels of albuminuria. Kenealy et al’s study of estimated glomerular filtration rate (eGFR) and the risk of CVD, on the other hand, highlighted heterogeneity among Asians, with Indian population groups demonstrating the same levels of risk as Europeans, whereas other Asians demonstrated lower risk. In contrast, Sankaran et al found the emergence of Paget’s disease among New Zealand’s Asian populations, challenging the long-accepted view that these groups had genetic protections and instead noting environmental factors in the propensity to new health risks for A/EM groups.

Culture and cultural practices of A/EM groups were another important health determinant. Studies noted the adverse influence of culture on diets that in turn resulted in nutrient deficiencies, lack of physical activity, avoidance of exposure to sun and reproductive and sexual health. The studies also demonstrated the ways in which cultural values shaped meanings of illness, pain and risk. Cultural perceptions and stigma were also implicated in Asian healthcare practices, including reduced help-seeking behaviours and child-birth practices.
mental health particularly evident included maternity care, these cultural value differences were partic
measurements of illness and intervention in existing conceptualisations and impact of dominantly western values.
A number of studies also highlighted the evidence of explicit systemic racism.

Normalisation of Eurocentric discourses among healthcare practitioners that dele
normalisation of Eurocentric discourses and through participation in their communities. Studies differed in their appraisal of acculturation, with two studies noting the inherent conflicts in health practices arising from acculturation and another that linked migrant integration with less conflict in health beliefs and behaviours.

Lastly, the studies highlighted shortcomings in healthcare systems as a determinan
t of health outcomes for Asian population groups. Studies noted normalisation of Eurocentric discourses among healthcare practitioners that delegitimised A/EM experiences of health and wellbeing, and others noted evidence of explicit systemic racism.

A number of studies also highlighted the impact of dominantly western values in existing conceptualisations and measurements of illness and intervention practices. The areas where these cultural value differences were particularly evident included maternity care, mental health, and obesity/BMI measures.

Health services
A third overarching theme from this review was health services, or the provision and utilisation of formal and informal healthcare.

Ethnicity differentiation was notable in the access and use of health services. Studies noted variability in elective and emergency caesarean sections, namely reduced odds among Chinese and increased odds among Indian women, reduced risk of lower limb amputation among (all) Asians, and high revervascularisation for acute coronary syndrome among Asian and Indian populations. Low rates of mental health service utilisation and delayed seeking of psychiatry services were also noted. In contrast, positive parental attitude towards immunisations and minimal barriers to immunisation service access resulted in high coverage among Asian children under five years of age.

Studies on enablers and barriers to healthcare access among A/EM identified inadequacies in primary mental health care services, barriers to accessing Accident Compensation Corporation (ACC) services, stigma and discrimination in relation to HIV services, and lack of knowledge of available health services for multi-morbid culturally and linguistically diverse (CALD) patients and older migrants and hospice services.

The importance of culturally appropriate services were highlighted in studies on contraception, diabetes self-management, pain relief, child-birth practices, palliative and end-of-life care, HIV and residential aged care facilities. Strong preferences for decisive and comprehensive treatment in culturally comfortable settings was highlighted in a study exploring the practice of visiting homeland for medical operations.

The role of the family was highlighted as fundamental in decision-making and satisfaction with care and around communicating end-of-life information with the family rather than the patient. However, studies also showed that, in contrast to New Zealand Europeans, Asians relied on doctors for decisions around medication related to CVD and the decisive role of practitioners was associated with comfort and trust for Asians. Similarly, patient-
practitioner interaction was found to be influential in the patient’s decision to seek screening.\textsuperscript{25} The importance of receiving client feedback on models of care was highlighted in a study on maternal and child health services.\textsuperscript{65}

Research during this period also examined a range of personnel and organisational factors impacting the provision of healthcare services. For example, studies highlighted personal challenges faced by migrant nurses when working in New Zealand\textsuperscript{86} and struggles by host and migrant registered nurses in a care-rationed work environment, complicated by increasing diversity in both patients and staff.\textsuperscript{82,108}

Another study highlighted how migrant care workers providing health and social care to the elderly were found to be vulnerable to exploitation.\textsuperscript{86} Research on training of healthcare staff and students have highlighted the specific need for cultural safety training of non-European international nursing students on aspects of cultural safety unique to New Zealand.\textsuperscript{19,35} Additionally, several studies have recommended strengthening training in culturally safe practice.\textsuperscript{16,103}

**Discussion**

This scoping review was undertaken to identify key issues in A/EM health and well-being that have emerged through existing published research in New Zealand. Some notable findings emerged. First, the range of health conditions studied (and published) in relation to A/EM in New Zealand remains limited. Studies tended to focus on the “usual suspects” (CVD, macronutrient deficiencies and diabetes mellitus), that is, conditions that are widely accepted as being highly prevalent among A/EM. Although research on these conditions is necessary, there is clearly a need to broaden the scope of disease and ill-health beyond “ethnic” diseases. Similarly, the range of A/EM subgroups researched needs broadening. There is some diversity and group disaggregation in the research, but these tend to be qualitative in nature; small population sample sizes unfortunately are a challenge to establishing statistical significance and remain an ongoing challenge in undertaking quantitative research on health conditions among A/EM.

Second, the review found that a wide array of determinants, ranging from fixed genetic to social-structural influences, moderate A/EM health and wellbeing. Key social-structural determinants include culture, cultural practices and perceptions (with some being protective and others enhancing risks), post-migration hardships (with adaptive strategies demonstrating resilience in Asian communities) and shortcomings in healthcare systems, such as explicit systemic discrimination. Importantly, several studies pointed to limitations in the health data on A/EM populations and called for ethnic-specific screening measurements to facilitate precision in diagnosis.

Thirdly, the analysis highlighted the barriers faced by A/EM in accessing primary care and ACC services, as well as the general lack of research on the use and impact of health and community care by A/EM in New Zealand. Although only one study reported the practice of visiting the “homeland” for medical care,\textsuperscript{15} anecdotal evidence certainly suggests the widespread prevalence of this practice among A/EM communities in New Zealand. The few studies available globally on this have shown health status, level of social integration, experiences of discrimination and attitudes towards services in the countries of residence and origin to be significantly associated with healthcare use by ethnic minority people in their country of origin.\textsuperscript{127,128} The other side of healthcare use is service provision; studies in our review highlighted the need for culturally appropriate services, including a greater awareness of the influence of family and medical experts on decision-making and health workforce training. Although there have been some efforts in improving A/EM healthcare experiences (eg, through CALD training of health professionals and the appointment of Asian and migrant health gain managers at some DHBs), research is needed to explore the gains of these system changes. Ongoing barriers to culturally sensitive practices reported anecdotally remain largely unresearched.\textsuperscript{129} Self-reported experience of racism, both among patients and health professionals, is higher for Asian, Māori and Pacific peoples in New Zealand compared to European/Other ethnicities; these need to be systemically addressed.\textsuperscript{130}
Overall, the number of research studies on A/EM health and wellbeing in New Zealand published over this 10-year period is limited in quantity and the research areas covered. This may reflect the low number of studies conducted, a lack of funding to support A/EM research and/or a lower rate of publication. In 2015, Wong highlighted the relative invisibility of the discourse on Asian health in New Zealand’s health agenda and its related policies and research. Historically, A/EM health has not been recognised as a priority in New Zealand, which has led to poor funding for A/EM health research. A 2018 paper for establishing priorities for health research in New Zealand to achieve the vision of the New Zealand Health Research Strategy 2017–2027 noted: “No summary on the health of Asian peoples is presented, because to date very little research has been targeted to this population despite the unique position they have in New Zealand.” Although the ensuing strategy notes the low investment in Asian health as a limitation, there is no mention of A/EM in any of the strategic priority areas.

Importantly, the findings of this review raise several issues that have relevance for A/EM health research, practice and policy. Although the three thematic-focused sections (health conditions, health determinants and health services) highlight key focus areas in the published literature, there are several gaps evident in the body of published A/EM research. For example, research studies focused on MELAA groups were very limited, as were studies on men and intersectional groups, such as A/EM sexual or gender minorities or A/EM groups living in material hardship.

Although this review grouped various A/EM ethnicities together to learn what research is available in general, it is important to have greater understanding of specific A/EM population subgroups, where appropriate, as diversity exists between and within A/EM communities and different groups have different needs, priorities and issues. Categorisation of A/EM in New Zealand is an ongoing challenge. Researchers also continue to contend with the dilemma of balancing sample size, statistical power and representation of ethnic communities. There is strength in a collective group of A/EM, but this leads to “averaging” and masking health issues, further marginalising those with the greatest need.

A major strength of this review is that it focused on published academic peer-reviewed literature, and consequently, the findings presented are high-quality and reliable. The decision to undertake a scoping review over a systematic review allowed us to map the body of literature and identify knowledge gaps. The findings and themes are likely to be relevant for their intended audience (health researchers, A/EM health practitioners and policymakers). Both quantitative and qualitative research was included. Eclectic methodologies, heterogeneous sample groups and inclusion of all available health conditions mean that this can be regarded as a comprehensive overview of the available evidence. The exclusion of grey literature is a limitation of this review and an area for further research.

Conclusion

This review has identified the current state of peer-reviewed published literature on A/EM health research in New Zealand. Overall, the evidence base on A/EM health in New Zealand is weak, as there is limited information on health conditions and its determinants (including health service use). The nature and content of A/EM health research requires further substantive development in terms of understanding the health and health determinants of this significant population demographic in Aotearoa New Zealand.
Appendix

Appendix Table 1: Example of search strategy used in Medline and PubMed databases.

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Asian Continental Ancestry Group/</td>
</tr>
<tr>
<td>2</td>
<td>Ethnic Minority.mp. {mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms}</td>
</tr>
<tr>
<td>3</td>
<td>(East Asian or Chinese or Japanese or Korean or Hong Kong or Taiwan).mp.</td>
</tr>
<tr>
<td>4</td>
<td>(South East Asian or Filipino or Cambodian or Vietnamese or Burmese or Indonesian or Malay or Lao or Thai).mp.</td>
</tr>
<tr>
<td>5</td>
<td>(South Asian or Indian or Bengali or Fijian Indian or Tamil or Punjabi or Sikh or Sri Lankan or Sinhalese IR Bangladeshi or Pakistani or Nepalese).mp</td>
</tr>
<tr>
<td>6</td>
<td>(Middle Eastern or Arab or Afghani or Assyrian or Egyptian or Iranian or Persian or Iraqi or Israeli or Jewish or Jordanian or Kurd or Lebanese or Moroccan or Palestinian or Syrian or Turkish).mp.</td>
</tr>
<tr>
<td>7</td>
<td>(Latin American or Argentinian or Brazilian or Chilean or Colombian or Mexican or Peruvian or Uruguayan).mp.</td>
</tr>
<tr>
<td>8</td>
<td>(African or Jamaican or Kenyan or Nigerian or West Indian or Somali or Eritrean or Ethiopian or Ghanaian).mp.</td>
</tr>
<tr>
<td>9</td>
<td>New Zealand/</td>
</tr>
<tr>
<td>10</td>
<td>(Immigrant or Migrant or Refugee or Asylum Seeker).mp.</td>
</tr>
<tr>
<td>11</td>
<td>1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 10</td>
</tr>
<tr>
<td>12</td>
<td>9 and 11</td>
</tr>
<tr>
<td>13</td>
<td>limit 12 to yr=&quot;2010 - 2019&quot;</td>
</tr>
</tbody>
</table>
Competing interests:
Nil.

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URL:

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Suicide among Asian young people aged under 25 years in Aotearoa New Zealand: different methods warrant different preventive initiatives

Jerry Goh, Sarah Fortune, Gabrielle McDonald

ABSTRACT

BACKGROUND: The Asian population is growing rapidly in New Zealand and is expected to overtake Māori and Pacific population groups by 2038. Although there has been research on suicide in elderly Asian people in New Zealand, there is relatively little knowledge regarding suicide within Asian young people.

AIMS: To describe the characteristics and prevalence of suicide among Asian young people aged 10–24 years between 2002 and 2017.

METHODS: A retrospective review of all child and adolescent suicide deaths in New Zealand was conducted using a national database.

RESULTS: Results include a pattern of increasing deaths with increasing age, with 87.5% over the age of 16 years, and two-thirds of deaths occurring in the Auckland region. The majority of Asian young people who died by suicide were born outside of New Zealand (80.7%), consistent with the fact that the majority (77%) of the Asian population in New Zealand were born overseas. However, deaths tended to decrease with longer duration of residence in New Zealand. That certain methods of suicide were more prominent among Asian young people has important implications for suicide prevention.

CONCLUSIONS: Overall, there has been no significant change in the rates of suicide between 2002 and 2017. Young Asian people who die by suicide come from heterogeneous cultural and linguistic traditions, so prevention strategies need to be culturally responsive and delivered across multiple settings, including education, primary care and mental health services. However, certain methods are more common in many Asian countries, such as jumping from a height. We found this method was more commonly used by Asian young people compared with NZ Europeans, which should be a consideration in town planning, particularly in areas where there is a significant Asian population as part of a multilevel approach to suicide prevention.
positive psychosocial outcomes, such as low rates of crime and divorce as well as a high degree of occupational and educational attainment. However, research has also suggested that stigma towards poor mental health within Asian culture prevents people from accessing mainstream health service and may lead to an underestimation of the difficulties faced by this group.

Existing models of suicide, such as the Interpersonal Theory of Suicide and the Integrated Motivational–Volitional Model of suicidal behaviour, are based on Western concepts of health and wellbeing. However, it is important to consider cultural aspects of suicide. Chu’s Cultural Model of Suicide suggests that culture is important for defining which types of stressors lead to suicide and the threshold for tolerating psychological distress at which suicidal behaviours are expressed. Chu highlights the importance of stressors experienced by members of cultural minority groups because of their social identity. Prejudice and discrimination towards ethnic minority groups, combined with stigma towards mental illness, creates a double stigma that acts to deter Asian individuals experiencing mental illness from seeking treatment. Stigma and ethnic discrimination are also known to be associated with adverse psychological and behavioural outcomes such as depressive symptoms, smoking and use of alcohol, each of which is also associated with higher rates of suicidal ideation and behaviour. Ethnic discrimination is one of the many developmental challenges Asian young people experience during growth and adjustment when migrating to a foreign country.

Suicide is the second leading cause of mortality for individuals aged 15–19 years globally and suicide rates in Asian countries appear to be increasing. Asian young people bring with them culture that influences their susceptibility to suicidal ideation and behaviour. There have been some studies of older Asian people in New Zealand, but the characteristics of those young Asians who die by suicide remains relatively unknown. It is important to conduct research on suicide in Asian young people in order to understand trends and the characteristics of affected individuals.

This study aims to describe the characteristics and prevalence of suicide among Asian young people aged 10–24 years; to compare numbers and rates to other ethnic groups; and to examine trends between 2002 and 2017. This study can help inform initiatives to prevent suicide among young Asian people in New Zealand.

Methods

Cases were identified using the Mortality Review Database at the University of Otago. This is a secure database that contains information on the deaths of all children and young people aged between 28 days and 24 years in New Zealand who have died since 1 January 2002 onwards. The data are collected and stored for the Child & Youth Mortality Review Committee (CYMRC). Cases were included in this study if death was determined by a coroner to be a suicide. The data of individuals aged 10–24 years who died from any cause between 2002 and 2017 inclusive (n=6,642) were extracted from the database. The examined demographic characteristics included age, sex, year of death, method of death (by ICD-10-Australian Modification code), geographical location (district health board (DHB) of residence), country of birth, socioeconomic status (measured by New Zealand Index of Deprivation 2013 decile), and, where available, duration of residence and whether or not they were studying at a tertiary institution. Data were extracted, coded and cleaned by the two senior authors (GMcD and SF). Blind double coding was conducted to ensure good inter-rater reliability on the identification of cases and key variables. Descriptive statistics were generated using a 95% confidence interval (CI) based on a binomial distribution using SPSS Statistics. A denominator set from Stats NZ, based on the estimated resident population at each census, was used. Linear extrapolation was undertaken to calculate the population between census years. All rates are age- and ethnic-group specific.

There are multiple sources for ethnicity information in the Mortality Review Database, including Births, Deaths and Marriages, Ministry of Health collections and information from coroners, all of which allow multiple ethnic groups to be recorded. These sources of ethnicity data vary in their quality and completeness. A
hierarchy determines which data source is used to determine ethnicity. In addition, in order to allocate one ethnic group to each individual, a system of prioritisation is used, as per Ministry of Health protocols. This system gives precedence to Māori, followed by Pacific, Asian, MELAA (Middle Eastern, Latin American and African), then Other and European Ethnicities. For this study, prioritised ethnicity was used so as to match the denominator set. However, occasionally a “total response” Asian category is used if “Asian” is listed as any of the ethnic groups, then that individual is included as “Asian.” Ethics approval was given by the University of Otago Human Ethics Committee. A study advisory committee including experts in Asian suicide was established to provide cultural insight and expertise.

Results

Of the total sample of deaths (n=6,642), 1,894 young people (aged under 25 years) in New Zealand between 2002 and 2017 (inclusive) were classified as having died by suicide. Of these, 88 (4.6%) identified as being of Asian ethnicity with a rate of 4.8 per 100,000. The Asian ethnic sub-groups who had the highest numbers of suicide in this study were Indian (n=26), Chinese and Korean (both n=12) and Filipino (n=9). If using a total response ethnicity, an additional six Asian cases were identified.

Age

No suicide deaths were recorded for young Asian people aged under 12 years. But there appeared to be a pattern of increasing deaths by suicide as age increased beyond 12. Of all Asian suicide deaths, 87.5% (n=77) occurred among individuals aged 17 or older. When examined by a five-year age band, the oldest age group (20–24) had the highest rate of 6.3 per 100,000, with rates of 0.9 and 5.6 per 100,000 in the 10–14 and 15–19 year old age groups, respectively. The highest number of deaths was in those aged 23 and 24 years of age (Figure 1).

A similar pattern, whereby the total number of suicides increased with age, was observed for European young people. However, in comparison to the Asian group, the prevalence of suicide by age peaked in individuals at 20 years and slowly decreased from that point. Europeans also had a high rate of suicides in the 20–24 age group, at 20.4 suicides per 100,000.

Sex

Males made up 68.2% (n=60) of deaths by suicide within the Asian group. By rates,
Asian males had twice the rate of suicides compared with females, at 6.3 and 3.2 per 100,000 respectively.

Similarly, within European young people, deaths were more prevalent in males, accounting for 76.9% (n=690) of the deaths with a male to female ratio of 3.2:1 (17.3 and 5.4 per 100,000 respectively).

**Method of death**

Within the Asian ethnic group, the most common methods of suicide were hanging, strangulation and suffocation (71.6%, n=63), followed by intentional-self poisoning (12.5%, n=11) and jumping from a high place (6.8%, n=6).

Hanging was also the most common method of suicide within the NZ European ethnic group (68.8%, n=617), followed by self-poisoning (11.9%, n=107) and firearm discharge (7.4%, n=66).

Some notable differences include a higher proportion of individuals within the Asian group jumping from a high place (6.8%) compared with NZ Europeans (3.1%) and a higher proportion of death by suicide within the NZ Europeans due to firearm discharge (7.4%) compared with the Asians (2.3%).

**Location of residence by DHB**

The DHBs with the largest number of deaths by suicide in Asian young people were in the Auckland area (Auckland, Counties Manukau and Waitematā) and made up 63.6% (n=56) of suicide deaths within the Asian group. This was expected because this is where 65% of Asian young people within New Zealand reside. The other DHBs where a significant proportion of suicides occurred were Waikato (9.1%, n=8), Capital & Coast (6.8%, n=6), Canterbury (5.7%, n=5) and MidCentral (5.7%, n=5).

The DHBs with the highest rates of suicide deaths within the Asian ethnic group were MidCentral and Waikato, at 12.1 and 8.1 per 100,000 respectively.

The DHBs with the largest number of deaths for NZ Europeans were Canterbury (17.7%, n=159), Southern (12.8%, n=115) and Waitematā (10.8%, n=97). The proportions of Asian and European deaths by suicide differed in the South Island DHBs. However, there was overlap within the Waitematā DHB. The DHBs with the highest rate of suicide within the NZ Europeans were South Canterbury and Wairarapa, at 21.8 and 17.5 per 100,000 respectively.

The location of residence is where the individual resided within New Zealand and not necessarily where they died.

**Country of birth**

The greatest proportion of suicides within the Asian ethnic group came from those who were born outside of New Zealand (80.7%, n=71), which is consistent with the fact that the majority of Asian population in New Zealand were born overseas. This fact, however, is changing over time, with 58%

Figure 2: Suicide mortality (rates and 95% CIs) in Asian young people by year of death, New Zealand 2002–2017 (n=88).
of Asian children 10–14 years having been born in New Zealand according to the 2018 census. The majority of those born outside of New Zealand were from an Asian country (83.1%, n=59). The number of deaths by suicide by country of birth were as follows: New Zealand n=17, India n=13, China n=11 and Korea n=10.

**Duration of residence**

Of the individuals classified as Asian who were not born in New Zealand, 64 out of 71 had the number of years living in New Zealand recorded. The range of time that was recorded was less than one year to greater than 20 years. There were fewer deaths in those who had been recorded as being in New Zealand for a longer time—although note there are many missing observations, and any associations between age and duration of residence may reflect the fact that older children/youth may have lived in New Zealand longer and also the significant degree of spread in duration of residence.

**Year of death**

The number of deaths per year within the Asian ethnic group ranged from less than three to more than 11, with the lowest rate of 1.6 per 100,000 in 2014 and the highest rate of 8.6 per 100,000 in 2016. The deaths in the Asian ethnic group were numerically small and fluctuated greatly from year to year. Consequently, there were not statistically significant trends observed (Figure 2).

In comparison, the number of deaths per year in NZ Europeans ranged between 44 and 68 and there was less fluctuation in the numbers and rates of suicide compared to Asian young people. Suicide rates ranged between 8.9 and 14.6 per 100,000, with an overall rate of 11.4 per 100,000.

**Education details**

Education details were only available for individuals who died by suicide from 2014 onwards (n=32). Of the 32 individuals, 20 had their details recorded: 12 were enrolled in an educational institution, and the remaining eight were not enrolled in any form of education. Of those who were enrolled at an educational institution, eight were enrolled in a tertiary institution and four were enrolled in a school.

**Deprivation**

In the Asian ethnic group, there was a higher number of deaths by suicide in those who lived in deprivation deciles 8 and 9 based on the New Zealand Index of Deprivation 2013 (NZDep) (n=13 and n=17 respectively). It is important to note that NZDep is an area level rather than an individual measure of deprivation, where NZDep 1 is an area with the least deprivation and NZDep 10 is an area with greatest deprivation. By rate, suicide deaths within the Asian ethnic group tended to follow a bimodal distribution, with a higher rate in deprivation deciles 1 and then in 8 and 9 in contrast to the NZ European group, where the greatest rates of suicide deaths were in deprivation deciles 6, 7 and 10.

**Discussion**

Consistent with previous studies, our results indicated an association between older age and death by suicide, with 87.5% of suicides occurring within individuals of age 17 years or older. The male-to-female suicide ratio within this study was close to 2:1 consistent with previous studies in Australia, the United Kingdom and the United States, in which immigrant populations have a lower male-to-female suicide ratios compared with the general population. As for NZ European young people in New Zealand, intentional self-harm by hanging and strangulation were the most common method of suicide among Asian young people, followed by intentional self-poisoning. However, in contrast to other groups, the Asian young people had fewer deaths associated with firearms and more deaths due to jumping from high places. The greatest number of deaths by suicide were within Auckland, Waitematā and Counties Manukau DHBs. However, this is to be expected given the concentrations of Asian residents in these districts.

However, when calculating suicide rates, MidCentral and Waikato DHBs had the highest rate of suicides among Asian young people. Consistent with previous literature, there is an increasing number of suicides with increasing deprivation. However, our results also show there was also a higher rate of suicide in the least deprived (decile 1) population.

The biggest contributors to the number of Asian suicides within this study were Asians who were born outside of New Zealand, which is consistent with the most
recent census that indicated the majority of the Asian community are born overseas. However, when classified by country of birth, New Zealand-born Asians had more deaths by suicide (n=17) than any other individual country and made up 19.3% of Asian suicide deaths within this study. This indicates a significant number of deaths came from second and subsequent generation Asians within New Zealand and not solely from Asian immigrants. Overseas-born immigrants who had been in New Zealand for a longer appeared to have lower rates of suicide. Previous research has suggested that the longer an individual spends in a country, the more their suicide risk converges to that of the host country. Countries such as Korea, Sri Lanka, Japan and China have overall suicide rates higher than New Zealand, with males 15–29 years having particularly high rates in the South East Asian region. It is important to note that, although the Asian population within New Zealand is increasing, the observed suicide rate fluctuates due to the relatively small numbers of deaths each year, and overall there is no significant trend either up or down in terms of suicide rates.

Strengths and limitations

To our knowledge, this is the first study conducted on the trends and characteristics of Asian youth in New Zealand who have died by suicide. This study, which covers all reported deaths of individuals aged under 25 years within New Zealand, offers a complete picture of mortality by suicide across the study period in this age group. Being a complete set of data, rather than a sample, there are no concerns about whether the study population is representative of all Asian young people who died by suicide. However, the numbers are still relatively small and need to be interpreted with caution. The limitations of this study include variable quality of ethnicity data with routinely collected datasets, use of country of birth as a proxy immigrant status, lack of data on first and subsequent generation immigrants for the total population of Asian young people and the lack of detailed ethnic subgroup demographic data. The Asian population in New Zealand is diverse in terms of cultural and linguistic traditions.

However, the relatively small number of deaths in any given community precludes robust statistical analysis at a more fine-grained level. In addition, the information collected in official case records may reflect institutional racism.

Implications

Our study found that a significant number of suicides occurred in individuals 17 years and older, suggesting that secondary and tertiary institutions should be considered as locations for delivering suicide prevention work. The role of pastoral care within these settings needs further exploration, particularly within the private tertiary education section. More universal interventions supporting young people to develop healthy problem-solving skills should also be explored. It is important to recognise that the Asian community is heterogeneous with regard to country of origin, culture and language, so strategies need to be tailored accordingly.

Although making up a relatively small percentage of all suicide deaths, it was notable that there was a higher prevalence of the jumping from a height in Asian young people. This is consistent with international literature that has shown immigrants who die by suicide are more likely to use methods that are common in their country of origin. Jumping from a height is a common method of suicide in many Asian countries, possibly in part because of the ease of access to high buildings. There is growing interest internationally in strategies to reduce suicide deaths by jumping, as part of a multi-level approach to suicide prevention. As our Asian population grows and our urban centres require more high-density housing, planners should ensure that housing and public amenities are designed with suicide prevention in mind.

The continued development and support of culturally responsive health services is likely to be important in areas with high and growing Asian populations such as Auckland. Integrated physical and mental health services should also be made accessible to those in highly deprived areas. In addition, further work to de-stigmatise mental illness within the Asian population could be of benefit.
Competing interests:
Sarah Fortune is Chairperson of the national Suicide Mortality Review Committee and a member of Local Child and Youth Mortality Review Committee, Counties Manukau DHB. Gabrielle McDonald, Epidemiologist, is a member of Mortality Review Data Group at the University of Otago.

Acknowledgements:
The first author would like to thank Dr Gary Cheung and Patrick Au for their input and advice regarding suicide prevention within the Asian community and to the Child and Youth Mortality Review Committee for their support. The lead author also expresses deepest gratitude to the Otago Medical Research Foundation (OMRF) for the funding and opportunity to undertake this research scholarship.

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New Zealand’s immunisation policy fails again and entrenches ethnic disparities

Owen Sinclair, Cameron Grant

New Zealand has a long history of failing to immunise and protect its children. The last national immunisation survey in 2005 showed overall immunisations rates of 77% at age two years. It also revealed a significant ethnic disparity with overall Māori rates of 69% compared to European rates of 80%.

There was an effort to improve overall immunisation coverage rates when the then government made childhood immunisation one of six health targets in 2009. It was hoped that using the National Immunisation Register to identify missed immunisations could raise immunisation coverage levels. There was much celebrating when the Māori and European immunisation coverage rates equalised at the two-year target (93%) in September 2014 (Figure 1).

However, those who understood how this was achieved and looked at other time points remained concerned that these gains were illusory. The increases in immunisation coverage rates at the two-year age that occurred from 2009 to 2014 were not achieved by addressing the previously underperforming system in primary care. Instead, they were achieved by having another separate district health board (DHB) immunisation register based system. The details of patients who did not have their immunisations on time at primary care were sent to the local DHB who then contacted these families to facilitate immunisation catch up. The process of reporting and immunisation catch up took time and the age six-months immunisation coverage levels provided a better indicator of how the immunisation delivery process was truly performing.

These age six-months immunisation coverage data show that immunisation coverage levels at age six-months peaked at a meagre 85% for Europeans and that the ethnic gap in coverage between New Zealand European and Māori has never narrowed (Figure 2). Māori immunisation coverage rates at age six months peaked in 2015 at 71%. More disturbingly, the data show that, since 2017, immunisation coverage rates have been declining and the ethnic gap has been widening at all age points. The current age six-months immunisation percentage for Māori is a dire 54%.

From a population health perspective, the age two-years time point is much less relevant than the age six-months time point. The majority of serious and lethal vaccine preventable disease occurs in the very young. The age two-years time point also ignores the crucial element of timeliness of the primary infant immunisation series. Receiving the age six-weeks immunisation on time (which is not recorded in New Zealand) has significant disease prevention benefits to each young infant. Immunisations remain the premier medical intervention of all time. It has saved countless lives and has economic benefit surpassing any other medical intervention. The dangers of immunisation-preventable disease remain, pertussis epidemics still occur and measles is resurgent. Eighty-three Samoans, mainly children, died when measles was imported from New Zealand in 2019.

Targeted immunisations of at-risk groups with active facilitation is a valid strategy for achieving on-time immunisations and eliminating inequalities. It is well known which groups are at risk of under immunisation and, with almost all births in New Zealand occurring in hospitals, they could be easily
**Figure 1:** Immunisation coverage in New Zealand children aged two years by ethnicity.

**Figure 2:** Immunisation coverage of New Zealand children aged six months by ethnicity.
identified at the time of birth. A coordinator working between DHBs and primary care could manage the process. The number of infants is not overwhelming. For example, in Hawke’s Bay DHB, achieving 95% immunisation coverage in Māori would require 95 extra tamariki to be immunised in a three-month period. This system would contrast starkly against the current one that waits for failure and therefore can never succeed.

There has only been one study in Aotearoa into how immunisations are given at the primary care level. The study identified primary care practice and practitioner factors associated with immunisation coverage and timeliness in New Zealand. Although there was variation in how well practices immunised their communities, all primary care practices had a significant ethnic disparity with respect to completed immunisations. When economic deprivation was factored into the multiple variable models, these practice-level differences in immunisation coverage by ethnicity disappeared. This is consistent with the observation that poor people in New Zealand have difficulty accessing quality primary care. In Aotearoa, 50% of Māori live in households in the lowest three neighbourhood deciles of socioeconomic status. Despite childhood immunisations being free, there are costs associated with getting to a primary care practice and real barriers for lower socioeconomic people with respect to transport, time off employment and family members owing money to the primary care practice.

Socioeconomic factors appear to account for much of the ethnic differences in immunisation coverage at a primary care practice level. But they do not explain why the ethnic gaps in immunisation coverage have not narrowed over the past 12 years and, in infants, appear to be increasing (Figure 2); they do not explain why the immunisation process has not changed to address the barriers Māori face in accessing childhood immunisations; and lastly, socioeconomic factors do not explain why a Pākehā-dominated health system has done nothing to address this systematic failure. The only explanation that ties all of these threads together is systemic racism and the colonialisit practises of a Pākehā health system. Such systemic racism is now well documented across the New Zealand health system as a cause of ethnic disparities in health outcomes.

The immunisation system in New Zealand is not fit for purpose. It has never achieved the goal of 95% immunisation for all, let alone the on-time immunisation that is required to protect the most vulnerable in New Zealand. It has entrenched ethnic disparities and has resulted in both New Zealand and exported preventable morbidity and mortality. The current approach to providing immunisation, based in primary care, is fundamentally flawed and will never be sufficient. In this system immunisations are being given by a wide group of individual organisations that makes coordination impossible. The for-profit nature of primary care does not favour preventative medicine and has resulted in a passive approach that waits for missed immunisation rather than on-time delivery. It is also a system that is exquisitely vulnerable to denominator inaccuracies and a lack of clarity regarding, for example, who is responsible for the immunisation of “casual patients.” It is a disappointing conclusion that the individual, private nature of primary care means they do not have the ability or willingness to lead and address under immunisation at a national level. The continued failure of immunisation delivery in New Zealand means there needs to be a total ground-up reworking of how immunisations are delivered. This can only be achieved through direction and coordination from the Ministry of Health to convince or require all players to deliver the most effective medical intervention of all time. Our children deserve this.

Ethnic inequalities should be completely unacceptable in Aotearoa, particularly when they are a direct threat to our tamariki. The benefits of eliminating inequities are huge. That all of the organisations responsible for providing immunisations have stated a commitment to the principles of Te Tiriti o Waitangi makes the persistence of, and especially the increase in, ethnic disparities, without action, morally corrupt. As we embark on an immunisation programme to address the biggest public health threat of our generation, the only unknown for Māori is how big the disparity will be.
Competing interests:
Nil.

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Chimeric antigen receptor T-cells in New Zealand: challenges and opportunities

Robert Weinkove, Philip George, Myra Ruka, Tia Huia Haira, Giulia Giunti

ABSTRACT

Chimeric antigen receptor (CAR) T-cells are an emerging modality of cancer therapy. CAR T-cells are patient lymphocytes that have been engineered to express a synthetic receptor, which enables them to target tumour cells. Internationally, CAR T-cell therapies are becoming a standard of care. They are a potentially curative treatment for certain relapsed and refractory (r/r) B-cell malignancies. In adult patients with r/r B-cell lymphomas and leukemias, overall response rates of 73–83% and complete response rates of 51–83% have been reported following CAR T-cell therapy. These responses can be durable, with 75% of patients with aggressive B-cell lymphoma who respond at three months reporting being progression free at 24 months following CAR T-cell therapy. Promising results have also been reported for other malignancies, notably myeloma. CAR T-cell therapies involve a single cell administration, offer curative potential and can often be delivered in a near-hospital outpatient setting.

As a personalised cell and gene therapy, CAR T-cells present unique regulatory requirements. The logistics of CAR T-cell production and delivery, and the potential for specific adverse events, demand preparation by treatment sites. The nature of CAR T-cell therapies may raise ethical and equity issues that need to be addressed to ensure equity of access and outcomes.

We recently established local Good Manufacturing Practice (GMP) manufacture of lentiviral vectors and CAR T-cells and commenced enrolment to New Zealand’s first CAR T-cell trial, ENABLE (ClinicalTrials.gov reference NCT04049513). This involved close liaison with regulators and stakeholders and multidisciplinary input for safe clinical delivery of CAR T-cell therapies. Here we build on this experience by outlining the regulatory landscape for CAR T-cell therapies in New Zealand, summarising the preparation of sites and discussing the opportunities to broaden access to this new cancer treatment modality in New Zealand.
CAR T-cell manufacturing and logistics

Leukocyte harvest and leukapheresis

Figure 1 illustrates a typical CAR T-cell manufacturing process. In brief, white blood cells are collected using an automated apheresis machine or by venesection of whole blood. Following initial processing and purification of T-cells, a new gene (the “transgene”) encoding the CAR is introduced, typically using a lentiviral or retroviral vector. CAR T-cells are expanded and then either administered fresh or cryopreserved following quality control testing.

Commercially licensed autologous CAR T-cell products, such as tisagenlecleucel (tisa-cel) and axicabtagene ciloleucel (axi-cel), require a leukapheresis procedure. The New Zealand Blood Service (NZBS) is a national service that routinely performs leukapheresis for haematopoietic stem cell harvest across New Zealand. The NZBS is licensed by Medsafe to collect and manufacture therapeutic cells by apheresis and has conducted leukapheresis procedures for cellular therapy trials, including our own ENABLE CAR T-cell trial. Leukapheresis product testing for blood-borne viruses is routinely performed at the Medsafe-licensed NZBS Donation Accreditation Laboratory. For the ENABLE trial, the leukapheresis procedure and leukapheresis product testing is funded from the trial research budget.

Manufacturers of commercial and investigational CAR T-cell products are likely to have specific requirements for patient identification, infectious agent testing, leukapheresis performance and product labelling and shipping—and in our opinion, the NZBS network is likely to be well placed to conduct leukapheresis or venesection procedures for CAR T-cell manufacture in New Zealand in the future.

Current commercial CAR T-cell therapies are manufactured in a limited number of centres globally, none of which are in New Zealand. This offers advantages of scale, standardisation and cost, but the need for bidirectional international shipping of cells can present a logistical challenge, especially if travel is disrupted by pandemic or natural disaster. Māori regard tissue and genetic material as a taonga (precious item), and international manufacture limits opportunities for Māori engagement and kaitiakitanga (guardianship) over the cells and the genetic material they contain—the destination(s) and use of the cells must be made clear during consent processes. In our view, future CAR T-cell manufacture within Aotearoa, either of locally developed products or through distributed manufacture of commercial products, would improve opportunities for Māori engagement in the governance of tissue use and disposal.

Manufacture and release of CAR T-cells

Although not viable except under specialised laboratory culture conditions or within the intended recipient (ie, the patient who underwent white blood cell collection used for the manufacture of that specific CAR T-cell product), CAR T-cells are defined as genetically-modified organisms (GMOs) by New Zealand legislation. Therefore, CAR T-cell manufacture is regulated by the Environmental Protection Authority (EPA) under the Hazardous Substances and New Organisms (HSNO) Act 1996 (Table 1).

Before granting approval to manufacture CAR T-cells for the ENABLE trial, the EPA sought assurance that the cells could not escape into the environment. To meet these containment requirements, we modified our GMP manufacturing facility and its operating procedures. The facility is inspected and audited by the Ministry for Primary Industries (MPI) and Medsafe.

CAR T-cells are manufactured according to validated protocols and must meet the requirements of the Pharmaceutical Inspection Convention/Pharmaceutical Inspection Co-operation Scheme (PICS) Guide to Good Manufacturing Practice (Table 1). Once a CAR T-cell product has been manufactured and met pre-specified “release criteria,” the CAR T-cells are retrieved from storage and prepared for delivery to the hospital.

Shipping, product traceability, cell storage and disposal

Release of CAR T-cell products to the hospital site for administration to patients also required EPA approval. Measures to
Figure 1: Outline of CAR T-cell manufacture. Manufacture of CAR T-cells involves white blood cell harvest, typically by leukapheresis (1), followed by purification of T-cells, and transduction of the T-cells (2), typically using a lentiviral or retroviral vector. Transduced cells express a CAR directed against a tumour antigen (3), and are expanded in vitro in the presence of cytokines (4). Once CAR T-cell product release testing is complete, the patient received lymphodepleting (conditioning) chemotherapy (5), followed by intravenous administration of CAR T-cells (6). The recipient is then monitored for toxicities.
Table 1: Regulatory requirements for manufacture, release and delivery of CAR T-cell therapy in New Zealand.

<table>
<thead>
<tr>
<th>Regulatory body</th>
<th>Application to CAR T-cell therapy</th>
<th>New Zealand legislation or guidance</th>
<th>Standards to be met</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health and Disability Ethics Committee (HDEC)</td>
<td>Approval required before conducting CAR T-cell clinical trials.</td>
<td>Medicines Act 1981, the Guideline on the Regulation of Therapeutic Products in New Zealand*</td>
<td>Conduct according to CHMP† guidance document EMA/CHMP/IHC/135/95 Guideline for Good Clinical Practice E6(R2) to meet International Conference on Harmonisation Good Clinical Practice (IHC GCP) criteria.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standard Operating Procedures for Health and Disability Ethics Committees, v 2.0, August 2014</td>
<td></td>
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<tr>
<td>Gene Technology Advisory Committee (GTAC) ‡</td>
<td>As a cell therapy comprising gene-modified cells, CAR T-cells require GTAC approval.</td>
<td>Section 30 of the Medicines Act 1981</td>
<td>Demonstration of:</td>
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<td>• clinical benefit (or scientific rationale for potential benefit, if investigational)</td>
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<td>• acceptable safety and toxicity data</td>
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<td>• risk assessments and risk mitigation procedures in place</td>
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<td></td>
<td></td>
<td>• if investigational, qualifications and experience of investigators suitable.</td>
</tr>
<tr>
<td>Māori consultation</td>
<td>Consent and equity of access. Māori consultation is an ethical and legislative requirement for research carried out within New Zealand’s district health boards.</td>
<td>Te Ara Tika Guidelines for Māori research ethics, Health Research Council New Zealand Ministry of Health document- Equity of Healthcare for Māori: A framework The Treaty of Waitangi Guidance about consent with respect to the Human Tissue Act</td>
<td>Equity of access to therapy, including for those living distant from treatment centres. Consent to treatment, including consent to cell shipment and storage, and future use of tissue. Māori consultation processes for research vary regionally.</td>
</tr>
</tbody>
</table>

* Guidance document EMA/CHMP/IHC/135/95 Guideline for Good Clinical Practice E6(R2)
† CHMP = Committee for Medicinal Products for Human Use
‡ GTAC = Gene Technology Advisory Committee
Table 1: Regulatory requirements for manufacture, release and delivery of CAR T-cell therapy in New Zealand (continued).

<table>
<thead>
<tr>
<th>Regulatory body</th>
<th>Application to CAR T-cell therapy</th>
<th>New Zealand legislation or guidance</th>
<th>Standards to be met</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Environmental Protection Authority (EPA)</strong></td>
<td>Approval required to: • manufacture CAR T-cells, classified as GMOs (genetically modified organisms) in containment • release CAR T-cells from containment to treatment delivery site and to clinical laboratory for safety testing.</td>
<td>Hazardous Substances and New Organisms (HZNO) Act 1996, Section 40</td>
<td>• Demonstrate satisfactory containment level in place to prevent escape of the GMOs into the environment. • Demonstrate negligible risk of GMO forming a self-sustaining population outside of containment when released. • Ensure necessary controls to mitigate potential risk are in place to release GMO from containment.</td>
</tr>
<tr>
<td><strong>Medsafe</strong></td>
<td>License to manufacture cell therapy product (pack, label and sell by wholesale). Licenses the New Zealand Blood Service to collect and manufacture therapeutic cells by apheresis.</td>
<td>PIC/S§ Guide for Good Manufacturing Practice for Medicinal Products, annexes 13 and 14</td>
<td>Ensuring the manufacturing facility and manufacturing procedures (including batch manufacturing records and product release criteria) meet Good Manufacturing Practice (GMP) standards. Leukapheresis service audited against the code of GMP.</td>
</tr>
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</table>

*Under this legislation all clinical trials in New Zealand must receive HDEC approval.
†CHMP (The Committee for Medicinal Products for Human Use) is the European Medicines Agency’s (EMA) committee responsible for human medicines.
‡ A committee maintained by the Health Research Council (HRC) of New Zealand to consider applications for trials involving gene or other biotechnology therapies.
§ PIC/S Pharmaceutical Inspection Convention Pharmaceutical Inspection Co-operation Scheme.
assure safe release within the ENABLE trial included rigorous product labelling, shipping and traceability measures. The International Society of Blood Transfusion (ISBT) standards recommend standardised bar codes to allow blood products to be shipped internationally with clear, unambiguous labelling and help to overcome language barriers. Furthermore, there are stringent procedures for packaging, transport, administration and disposal.

Rigorous identity checks using independent patient and product identifiers are performed and recorded on designated forms, to ensure the “chain of custody” is maintained and that the right patient receives the right product. Unused CAR T-cell vial(s) are returned to the manufacturing facility for safe disposal.

The number and expansion of T-cells varies widely between patients, so the manufacturing facility often has an excess of lymphocytes and/or CAR T-cells following product manufacture. Some cells must be retained for quality control purposes, and unless made available for future research (which requires proper consent), the remaining cells are typically destroyed. For our own CAR T-cell trial (ENABLE), we seek consent to store unused cells within an Immune Tissue Bank. This tissue bank was formed with input from Māori researchers, and its governance group includes Māori representation. At present, unused CAR T-cells cannot be returned to their recipient or to the recipient's whānau due to the cell's legal status as a GMO, although it is our opinion that this might be possible in a domestic CAR T-cell manufacturing facility in future, with appropriate risk assessment and controls.

Table 1 summarises the agencies involved in regulating CAR T-cell manufacture, release and delivery in New Zealand.

**CAR-T cell therapies and equity for Māori**

In Aotearoa New Zealand, Māori are afforded the right to equitable health outcomes under Te Tiriti o Waitangi and ethical obligations under the United Nations Declaration on the Rights of Indigenous Peoples. Clinicians in New Zealand have an obligation to consider the degree to which they can contribute to improving Māori health outcomes, and Māori consultation is an ethical and legislative requirement for research carried out within district health boards. Yet significant health inequities exist. Māori are approximately 20% more likely to develop cancer than non-Māori and are twice as likely to die from cancer, including from non-Hodgkin lymphoma. These inequities are driven by delays in diagnosis and treatment, worse access to the wider determinants of health and inequities embedded in health system design.

Cancer research has the opportunity to contribute to Māori health advancement. The Health Research Council (HRC) of New Zealand has implemented the Māori Health Advancement Guidelines, which require meaningful collaboration, consultation and partnership with Māori at the research design stage. Māori expertise within the research team is recommended to ensure the research results in Māori health advancement and that tikanga Māori (Māori processes and protocol) is valued in the research design and the sharing of results. This framework provides an excellent resource for all health research conducted in Aotearoa New Zealand.

If access were equitable, investigational CAR-T cell therapies within Aotearoa New Zealand would provide an opportunity for Māori to benefit from treatments that are not publicly funded and that would otherwise be cost prohibitive. Māori, who regard genetic material as tapu (sacred/restricted), may be concerned with the application of genetic engineering. However, where there are direct health benefits for Māori, and provided that these benefits are well communicated, many will be supportive of this application. A Māori consultation process is essential for CAR T-cell research and standard of care delivery, and this should include development of educational materials for Māori, their whānau and their clinicians.

For our own trial (ENABLE), Māori consultation was sought at an early stage during protocol development. In order to address issues relating to Māori involvement and recruitment and contribute to Māori health development, our CAR T-cell researchers met with Research Advisory Group Māori (RAG-M) at Capital and Coast District Health Board (CCDHB) and Te Urungi Māori, the
Māori steering group at the Malaghan Institute. Following consultation, a brief patient-focussed summary, in both English and te reo Māori, and a visual representation of the CAR T-cell treatment process (Figure 1) were incorporated into the participant information and consent form. ENABLE participants are able to donate tissue to an Immune Tissue Bank, and we have consulted with our (Māori) Tissue Bank Manager at the Malaghan Institute regarding tissue retention and karakia arrangements. We collaborated with a Māori clinician and researcher familiar with managing patients with haematological malignancies. To reduce the risk that distance from the treatment centre impedes study access, an agreement was reached with a national cancer charity to support the travel costs for study participants and a family member, if they were not eligible for the National Travel Assistance Scheme.

Clinical delivery of CAR T-cell therapy

CAR T-cell toxicity working group

CAR T-cell therapies can cause specific toxicities, particularly cytokine release syndrome (CRS) and immune effector cell-associated neurotoxicity syndrome (ICANS; neurotoxicity). The consensus guidelines for the diagnosis and grading of CRS and ICANS published by the American Society for Transplantation and Cellular Therapy (ASTCT) can be readily applied in New Zealand hospitals. Consensus recommendations for the management of CRS and ICANS are also available.

For the ENABLE trial, we convened a CAR T-cell toxicity (CARTOX) working group, which included representatives from haematology, neurology, intensive care, immunology and nursing. The CARTOX group developed and reviewed CRS and ICANS recognition and management pathways, based on consensus recommendations and advice from experts in the field (Neelapu and Turtle, personal communications). These management pathways have been posted on the hospital intranet at the CAR T-cell treating site, with clear paper-based management algorithms being available for easy reference on the haematology ward where patients are treated.

The CARTOX group was also consulted regarding CAR T-cell toxicity education and training material for clinical staff. Since commencing the ENABLE trial, the CARTOX group have met at least every six months in order to review CAR T-cell-related toxicities reported in the ENABLE trial and to evaluate up-to-date published guidance on CAR T-cell toxicity management. This has led to modifications of both CRS and ICANS management pathways as well the production of a working document reviewing the evidence for second-line management of severe CAR T-cell-related toxicities. Given our early experience and feedback from international CAR T-cell treating clinicians and , we recommend implementation of a CARTOX group (or similar) for other centres administering CAR T-cell therapies.

CAR T-cell toxicity education

To safely deliver CAR T-cell therapy, clinical teams must be trained in the recognition and management of CAR T-cell-related toxicities. For commercial products, specific risk evaluation and mitigation strategies (REMS) may be required by the manufacturer, which are likely to involve product-specific training and knowledge assessments for specific clinical staff. Training typically encompasses areas such as prescribing, dispensing and administering CAR T-cells and monitoring for, recognising and treating CAR T-cell related toxicities. For the ENABLE Trial, we developed an educational tool and competency assessment for clinical staff in our inpatient and day-ward areas and for members of the Patient at Risk and intensive care teams. Regular educational updates are held. One-page CRS and ICANS “quicksheets” were produced, and are displayed prominently in the clinical area in which a CAR T-cell recipient is being treated.

Availability of anti-cytokine therapy

The hallmark of CRS is fever caused by high levels of interleukin-6 (IL-6) during CAR T-cell recognition of, and activation by, tumour cells. Tocilizumab, a monoclonal antibody against the IL-6 receptor, is highly effective for management of CRS and can be useful for ICANS. Although tocilizumab is not licensed by Medsafe in New Zealand for the treatment CAR T-cell therapy toxicities, it is registered by the US Food and Drugs Administration (FDA) for this indication.
and is universally recommended in international guidelines for CRS and ICANS. The REMS strategy for axicabtagene ciloleucel requires that at least two doses of tocilizumab are available on site for each patient when they are treated. Tocilizumab was already approved for treating paediatric Acute Lymphoblastic Leukaemia (ALL) trial participants, so a clinician-led application to PHARMAC was made in order to extend this existing approval to include ENABLE trial participants. This application was successful, and PHARMAC will now fund up to three doses of tocilizumab to treat CRS and/or ICANS in ENABLE trial participants. In our opinion, emergency availability of anti-IL-6 therapies will need to be assured for future investigational or commercial CAR T-cell therapies in New Zealand. High-dose corticosteroids are used for severe CRS and ICANS; there are no restrictions on the use of these in New Zealand.

Expert opinion, preclinical data and case reports have recommended anakinra, siltuximab and dasatanib as second-line treatments for severe CRS or ICANS. Although there are no definitive recommendations on which second-line agent to use first, many sites use anakinra (a human interleukin-1 receptor antagonist) in this setting because pre-clinical studies have suggested that IL-1 plays a crucial role in the pathogenesis of CRS and neurotoxicity, and because of anakinra's clinical efficacy in similar settings, such as for macrophage activation syndrome (MAS), which can have features that overlap with severe CRS. In conjunction with the CARTOX group, we developed contingency plans for second-line treatment of severe CRS or ICANS, which included the study sponsor purchasing a supply of anakinra to be stored at the treatment site.

Patient education

Patients and their whānau need to receive education about the potential adverse effects of CAR T-cell therapy. As CRS and ICANS are typically early toxicities, it is often recommended that patients remain close to the CAR T-cell treating centre, alongside a support person, for at least 21 days after CAR T-cell therapy. We provide in-person and written education on CAR T-cell toxicities for recipients and their support person, as well as 24/7 contact details for the CAR T-cell treatment centre. After 3–4 weeks, most CAR T-cell recipients will be able to return to a home further afield. Recipient education is key. Because their primary and secondary care clinicians may lack CAR T-cell experience, recipients should also receive clear and accurate information to pass on to other healthcare professionals they may meet. For the ENABLE Trial, CAR T-cell recipients are given a wallet emergency card and a discharge summary sheet (Supplementary Materials).

Cellular therapy registries

As CAR T-cells are a relatively new treatment modality, there is a possibility that low incidence or late onset toxicities will emerge, such as second malignancies or adverse pregnancy outcomes. Cellular therapy registries provide an important framework for long-term follow-up and detection of such risks. The Center for International Blood and Marrow Transplant Research (CIBMTR), to which New Zealand stem cell transplant centres already report safety and efficacy data following stem cell transplantation, opened its Cellular Therapies Registry in June 2016, which aims to standardise CAR T-cell toxicity reporting and data collection. Participation in the CIBMTR Cellular Therapies Registry is open to CAR T-cell treatment centres worldwide, provided ethical approval for data collection and sharing is in place. Within Australasia, the Australian Bone Marrow Transplant Recipient Registry (ABMTRR) has recorded outcomes of haematopoietic stem cell transplantation since 1992 and has expanded its remit to collect data from CAR T-cell recipients.

Challenges and opportunities

In many respects, New Zealand's healthcare system is well-suited to the delivery of CAR T-cell therapies for haematological malignancies. Although our regulatory processes are unique, they have been successfully tested for CAR T-cells through the ENABLE trial. The New Zealand Blood Service (NZBS) runs a national network of blood collection and leukapheresis centres, and NZBS electronic systems and National Health Index (NHI) numbers facilitate vein-to-vein traceability.
of transfused products, follow-up and the recording of national healthcare alerts. Clinical haematology services benefit from a national network of bone marrow transplantation centres, with established referral pathways, and with comprehensive on-site services, including intensive care, neurology, immunology, infectious diseases, oncology pharmacy and specialist laboratory services. Although commercial CAR T-cells are manufactured in large global hubs at present, the capability to manufacture CAR T-cells within New Zealand will facilitate Māori engagement and guardianship and could offer logistical advantages for CAR T-cell delivery.31 Furthermore, future developments, such as outpatient management following CAR T-cell treatment and the use of automated CAR T-cell product manufacturing systems, may be means of lowering the cost of delivering treatment in New Zealand.32

Equity of access is a key consideration for all new therapies. Some mechanisms needed to address this are in place, and some require strengthening. A network of sites offering CAR T-cell therapies across Aotearoa New Zealand will reduce travel requirements for patients, but the nature of CAR T-cell therapy means that most recipients will have to spend time away from home; travel and accommodation support will be essential. The need to travel is offset by the one-off nature of CAR T-cell delivery and the fact that its principal toxicities occur early after administration.

Cost is a barrier to commercial CAR T-cell therapies at present, and list prices for the licensed autologous CAR T-cell products axicabtagene ciloleucel and tisagenlecleucel are high, at US$373,000 and US$475,000, respectively.33 However, increasing competition between manufacturers, negotiations including schemes that link payment to clinical response and the likely future availability of tocilizumab and anakinra biosimilars are expected to lower total treatment costs in future. Pending funding

Table 2: Opportunities and challenges for CAR T-cell therapies in New Zealand.

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unique regulatory environment</td>
<td>Medsafe regulations are harmonised with EMA*; ENABLE trial provides regulatory experience</td>
</tr>
<tr>
<td>Logistics of cell harvest and manufacturing</td>
<td>National leukapheresis &amp; blood collection network (NZBS†); national patient identifiers (NHI‡); domestic CAR T-cell and lentiviral vector manufacturing capability (MIMR§; small-scale)</td>
</tr>
<tr>
<td>Equity of access</td>
<td>Involve Māori in service planning; leverage national stem cell transplant network; one-off CAR T-cell therapy possibly preferable to ongoing treatments; inter-district funding and national travel assistance schemes</td>
</tr>
<tr>
<td>High cost of commercial CAR T-cell therapies</td>
<td>CAR T-cells are a “one-off” rather than ongoing cost; declining costs due to competition; clinical trial access pending commercial delivery; outpatient administration can lower costs</td>
</tr>
<tr>
<td>Limited clinician experience of CAR T-cell delivery</td>
<td>National network of stem cell transplant centres; clinical trial experience of CAR T-cell delivery (ENABLE)</td>
</tr>
<tr>
<td>Restrictions on medicines used to treat CAR T-cell toxicities</td>
<td>Tocilizumab and anakinra biosimilars are in development; PHARMAC provides a national funding mechanism (“Special Authority”)</td>
</tr>
</tbody>
</table>

* European Medicines Agency (EMA).
† New Zealand Blood Service (NZBS).
‡ National Health Index (NHI).
§ Malaghan Institute of Medical Research (MIMR)
of CAR T-cell therapies, clinical trials can help bridge the gap in availability, at least for some patients, and prepare our regulatory and clinical systems for routine CAR T-cell delivery. Table 2 summarises key challenges and opportunities for CAR T-cell therapies in New Zealand.

Conclusions

CAR T-cell therapy is shifting the treatment paradigm of relapsed and/or refractory B-cell malignancies internationally. In this viewpoint, we have outlined the regulatory processes and clinical preparations involved in establishing the first CAR T-cell therapy programme in New Zealand, with particular consideration to Māori engagement and access to treatment. Having reviewed the challenges and opportunities, we believe Aotearoa New Zealand is in an excellent position to develop and implement both investigational and commercial CAR T-cell therapies in the future.

Supplementary material

- Supplementary Material 1: CAR T-cell Wallet Emergency Card
- Supplementary Material 2: ENABLE Trial Discharge Summary Sheet
Competing interests:
RW, PG, TH and GG are employees of the Malaghan Institute of Medical Research, which sponsors the ENABLE trial. The authors do not have proprietary or financial interests in the WZTL-002 CAR T-cell product.

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This manuscript is dedicated to the memory of Dr John Carter.

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New Zealand’s Climate Change Commission report: the critical need to address the missing health co-benefits of reducing emissions

Tim Chambers, Simon Hales, Caroline Shaw, Michael Baker, Jude Ball, Christine Cleghorn, Nick Wilson

ABSTRACT

The Climate Change Commission’s draft report and recommendations provide a pathway towards achieving the New Zealand Government’s commitment to net zero emissions by 2050. However, the Commission has not adequately considered the health co-benefits of climate change mitigation. In this viewpoint, we assess how the Commission has considered health co-benefits in the key response domains. Extrapolating UK evidence to the New Zealand context suggests climate change mitigation strategies that reduce air pollution, transition the population towards plant-based diets and increase physical activity via active transport could prevent thousands of deaths per year in coming decades. Substantial health co-benefits would also arise from improved housing, cleaner water, noise reductions, afforestation and more compact cities. The Commission’s draft report only briefly mentions many of these health co-benefits, and some are completely absent. We recommend the Commission’s final report: (i) use health co-benefits as an explicit frame; (ii) ensure the government’s Treaty of Waitangi obligations are met in all the domains covered to maximise benefits for Māori health and wellbeing; (iii) build on the successful COVID-19 response that demonstrated rapid, science-informed and vigorous government action can address major global health threats; (iv) include both public health expertise and Māori health expertise among its commissioners; (v) explain how health co-benefits are likely to generate major cost-savings to the health system.
Food environment and dietary patterns

The Report is largely focused on the industrial “food production” system and does not mention the word “diet” (eg, human diet) despite the huge potential co-benefits from a move towards more plant-based diets. It notes that “Transitioning to a low emissions economy will require New Zealanders to change some aspects of their lives,” yet reducing consumption of meat and dairy is omitted from the examples provided. New Zealand research demonstrates a shift towards more plant-based diets could lower greenhouse emissions, improve health, lower costs to the public and lower healthcare costs. One New Zealand study demonstrated that, if New Zealanders adopted the New Zealand Dietary Guidelines, diet-related emissions would reduce by 4–42%, depending on the degree of dietary change and food waste minimisation. The estimated lifetime health gains for the current New Zealand population were 1.0–1.5 million quality-adjusted life-years, and the estimated healthcare system cost-savings were NZ$14–20 billion. Another New Zealand study showed the large health gains and cost-savings from a modelled junk food tax and a saturated fat tax, with some of these benefits arising from reductions in meat consumption. Finally, the health co-benefits of improved diets also include potential reductions in health inequalities as Māori and Pasifika disproportionately suffer chronic diseases (cardiovascular disease, diabetes and some cancers) related to New Zealand’s obesogenic food environment.

Plant products typically produce far fewer greenhouse gas emissions compared to animal products. Indeed, New Zealand meat and dairy products still produce approximately five times the greenhouse gas emissions per gram of product of the highest plant-based emitter, rice. Plant-based milk and meat, which is becoming increasingly price competitive, is estimated to contribute around 4% of the greenhouse gases per unit of protein and use less land and water compared to meat and dairy.

The Report also says that “red meat and dairy products from Aotearoa are already some of the least emissions intensive in the world.” However, the lifecycle assessment for lamb and beef emissions have point estimates that fall within the confidence internals of global averages, suggesting there is no statistically meaningful difference between New Zealand and the international pattern of global emissions for lamb and beef. Further, such comparative analyses can be misleading because they typically don’t consider that dairy and meat production still generate the largest dietary emissions by far, as well as having other land-use consequences (eg, the native bush that was removed to allow for livestock grazing). For example, one New Zealand Government report noted that “The exclusion of carbon losses arising from forest harvesting, deforestation and scrub clearance has a significant impact on the overall estimate of net emissions and removals.” The ideal analysis of agriculture/food impacts should also account for the carbon costs of using coal in the milk drying processes often used in New Zealand, which was not considered in one study of the carbon footprint of New Zealand milk. Finally, greater independence from industry-produced or funded livestock lifecycle assessments is required to ensure the validity of the results.

Physical activity benefits from active transport

The Report states: “There are significant co-benefits from increasing alternative types of transport. In particular, walking and cycling benefit health.” Two New Zealand publications on the benefits of active transport for health are referred to in the Report. But, considering that this might be the second most important area for health gain, there is still a marked lack of detail on these benefits. This deficit includes the minimal consideration of increased use of electric bikes, despite their rapid uptake in many cities internationally. Other relevant New Zealand-based modelling work was not mentioned. For example, this other work reported that switching short vehicle trips to walking and cycling could generate large healthcare cost-savings (range: NZ$127 million to NZ$2.1 billion) and reduce greenhouse gas emissions by up to 194 kilotonnes CO₂e/year. Another modelling study that
considered health aspects of bicycling (relating to physical activity, injury and air pollution) reported that “transforming urban roads over the next 40 years, using best practice physical separation on main roads and bicycle-friendly speed reduction on local streets, would yield benefits 10-25 times greater than costs.” Improved walking and cycling infrastructure would particularly improve transport options for Māori, Pasifika and low-income New Zealanders.

International and local examples show that a rapid and substantial mode shift towards active and public transport is highly achievable. For example, an evaluation of New Zealand’s “model communities” found a 30% net increase in active transport in intervention cities compared with control cities over a three-year period. Yet this potential is not reflected in the Report’s mode shift assumptions, which are modest ("walking, cycling and public transport can be increased by 25%, 95% and 120% respectively by 2030"). Instead, the Report puts emphasis on the electrification of New Zealand’s transport fleet, a strategy that will not increase physical activity or address other problems associated with car-dependency, such as the safety of children and other vulnerable road users, traffic congestion, cost of road maintenance or use of valuable urban land for storing cars.

Benefits from reduced air pollution

Another co-benefit of using less fossil fuel for energy, heating and transportation that only received brief mention in the Report is improved health from reduced air pollution. The Report refers to one New Zealand study on the harm from air pollution to health, which estimated particulate matter emissions cause adverse health outcomes, including over a thousand premature deaths, with a cost of NZ$8 billion per year. The Report also mentions further government encouragement for working-from-home arrangements, which may reduce air pollution from commuter traffic. Nevertheless, there is still a marked lack of detail in this important area for health co-benefits. Two other relevant papers were not mentioned: one on the association between air pollution and mortality for New Zealand, and the other on the impact of the COVID-19 lockdown on improved air quality in New Zealand, which highlights the potential gains that can be made. Fortunately, New Zealand estimates of health impacts attributable to ambient air pollution are currently being updated and can be included in future reporting.

Health inequities

The Report is reasonably good at considering some aspects of inequities—but these are predominantly around income inequality. The Report notes the health impacts of climate change would likely be spread unevenly across the population, with more vulnerable groups being more exposed. It includes a vision of ensuring the low emissions transition takes opportunities to reduce inequalities and consider intergenerational equity. However, the Report does not fully outline the potential of climate actions to reduce existing health inequities by reducing exposures disproportionately borne by disadvantaged groups (eg, cold, damp homes, poor food environments, air pollution and traffic injuries). This gap is despite existing health inequities being of major concern from the perspective of preventable health loss, an ethical perspective and a Te Tiriti o Waitangi (Treaty of Waitangi) perspective.

Other health co-benefits

The health co-benefits presented above are not an exhaustive list. In Appendix Table 1, we outline other health co-benefits that are also important from health, social and cultural perspectives. These co-benefits include: (i) improved health from warmer and drier homes (with improved house designs and increased use of insulation); (ii) improved cardiovascular and mental health from reduced noise pollution (with a shift to electric vehicles, increased use of rail and shipping for freight and any reduction in air transport); (iii) improved water quality from increased reforestation and livestock reductions (reducing nitrates and enteric pathogens from livestock agriculture); (iv) improved mental health, reduced injury and improved physical health and wellbeing.
from more compact cities and less urban sprawl (less commuting time, better access to central city services via walking and cycling).

Our recommendations to the Commission

Health co-benefits should be used to explicitly frame the Commission’s final report. The advantage of this approach is that it identifies meaningful value for the public and it is likely to create better support for action.24 The idea that we can reduce emissions and simultaneously improve wellbeing (often with immediate and local effect) is far more appealing than a technical and sectoral approach to reducing emissions. Furthermore, the Commission should include reducing health inequities as a co-benefit. To assist them in this work, the Commission should include both public health expertise and Māori health expertise among its commissioners.

Health and other co-benefits should also be quantified and included in cost–benefit analyses of proposed emission-reduction strategies. Given the likely size of the health and societal wellbeing co-benefits of taking actions to reduce New Zealand’s emissions, we think it is quite possible that a full cost–benefit analysis that includes these components would be positive. This conclusion makes arguing about whether or not the economic impact is under 1% of GDP (as the Climate Change Commission has estimated) somewhat superficial and premature. Indeed, there is a need for a full cost–benefit analysis that captures the co-benefits we have outlined. New Zealand researchers have already conducted health and economic analyses on various interventions that involve emissions reductions and health co-benefits.7,15,16,25 The challenge now is to integrate such findings with the higher-level economic modelling performed by the Commission to produce more comprehensive understanding of the likely impacts on society as a whole. There should also be consideration of whether GDP is the appropriate metric to be considering as the outcome of modelling. Recognising the limited nature of GDP, the New Zealand Treasury has already moved towards a wellbeing framework.26 The Commission’s modelling also needs to consider the wider range of outcomes that are important to people. The Commission should consider ways to minimise any strategies that could exacerbate health inequities and develop compensatory mechanisms to counter these (eg, expanding winter heating subsidies and home insulation subsidies for those at risk of fuel poverty).

The Commission also needs to do more to ensure that the government’s Treaty of Waitangi obligations are met in all the domains covered. The sector-specific plans to reduce emissions within the Report do not reflect the values of He Ara Waiora, the analytical framework to improve Māori wellbeing that the Commission states it used to inform their work. The Commission needs to develop more meaningful and enduring partnership with Māori to fully embed these values in their work.

The Commission should also build on the experience of New Zealand’s successful response to the COVID-19 pandemic. This response to another major global health threat has shown the benefits of rapid, science-informed, vigorous government action (albeit with some aspects being far from optimal,27,28 such as increased psychological stress for some29 and uneven economic shocks to particular communities). A key aspect of the response was the successful communication of the need for collective action for the long-term good of all—a message that is also relevant to climate action and one New Zealanders have shown willingness to respond to. Ultimately, the COVID-19 response demonstrated how a collective response can achieve both public health and economic benefits.30

Lastly, the Commission’s final report should explain how these health co-benefits are likely to generate major cost-savings (eg, by reducing healthcare costs and improving productivity from improved health). Therefore, the overall impact on the New Zealand economy of responding to climate change may be much less than estimated by the Commission. Indeed, in the long run, the economic issues of countries responding to climate change pale into insignificance compared with the potentially catastrophic disruptions to planetary systems and human societies that uncontrolled climate change could cause.
### Appendix

**Appendix Table 1:** Our analysis of the coverage of health co-benefits in the Climate Change Commission Report not covered in the main text.

<table>
<thead>
<tr>
<th>Potential health co-benefit of climate change action</th>
<th>Summary of coverage of health co-benefits</th>
<th>Further details and comments</th>
</tr>
</thead>
</table>
| Improved health from **warmer and drier homes** (with improved house designs and increased use of insulation) | Some mention and brief quantification | The Report notes: “An evaluation of the Warm Up New Zealand programme found that the health benefits from insulating lower income households were substantial, resulting in savings in health costs of more than $800 a year on average” (with cross referencing to published work). The evidence documentation also refers to a New Zealand report on gas heating and its role in mouldy homes and indoor air pollution.

**Comment:** This is the only health co-benefit where the Report provides some quantification. Nevertheless, key published literature on the health co-benefits of improved insulation in homes is not referred to. Also, that retrofitting insulation has a favourable cost-benefit ratio in the New Zealand setting is not mentioned. Improved housing for Māori, Pasifika and low-income New Zealanders is also likely to reduce health inequities given the New Zealand evidence for how dampness and mould contributes to young children’s hospitalisation rates for acute respiratory infections in these groups.

| Mental health, injury physical health and wellbeing benefits from **more compact cities** and less urban sprawl (less commuting time, better access to central city services via walking and cycling) | Brief mention only | Health co-benefits of urban form are considered in the Report: “Where urban form encourages cycling and walking, alongside efficient, affordable and interconnected public transport networks.” It cites work that states: “If designed appropriately, urban form and transport can increase physical activity, improve air quality, reduce road traffic injuries, increase social cohesion, and achieve maximum health benefits from services and facilities.”

**Comment:** But despite the above, the health co-benefits are not explored in any further detail in the Report. This is despite the health benefits and greenhouse gas reduction benefits of active transport being modelled for New Zealand. There is no mention of the mental health and wellbeing benefits of reduced traffic congestion and reduced long daily commutes by private car. It is not mentioned that good design of green space can potentially ensure that urban intensification can maintain the health and wellbeing benefits of access to parks etc. Furthermore, there is the issue of how urban sprawl can exacerbate inequities. That is, Māori, Pasifika and low-income New Zealanders can be forced to the periphery of urban areas where rents/house prices are lower, but then face greater commuting costs and poorer access to public services. Finally, more compact cities would facilitate a mode shift to more active transport and public transport and evidence suggests that such a mode shift also reduces overall road traffic injury risk and deaths.
### Appendix Table 1: Our analysis of the coverage of health co-benefits in the Climate Change Commission Report not covered in the main text (continued).

<table>
<thead>
<tr>
<th>Potential health co-benefit of climate change action</th>
<th>Summary of coverage of health co-benefits</th>
<th>Further details and comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved mental health and cardiovascular health from reduced noise pollution (as a result of decreased private vehicle use, increased use of rail and shipping for freight and any reduction in air transport)</td>
<td>Very brief mention</td>
<td>The Report mentions this potential benefit in brief and general terms (e.g., “quieter streets”). <strong>Comment:</strong> There is a marked lack of detail in the Report. There is no mention of the evidence that suggests that exposure to traffic noise is associated with mental health and cardiovascular problems (depression, high blood pressure, myocardial infarction, heart failure and stroke in adults, hyperactivity/inattention and “total difficulties” in children and adolescents). Health inequities could also be reduced as Māori, Pasifika and people on low incomes are more likely to live in noisy areas (e.g., near arterial roads and airports).</td>
</tr>
<tr>
<td>Improved water quality from increased reforestation and livestock reductions (reducing nitrates and enteric pathogens from livestock agriculture)</td>
<td>Very brief mention</td>
<td>The Report mentions “cleaner water” as a potential benefit of reforestation and mentions the issue of “pathogen loss into waterways.” The Report also considers reduced livestock numbers and reduced land used for livestock farming as options, and these would also be likely to reduce water pollution. <strong>Comment:</strong> Enteric pathogen contamination of waterways is an important issue in New Zealand as indicated by a major water-borne outbreak of <em>Campylobacter</em> infection in Havelock North. The water contamination issue has also been considered in the context of giardiasis. Nitrate pollution of water is also a likely risk factor for colorectal cancer, as well as emerging evidence of it being a risk factor for birth defects and other cancers.</td>
</tr>
<tr>
<td>Other reduced health harm and water treatment costs arising from increased reforestation</td>
<td>Briefly implied</td>
<td>The Report notes that establishing new native forests on less productive land offers erosion control benefits. <strong>Comment:</strong> But the Report fails to draw linkages with reforestation and: (i) lower risk of flooding; (ii) lower water treatment costs.</td>
</tr>
</tbody>
</table>
Competing interests:
Caroline Shaw declares funding from the Health Research Council outside the submitted work. Christine Cleghorn declares a financial relationship with Horticulture NZ outside the submitted work.

Acknowledgements:
A short version of this document was published in The Conversation and benefited from editorial input from this publication. Between the submission and publication of this article, the Commission’s final advice to the government was released. The final report put greater emphasis on active transport and made greater acknowledgement of the potential health co-benefits of climate action. Yet these benefits were not incorporated into financial modelling. The potential cost-savings from diets less reliant on animal products remain absent in the final report. There remains a lack of public health expertise among the commissioners, and attention to Treaty of Waitangi obligations and health equity impacts is insufficient.


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Diesel matters: accelerating the light diesel vehicle endgame in Aotearoa New Zealand

John Horrocks, Nick Wilson

ABSTRACT

Air pollution from diesel-powered vehicles is likely to be contributing substantial harm to health in Aotearoa New Zealand, as well as making it harder for this country to meet its international climate change commitments. There are a lack of controls and outdated standards applied to diesel vehicles in New Zealand, and there is scope to extend the monitoring of emissions. A comprehensive list of interventions that would assist with the phase-out of light diesel vehicles and reducing their emissions during the transition has been compiled. This list includes regulatory interventions such as bringing forward the year in which the Climate Change Commission proposes to ban imports of internal combustion light vehicles (ie, from 2035 to 2025). Also detailed are fiscal measures (incentives and disincentives) and improvements to information for consumers at point-of-sale.

The relationship between air pollution and health, including premature death, is well-recognised. The Global Burden of Disease (GBD) study estimated in 2020 that in the previous year there were 6.7 million premature deaths globally from air pollution (ambient particulate matter and ambient ozone pollution). This number comprised 11% of all female deaths and 12% of all male deaths. Another study has produced an even higher figure: 8.7 million premature deaths annually from fine particulate matter (PM$_{2.5}$) produced by the burning of fossil fuels.

In this viewpoint, we have concentrated on the impact on air pollution of New Zealand’s light diesel vehicles, which have made up a growing proportion of the diesel fleet since the year 2000. This category covers vehicles that have a gross mass of under 3,500 kilograms. It includes passenger cars and vans, but recent growth in the number of light diesel vehicles has been concentrated in the commercial fleet, which contains utility vehicles (utes), goods vans, motor caravans, lighter trucks and buses. Since 2000, the proportion of light commercial vehicles powered by diesel has increased from 44% to 74.3.

The popularity of diesels has created a potentially powerful lobby for the continued use of this fuel and poses a challenge to the proposals by the Climate Change Commission (CCC) for a rapid decarbonisation of the transport sector and a shift to electric vehicles. According to the CCC’s 2021 draft timetable, no further internal combustion light vehicles would be imported after 2035.

In order to clarify the steps that would need to be taken to achieve the CCC’s transport goals, we assessed how much is known about the local ambient concentrations of the most harmful components of diesel emissions, nitrogen oxides (NO$_x$) and PM$_{2.5}$: that is, how they are being monitored and how well-informed about their emissions are the purchasers of diesel vehicles. A reduction in these pollutants would comprise an important health co-benefit to any initiatives to control carbon emissions from diesel. We also examine some of the actions that could accelerate the removal of light diesels from the vehicle fleet.

Since 2013 there has been a trend away from petrol cars towards large diesel-powered sports utility vehicles (SUVs) and...
utes. Modern versions of the latter have incorporated the tray into the bodywork, and twin cab models can often be seen in the country's towns and cities, where they are used as family vehicles. Because New Zealand's popular utes fall under a commercial designation, owners who claim that they use their vehicle for business can enjoy tax advantages such as depreciation of the asset, exemption from fringe benefit tax, rebates of goods and services tax (GST) and the ability to offset running expenses against income. These attractive incentives go some way to explaining why Ford proudly labels its Ford Ranger utility vehicles as “NZ's Favourite Workmate,” a reasonable claim as the Ranger has been the country’s highest-selling new vehicle since 2015, with 7975 new Rangers registered in 2020. All these models of the Ranger in New Zealand run on diesel.

At a time when sales of light diesel vehicles are falling in other countries and there are restrictions on their use in many European cities, New Zealanders continue to have a love affair with diesel. Most SUVs imported into the country are available in diesel versions, including the Kia Sportage, the fifth-highest selling new car in 2020. The popular Toyota Hiace range of vans and camper vans also includes diesel options. In 2019 diesel vehicles accounted for 19.8% of the fuel use in New Zealand's light fleet.

Health impacts of diesel emissions

Diesel vehicles are heavy producers of NO\textsubscript{x} and PM\textsubscript{2.5}. The main source of nitrogen dioxide (NO\textsubscript{x}) from on-road emissions in New Zealand comes from diesels, which contributed 70% of the 47,800 tonnes of NO\textsubscript{x} produced by vehicles in 2015. Diesel emissions contain far more NO\textsubscript{x} than emissions from petrol engines because diesels operate at a higher pressure and can also operate at a higher temperature under some driving conditions—factors that during combustion favour the creation of NO\textsubscript{x} from the nitrogen and oxygen in the air/fuel mix. NO\textsubscript{x} itself is, in turn, produced when emissions of NO\textsubscript{2} react with other chemicals in the air. PM\textsubscript{2.5} resulting from the use of vehicles can be formed by mechanical abrasion from traffic (eg, from wear on tyres), but its contribution from traffic is mainly found in the form of soot as a result of incomplete combustion.

Both NO\textsubscript{x} and PM\textsubscript{2.5} are associated with a variety of harms to health. NO\textsubscript{x} irritates the respiratory tract and can lead to long-term cardiovascular damage, and diesel engine exhaust has been identified as a cause of lung cancer. The increased mortality within populations that are exposed to particulate pollution, even at low levels, is long-established. A study of the impact of both ozone and PM\textsubscript{2.5} pollution on mortality among the 61 million Medicare beneficiaries in the US found that even at levels below those set by national air quality standards for PM\textsubscript{2.5}, these pollutants were linked to a greater all-cause risk of death.

New Zealand-based research has also linked air pollution exposure to increased mortality risks, with stronger associations for Māori.

The most recent estimates for the year 2016 were for approximately 4,000 premature deaths from PM\textsubscript{2.5} and NO\textsubscript{x} combined for New Zealand (more specifically: approximately 2,000 deaths from for PM\textsubscript{2.5} from all sources and approximately 2,000 from NO\textsubscript{x} from road traffic). Such estimates do not even include the health loss from disability (eg, from chronic respiratory disease and cardiovascular disease). Furthermore, a large study in London has linked typical diesel exhaust pollutants with more severe symptoms of mental illness in vulnerable individuals.

The limited controls on New Zealand’s light diesel vehicles

Diesels can be significant contributors to climate change through their emissions of carbon dioxide (CO\textsubscript{2}). Although they have lower fuel consumption than petrol vehicles, each litre of diesel accounts for more CO\textsubscript{2} emissions than a litre of petrol. Together with the sheer size of many diesel SUVs and utes in New Zealand, this means that the larger models in these classes can emit more than 200 grams of CO\textsubscript{2} per kilometre. This contrasts with the emissions of the country’s highest-selling smaller car, the Toyota Corolla, the petrol versions of which are claimed to produce less than 140g/km.
New Zealand consumers are not well-informed about the fact that diesel vehicles also produce NO\(_x\) and PM\(_{2.5}\). A cursory chat with salespeople at car yards makes this clear, and the manufacturers’ figures for NO\(_x\) emissions from diesels are not displayed at the point-of-sale, unlike the CO\(_2\) data for models sold locally. CO\(_2\) figures are published at the point-of-sale, on the motor distributors’ websites and by the New Zealand Government website Rightcar (though Rightcar does provide an opaque and poorly characterised composite rating for pollutants other than CO\(_2\)).

Apart from this lack of information, the control of emissions from New Zealand’s light diesel fleet is held back by the country’s weak and outdated emission standards for new vehicles and newly imported used vehicles. Since November 2016, importers of light vehicles have had to meet the emission standards set by EURO 5 or its equivalents, like Australian Design Rule (ADR) 79/04, JAPAN 09 and US 2007. EURO 5, however, was superseded as long ago as September 2014 by the new requirements set by EURO 6. EURO 6 sets a limit for NO\(_x\) emissions of 0.08g/km, a 67% reduction on the EURO 5 limit. In order to meet the more stringent limits and tests that must be met by EURO 6 vehicles, the particulate filters on the exhaust systems of EURO 5 models must be supplemented by other devices. These may include a NO\(_x\) trap that uses a catalyst to reduce NO\(_x\) to nitrogen. Another process, selective catalytic reduction (SCR), uses an additive, AD Blue, which contains urea. This is injected into the exhaust and reduces NO\(_x\) to nitrogen and water. As one might expect, these devices need expert maintenance. Even the particulate filters on EURO 5 models need regeneration through occasional periods of high-speed driving. Beside these innovations, the later versions of EURO 6 assess emissions by tests that also reflect real-world driving conditions, rather than just the laboratory results that supported earlier standards.

The protective value of the EURO 5 standard currently used in New Zealand for new and used additions to the light vehicle fleet is doubtful, as NO\(_x\) emissions are likely to be far higher than the official limit. A study conducted for the German Environment Agency (Umweltbundesamt) found that if temperature changes were taken into account and measurements were also taken under real-world driving conditions, EURO 5 diesel vehicles could exceed the limit for NO\(_x\) of 0.18g/km by over 400%. The health implications of this gap between testing under laboratory conditions and real-world driving conditions was illustrated by a study of the effect of diesel emissions in 11 major markets. It estimated that, because of their role as ozone and PM\(_{2.5}\) precursors, excess NO\(_x\) emissions were linked in 2015 to approximately 38,000 premature deaths worldwide. These “excess” emissions were those observed during on-road driving over and above those recorded by testing under laboratory conditions.

In May 2021, the Ministry of Transport canvassed motor industry opinion over its suggestion that stricter emissions requirements for imported used diesel vehicles could come into force after January 2022 and new vehicles a year later. The immediate response from the Vehicle Industry Association was that 90–95% of used imported models would be banned as a result—an indicator of the degree to which New Zealand has become a haven for polluting vehicles.

EURO 6 does set more demanding standards for NO\(_x\), but there are questions about how many new diesels can actually meet these standards when in use. Results for different passenger brands vary widely and only 10% of EURO 6 cars tested by the International Council on Clean Transportation passed the NO\(_x\) standard on the road. Official figures from vehicle manufacturers also need to be treated with scepticism, quite apart from any deliberate falsification of test bed results, as seen in the “Dieselgate” scandal with Volkswagen in 2015.

As outdated as EURO 5 may be, it does set limits for emissions besides CO\(_2\), including limits for NO\(_x\) and PM. The limit for PM is a measure based on the total mass of particles in exhaust emissions. The majority of particles are very small (less than PM\(_{2.5}\)), but a relatively few larger particles contribute most of the mass.

One unintended benefit of New Zealand’s tardy adoption of newer emission rules may be the opportunity to set in place measures to stop motorists from tampering with the various technologies used to reduce diesel emissions.
emissions. As well as exhaust system filters and exhaust gas recirculation, these include engine software and on-vehicle diagnostic systems to monitor emissions. The potential for tampering has been recognised by New Zealand industry groups such as the Motor Industry Association, and in 2016 the Ministry of Transport began work on how legislation and associated operational actions could prohibit this practice. The New Zealand Transport Agency's 2021 requirements for urban buses explicitly prohibit these practices in the case of buses. The seriousness of tampering is demonstrated by the fact that over the previous decade in the US, at least 550,000 owners of diesel pickup trucks (utes) have disabled or modified these control devices. The US Environmental Protection Agency (EPA) estimates that the polluting impact of this tampering has resulted in emissions equivalent to those produced by an additional nine million (compliant) pickup trucks.

The blatant use of this practice has been seen by prosecutions in which offenders have been found to have used defeat devices on diesels with names such as Deviant Race Parts, Alligator Diesel Performance and Adrenaline Performance. Some modified vehicles can also “roll coal”, a kind of “exhaust-belch” of sooty exhaust that can be released on demand. Rolling coal is used as a political challenge to protesters about liberal causes, as well as drivers of eco-friendly cars, such as Prius owners.

In New Zealand, more old vehicles are kept in use than in countries with a comparable degree of motorisation, such as Canada, the US and Australia. In 2018 the average age at exit for all light vehicles bought new was 18.9 years, and for used imports the figure was 20 years. This feature of the country's vehicle fleet means that it includes relics from a time when standards for fine particle emissions were far laxer than the current requirement for new imports. For the heavier diesel fleet, buses are among the more visible examples of the local tendency to keep older vehicles in service, even when there are strong efforts by local and regional authorities to phase them out. In Wellington, for example, 79% of the fleet is now EURO 5 or above, including 10 electric vehicles. The remaining ancient buses can be identified easily enough by the black exhaust that emerges from their tailpipes as they travel through central city streets like Lambton Quay. Similar buses continue to enjoy second careers as school buses or be used on contract. This can be seen in old Volvo buses operated in these roles by Mana Coach Services.

They met EURO 3 emission standards when they entered the passenger transport fleet, but these are criteria that date back to the year 2000. EURO 3 included an allowable PM level in exhaust five times higher than applies to later EURO 5 imports. During operation, this will be an underestimate, in view of the age of these buses and the fact that emissions tests for vehicles earlier than EURO 6 were not conducted under real-world driving conditions.

Given the above issues, further development of high-quality monitoring of diesel emissions in New Zealand is important. In the Appendix we discuss the current arrangements and scope for further improvements.

Accelerating the light diesel vehicle endgame and reducing harmful emissions

In Table 1 we outline potential interventions to accelerate the light diesel vehicle endgame and to reduce air pollution during this transition. Some of these interventions apply to all vehicle use but have particular relevance for diesels (the first part of the table), and some of these would have health co-benefits via other pathways (eg, increased physical activity from infrastructure to support walking and cycling). Some of these steps have been considered by the CCC and the Ministry of Transport, but others do not appear to be under substantive discussion (eg, scrappage schemes). We discuss such schemes and other precautionary actions in the text below.

Extensions to the Clean Car Discount

The Clean Car Discount, or feebate scheme, was proposed by the Labour government in 2019 and is now a key part
of the transport strategy of the CCC. It has two main features. The first is a Clean Car Standard, which sets goals for importers of average grams of CO₂ emitted per kilometre among the vehicles they bring into the country each year. The second is a combination of charges at the time of purchase for vehicles that are heavy emitters of CO₂ and discounts for less polluting vehicles (Clean Car Discount). The aim is to encourage motorists to move towards smaller cars and hybrid or electric vehicles (EVs). The Clean Car Discount for new imports of new and used EVs and plug-in electric hybrid vehicles has already applied from 1 July 2021, with the maximum discount at $8,250 for new EVs.

The next stage of this scheme is a first step towards controlling the dominant position of large diesels in the light vehicle fleet. From 1 January 2022, large diesels will attract charges at the time of purchase. Detailed charges are still to be finalised (at the time of writing), but in the 2019 version, a buyer of a new Ford Ranger would pay an additional $2,175, whereas a buyer of a small car, such as the Toyota Corolla, would receive a discount of $600 because of the vehicle's much lower CO₂ emissions. The proposed charges for a large diesel-powered ute like the Ford Ranger are controversial enough to have led to a rush to buy such vehicles before the scheme comes into effect, yet these charges are minimal by comparison with proposals in other jurisdictions for charges that could be as much as 20 times higher.

A serious limitation in this scheme is that it applies only to vehicles that are newly imported. In the case of diesels, it does not take into account the numbers of large diesel vehicles already in the country and their longevity. It is also based on CO₂ emissions and overlooks the variety of other hazardous emissions produced by diesels. In order to more rapidly reduce carbon emissions and other hazardous outputs, it would be better to make an annual charge at the time of registration for all larger light vehicles, including diesels, not just new imports. This charge could be differentiated by the size and type of vehicle, as in the feebate scheme proposals, but at a lower overall rate. That would overcome the disincentive to buy a new vehicle, an unintended consequence that could ensure only older and more polluting diesels are being used during the transition to a low-carbon vehicle fleet. At the same time, it would signal to all diesel owners that large diesels are a costly transport option. Additional charges based on the NOₓ and PM emissions from diesels could help to differentiate them from similar models that run on petrol.

The Clean Car Standard is sometimes described as a fuel efficiency standard, as in the 2021 Ministry of Transport's Green Paper on pathways to net zero for transport emissions by 2050. Carbon emissions are closely related to fuel usage, and the merit of this standard is that it applies to all fuel types and prioritises carbon. As a performance measure, however, the use of the phrase “fuel efficiency” needs to be distinguished from actual fuel economy standards, which have been set in all of the 24 OECD countries apart from Australia, Russia and New Zealand. This further evidence of a long-standing lack of pressure to improve the fuel economy of the New Zealand vehicle fleet explains why it is one of the most fuel-hungry in the OECD.

In its submission to the first report of the CCC, the Motor Industry Association made a strong case that the CCC’s focus on a rapid shift to EVs overlooked the fact that the current supply chain for vehicles is closely linked to Australia, and that the small size of the local market means that New Zealand has little prospect of influencing what global manufacturers should build for us, especially as production is geared towards left-hand-drive vehicles. The CCC’s views about the future of EVs may not go as far as entering the “realm of fantasy,” as the Motor Industry Association argued, but supply issues for new EVs and the durability of the current fleet of diesels indicate that incentives for getting older diesels off the road will also be very important. The accelerated retirement of these polluting vehicles will not be achieved simply by the introduction of the Clean Car Discount scheme in its current form.

Vehicle scrappage schemes

New Zealand can learn from the example of other countries about how to plan for the scrappage of older and polluting vehicles. In the US, for example, there are detailed...
protocols for replacing old school buses. In some cases there are rebates for this or for retrofits.38 The limited scrappage trials run in New Zealand in 2007 and 2009 are mainly of interest now for the degree to which the participants were ill-informed before the trial about their options for getting rid of old vehicles.39

Fiscal incentives to scrap older vehicles could speed up their withdrawal from use, as well as being an equitable solution for lower-income families who may find it difficult to replace their vehicles. These could be funded by the income generated by the type of feebate scheme described above, or from Emissions Trading Scheme revenue. Actual disposal of old vehicles should be part of a nationwide scrappage scheme, as in Ireland. In the United Kingdom, distributors of particular brands of vehicles are also beginning to offer scrappage incentives for older vehicles instead of traditional trade-ins,40 such as Hyundai with its Scappage and Emission Reduction Scheme. New Zealand distributors could be encouraged to support such schemes.

Studies of gross emitting vehicles in the light vehicle fleet (defined as the 3% of the fleet that produce the most emissions) may in future provide a guide to which vehicles can be singled out for scrappage. These studies are discussed further in the Appendix.

Shifting perceptions and informing the public about the hazards of diesel

Light diesel vehicles have enjoyed years of heavy promotion based very much on a psychological aura of dominance and outright aggression. The most extreme example of the macho image of utes is the availability from several online suppliers of “truck nuts,” a popular accessory for pickup trucks in the US. These are outsize and brightly coloured imitation testicles that can be hung from a vehicle's tow bar.

Vehicle size itself has also been emphasised as a positive feature of diesel vehicles, illustrated by the slogan in an advertisement for the 2019 Ford Ranger Raptor: “You’re Going to Need a Bigger Garage.”41 Other attributes of these vehicles have names that associate them with predatory beasts: aspects such as “a muscular presence,” appeals to urbanites that convey the vehicle’s capacity to ride over “annoying” speed bumps, and the vehicle’s “look”—“these look ready to scale mountains” was a description of the Ford Everest bi-turbo diesel.8

Marketing like this is at odds with a transition to a low-emissions economy. The CCC recognises that “significant changes to behaviour” will be required to realise its goals.42 In the face of such advertising, behavioural change becomes more difficult. In similar fashion, the Motor Industry Association emphasises the importance of incentives if demand is to be shifted from popular models such as SUVs and utes, automatics and vehicles that are suitable for towing.

The Motor Industry Association points out that importers place orders for the models consumers want.37 The impact of these consumer choices is exacerbated by the way manufacturers provide model versions to New Zealand that are less efficient than those supplied to countries that have regulated fuel efficiency standards.43

Another example of the need for better information for consumers is the controversy over the 2021 Clean Car Discount.44 This reflects debates in Australia at the time of their 2019 General Election, when the governing Liberal Party claimed that the Opposition’s call for a move towards electric vehicles and new emission standards would damage “tradies,” kill the economy and represent an attack on four-wheel drive vehicles that would spell “the end of the weekend.”45,46 New Zealand’s National Party used similar tactics later that year to attack an earlier version of the feebate scheme, but was forced by the Advertising Standards Authority to withdraw an advertisement that exaggerated the costs.47 It is no surprise, therefore, that some of the more negative reactions to the current Clean Car Discount are not new. They indicate that there is a need for a vigorous strategy to alert consumers to the advantages of the scheme. This could include material about the need to move away from the country’s most polluting vehicles, diesels.
Specific actions to shift public perceptions could have the following features:

• Mandatory information at the point-of-sale about the NO\textsubscript{X} and PM emissions of diesel vehicles, in line with the information that is currently provided about CO\textsubscript{2} emissions and fuel economy.

• Mandated clear labelling of vehicles themselves to indicate their emission status, as required in Europe. In Britain, for example, the EURO standard to which a new car has been certified has been noted on the vehicle’s registration certificate since September 2018.

• Explanatory information about steps to reduce the number of diesel-fuelled vehicles, to avoid misconceptions among groups such as farmers and tradespeople that their work vehicles will be unfairly targeted during the transition away from fossil fuels.

• A ban on all New Zealand marketing for older diesel vehicles that cannot meet the latest European emission standards. This would include almost all light diesels in the current vehicle fleet. Promotion about vehicles could be permitted only at the point-of-sale and could be limited to vehicle specifications.

• Government information material about the health risks of diesel emissions, in order to inform not only the motoring public, but organisations such as the Automobile Association, the Motor Industry Association, and motoring publications.

Conclusions

Air pollution from diesel-powered vehicles is likely to be contributing substantial harm to health in New Zealand, as well as making it harder for this country to meet its international climate change commitments. There are a lack of controls and outdated standards applied to diesel vehicles in New Zealand, and there is scope to extend the monitoring of emissions. A comprehensive list of interventions that would assist with the phase-out of light diesel vehicles and reducing their emissions during the transition has been compiled. This list includes regulatory interventions such as bringing forward the year in which the Climate Change Commission proposes to ban imports of internal combustion light vehicles (ie, from 2035 to 2025). Also detailed are fiscal measures (incentives and disincentives) and improvements to information for consumers at point-of-sale.
Table 1: Framework of options for accelerating the light diesel vehicle endgame and reducing air pollution during the transition

<table>
<thead>
<tr>
<th>Potential actors</th>
<th>Potential intervention/s</th>
</tr>
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<tbody>
<tr>
<td><strong>Impacting specifically on light diesel vehicles</strong></td>
<td></td>
</tr>
<tr>
<td>Central government</td>
<td>Bringing forward the CCC’s proposed end date (2035)(^{31}) on the permitted importation of internal combustion light vehicles (eg, to 2025, the year that Norway will <em>end the sale of all</em> fossil fuel-powered cars(^{46})).</td>
</tr>
<tr>
<td>Central government, local government, and vehicle distributors themselves</td>
<td>Vehicle scrappage schemes for light diesel vehicles. See text above for further details.</td>
</tr>
<tr>
<td>Central government</td>
<td>A ban on all New Zealand-based marketing for older light diesel vehicles that cannot meet the latest European emission standards. See text above for further details on how diesels are currently marketed and other steps to counter the momentum this gives to providers of these vehicles.</td>
</tr>
<tr>
<td>Central government</td>
<td>Mandatory information at the point-of-sale about the NO(_X) and PM emissions from light diesel vehicles.</td>
</tr>
<tr>
<td>Central government</td>
<td>Mandated clear labelling of light diesel vehicles themselves to indicate their emission status.</td>
</tr>
<tr>
<td>Central government</td>
<td>Explanatory information about steps to reduce the number of diesel-fuelled vehicles, to avoid misconceptions among groups such as farmers and tradespeople. See text above for further details.</td>
</tr>
<tr>
<td>Central government (Ministry of Health)</td>
<td>Informational material about the health risks of diesel emissions (especially at the time that related laws or regulations are introduced).</td>
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<tr>
<td>Central government, operationalised by workers doing WOF inspections</td>
<td>Requirements for pollution mitigation devices (to reduce NO(_X) and PM) on new light diesel vehicles from a specific date. Mandatory checking of such devices at warrant of fitness (WOF) inspections could follow (with appropriate fines for non-compliance).</td>
</tr>
<tr>
<td>Police</td>
<td>Tighter enforcement around obviously polluting diesel vehicles—at present drivers can avoid penalty if they claim that smoky emissions are unavoidable because the design of the vehicle’s equipment is original and it would entail disproportionate effort or expense to remedy its faults.(^{49})</td>
</tr>
<tr>
<td><strong>Potentially impacting on all vehicles but including light diesel vehicles</strong></td>
<td></td>
</tr>
<tr>
<td>Central government</td>
<td>Increasing fuel prices,(^{32}) or increasing the price of carbon via further reform of the Emissions Trading Scheme. But preferable to these may be a more effective carbon tax,(^{50}) with per capita annual pay-outs to all citizens (as “climate dividends”).(^{51}) The latter could actually ensure that low-income households are better off.(^{51})</td>
</tr>
<tr>
<td>Central and local government</td>
<td>Financial and regulatory support for the CCC’s recommendations around: public transport, changes to urban form to support walking and cycling and remote working.(^{51})</td>
</tr>
<tr>
<td>Central government</td>
<td>Adoption of the latest Clean Car Standard and Clean Car Discount, but in the latter’s case with the addition of an annual charge at the time of registration (also based on vehicle type and size). See text above for further details.</td>
</tr>
<tr>
<td>Central government (to empower local government), then local government to act</td>
<td>Establish low-emission zones in major city centres where only EURO 6 standard vehicles are permitted (eg, as per some European cities(^{9})).</td>
</tr>
<tr>
<td>Central government (to empower local government), then local government to act</td>
<td>Introduce transport pricing, with congestion charging and distance pricing considered in a Ministry of Transport Green Paper.(^{27}) These can be potentially combined with subsidies (free public transport) and funding support for the uptake of low pollution transport modes (walking and cycling).</td>
</tr>
<tr>
<td>Central government and local government</td>
<td>Minimum parking prices nationally within inner-city areas and enhanced enforcement. Parking on roads that are popular cycle routes could also be prohibited.</td>
</tr>
</tbody>
</table>
Appendix

Monitoring of diesel emissions in New Zealand

Monitoring of emissions is critical, as it establishes where public exposure to them is likely to be at its highest and what trends in exposure are emerging.

Monitoring of NO₂

An indicator of the volume of diesel emissions in New Zealand is the data provided by a nationwide network of passive monitors managed by Waka Kotahi New Zealand Transport Agency (NZTA). These monitors record levels of NO₂ in selected cities, with a focus on monthly averages. Because the monitoring sites are alongside the kerbside of roads, they record the immediate impacts of traffic—NO₂ levels drop quickly according to their distance from the monitors. The NZTA results are also supplemented by data collected from sources such as the Greater Wellington Regional Council (GWRC). They are based upon the assumption that NO₂ is useful as an indicator pollutant, a proxy for other traffic-related emissions, in accordance with a guideline from the World Health Organization (WHO). The fact that these data also provide a rough estimate of the impact of diesel on emissions is a handy side benefit, as diesel vehicles are the principal contributors to traffic-related NOₓ emissions.

An analysis by the NZTA of concentration levels of NO₂ recorded at roadside monitoring sites in the three largest cities over the years 2011–2019 shows a trend towards a reduction in mean and median levels of annual exposure over this period. This has been most marked over the last of these three years, a result attributed to improvements in vehicle design. However, three of the four sites that in 2016 exceeded the WHO annual guideline of >40 micrograms per cubic metre (µg/m³) continued to do so through 2017–2019. Two of these sites were in Auckland and one in Hamilton.

Local “hot spots” appear to be the areas most of concern for NO₂ concentrations. Rather than locations where people live, they are more likely to be places where there is stop–start driving, heavy traffic at rush hour and buildings that, due to their height, create a canyon effect, as on Lambton Quay in Wellington and Queen Street in Auckland. Poor air quality along Wellington’s “Golden Mile” between Courtenay Place and Lambton Quay has been attributed to the combination of these physical features and the presence of a small number of old dirty diesels that have a disproportionate impact.

As well as places such as this, there are other urban sites in New Zealand where concentrations of NO₂ may not actually breach the WHO guideline for annual exposure, but that still approach or exceed the range that has been identified by the NZTA as a medium level of pollution (30–39.9 µg/m³).

More monitoring of similar hot spots would be desirable, especially with the trend for intensification of housing in the central parts of cities and the accompanying conversion of some office blocks for this purpose. For pedestrians and people waiting at bus stations in the centre of cities, especially those with respiratory conditions like asthma, exposure to pollutants at peak traffic times may be more significant than measures of annual concentrations. In central Wellington, however, one-hour exposures to NO₂ are within New Zealand’s National Environmental Standards, which permit levels to exceed an average of 200 µg/m³ no more than nine times per year. Acceptable limits today may, of course, be altered in the future. A recent multi-city and multi-country study of data from 398 cities and 27 countries or regions has found that exposure to NO₂ was associated with increased risks for mortality and morbidity even when levels were below regulatory guidelines. The authors suggest that considerable health benefits could follow from a strengthening of WHO limits the next time they are reviewed.
Contributions of particular classes of vehicle to emissions of $\text{NO}_x$

The contribution of various types of vehicles to urban air pollution in New Zealand was explored by Bluett and various co-workers in a number of studies between 2003 and 2015. By using a remote sensory device (RSD), they were able to differentiate between the emissions of vehicles according to parameters such as age, type and whether they were diesel- or petrol-powered. The importance of the actual number of diesel-powered vehicles was illustrated by the 2015 study, which found that $\text{NO}_x$ emissions from the more recent light-duty diesel vehicles had not improved significantly with new technology and, in fact, the negative pressure from a recent increase in the number of diesel light-duty vehicles was one factor leading to a plateau effect in the volume of $\text{NO}_x$ emissions at this time, after a period of decline.55

A recent and more comprehensive RSD study of the contribution to pollution of the gross emitters in the light vehicle fleet has helped to clarify the relevance of variables such as the age of these vehicles, which emission standard applies to them, their mileage, their fuel type and how long they are likely to stay in operation.56 When the contribution of these gross emitters is contrasted with the median emissions of typical emitting vehicles in the rest of the fleet, it is estimated that their removal would result in a net reduction per year of 37,500 tonnes of carbon monoxide (CO), 2,500 tonnes of hydrocarbons (HC), 4,600 tonnes of nitrogen oxide (NO), 520 tonnes of nitrogen dioxide (NO2,) and 53 tonnes of particulate matter (PM). This work could, in future, provide guidelines for which older vehicles should be selected for scrappage, which is an area in which more monitoring would be desirable.56

Vehicle emissions prediction model

A broad assessment of the annual quantities of different categories of pollutants is provided in New Zealand by the vehicle emissions prediction model (VEPM) developed by the Auckland Council and the NZTA.57 This can provide annual national emissions estimates in terms of tonnes per kilometre travelled. These are for a variety of pollutants—CO, volatile organic compounds (VOC), $\text{NO}_x$, $\text{CO}_2$, $\text{PM}_{10}$ and $\text{PM}_{2.5}$. Emission factors are derived from a European model (COPERT). This model is used to identify trends in the country’s emissions inventory, based on specifications of vehicles in the local fleet. Updates of the model since 2008 have moved beyond averaged speed estimates and fleet characteristics. Among the refinements are adjustments for changes in European emissions standards, the introduction of data on various vehicle types, including hybrids, alignment with Japanese emissions criteria and subtle aspects such as changes in road gradients.

This tool promises to be a useful source of estimates about emissions. In one example from research on the practicality of the model, real-world emissions from a small number of petrol and diesel vehicles were measured using a portable emissions monitoring system. The real-world emissions of most pollutants were up to eight times higher than those predicted by the VEPM, but the real-world $\text{NO}_x$ results were comparable to those from Australia and Europe for similar vehicles.58

Monitoring of fine particle pollution

New Zealand currently has no national standards for $\text{PM}_{2.5}$ exposure. Work is now being done on developing standards for $\text{PM}_{2.5}$ which would align with WHO guidelines. The proposed standards would become the main regulatory tool for managing exposure to ambient particulate matter.59 This will be a major step forward, as the absence of such standards is hard to justify, especially in the light of the vast literature about $\text{PM}_{2.5}$ in other countries and its impact on health. In the US, for example, standards for $\text{PM}_{2.5}$ exposure were first promulgated in 1997.60 The availability of such data in the US facilitates the assessment of health and monetary benefits as the result of decreases in diesel exhaust emissions.61

At present, information about $\text{PM}_{2.5}$ depends on whether local authorities collect such data. Otherwise, findings must be inferred from the results of monitoring larger $\text{PM}_{10}$ particles. The most comprehensive dataset comes from Auckland, where monitoring of $\text{PM}_{2.5}$ has been focused on four particular sites—Queen Street, Khyber Pass, Takapuna and Penrose.62 The
results for the years 2006–2013 demonstrate the seasonal nature of PM$_{2.5}$ exposure, particularly from biomass burning, as well as the variety of sources of these particles, which include sea spray. The Auckland data also enable the respective contributions from diesel and petrol emissions to be determined. At the Queen Street site, for example, diesel emissions accounted for 39% of total PM$_{2.5}$ and the contribution from petrol vehicles was 3%. The site-specific nature of such data is illustrated by the detail in the Auckland findings: ship emissions accounted for 5% of PM$_{2.5}$ at the Queen Street site near the port, whereas the comparative PM$_{2.5}$ contribution of diesel to petrol was lower at Takapuna than in the central city. The Auckland study has also been able to demonstrate long-term trends in PM$_{2.5}$ exposure, with a significant decline over the period 2006–2013. More recent data from the Takapuna site and another Auckland site show that this trend has continued and is traffic related. The proposal to give a greater role to nationwide monitoring of PM$_{2.5}$ offers the opportunity to conduct further monitoring of the type carried out in Auckland and thus arrive at a better understanding of the role of diesel emissions in New Zealand.
Competing interests: Nil.

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REFERENCES


A case of prolonged SARS-CoV-2 viral shedding for 150 days
Andrew Fox-Lewis, † Shivani Fox-Lewis, † Sandra Hotu, Sally Roberts, Gary McAuliffe, Mary De Almeida

Community SARS-CoV-2 (COVID-19) transmission was eliminated in New Zealand by May 2020 following a stringent nationwide lockdown. Other than two discrete community clusters (179 cases in August 2020 and 15 cases in February 2021) there has been no evidence of ongoing community transmission in New Zealand despite extensive surveillance testing. Here we report a case of prolonged viral shedding in an individual infected in the August 2020 cluster, who tested positive again 150 days later.

Case report
A fit and well 34-year-old man with mild COVID-19 symptoms tested positive on 14 August 2020 (nasopharyngeal swab [NPS], in-house E-gene RT-PCR assay, cycle threshold [Ct] value 17.6) (Figure 1). The patient was linked to the August 2020 cluster epidemiologically (likely infected via his church congregation) and genomically (identical lineage with signature T15867G single nucleotide polymorphism). He re-presented 150 days later on 11 January 2021 with acute breathlessness and tested positive again for SARS-CoV-2 on two different highly specific commercial RT-PCR assays, effectively ruling out a false-positive result due to non-specific reactions or laboratory contamination (NPS, BioFire Respiratory 2.1plus Panel and Xpert Xpress SARS-CoV-2 [E/N2 Ct values 36.9/38.4]). He denied infective symptoms and could not be linked contemporaneously to any imported COVID-19 cases or high-risk exposures. The aetiology of his breathlessness was mediastinal lymphadenopathy causing bronchial obstruction, and he was later diagnosed with sarcoidosis. Re-infection was considered unlikely, and since there was an alternative diagnosis for his clinical presentation, the “weak” positive (high Ct value) result from 11 January 2021 was attributed to prolonged viral shedding from the upper respiratory tract and he was discharged without further isolation.

Discussion
New Zealand is one of the few countries to have eliminated COVID-19, and this post-elimination setting presents a relatively unique opportunity to observe patterns of SARS-CoV-2 viral shedding in the absence of re-infection or re-exposure. Viral shedding duration (presence of detectable...
Viral nucleic acid should be distinguished from duration of infectivity (presence of viable virus). Infectivity generally ends 10 days after symptom onset in adults with mild-moderate COVID-19, with replication-competent virus rarely isolated after this time. In contrast, upper respiratory tract viral shedding lasts for a mean of 17 days and can persist for months after recovery. Prolonged viral shedding in no longer infectious individuals can result in unnecessary isolation, inappropriate use of PPE and limited isolation rooms, delays in medical care, discharge and return to work and separation from social support. Laboratory testing alone cannot reliably establish a case as being “historical”: RT-PCR Ct values should not be used to exclude infectivity, and due to considerable variation in serological assay performance and individual patient seroconversion rates and timings, serology should not be used to exclude acute SARS-CoV-2 infection. Classification of any newly detected case as non-infectious should be made cautiously with expert consultation.

This case is important for illustrating that, in individuals previously infected with SARS-CoV-2, sporadic positive RT-PCR results may be obtained many months after initial infection, even with multiple negative results in the interim. At 150 days, this case represents one of the longest shedding durations reported to date. It has important public health implications for the interpretation of SARS-CoV-2 RT-PCR results in previously infected individuals and for studies characterising the SARS-CoV-2 shedding duration, which may otherwise fail to accurately capture the maximum shedding duration and thus underestimate the mean duration of viral shedding.
Competing interests: Nil.

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1Andrew Fox-Lewis and Shivani Fox-Lewis contributed equally to this work.
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REFERENCES

A Case of Amoebic Dysentry Contracted in New Zealand

1921

This patient was referred to me by Dr. Barnett, C.M.G. J.M., a man aged 36, stated that about 1916, he went to Trentham Camp for military training. The weather was very hot, and after a week he reported sick with diarrhoea and vomiting, and was in bed for about a fortnight, and then went away on sick leave. He returned to duty, but the diarrhoea recurred, and after a while he was discharged from the service, without ever leaving the country. The diarrhoea had continued at intervals ever since, the stools were never quite normal, being always unduly relaxed, never less frequent than two a day, and in attacks being as many as twelve. The attacks lasted about a week, the stools were then liquid, and contained mucus and sometimes blood. There was pain referred to the left iliac fossa, it was relieved by defaecation, but recurred. Defaecation was precipitate. The attacks recurred about once a month.

On examination, he was found to be of big frame, but thin, he weighed only 11st., but stated that he had weighed as much as 12st. 7lb. No abnormalities were found outside the alimentary system. The tongue was large, pale, flabby and indented by the teeth. The abdomen was not distended nor retracted, there was no tenderness, but a long mass could be felt in the left iliac fossa, which was thought to be a contracted sigmoid flexure. There was some hyperalgiesia over the 10th dorsal, and the sacral cutaneous distributions.

The stools contained blood-stained mucus in which large number of entamoeba histolytica were found. The best remedy for the condition, emetine-bismuth-iodide, could not be obtained, so he was treated with subcutaneous injections of emetine hydrochloride, one grain daily for a week. There were no unpleasant symptoms, and in about five days he was passing nearly solid stool for the first time for five years, and about a month after discharge he wrote: “I am keeping well, and so far my bowels move every other day without the use of medicine.” Many infected troops must have returned to this country during the war, so that a chance infection in a military camp is not difficult to credit. I am not, however, aware of any other case contracted in the country, but in view of it, it would be worth while to examine the stools in any case of intractable diarrhoea, as a condition due to entamoeba histolytica alone is easily cured. Also, and apart from war-time infection, a recent report issued by the Medical Research Council on “The Occurrence of Intestinal Protozoa in the Inhabitants of Britain,” by Professor Clifford Dobell and others, is of interest. More than 3000 persons who had never left the United Kingdom were examined, and in the stools entamoeba histolytica was found in more than 3 per cent. These persons apparently had no symptoms of enteritis. The report emphasises the fact that this parasite has hitherto been considered peculiar to tropical climates, but the opinion is expressed that it is quite common in temperate countries, but that it is generally harmless and only produces symptoms under exceptional conditions.

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Retirement villages and their residents: village characteristics, residents' health profile and trajectories, and a multidisciplinary intervention aiming to reduce adverse outcomes

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Aim
NZ retirement villages house 14% of people aged 75+ years. Little is known of resident demographics, health or needs. We describe villages and their residents' demographics, socio-behavioural, health status/needs, and prospective health care trajectories, plus results of a randomised controlled trial (RCT) aiming to reduce adverse outcomes.

Method
Cross-sectional study of village (n=33) residents who completed a survey and validated health needs assessment. Cohort followed over 2.5 years. A vulnerable (pre-defined/validated) sub-group (n=412) participated in an RCT multidisciplinary intervention aiming to reduce adverse outcomes (1.5 years follow-up). NZ Health and Disability Ethics Committee approved. Written, informed consent from participants.

Results
Survey comprised 578 people; median age: 82 years; 27% men; 61% lived alone; 97% self-identified as NZ European/European. Downsizing/less maintenance (77%), less stress (63%) and perceived improved healthcare access (61%) were commonest reasons for entry. 34% received home supports, 10% personal cares. Hypertension, heart disease, arthritis and pain were reported by over 40%. Loneliness by 37%. Many had unmet health needs. After 2.5 years follow-up 53% had acute hospitalisations; 65(11%) moved to long-term care (LTC); 51(9%) died. Factors statistically associated with these outcomes (covariate-adjusted) included: falls risk; comorbidities; not leaving village in two-weeks prior; functional needs; cardio-respiratory conditions; acute hospitalisation in year prior; and age. Presence of on-site clinic was associated with 38% lower risk of acute hospitalisation. RCT found no difference in acute hospitalisations, LTC transitions or mortality vs. usual care. Two-thirds of villages were part of corporate entities. 73% had resident alarms in units/apartments. Over half had on-site health clinics.

Conclusion
Morbidity and adverse outcomes are common in residents. An MDT intervention did not improve outcomes. Service providers and village operators could co-design/test service initiatives (eg, on-site clinics) to improve residents' health.

Breast cancer management in women over the age of 80: a service evaluation and proposal of guidelines

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Introduction
Breast cancer in the elderly is projected to become an increasing health burden due to increased incidence with age, increased life expectancy, and an aging population. Elderly patients represent a complex challenge of balancing treatment against comorbidities and life expectancy. Treatment may be suboptimal as there are no specific guidelines for the elderly.

Aims
Our primary aim was to assess the current management of invasive breast cancer in the elderly in our institution and to evaluate our management against available literature to see if improvements can be made. A secondary aim was to develop guidelines for management of these patients. As part of this several co-morbidity tools were reviewed.

Methods
We evaluated our prospectively kept database and extracted data for all patients with invasive breast cancer over the age of 80 from 1 January 2010 to 31 December 2016. The data was analysed and deaths were evaluated. A literature review was undertaken to assess current accepted management and
Results
Out of 207 patients, 117 (56.5%) underwent surgery. Surgical intervention rates decreased with increasing age. Surgical mortality was 0%. The majority of surgical patients were stage I and II (66.6%) and there was a high mastectomy rate (64.1%). Overall survival (OS) and breast cancer specific survival (BCSS) were higher in the surgical group. We found our axillary surgery rate (98.3%) and radiotherapy rate (37.6%) were higher than reported by others. Of the 90 (43.5%) non-surgical patients, 12.2% had metastatic disease and 11.1% were deemed unfit for surgery. The main reason for not having surgery was the patient declining surgery (43.3%). There were more oestrogen receptor positive patients in the non-surgical group (90% vs 77.8%), 72.2% of non-surgical patients were node negative on clinical and radiological exam.

Conclusion
Breast cancer management of the elderly in our institution is documented with long term outcomes. Our results confirm that surgery is safe and should be considered for all breast cancer patients over 80, particularly those in the 80–84 age group unless they are not fit for surgery or have a limited life expectancy. Our review has suggested that we could increase our surgical intervention rate and decrease our mastectomy rate to improve our outcomes and improve quality of life. We have proposed a set of guidelines and a flow diagram to be used at our breast clinics.

Hui: a partnership in practice in familial hypercholesterolemia

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Background
Familial hypercholesterolemia (FH) is the most common dominant genetic disorder however there is no national screening program in New Zealand and current approaches may not take into account the needs of Indigenous Māori. A LDL-Rc:2312-3C>A splicing mutation was found in an Māori male with premature heart disease with a history of a large extended family (whānau) blighted by premature death. This was described in another relative 15 years ago and family members were tested for academic reasons. No cascade screening and treatment was initiated.

Methods
A traditional meeting (hui) was held with the extended family to ensure all were informed, appropriately screened and treated. This included acknowledgement of how the health service had let this whānau down.

Results
We created a closed social media page for the whānau that includes a family tree (for those who consent), prepopulated letters with the proband for local doctors, consent and blood test forms. Information is constantly updated by the family and liaising health professional.

Conclusion
Current approaches to FH are dependent on index patients presenting for cascade screening and do not incorporate the needs and views of the extended whānau. Establishing a partnership and giving back control of health information is crucial to ensure equity and improve health outcomes. This approach has increased screening and treatment of whānau across geography and generations.

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Denise Staple – Rural Practice Nurse. Nicola Reid and Andrew Laurie – Cardiovascular Prevention & Lipid Disorders, Canterbury District Health Board.

MPR: feasibility of a mHealth pulmonary rehabilitation programme

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Background
Pulmonary rehabilitation (PR) has been proven effective in improving quality of life of those with chronic respiratory disorders (such as COPD). However, only a small proportion (approximately 2% at Waitematā DHB) of eligible people attend or complete group-based in-person PR. Barriers to attendance include transport, time, cost and physical limitations of people with COPD. We hypothesise that PR could be delivered remotely in the home for those unable to attend.

Aims
To determine the feasibility and acceptability of a mobile phone delivered PR program for people with COPD in Waitematā and Counties Manukau DHBs.

Methods
mPR was developed with a broad multi-disciplinary team and involved formative research including people with COPD and their whānau, and clinicians. The programme delivers topics covered in existing PR sessions including prescribing and prompting regular exercise. mPR has a core text message program plus an app that includes an action plan, exercise videos, lung visualisation, education, symptom score questionaire and 1-minute sit-to-stand test. A 9-week non-randomised pilot study was conducted. Participants were 26 adults with COPD plus four whānau members, who were offered participation at first assessment or during group PR sessions. Outcomes included satisfaction, engagement with the program, and perceived impacts.

Results
Eight people (31%) opted for text messages only, and 18 (70%) chose text messages plus the app. Only three people ended the program early. Of those that completed follow up interviews (n=20), all (100%) reported that
they would recommend the program to other people with chronic respiratory conditions, 17 (85%) reported that the program had helped them to learn about their condition, and 19 (95%) reported the program made them feel more supported.

Discussion
The mPR program was appreciated by people with COPD and their whānau. Their feedback plus further testing with Waitematā COPD patients has informed the next version of mPR, which is now being tested for effectiveness.

Conclusion
It is feasible and acceptable to provide a PR programme via mobile phones.

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Workforce intentions of recent NZ medical graduates from the MSOD project

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Background
The Medical Schools Outcomes Database and Longitudinal Tracking Project (MSOD) has invited medical students and graduates in Australia and NZ to complete surveys on career intentions to explore how student background or attributes interact with curriculum or early postgraduate learning experiences on career choice and location.

Aims
To describe contemporary NZ medical graduate career choices; To explore factors associated with a career intention in Waitematā.

Methods
Data were anonymised before analysis. Summary statistics were collated and crosstabs performed.

Results
For students graduating in the years 2011 to 2019 inclusive, 1,786 (78%) responded. Overall, 96% intend to work in NZ with 33% in the Auckland region. 56% are female, 10% Maori, 5% from the Pacific, 59% NZ European and 39% other (more than one response allowed). At graduation, surgery and general practice are the most popular specialty choices (~19% each), with internal medicine next (~12%). 274 (15%) of NZ graduates nominated Waitematā DHB for their internship, with the majority (85%) from the University of Auckland. 190 (77%) were accepted for their PGY1 year at Waitematā, and 223 (90%) intend to work in greater Auckland in the longer term. The characteristics of these graduates will be presented, and compared with the overall cohort, and with the demographics of the Waitematā DHB population.

Discussion
Medical workforce development is a continuum, starting before selection into medical school, influenced by experiences through undergraduate and early postgraduate years, as well as employment practices. Waitematā intending graduates have some demographic differences to NZ medical graduates as a whole.

Conclusion
Understanding factors in career decision making may assist DHBs in designing and shaping an SMO workforce for their communities.

Acknowledgements
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Using the Talanga method to engage Pasifika elderly and disabled people to explore unmet needs at the nexus of transport and health

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Background
The Talanga approach provided insights regarding transport-related health and wellbeing
Feasibility of hepatitis C screening in community pharmacy: uptake, frequency of positives and pharmacists’ views

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Background
Hepatitis C Virus (HCV) can be deadly decades after infection, through cirrhosis and liver cancer. Treatment is very effective, but insufficient people are being diagnosed and treated, endangering New Zealand’s 2030 HCV elimination goal.

Aims
To ascertain the feasibility and outcomes of point-of-care testing for HCV in people with risk factors screened in community pharmacies in Waitematā DHB.

Methods
Following training, pharmacists from 10 pharmacies provided free point-of-care HCV screening over 7–15 months. If positive, participants received a medical referral and lab test form for RNA testing. RNA test results and treatment were recorded. Pharmacists were surveyed.

Results
Of 192 participants tested, 62% were female, the average age was 52 years, and 74% were European and 15% Māori. Seven tests were positive (3.6%), two of whom were Māori. Two people screening positive were RNA negative, four were RNA positive and were treated by a doctor, and one was RNA positive but remained untreated despite referral and pharmacist follow-up. Three people were previously identified as positive but lost to follow-up. Pharmacists were positive about providing HCV screening. Most pharmacists reported 10–20% of those approached agreed to be tested, and estimated the tests took 15–20 minutes. Some noted time-limitations affected the service. Most pharmacists wanted pharmacy technicians to conduct tests, and 64% supported pharmacists prescribing HCV treatment, primarily to remove barriers to treatment. In-store promotion aided test uptake.

Discussion
To achieve HCV elimination by 2030, diagnosis and treatment need to be accessible. This Waitematā feasibility study has informed development of a pharmacist test and treat programme soon to roll out across the Northern region.

Conclusion
Pharmacy can aid access to testing and awareness of HCV, find people with HCV, and reconnect people lost from the system. Using pharmacy technicians to test and pharmacists prescribing treatments could improve this service.

Extended release oral ketamine for treatment resistant depression; preliminary findings

W Miles1
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Background
Major depressive disorder ranks high on the indices of disorder ranked functional impairment and socio-economic cost. Currently available treatments produce substantial improvement in around 50 per cent of patients. Ketamine used via intravenous or inter-muscular administration has been shown to be an effective antidepressant in subjects with poorly responding depression. The development of a novel formulation of extended release oral ketamine by Douglas Pharmaceuticals Limited that showed satisfactory tolerability in human volunteers has allowed the investigation of the use of the product in subjects with treatment resistant resistant depression.

Aims
Primary objective is to evaluate efficacy as measured by Montgomery-Asberg Depression Rating Scale (MADRS).

Methods
This presentation will present early phase results of a phase 2 clinical trial which aims to enrol 200 subjects. The trial protocol exposes subjects to the active agent for 5 days (enrichment phase); their response is measured by MADRS score changes 8 days after the first dose. Those with significant change (50% or greater reduction) can then enter a randomised phase where they are allocated one of 4 different doses of investigational drug or placebo for 85 days. Primary outcome measure is change in MADRS score. The study also investigates tolerability and safety data, the early phase tolerability will be outlined.

Results
The presentation will present the results from the first 100 subjects of the trial. The initial data including MADRS scores will be outlined. The response of those subjects to 5 days of active treatment will be presented. Data to date on 119 subjects showed a baseline MADRS mean of 31. After 5 days open label ketamine (at study day 8) mean MADRS reduced to 11. Seventy-six % of subjects achieved the goal of 50 % or greater reduction with MADRS score equal to or under 12.

Conclusion
Initial impressions are of a dramatic and rapid reduction of depression score in a high percentage of the enrolled subjects. Should these results continue across the trial and show sustained improvements the new form of oral ketamine should offer a unique alternative for treatment of a burdensome and costly disorder.

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Increased risk of EGFR mutation-positive lung cancer in Māori and Pacifica in New Zealand revealed by analysis of population-based incidence rates

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Background
In non-squamous Non-Small Cell Lung Cancer (NSCLC), the proportion of cancers which are positive for Epidermal Growth Factor Receptor (EGFR) mutations has been studied extensively. However, population-based incidence rates of EGFR mutation-positive and EGFR mutation-negative non-squamous NSCLC are needed to understand these diseases further and have not been assessed.

Aims
To estimate the population-based incidence rates of EGFR mutation-positive and EGFR mutation-negative non-squamous NSCLC in New Zealand population groups defined by sex, ethnicity and smoking.

Methods
This study used the data of all non-squamous NSCLC patients diagnosed in northern New Zealand (Northland, Waitematā, Auckland and Counties Manukau) between 1 February 2010 and 31 July 2017 (N=3815), identified from a population-based cancer registry. We calculated age-specific incidence rates, WHO age-standardised rates (ASRs) and rates estimated for complete testing for EGFR mutation-positive and EGFR mutation-negative groups as a whole and by patient subgroups.

Results
Of the total cohort, 45% were tested for EGFR mutations; of which 22.5% were EGFR mutation-positive. The annual ASR of EGFR mutation-positive NSCLC was 5.05 (95%CI 4.71–5.39) per 100,000 population. ASRs for EGFR mutation-positive NSCLC were higher in females than males: standardised incidence ratio (SIR) 1.50 (1.31–1.73); higher in Pacifica, Asians and Māori compared with New Zealand Europeans: SIRs 3.47 (2.48–4.85), 3.35 (2.62–4.28), and 2.02 (1.43–2.87), respectively; and, only slightly increased in ever-smokers compared with never-smokers: SIR 1.25 (1.02–1.53). The ASR of EGFR mutation-negative NSCLC was 17.39 (16.75–18.02) per 100,000 population; it was strongly associated with smoking, more common in men than women, and had the highest incidence in Māori, followed by Pacifica, the New Zealand European population, and then is lowest in Asian population. SIRs, corrected for incomplete testing, by sex, ethnicity and smoking, for both diseases, remained similar to those based on tested patients.

Conclusion
The population-based incidence rates revealed that the incidence of EGFR mutation-positive NSCLC was significantly higher for Māori and Pacifica compared with New Zealand Europeans.

Risk of bleeding with anticoagulants in patients with liver cirrhosis

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Background
The safety of dabigatran a novel oral anticoagulant is poorly studied in cirrhotic patients due to their exclusion from primary landmark trials. The current standard treatment for thrombotic conditions in patients with cirrhosis is warfarin. We assessed the rate of bleeding in cirrhotic patients taking warfarin compared to those taking dabigatran.

Methods
This was a retrospective cohort study in adult patients admitted with liver disease to three district health boards in Auckland from 2008 to 2020. Patients were included if they had a confirmed diagnosis of liver cirrhosis and had received warfarin or dabigatran therapy during the study period. Data collected included demographic data, biochemistry data, medication history and past medical history. The primary outcome measured was the incidence of any bleeding event that resulted in hospital admission. We calculated crude incidence as the number of any bleeding events divided by 100 person-years of follow-up.

Results
Initially, 4518 patients admitted with liver disease were identified; after applying our inclusion and exclusion criteria, the final cohort included 100 patients. Overall, 52 patients took warfarin, and 48 took dabigatran. Baseline characteristics for both groups were generally similar. The incidence rate of bleeds for patients taking warfarin was 14.4 per 100 person-years (95% CI 8.8–23.5) compared to 9.1 per 100 person-years (95% CI 4.5–18.1) for patients taking dabigatran. The incidence rate ratio comparing dabigatran to warfarin is 0.63 (95% CI 0.23–1.60), suggesting that patients taking dabigatran may have less risk of bleeding than patients taking warfarin, but this difference was not statistically significant, (p=0.25).

Conclusion
Our study found no statistically significant difference in the bleeding rate in cirrhotic patients treated with warfarin and those treated with dabigatran. Our results suggest dabigatran may be as safe to use as warfarin in patients with cirrhosis.

Māori perspectives on a potential lung cancer screening programme

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Background

Lung cancer is a significant health issue for Māori and has been found to be the greatest contributor to the absolute inequity in mortality for Māori compared to NZ European/Other. Internationally, lung cancer screening trials have demonstrated a 20–26% reduction in lung cancer mortality. A pilot lung cancer screening trial at Waiārata DHB and Auckland DHB is planned as an intervention to accelerate Māori health gain through early detection and treatment.

Aims

To understand the attitudes and beliefs of Māori toward a lung cancer screening programme.

Methods

Māori aged 50–80 years who were current or former regular smokers were recruited to complete a survey using convenience and snowball sampling from various locations in Auckland and Northland. Whānau support people were also recruited to complete a similar survey in both regions. Results were analysed using descriptive statistics, plus Chi-squared and z-tests for comparing groups.

Results

388 (306 ADHB/WDHB; 82 Northland) current/former smokers and 134 whānau support people completed the survey. 91% (+8% maybe) said they would attend a screening programme. A large number of gender, age group, educational level and smoking status differences were found for questions about factors that might influence attendance. Gender and smoking status were significant factors for questions relating to things that would make participants more comfortable with including smoking cessation help in a screening programme. Following tikanga in the taking and storage of blood was a significantly greater issue for those with tertiary education. There were also gender and education level differences in who they would prefer to receive information about a screening programme from.

Discussion

The results are encouraging in terms of the high proportion of the sample who would be willing to attend a screening programme. There were, however, numerous factors identified that may create enablers or barriers to actual attendance.

Conclusion

These results have played an important role in designing a lung cancer screening programme which intentionally focuses on Māori first. The findings have been incorporated into the pilot study, including specific elements to address identified barriers.

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Primary healthcare intervention to improve outcomes for at-risk older people: Kare Project

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1Waiārata District Health Board; 2Comprehensive PHO

Background

It is estimated that the number of people aged 75 and older will increase by 77% from 2014 to 2026 and up to a quarter of people over 85 years old are frail. This requires proactive model to address the multiple and complex problems faced by older people.

Aim

The Kare Project aims to reduce hospital admissions and residential aged care admission for older people with multi-morbidity and/or frailty through comprehensive assessment, care coordination and proactive follow up by the primary health-care team.

Methods

Nine general practices participated in the pilot project, and 1,091 patients were recruited between 2015–2017. Kare participants had a comprehensive geriatric assessment by a practice nurse. Then goals and a care plan were developed with the older person, the practice nurse and GP, and followed by six monthly proactive visits. Secondary care gerontology nurse specialists supported the GP practice team. Kare patients were matched with a comparison group drawn from non-Kare practices using propensity score matching. The primary outcomes were acute hospitalisation and residential aged care admission 12 months after the initial assessment.

Results

Aged-residential care placement (odds ratio (OR) 0.66, 95% confidence interval (CI)=68 0.48–0.91) and mortality (OR 0.66, 95% CI=0.49–0.88) were significantly lower over the first year in Kare patients compared with matched controls. There was no difference in acute hospitalisation (+0.06 admissions per year, 95% CI=–0.01, 0.13). Support service use (allied health and community support) was increased, and emergency department use decreased.

Discussion

The Kare programme delivered improved health outcomes across several measures for patients but did not decrease acute hospitalisation. The positive outcomes are the result of primary care practice changes that improved quality of care.

Conclusion

This model of primary healthcare enables general practices to sustainably and effectively manage the needs of the rapidly expanding ageing population.

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Introducing smart phone applications into care for inflammatory bowel disease (IBD) patients at WDHB

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Introduction

IBD is a chronic, relapsing disease requiring on-going monitoring and access to specialist care. Waiārata DHB has a large geographic catchment and smart apps will allow reporting/monitoring at distance. IBDSmart (Otago University Gut Health Network) is a phone application for patients to self-report flares and monitor...
Patients and clinicians although both applications are highly oriented towards Quality of Life (QoL). IBDSmart® and IBDSmart® provide a validated visual representation of QoL.

**Aims**
(1) Develop standard procedures and documentation for gastroenterology clinics. (2) Assess patient & clinician usability/accessibility. (3) Assess accuracy of clinician vs patient HBI & SCCAI.

**Methods**
IBD patients attending WDHB gastrointestinal clinics were recruited over the phone, emailed, and asked to do IBDSmart® surveys 1–2 weeks before appointment. Clinicians were provided with HBI/SCCAI at appointment and reminded to discuss IBDSmart®. Feedback was collected using 5-point scoring of 5 affirmative statements.

**Results**
Eighty-four participants were recruited (45 used IBDSmart®, 10 used IBDSmart®) and nine clinicians were involved. Technical issues were experienced with the IBDSmart® link which expired in 48 hours, and with IBDSmart® which did not work in Android Operating Systems 9.0–11.0. Despite the technical limitations, 79–93% of patients and 50–91% of clinicians using IBDSmart® either completely agreed or agreed with the positive affirmative statements. 68–92% of patients and 87–90% of clinicians using IBDSmart® either completely agreed or agreed with the affirmative statements. Correlation between clinician and patient scores was moderate (R2 for HBI 0.52, for SCCAI 0.49). Participants scored their HBI/SCCAI higher than clinicians on extraintestinal manifestations and abdominal self-examination.

**Conclusions**
Both applications are highly usable and accepted by patients and clinicians although correlation of scores could be improved by better education and application design. Addition of patient treatment plans could help with involvement of primary care. Technological issues need addressing, but apps can be introduced now.

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**Patient participation and preparation within general medicine clinic**
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**Background**
IBD patients attending General Medicine Outpatient Clinics (GM OPCs) at hospital face multiple healthcare demands in an environment that has evolved with the clinician at its centre. The ideas, knowledge and understanding that patients bring to their clinic appointments is not well studied in the New Zealand setting.

**Aims**
To assess how hospitals prepare patients for their OP appointments and encourage people to actively participate in their own care.

**Methods**
A prospective survey of 50 patients attending follow up GM OPCs was performed at two centres. Participants’ understanding of the purpose of their appointment, and knowledge of their prescription medications was explored using a nine-item questionnaire. Patient-directed hospital communication was then analysed to assess the quality and quantity of written information supplied to patients.

**Results**
Two-thirds of participants (66%) attending follow up GM OPCs recalled being informed of an appointment at the time of leaving hospital; only half (34%) felt they had been informed of the purpose of these appointments. Patient-directed communication was not completed in half (50%) of the analysed discharge letters. One third (36%) of participants did not have specific questions for their clinic visits.

**Conclusion**
Limited information and support is provided to patients attending follow up GM OPCs and is not tailored to individuals’ health literacy. This practice assumes patients have comparable health literacy to clinicians, which may have downstream impacts on the usefulness of the clinic experience. The information that health users bring to clinic may be improved by increasing user engagement and through novel patient-centred solutions.

**Proposed Quality Performance Indicators of sentinel lymph node biopsy for cutaneous melanoma**
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**Background**
Melanoma is a leading cause of morbidity and mortality in Australia and New Zealand. NZ has the highest melanoma incidence in the world alongside Australia at 54 per 100,000 persons.

**Aims**
Conduct a retrospective quality audit of sentinel lymph node biopsy (SLNB) practices from 2007 to 2019 of a high-volume melanoma surgeon. Primary outcome was false negative rate (FNR). Secondary outcomes were sentinel node (SN) identification and removal rate, and complication rates.

**Methods**
A database was maintained, containing n=553 consecutive SLNBs for cutaneous melanoma from 31 August 2007 to 31 August 2019. Patient characteristics and details of the primary lesion, sentinel lymph node biopsy, recurrence, and complications were recorded.

**Results**
SNs were successfully identified in 444 (99.6%) out of 446 patients with a FNR of 9.1%. Positive SNs were identified in 70 (12.7%) SLNBs. Complications occurred in 76 out of 553 (13.7%) SLNBs.
Discussion
A review of internationally published literature reveals a SN identification rate of 94.4–99.5% with a FNR of ~37.5%. SLNB is the best staging tool for melanoma and gives potential access to adjuvant systemic treatment if >1mm deposits are found. It is a day-stay procedure with a low complication rate.

Conclusion
SLNB is a safe and reliable procedure utilised for cutaneous melanoma. We propose our data should be used alongside international sentinel node series to establish Quality Performance Indicators (QPIs) to improve melanoma management.

Development of a pharmacist-facilitated medicines review intervention for community-dwelling Māori older adults in Aotearoa New Zealand

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Background
Pharmacist-facilitated medicines reviews improve the quality of prescribing and reduce adverse outcomes in older adults. National policies in Aotearoa New Zealand (NZ) identify the importance of pharmacist-facilitated medicines reviews, which remain underutilised in NZ. Services that do exist may not meet the particular needs of older adults or Māori and may increase inequities in the quality use of medicines between Māori and non-Māori.

Aims
To develop and test the acceptability and feasibility of a pharmacist-facilitated medicines review intervention for community-dwelling Māori older adults.

Methods
Kauapa Māori theory and the UK Medical Research Council’s Guidance on the Development and Evaluation of Complex Interventions were used to develop the intervention. Eligibility: >55 years, Māori, taking 4 or more medicines, live in Waitematā District Health Board. Intervention: Medicines knowledge-sharing session (participant and pharmacist) and medicines optimisation session (participant, pharmacist and prescriber). Outcomes included: acceptability, medicines knowledge, medicines appropriateness, quality of life and pharmacist recommendations.

Results
Participants valued the clinical expertise and advocacy provided by the pharmacist during the intervention, and the perceived increase in medicines knowledge, control and autonomy. The intervention was feasible to deliver and it was feasible to use the selected tools to study outcomes.

Scopolamine: a potential new pharmacotherapy for treating depression?

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Background
Depressive disorders are leading causes of disability, but current pharmacotherapies and psychotherapies typically take several weeks before achieving efficacy. Comparatively, prior studies involving intravenous scopolamine infusions reduced depressive symptomologies compared to saline placebo infusions within days. However, several parameters of scopolamine's antidepressant effect remain unknown, such as the dose-response profile and washout period. Glycopyrronium was chosen as the active placebo as it has antimuscarinic properties similar to scopolamine but is unable to cross the blood-brain barrier.

Aims
To characterise the antidepressant response of scopolamine.

Methods
The present clinical trial recruits depressed individuals and randomises participants to receive single intravenous doses of either scopolamine hydrobromide (4–6µg/kg) or glycopyrronium bromide (4µg/kg). The primary mood outcome measure for detecting depression severity was the Montgomery–Asberg Depression Rating Scale, which was administered from pre-infusion to 6 weeks post-infusion.

Results
Preliminary results at thirty-seven (of forty) participants show that both scopolamine and glycopyrronium reduce depressive symptomologies within a day of drug administration and maintain such antidepressant effect until approximately 2 weeks post-drug administration. No significant mood difference was detected between the two drugs.

Discussion
The present results raise questions about the magnitude of the placebo response and the potential for antimuscarinic contributions to depressive aetiologies. A large placebo response may have mediated the observed results in prior studies. Alternatively, central and peripheral muscarinic receptors may play an important role in depression.
Rethinking endometriosis care at Waitematā: implementing international best practice to better serve women with chronic pelvic pain

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Background
Pelvic pain affects one in five women, with endometriosis observed in 71–87% of cases. Yet, endometriosis still remains largely underfunded and under-researched, resulting in a lack of knowledge among healthcare providers. This has resulted in long, painful and frustrating journeys to diagnosis and treatment for many women with endometriosis.

Aims
To compare current endometriosis and pelvic pain services within Waitematā DHB against international best guidelines to develop a patient-centred care pathway.

Methods
A retrospective audit of all patients that underwent treatment for endometriosis and/or pelvic pain within Waitematā DHB over two years. Outcomes assessed include examinations done prior to referral and procedure, information on fertility and multifactorial pain provided to patients, number of surgeries per patient and appropriate triaging to specialist surgeons.

Results
232 patients received treatment for endometriosis and/or pelvic pain between August 2017 and September 2019. Of pre-referral assessments 38% of cases had abdominal and 40% had vaginal examinations. Of pre-procedural assessments 47% had abdominal and 72% had vaginal examinations. 59% of patients were informed about fertility impacts and 50% had multifactorial pain discussed. 32% of patients had >2 surgical procedures and of patients identified with severe endometriosis, 71% were referred to a specialist surgeon.

Discussion
Waitematā DHB endometriosis services were found to be incomplete when compared to best practice. Of particular concern was the suboptimal triaging to specialist surgeons to optimise patient outcomes and prevent multiple surgeries. Furthermore, pre-referral and pre-procedure assessments as well as information relayed to patients were insufficient.

Conclusion
The findings of this study enabled the development of a new endometriosis service at Waitematā DHB to improve patient experiences and outcomes. All triaging is now controlled by specialists and all women are seen in the endometriosis clinic for assessment. This new care pathway can provide a framework for improved and standardised national endometriosis care.

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A qualitative and quantitative account of patient’s experiences of ketamine and its antidepressant properties

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Background
Ketamine has been central to some of the most rapidly growing areas of neuroscientific research into novel treatments for depression. Ketamine is effective in 2/3 people with treatment-resistant depression and the onset of symptom relief occurs rapidly—within 24 hours. Ketamine is best known for its role in anaesthesia and pain medicine. When administered intravenously at sub-anaesthetic doses ketamine produces marked psychoactive effects including out of body and mystical experiences. Limited research has indicated that the psychedelic properties of ketamine may play a role in its antidepressant effects.

Aim
The main aim was to explore the psychedelic experiences of ketamine when administered as an antidepressant, and whether the experiences are related to the treatment response. We also aimed to explore the impact of the trial on participants perspectives around depression, their life in general, and future treatments.

Methods
In the current study, ketamine (0.44mg/kg) was administered to 32 volunteers with major depressive disorder in a crossover design, with the active-placebo remifentanil. The 11-dimension altered states of consciousness (11D-ASC) questionnaire and individual qualitative interviews were used to capture the acute psychedelic experience. A second qualitative interview took place ≥3 weeks post-ketamine to explore the lasting impact. The Montgomery-Asberg Depression Rating Scale (MADRS) was used to measure antidepressant response. A second qualitative interview took place ≥3 weeks post-ketamine to explore the lasting impact. The Montgomery-Asberg Depression Rating Scale (MADRS) was used to measure antidepressant response.

Results
70% of participants experienced ≥50% reduction in depression symptoms within 24 hours of receiving ketamine. Greater antidepressant response correlated with the 11D-ASC dimensions: spirituality, experience of unity, and insight. The first qualitative interview revealed all participants experienced perceptual changes. The final interview
showed evidence of a psychedelic afterglow, and changes to perspective on life, people, and problems, as well as changes to how participants felt about their depression and treatments.

Conclusions
The current study provides preliminary evidence for a role of the psychedelic experience and afterglow in ketamine's antidepressant properties.

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Targeting screening to the Pacific population: an AAA screening pilot for Tongan men
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Background
Along with Māori men, Pacific men in NZ have a higher risk of dying from abdominal aortic aneurysm (AAA). A once-in-a-lifetime abdominal ultrasound of the aorta for men 60–74 years has been shown to reduce mortality from AAA. However, there are uncertainties regarding the prevalence of AAA, suitability of abdominal ultrasound and the optimal screening programme for Pacific men. The encounter allowed additional screening for atrial fibrillation (AF), a risk factor for stroke.

Aims
To assess the prevalence of AAA and the feasibility, acceptability and the potential benefits of AAA/AF screening for Pacific people.

Methods
Focus groups were held with Tongan men to advise on invitation methods and resources. Screening sessions at convenient community locations included an abdominal ultrasound scan, a test for AF, and a range of “co-benefits” such as blood pressure test and offer of referral for smokers.

Results
Invitations to 227 Tongan men resulted in 150 men completing screening. Seven AAAs (33-41 mm, including one previously known) in men aged 63–73 yrs are being followed up along with four new cases of AF. There were no cases of non-visualisation of the aorta at screening.

Discussion
Optimisation of the screening programme for a Tongan population from the outset resulted in a high uptake of the offer of screening and a positive screening experience. The employment of a Tongan lead with established relationships with the Tongan community was also an important factor. Feedback to the screening team suggested such positive experiences can contribute to increased trust in the health system.

Conclusion
While the sample of Tongan men in the pilot was small, the acceptability of screening, high uptake, AAA prevalence and co-benefits indicate that Pacific men may benefit from such a screening programme. Continuation of the DHB AAA research with other Pacific groups will provide further data to inform recommendations regarding a national screening programme.

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Reasons for failure following medial unicompartmental knee arthroplasty (UKA)
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Background
Knee arthroplasty can substantially improve quality of life for patients with debilitating knee osteoarthritis (OA). With combined effects of ageing and increasing obesity, the number of patients needing knee arthroplasty is steadily increasing. For a majority of patients, unicompartmental knee arthroplasty (UKA) is an option instead of total knee arthroplasty (TKA). UKA has advantages over TKA including cost-effectiveness, fewer complications and faster recovery, however UKAs also have higher revision rates. A stronger understanding of revision indications for UKA is needed for improved clinical outcomes.

Aims
We aimed to identify revision indications for medial UKAs, and to examine differences by implant bearing, cement use and time.

Methods
A systematic review was performed by searching Medline, EMBASE, CINAHL and Cochrane databases between 2000 and 2020. A retrospective audit was conducted using data from the New Zealand Joint Registry combined with electronic patient notes from within Waitematā District Health Board between 2000 and 2017.

Results/Discussion
A total of 24 cohort studies were selected. The most common indications were aseptic loosening (24%) and OA progression (30%). Revision indications differed depending on time from surgery. Rates of failure from wear were higher with fixed-bearing prostheses, whereas rates of bearing dislocations were higher with mobile-bearing prostheses. Cemented components had a high rate of failure due to aseptic loosening, which was reduced with use of uncemented components. At WDHB, 403 medial UKAs were performed between 2000 and 2017 with a 92.1% survival rate. All revisions in this cohort were for mobile bearing cemented implants, with a majority as a result of osteoarthritis progression in non-replaced compartments (64%).

Conclusion
Indications for revision of medial UKA differ by implant bearing, cement use and time. Future UKA research should focus on reducing these failure modes, particularly aseptic loosening and wear in non-replaced compartments.

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Attitudes and practices of discharge opioid prescribing in junior doctors of the Auckland region: a descriptive study

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Background
In the first world, opioid abuse has become the foremost health challenge in the 21st century. Despite attempts to reduce opioid prescription, opioids have remained the mainstay of inpatient analgesia, especially after surgery. In New Zealand, prescribing of discharge analgesia is often the responsibility of resident medical officers (RMOs). A recent study of medical schools in Australasia found that pain education is inadequate. Furthermore, there is currently no published literature in New Zealand on RMO prescribing attitudes and practices of analgesia and in particular opioids on discharge.

Aims
To identify junior doctors' current attitudes, influences and prescribing habits when prescribing opioids upon discharge from hospital care.

Methods
An anonymised cross-sectional survey was provided to resident medical officers in the Auckland region at formal teaching sessions. The survey assessed the degree of training received on analgesia and opioid prescription, confidence to prescribe discharge opioids, influences of current prescribing and clinical scenarios to assess prescribing habits.

Results
Ninety-six respondents completed the survey. Overall, most respondents (n=80, 83.3%) stated that they would like more formal education on safe opioid pain medication prescribing. This was reflected in follow-up questioning where only 20 respondents (20.8%) felt they had adequate knowledge and clinical experience in understanding the pharmacokinetics and pharmacodynamics relevant to opioid prescribing. Furthermore, fewer respondents were confident to prescribe opiates independently to pregnant patients (n=12, 12.5%), patients with renal failure (n=34, 35.4%), patients at higher risk of respiratory depression (n=19, 19.9%) and elderly patients (n=31, 32.3%).

Conclusion/Discussion
RMOs describe a lack of confidence in prescribing discharge opioids requiring senior colleague input and to high-risk patients. As RMOs are largely responsible for prescribing opioids on discharge from hospital, these findings highlight a need for increased RMO education on pain and opioid management especially in the light of the global opioid epidemic.

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