Why are alcohol companies in our schools?

Towards a better world after COVID-19

“It is through shared conversation, that I understand” Māori older adults’ experiences of medicines and related services in Aotearoa New Zealand

Sustaining multidisciplinary team training in New Zealand hospitals: a qualitative study of a national simulation-based initiative

The 2019 Global Health Security Index (GHSI) and its implications for New Zealand and Pacific regional health security
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Erratum
Sustaining multidisciplinary team training in New Zealand hospitals: a qualitative study of a national simulation-based initiative

Jennifer A Long, Tanisha Jowsey, Kaylene Henderson, Alan F Merry, Jennifer M Weller

NetworkZ is national simulation-based team training programme for training operating room staff. In a high-fidelity simulation, operating room teams practice managing unusual and difficult surgical ‘patients’. Staff learn together, with their usual teams and in their own operating theatres. In a training environment as close to real as it can get, staff have the opportunity to refine their communication and teamwork skills so that they are better prepared to manage patients in clinical practice. Getting whole operating room teams together for training can be challenging and potentially difficult to sustain. We sought perspectives from a range of staff involved in NetworkZ training in their local hospital about sustaining the team training programme into the future. They valued the programme because of the improvements in teamwork and emergency management they’d seen following NetworkZ, and valued the unique, multidisciplinary features of the programme. The programme is resource intensive due to in-situ delivery, the attention to detail required to make scenarios realistic and the skills required of instructors to run and debrief the simulations. For programme sustainability we therefore call on a commitment from regulatory bodies and funders for multidisciplinary team training initiatives such as NetworkZ.

Correlation between epicardial adipose tissue and body mass index in New Zealand ethnic populations

Mohammed A Moharram, Hamish M Aitken-Buck, Robin Reijers, Isabelle van Hout, Michael JA Williams, Peter P Jones, Gillian A Whalley, Regis R Lamberts, Sean Coffey

Epicardial adipose tissue (EAT) is a special form of fat surrounding the heart which has been linked to increased risk of heart attacks and disturbances in heart rhythm. In our study, we used echocardiography (ultrasound of the heart) to measure EAT in patients scheduled for open heart surgery. We compared the association between body mass index (BMI) as a measure of obesity and EAT in New Zealand Europeans (NZE) and in Māori/Pacific people. BMI was associated with EAT thickness in NZE, but not in Māori/Pacific patients. Our results showed that using BMI as a measure of obesity is unlikely to be accurate in Māori/Pacific patients as a way to predict EAT. BMI is likely an inconsistent measure of obesity in Māori/Pacific patients.

“It is through shared conversation, that I understand”—Māori older adults’ experiences of medicines and related services in Aotearoa New Zealand

Joanna Hikaka, Rhys Jones, Carmel Hughes, Nataly Martini

Māori older adults in Waitematā DHB were interviewed to gain an understanding of their experience with prescription medicines. They described that medicines had positive and negative impacts on their physical and mental health, as well as being able to get ‘out and about’. They valued working together with healthcare professionals to get the best out of their medicines. They felt back and forth conversation also helped health professionals better understand them, and the impact medicines have on their lives. Māori older adults wanted to control their medicines journey and felt they had the ability, and right, to do this.
Rheumatic fever recurrences in New Zealand 2010–14
Adam Dennison, Briar Peat, Elizabeth Wilson, Alison Leversha, Miriam Wheeler, Simon Briggs, Yvonne Galloway, Janine Ryland, Nigel Wilson

Individuals who get rheumatic fever are at very high risk of getting another episode, known as a recurrent rheumatic fever. Our study shows that in Aotearoa, the public health programme to prevent recurrences using penicillin injections is working well for those 15 years and under. Most of the recurrences (as distinct from initial episodes) are occurring in those over 20 years of age. All recurrences occurred in those of Māori or Pacific ethnicity. Our current health systems may not be meeting the needs of adolescents and adults who are still recommended to be receiving penicillin injections.

Heart failure clinics improve use of evidence-based heart failure therapies in patients with reduced ejection fraction following acute coronary syndrome (ANZACS-QI 48)
Daniel Chan, Robert N Doughty, Janine Mazengarb, Andy McLachlan, Andrew J Kerr

Heart failure medications such as ACE inhibitors and beta-blockers improve outcomes in patients with reduced heart pump function after a heart attack. These medications need to be started at a low dose and up-titrated as heart rate and blood pressure allow to target doses used in clinical trials. Those seen in a specialised heart failure clinic were more likely to be receiving target doses of these medications one year following their heart attack, compared to a standard cardiology clinic. Although not all patients seen in heart failure clinic were able to achieve target doses of these medications, most were on maximally tolerated doses.

Energy-dense vs routine enteral nutrition in New Zealand Europeans, Māori, and Pacific Peoples who are critically ill
Alice L Reid, Marianne J Chapman, Sandra L Peake, Rinaldo Bellomo, Andrew R Davies, Adam M Deane, Michael Horowitz, Sally Hurford, Kylie Lange, Lorraine Little, Diane M Mackle, Stephanie N O’Connor, Jeffrey J Presneill, Emma J Ridley, Patricia J Williams, Paul J Young, on behalf of the TARGET Investigators and the Australian and New Zealand Intensive Care Society Clinical Trials Group

Nutrition therapy is an essential standard of care for all patients who require life support. Ethnic differences in body composition, socioeconomic status and patterns of prior nutritional intake as well as differences in the prevalence of diseases like obesity and type 2 diabetes made it plausible the calorie requirements of critically ill adults might vary by ethnicity. The principal aim of this study was to establish whether the effect of energy-dense nutrition on critically ill patient outcomes varied by ethnic group. Our findings do not support the hypothesis that in critically ill adults the effect of energy-dense nutrition on day-90 mortality varies for European, Māori and Pacific peoples ethnic groups in New Zealand. We also reported outcomes by ethnic group for critically ill patients in New Zealand ICUs for the first time and found that these were similar.

The 2019 Global Health Security Index (GHSI) and its implications for New Zealand and Pacific regional health security
Matt Boyd, Michael G Baker, Cassidy Nelson, Nick Wilson

The COVID-19 pandemic has highlighted the importance of all countries securing themselves against infectious disease threats, including potential global catastrophic biological risks. In this article we explore an international scoring system that gave New Zealand and its Pacific neighbours low scores in 2019. We present the case for why the New Zealand Government needs to do more to ensure its own optimal preparedness for global biological threats, and to work with Pacific Nations to enhance health security in the region.
Why are alcohol companies in our schools?

Jennie Connor

In a recent Viewpoint article,1 Nicki Jackson and Rachael Dixon examined a high school alcohol education programme called “Smashed” from public health and health education perspectives. It was developed in the UK with the sponsorship of Diageo and is funded in New Zealand by the Tomorrow Project. The article raises two important questions. Why would the alcohol industry want to fund school-based “responsible drinking” education in New Zealand, and why do we give them access to our schools?

Jackson and Dixon’s critique lays out why this initiative will fail to deliver benefit for most students and schools taking part, and may have negative impacts. It is a one-off activity package that is not integrated into, or coordinated with, existing health education or tailored to the students’ needs; a model considered ineffective by existing New Zealand health education guidelines. In addition to the format, there are serious concerns about the content, with its primary focus on “personal responsibility”.

Educational interventions to modify drinking have been extensively researched. Reviews of school-based programmes have failed to find evidence of effectiveness in reducing alcohol consumption or alcohol-related harm with any one-off session.2,3 “Smashed” claims to be “dedicated to reducing alcohol consumption and alcohol-related harm around the world”,4 but evaluations focus only on changes in knowledge, understanding and awareness, which have little or no association with changes in drinking.2 Given that benefit to the participants is unlikely, we need to look at the funders to understand why schools have been offered this programme.

Diageo is a major player in the huge global alcohol industry, where worldwide alcohol sales totalled more than 1.5 trillion US dollars in 2017. Diageo is both the leading spirits company in the world and a ‘Top 10’ beer producer, spending US $2.5b on advertising in 2017.5 As well as traditional advertising they have ample funds for promotion via digital media, sponsorship, product placements and ‘stakeholder marketing’, which is designed to “maintain policy environments conducive to increasing corporate sales and profits”.5

And who is the Tomorrow Project? Along with its website, “Cheers”, the Tomorrow Project is an instrument of global alcohol corporations in New Zealand. It is an example of a Social Aspects Organisation,5 funded and governed by New Zealand Winegrowers, Spirits NZ and the Brewers Association of New Zealand, many of whose brands are owned by the world’s large alcohol corporations. The Tomorrow Project calls itself a social change initiative, which aims to create “a culture where drinking in moderation is the norm and personal responsibility is inherent.”6

However, the alcohol industry worldwide is reliant on the harmful use of alcohol. In New Zealand, almost 50% of all alcohol consumed is drunk in heavy drinking occasions,7 and so profitability of companies is dependent on high prevalence of heavy drinkers in the population. As heavy drinking adults reduce drinking with age, or die, new heavy drinkers need to be recruited. This is a primary concern of the alcohol industry, and is in direct conflict with the stated aim of the Tomorrow Project.

To maximise consumption you need low prices, high availability, unconstrained promotion and a low purchase age, and so alcohol industries invest heavily in keeping government regulation as light as possible. In the last decade, they have been able to massively expand their marketing reach using the virtually unregulated digital media.8
On a much grander scale than Diageo’s “Smashed”, another alcohol mega-corporation, AB InBev, launched a programme in 2015 that aims to reduce global harmful use of alcohol by 2025 by getting people to make smart choices. With a budget of a billion dollars, it is still unlikely to be more than a marketing and public relations activity. A recent systematic review of such corporate social responsibility (CSR) projects concluded “There is no robust evidence that alcohol industry CSR initiatives reduce harmful drinking. There is good evidence, however, that CSR initiatives are used to influence the framing of the nature of alcohol-related issues in line with industry interests.”

Adolescents and young adults are important to alcohol corporations. They suffer a disproportionate amount of harm from alcohol, which gets attention in the media. While not personally responsible for their lifelong exposure to the physical, social and regulatory environments that drive drinking, they are vulnerable to being depicted as personally irresponsible about their drinking, and therefore in need of “education”. However, the industry has a vested interest in young people maintaining and increasing their drinking. A focus on youth drinking also serves the industry by deflecting attention from the high prevalence of heavy drinking in other age groups.

Thus, two reasons for industry funding of this programme emerge. Firstly, it will contribute to some corporate objectives. Creating an illusion that the industry cares, and is doing something to help, may make it more likely that the industry will be listened to by policy makers and the public. Reinforcing the notion that faulty “personal responsibility” is the real cause of harm from alcohol, allows the industry to argue that healthy alcohol policy such as controls on price, availability and promotion, that would actually reduce drinking and delay drinking initiation among adolescents, is unnecessary. Secondly, it will not reduce consumption.

The question of why alcohol companies have access to our schools is less easily answered.

Trust is placed in schools and teachers that what they provide is reliable and fair. If alcohol companies wanted to help they could offer no-strings-attached funding. After all, teachers are the experts in high school education and they know their students. By offering a ready-made package, the industry retains complete control of the messaging and the format. It brings its own agenda of individual responsibility, ignoring the hazardous nature of its product and its business. This is a marketing device that sells ideas to students, their teachers and their families that are designed to undermine support for effective policy, while enhancing the profile of the industry.

Ironically, while schools are not likely to take money directly from the alcohol industry because it is so clearly wrong, some have accepted the Trojan Horse that “Smashed” represents, and invited the industry in through the front gate. Would they also accept tobacco industry actors coming in to teach their students how to smoke safely? Surely it is time to ban all interaction of the alcohol, tobacco and unhealthy food industries with our education system.
Competing interests: Nil.

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REFERENCES:


Sustaining multidisciplinary team training in New Zealand hospitals: a qualitative study of a national simulation-based initiative

Jennifer A Long, Tanisha Jowsey, Kaylene Henderson, Alan F Merry, Jennifer M Weller

ABSTRACT

AIM: Healthcare is delivered by teams, but the training of healthcare staff is commonly undertaken in professional silos. This study investigated local perspectives on the sustainability of NetworkZ, a New Zealand national simulation-based multi-disciplinary operating room team training programme.

METHOD: Local course instructors and managers were invited to participate in semi-structured interviews. Diffusion of innovations theory was utilised to frame deductive thematic analysis of interview data.

RESULTS: Twenty-seven people participated. Interviewees described valuing NetworkZ for its multidisciplinary orientation, in-situ delivery, scenario realism, relevance to teamwork and communication and potential for generalisability to other settings. Interviewees also identified NetworkZ as generating improvements in teamwork and crisis management. NetworkZ was described as complex, due to multidisciplinary participation and the multiple roles and skillsets of instructors needed to run simulations smoothly, making the programme resource intensive to deliver.

CONCLUSION: NetworkZ is appreciated as a valuable and unique programme for developing important teamwork and communication skills. Its sustainability is dependent on adequate resourcing and funding.

Healthcare today is predominantly delivered by teams. There is burgeoning literature on teamwork, team competence and interprofessional learning, with convincing evidence that failures in teamwork and communication can lead to bad outcomes for patients. This suggests that team training should be incorporated into everyday practice. In New Zealand, multidisciplinary team training is not yet ‘business as usual’.

Evidence is emerging that the use of simulation can generate greater improvements in teamwork skills than team-based training delivered didactically. Internationally, there are a number of simulation-based team training initiatives such as PROMPT, TeamSTEPPS and a Harvard insurer-funded simulation programme for operating theatre teams. We set out to implement simulation-based team training for operating theatre teams in New Zealand.

We set out to develop simulations of surgical cases that equally engaged all members of the multidisciplinary surgical team. While technologies to simulate anaesthetic tasks were readily available, we were unable to source surgical models that we could integrate with an anaesthesia simulator to enable surgeons to perform procedures such as incision, resection, suturing or haemorrhage control. We
therefore created these models working with a medical special effects company (MedicFX). The course underwent an extensive pilot with 20 full surgical teams from two large hospitals. Each team participated in a full-day course. Participant evaluations were very positive and we demonstrated improved scores for teamwork in the workplace.15,16 Two further courses in an operating theatre suite tested the feasibility of running the simulations in situ.

With funding from New Zealand’s national no-fault accident insurer, the Accident Compensation Corporation (ACC),17 we developed NetworkZ,18 a simulation-based multi-disciplinary team training programme for operating theatre teams, and established it in New Zealand public hospitals (see Table 1). The programme is described on the website www.networkz.ac.nz. Implementation of NetworkZ began in 2017 and has sequentially rolled out across New Zealand public hospitals over four years. At the time of writing, 1,082 participants had attended a NetworkZ course, and 279 local DHB health practitioners had begun training to be a NetworkZ instructor. Participants reflect the full range of operating room roles; consultant surgeons (15%), consultant anaesthetists (15%), surgical trainees (7%), anaesthetic trainees (5%), nurses (38%), anaesthetic technicians (13%) and other staff such as healthcare assistants (7%).

Table 1: The NetworkZ programme.

<table>
<thead>
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<th>Features of NetworkZ</th>
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<tbody>
<tr>
<td>Multidisciplinary, involving all members of the surgical team in scenario and model development, and as instructors and participants.</td>
</tr>
<tr>
<td>Simulation-based with supporting communication workshops.</td>
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<tr>
<td>Delivered ‘in situ’.</td>
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<tr>
<td>Utilises bespoke surgical models that bleed and require cutting and suturing.</td>
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<tr>
<td>DHBs are provided with a 3G simulator, access to surgical models, free access to instructor training and support for implementation.</td>
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<table>
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<tr>
<th>Instructor training and commitment</th>
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<tr>
<td>Local staff from all professional groups are trained to deliver NetworkZ in their hospital.</td>
</tr>
<tr>
<td>Blended model of instructor training using a competency framework.</td>
</tr>
<tr>
<td>Training combines a two-day workshop with online modules and on the job mentoring and feedback.</td>
</tr>
<tr>
<td>Local instructors are supported by faculty until they can deliver the course independently.</td>
</tr>
<tr>
<td>For each course a minimum of four instructors or support staff are needed for approximately four hours, and for at least an hour before and after the course for set up and pack up. Additional tasks prior to the course include rostering and communicating with course participants.</td>
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<th>Rollout of the programme</th>
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<td>An engagement strategy targeted all levels of stakeholders from national committees to DHB executive and those tasked with running the training.</td>
</tr>
<tr>
<td>Progressive rollout of the programme to the 20 DHBs is scheduled over four years, with five DHBs joining the programme per year beginning in February 2017.</td>
</tr>
<tr>
<td>Ongoing evaluation strategy and feedback loop to stakeholders.</td>
</tr>
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<tr>
<th>Implementation process</th>
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<tr>
<td>Each chief executive signs a letter of agreement to commit resources to the training, and in return receives access to the programme and a Laerdal 3G simulator.</td>
</tr>
<tr>
<td>DHBs establish a project team to guide the implementation process.</td>
</tr>
<tr>
<td>Sites visited to identify and manage risks associated with in situ simulation.</td>
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<tr>
<td>Instructor training and onsite support until the DHB becomes independent.</td>
</tr>
<tr>
<td>Ongoing development of new scenarios and models.</td>
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<tr>
<td>Remote support systems—online booking system, technical web application and training websites.</td>
</tr>
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</table>
We know of no other national programme for multidisciplinary operating theatre teams that integrates a high fidelity anaesthesia simulator such as the Laerdal 3G simulator with surgical models on which surgeons can perform operative procedures.

In a qualitative study in the first Cohort of five district health boards (DHBs) Jowsey and colleagues\textsuperscript{19} identified local factors associated with implementation challenges and successes, which informed our approach to establishing NetworkZ in later groups of DHBs. As the implementation phase will be completed by the end of 2020, our attention is now on the sustainability of the programme.

Theoretical framework

We defined sustainability of NetworkZ in terms of the maintenance of programme activities into the future.\textsuperscript{20} As our theoretical framework we used Rogers' Diffusion of Innovation theory,\textsuperscript{21} which explains how new practices become embedded in organisations or populations. Rogers proposes that influential early adopters are important, as are the preceding conditions, such as decision-maker characteristics and communication behaviour, and features of the intervention itself. Rogers proposes that the key features of interventions that promote positive attitudes towards an intervention are: (1) the perceived relative advantage of the intervention, (2) compatibility of the intervention with existing structures, (3) (low) intervention complexity, (4) the ability to test out the intervention prior to full implementation and (5) observability of the interventions' impact. These attributes in turn influence adoption and discontinuation decisions.\textsuperscript{21}

In the present study we explored the perspectives on long-term sustainability of NetworkZ with DHB staff involved in its local delivery or establishment. Using the theoretical lens of Rogers' Diffusion of Innovation theory\textsuperscript{21} to interpret the data, we aimed to identify the elements of the NetworkZ programme that promoted positive attitudes, and elements that posed challenges for sustainability.

Method

In this qualitative study we undertook semi-structured interviews of staff involved with delivering or establishing the NetworkZ programme and used deductive thematic analysis\textsuperscript{22,23} of the data based on Diffusion of Innovation theory.\textsuperscript{21} The study is part of a larger programme of evaluation of NetworkZ, registered with ANZCTR (ACTRN1261700017325) and approved by the NZ Health and Disability Ethics Committee (16/NTB/143).\textsuperscript{24}

Interview

The semi-structured interview guide focused on programme strengths, impact, implementation experiences and needs for ongoing sustainability (Appendix). Minor changes to the interview guide were made iteratively to prompt participants to elaborate further on topics relevant to the project.

All interviews were conducted by one member of the research team (JL) who has a doctorate in psychology, and has been trained in interview techniques. She introduced herself to participants as a researcher on the NetworkZ evaluation team.

Sample population

At the start of the rollout, all 20 DHBs were divided into five groups (which we call cohorts), representing similar population catchments. Cohort 2, the focus of this study, included DHBs from each size grouping. The two largest DHBs in Cohort 2 were in large metropolitan centres each with multiple hospital sites and their own local simulation centre.

Potential interview participants were selected from existing lists of people involved in course delivery (instructors) and those who were involved in the establishment of NetworkZ through their role as managers (managers). Management roles included clinical director, chief medical officer, nurse manager, operating room manager, charge nurse, project manager or quality specialist. Instructor roles included course instructor, convenor and simulation technicians. In order to preserve confidentiality, we refer to these people in the findings as either managers or instructors. Potential interviewees were approached via email and invited to participate in a telephone or face-to-face interview. Interviews were conducted between December 2018 and March 2019.

Sampling

We used purposive sampling to recruit potential interviewees in proportion to the
Interviewee characteristics are outlined in Table 2.

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Instructors (n=16)</th>
<th>Managers (n=11)</th>
</tr>
</thead>
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<tr>
<td>Theatre nurse/nurse educator</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Anaesthetic technician</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Consultant anaesthetist</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Consultant surgeon</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

Results

Interviews were conducted between December 2018 and April 2019. Forty-nine people were invited via email to participate and 27 agreed. Of those who declined, reasons given were leaving their role, not knowing enough about NetworkZ or lack of time to participate. Interview length ranged from 8 to 51 minutes. Interviewee characteristics are outlined in Table 2.

Thematic overview

Elements of the programme that influenced attitudes to NetworkZ, and its ongoing sustainability are presented as themes using the Diffusion of Innovations framework (relative advantage, compatibility with existing systems, complexity of course delivery and observability of programme impacts) and subthemes specific to the interview data (Figure 1). Of note, a theme around trialability, one of the elements of the Diffusions of Innovations framework, did not emerge.

Theme 1: relative advantage

Interviewees perceived the key strengths of NetworkZ to be: multidisciplinary focus, in-situ delivery, realism of the courses and the relevance of the teamwork and communication focus, and generalisability of the course to other settings.

Figure 1: Thematic map.
The concurrent training of all members of the multidisciplinary team was seen as an advantage of the courses. Interviewees valued the uniqueness of having a course for a full theatre team, the opportunity to act in their own role, and to listen and support each other in the debrief after the scenarios.

“I've done a lot of courses for anaesthetists with pretend surgeons. I can’t think of anything like this where it was so multidisciplinary.” [Instructor, Anaesthetist]

“Something simple that came up between the nurses and the surgeons in terms of when to do the count. And I can't remember, the surgeons and the nurses each getting a shared insight into what each other’s priorities are at that time and how they can easily adjust or not to make it work for both of them.” [Instructor, Anaesthetist]

“The simulation process allows them to reflect on their degree of situational awareness they have, how they work safer as a team than as individuals in the team.” [Manager, Other]

The delivery of the courses in-situ using usual equipment and setup was described as facilitating engagement from participants by improving scenario realism (also discussed later), allowing for the troubleshooting of local systems and making access to simulation training possible for DHBs that did not have a local simulation centre.

“What happens in the simulation centre is everybody's stressed. And everybody's in an unfamiliar environment and so nobody performs to their best anyway. And besides, it goes back to the whole thing of, well actually if you’re stressing your own systems then you can improve your systems.” [Manager, Anaesthetist]

“It's also checking the processes and the policies and things and how they work in real life situations. So, I think that's what, one of the major benefits of doing in situ simulation is. Is that you're actually trying it out and seeing what works and if it doesn’t work you can change things.” [Instructor, Anaesthetic Technician]

The realism of scenarios was described as a key strength that assisted with buy-in to the programme, and active engagement during the course scenarios. Realism was described as particularly important for eliciting surgeon buy-in to the course.

“At the start of the session there's varying degrees of engagement. And then once you actually run the scenarios which are quite realistic, and people actually do their role and they feel like it was kind of like a normal day in theatre.” [Instructor, Surgeon]

“I was involved with one of the scenarios and you're actually sort of physically sweating... pretend scenarios where there's no blood or anything is very hard to take seriously.” [Manager, Nurse]

“We practically had exactly the same scenarios happen with the guy with the amputated leg. We actually had pretty had much a very similar scenario happen about a year and a half ago.” [Instructor, Nurse]

The programme's goals were described as highly relevant to the teamwork and communication priorities of instructors and managers alike.

“A lot of our issues are around communication breakdowns. So, you need any tools that we have that can help highlight and break down the hierarchical barriers.” [Instructor, Anaesthetic Technician]

“Our operating theatres should be a positive place for people to work, where there's less of the hierarchical stuff of the past, where people can communicate and I think that's going to lead to better patient outcomes.” [Instructor, Surgeon]

As described above, NetworkZ was viewed as uniquely valuable relative to other team training interventions currently available in New Zealand due to its multidisciplinary participation, in-situ delivery, realism and relevance to clinical practice. As such, interviewees felt that it could be useful for improving teamwork, local crisis response processes and patient safety in other areas of the hospital, such as emergency departments, intensive care units, post-operative care suites and in other surgical specialties such as obstetrics and gynaecology.

“We've got specialties that are really keen to do the programme but there are no scenarios for them.” [Instructor, Anaesthetic Technician]

“I'd like to see NetworkZ go into the different areas of the hospital, that we shouldn’t be the only ones that benefit from the training.” [Instructor, Anaesthetic Technician]
Theme 2: compatibility with existing systems

Strong compatibility of a programme with existing systems and values can increase the likelihood that it will be adopted and sustained. While the focus of NetworkZ was described as compatible with personal beliefs about the importance of great teamwork, the delivery of the courses was at times seen as challenging with available local resources.

Interviewees described resourcing of instructor time and theatre time as a key challenge. Some interviewees described friction between the ongoing delivery of the NetworkZ courses, and “time and money”, arising from busy staff workloads, fully booked theatres and the desire to fill theatres in order to maximise funding and reduce hospital deficits.

“It was a significant challenge for the DHB to be able to deliver that and maintain production.” [Manager, Surgeon]

“It’s been difficult to get that time allocated to the technical team so they’ve got time to go set up the day before.” [Instructor, Anaesthetist]

“We made a decision in the end that the only way we were going to make this work was to fit it into the programme of educational activities that we have once a month for an afternoon.” [Instructor, Anaesthetist]

As described in the quote above, a number of DHBs utilised pre-existing half-days set aside for education to run courses so that NetworkZ training had a negligible impact on their theatre lists. The use of non-operating education days minimised disruption to theatres but created an opportunity cost for instructors who missed other important education sessions that were happening at the same time. The time, cost and theatre space requirements of NetworkZ were larger than for many other courses held at these hospitals.

Theme 3: complexity of course delivery

Programme complexity can be a deterrent to programme adoption and sustainability. Instructing on local courses was described as a complex, and as described above, a resource-intensive experience. Interviewees referred to the “extra” tasks involved in setting up the courses and making them run smoothly on the day as often unaccounted for within the local resourcing budget.

“Not just an educational thing but all this. It goes where the manikin’s stored and who can touch it and who looks after it, the nurses can be freed up and contacting the surgeons to agree to it and all that sort of stuff.” [Instructor, Anaesthetist]

Tasks included recruiting staff, setting up the simulation equipment and organising course materials. For anaesthetic technicians and nurses, standard rostering practices did not offer instructors time to complete these tasks. For clinicians there was an option to use non-clinical time for this type of work, but interviewees noted there were many competing demands on this time. Thus, complexity in part reflected limited time to do the job as an “extra-curricular” instructor. Complexity was also generated by the multiple roles involved in delivering the courses, and the desire to ensure the courses were well run and were realistic for participants.

“It took us a long time to work out the different roles.” [Instructor, Nurse]

“There’s that pressure to run them smoothly on a, usually on a compressed timeframe.” [Instructor, Anaesthetist]

A number of interviewees also said that the complexity of course delivery meant they did not feel confident to provide optimal instructor training to their own local instructors. As such, they indicated a desire for ongoing national ‘expert’ support to deliver the instructors courses so that future staff were able to learn the content as it was originally intended. Similarly, many felt that national expertise would be important for troubleshooting, designing new scenarios and maintaining quality in the future. While people varied in their confidence about future delivery, some noted that they were likely to also need technical support to be able to deliver the programme beyond the initial period of support.

Interviewees in large DHBs reported challenges in course coordination and maintaining momentum when they did not have staff dedicated to support NetworkZ; those with dedicated staffing said this was critical to ensuring smooth running of the programme.
Theme 4: observability of programme impact

Observable benefits encourage adoption and continued support for programmes. The following sections discuss the improvements observed in (1) teamwork and communication, and (2) reduction in latent safety issues. Interviewees observed improved teamwork and communication at their DHB following NetworkZ training. Some interviewees referred generically to a sense of improved teamwork and communication skills, or improved teamwork behaviour.

“Having everyone work together during these simulations, it’s just really improving the communication between the groups and everyone’s starting to work together. It’s helping people get a better idea of everybody’s roles and what they’re capable of doing.” [Instructor, Anaesthetic Technician]

“Communication certainly seems to have improved in the fact that folk aren’t working in the little individual teams like the anaesthetics working independently from the scrub side of things. So there seems to be more teamwork.” [Instructor, Nurse]

Other observations about teamwork changes included better sharing of information between team members, improved confidence to speak up, better knowledge about their team members and reduced hierarchy.

“The briefings in the morning, they’re more clear. They’re more organised. So, calling each other by name.” [Instructor, Surgeon]

“Concepts like closed loop communication or introducing each other at the start or needing to have pre-briefings or sort of pauses in the middle of crises and stuff like that, that’s all just becoming a lot more familiar and expected and asked for.” [Instructor, Anaesthetist]

The delivery of the NetworkZ courses in local theatres provided opportunities to identify latent safety threats. Interviewees reported identifying gaps in staff knowledge of local crisis systems and equipment, and problems with those systems and equipment. Further training sessions were then held to respond to these gaps.

“People didn’t know how to use the defibrillator well and so it kind of brought out where the weaknesses were as a team.” [Instructor, Nurse]

“There was an issue with the Belmont [rapid infusion device] but there was some misunderstanding about how to set it up and of course that then generated an education session so the techs were more familiar with it.” [Instructor, Anaesthetist]

Other local improvements generated by the courses included changes to the process of ordering bloods in an emergency, the purchase of a second defibrillator and improved medication storage. Managers were generally supportive and hopeful about the programme impact. However, some felt they had not yet received sufficient information on course attendance or programme impact.

Discussion

Interviewees described the relative advantages of NetworkZ as multidisciplinary involvement, in-situ delivery, scenario realism, relevance to teamwork and communication in the operating theatre, and potential for translation beyond theatre to other areas in the DHB. While the training was compatible with local instructor and DHB interest in improved teamwork and perceived safety, it presented challenges due to pressure on staff time and operating theatre access. The perceived complexity of delivery suggested that ongoing dedicated expert support would be required. While those involved as instructors knew about the reported observable impacts of NetworkZ, this information was not always conveyed to senior management, who were the ones responsible for providing the time and resources required for course delivery.

Relative advantages

Overall interviewees described the programme as having several “relative advantages” over other teamwork or communication programmes they had attended, many of which did not involve established surgical teams working together in their own environment using realistic surgical models. These relative advantages drove engagement, and motivation to expand the programme to other hospital departments. Yet these advantages also made the programme more complex, requiring substantial resourcing. Decisions to cut programme costs or complexity need to be weighed up against the possibility that these will undercut programme benefits.
or stakeholder buy-in. While interviewees spoke about a number of ways that the NetworkZ programme improved upon other available training programmes, funders will also need to view this programme as offering greater benefit than other available programmes. Continuing medical education resources are commonly allocated to passive forms of education such as conferences, yet these activities have only small effects on physician performance and outcomes. Sustaining a programme such as NetworkZ into the future will require a rethink of the way practitioners and institutions use their budgets for continuing medical education. Recognition by regulatory bodies of the need to improve teamwork and communication through multidisciplinary activities would support the sustainability of such initiatives.

**Compatibility with existing systems**

Programme adaptation to align with local context is another core component of most sustainability approaches. Other simulation training programmes have also noted challenges to sustainability and scalability, including challenges with financing, resourcing, recruiting and upskilling trainers. Our findings revealed a range of local ‘solutions’ to resourcing constraints. For example, some DHBs have chosen to run courses for half a day instead of a full day, and most have integrated the courses with existing time scheduled for education. Support from managers of each professional group can also assist in overcoming resourcing constraints. Further, national budget streams specifically designed for health workforce development could reduce some of the resourcing costs for DHBs, yet these currently do not have obvious mechanisms to facilitate or incentivise the pooling of training funds from different professional groups to enable the delivery of multidisciplinary training programmes.

**Complexity of course delivery**

The physical resources, instructor skill-levels and staff time required to deliver NetworkZ pose challenges for sustainability, due to the complexity of scheduling multidisciplinary participation, multiple roles and skillsets needed to run the simulation smoothly. Interviewees expressed the view that ongoing support would be needed beyond the current period of ACC funding. Declines in skill and fidelity are common for health interventions, and interviewees requested ongoing input from key experts to maintain the quality of NetworkZ. Other team simulation training programmes (eg, PROMPT) also use experts, rather than peers to train new instructors.

Recruiting participants from all the professional groups that make up a team creates its own complexities and can be one of the biggest barriers to the delivery of simulation-based team training. Education has traditionally been delivered in professional silos, and multidisciplinary training is a paradigm shift creating challenges in timetabling, motivation to attend and funding streams. Leadership support is important for overcoming recruitment challenges, and adequate resourcing may assist here too. For large DHBs, dedicated staff time for a head instructor, or to cover recruitment, course coordination and timetabling was reportedly key to ensuring smooth delivery of the programme.

The existing delivery of NetworkZ would not have been possible without substantial funding from ACC. To sustain NetworkZ, ongoing funding will be required, either from a national source or local sites, or a combination of the two. Diverse sources of funding are likely to be more sustainable than a single funder.

**Observability of programme impacts**

For managers, evidence of programme impact was of key interest. Ward et al similarly noted that research, clinical and patient experience, and local evidence was important for enabling the implementation of the TeamSTEPPS curriculum in rural hospitals. Likewise, a systematic review of sustainability approaches identified that building evidence was a key strategy of most sustainability models and approaches, to ensure decision makers are informed of the theoretical and empirical data justifying expenditure on the programme. Ultimately, as noted by some of the managers interviewed, the most convincing evidence for ongoing delivery of the programme would be improved patient outcomes. We are collecting evidence on patient outcomes, as well as teamwork and communication at a national level, but results will not be available before 2022. Thus collating short-term evidence that can be fed back to
senior managers is also important. Documenting the improvements to local theatre systems, equipment and training may offer concrete, easy to collect, immediate evidence of programme impact for senior managers.

Strengths and limitations
A key strength of this work is sampling from multiple DHBs of different sizes from very large to very small, incorporating a range of perspectives from these varying contexts.

Limitations of the study include potential bias in data collection and analysis due to the researchers' vested interest in the success of NetworkZ. The extent to which our findings can be generalised to other countries, other stakeholders not involved in establishing or running NetworkZ in their local DHBs and other similar training programmes remains to be tested.

One of the themes of Diffusion of Innovations theory that did not arise was ‘trialability’ of the intervention. The intervention was extensively trialled prior to obtaining funding for the programme. When signing up to the intervention, each DHB committed to training instructors, providing time for the course, and accepting responsibility for maintenance and depreciation of the gifted simulator. A trial run of the programme was therefore not feasible. However, as noted earlier, each DHB worked out for themselves how to implement the programme.

Future research
In this study we identified programme complexity as a potential challenge. The extent to which programme gains could be achieved by delivering parts of the course in a less resource-intensive workshop format or delivering some courses in purpose-built simulation facilities is yet to be tested. The surgical models, however, seem to be a valued, key component of the experience, allowing surgical participants to actively participate in the simulation. While studies suggest that repeated training is one way to increase the sustainability of simulation training benefits, other opportunities to sustain health programme benefits have yet to be explored, such as the value of incorporating the discussion of communication and teamwork concepts into the debriefing of real-life trauma cases. Resourcing instructors’ time arose as an issue in sustainability of the programme. The sustainability of unpaid instructor involvement in programmes such as NetworkZ has not, to our knowledge, been explored and may be a particular challenge for complex train-the-trainer programmes, particularly where these roles are part of organisational service but are not explicitly reimbursed. Optimal approaches to maintaining engaged instructors in sufficient numbers is a potential area for workforce development research.

Conclusion
NetworkZ invokes positive attitudes in local stakeholders, but its complexity and resource requirements pose a risk without adequate resourcing. Existing workforce development programmes are predominantly uni-professional, and the multi-professional requirements of NetworkZ pose additional complexity as existing systems for staff development within institutions, and discipline-specific continuing professional development are not set up to support multidisciplinary training. Team training programmes such as NetworkZ have the potential to yield important benefits for healthcare and require adequate resourcing. This will require a commitment from funders, institutions and professional bodies to building effective healthcare teams and better outcomes for patients.
Appendix

Semi-structured interview guide

Indicative interview questions and prompts\textsuperscript{1}

1. First I’d like to talk about your experience of the NetworkZ programme so far:
   a. What’s been working well? What have been your highlights? What makes the course special, or different from other courses you’ve been involved in? (What do you see as the key strengths? Can you think of a time that illustrates X?)

2. What got you involved in NetworkZ in the first place? What do you value about being involved in the programme?

3. What positive impacts has the NetworkZ programme had in your DHB? (Are there any impacts that have come from delivering the course in-situ?)

4. In regards to your experience of the implementation of NetworkZ:
   a. What’s been working well? What things were done in your DHB that you would recommend to other DHBs starting out? How have you overcome any challenges along the way?

5. It is intended that NetworkZ could become business as usual in the future. What is already happening to facilitate long-term sustainability of the programme in your DHB?

6. I’d like you to think about your aspirations for the NetworkZ programme, what benefits would you like to see the NetworkZ programme achieve for staff and patients? (What ideas do you have for improve the programmes’ impact on teamwork and patient safety?)

7. What do you see as the optimal way of delivering NetworkZ in your own DHB over the longer term? Pprompt for frequency, integrated vs siloed from other training (development of future scenarios, who should deliver the training)

8. What needs to happen to make NetworkZ reflect your vision for an ideal programme? What resources would be required? What support would be needed? From whom? (this question was dropped in the second iteration as it was largely covered in other questions)

9. Thinking about the longer term, what else can be done to ensure the programme is sustainable? How would the courses be delivered and adapted over time? Who would be involved? What options might exist for funding?

10. Is there anything else you would like to tell me about in relation to the NetworkZ programme?

\textsuperscript{1}Additions and deletions made over the course of the interviews are detailed in parentheses.
Competing interests:

All authors report grants from ANZCA, grants from ACC, during the conduct of the study; Dr Merry reports shares in Safer Sleep, grants from Fisher and Paykel, consulting fee from Fisher and Paykel, outside the submitted work.

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Correlation between epicardial adipose tissue and body mass index in New Zealand ethnic populations

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ABSTRACT

AIM: We aimed to investigate the correlation between epicardial adipose tissue (EAT) and body mass index (BMI) in different ethnic groups in New Zealand.

METHODS: The study included 205 individuals undergoing open heart surgery. Māori and Pacific groups were combined to increase statistical power. EAT was measured using 2D echocardiography.

RESULTS: There were 164 New Zealand Europeans (NZE) and 41 Māori/Pacific participants. The mean (SD) age of the study group was 67.9 (10.1) years, 69.1 (9.5) for NZE and 63.5 (11.4) for Māori/Pacific. BMI was 29.6 (5.5) kg/m² for NZE and 31.8 (6.2) for Māori/Pacific. EAT thickness was 6.2 (2.2) mm and 6.0 (1.8) mm for NZE and Māori/Pacific, respectively. Using univariate linear regression, BMI showed moderate correlation with EAT in NZE (R²=0.26, p<0.001); however, there was no significant correlation between BMI and EAT in Māori/Pacific patients (R²=0.05, p=0.17). Using multivariate analysis, BMI remained a significant predictor of EAT thickness in NZE (R²=0.27, p<0.001).

CONCLUSIONS: BMI was associated with EAT thickness in NZE patients, but not in Māori/Pacific patients. The same level of BMI can carry different connotations of risk in different ethnic groups, with BMI likely being an inconsistent measure of obesity in in Māori/Pacific patients.

Obesity is a global epidemic linked to increased cardiovascular risk.¹,² In particular, increased visceral adiposity is associated with dyslipidaemia,³,⁴ insulin resistance,³,⁴ hypertension,⁵ and higher cardiovascular risk.³,⁴ Epicardial adipose tissue (EAT) is a type of visceral adipose tissue surrounding the heart; it is defined as the adipose tissue found between the myocardial surface and the visceral pericardium.¹⁰,¹¹ EAT does not function as a mere fat depot; instead, it produces multiple biomolecules and has a vasocrine and paracrine regulating effect on the heart and blood vessels.¹¹,¹² Recently, a number of studies investigating the relationship between EAT and cardiovascular disease have shown a significant association between EAT and myocardial ischaemia, coronary artery calcification, atrial fibrillation and major adverse cardiac events.¹³–¹⁸

Obesity and overweight are currently defined and classified by body mass index (BMI).¹⁹ However, BMI has limited ability to predict visceral adiposity, which has a central role in the development of adverse outcomes associated with obesity.²⁰–²² Despite its limitations, BMI is the most widely used anthropometric measure of obesity.²³ However, EAT (measured by standard echocardiography) has the potential to be
an accessible measure of visceral adiposity. The relationship between EAT and BMI has intrigued researchers interested in characterising this unique visceral fat depot and a significant positive correlation has been reported between EAT and BMI. In this study we investigate whether the correlation between EAT thickness and BMI is ethnicity-specific in a cohort of New Zealand Europeans (NZE) and Māori/Pacific people.

Methods

Study population

This study is a retrospective analysis of a subset of patients from the HeartOtago Heart Tissue Sample Study approved by the local Human Ethics Committee (Approval number: LRS12-01-001) for which prospective enrolment is used. Informed consent was obtained from patients undergoing clinically indicated coronary artery bypass graft surgery (CABG) and/or valve replacement surgery in Dunedin Hospital in the period from 2014 to 2019.

Clinical and biochemical data

Clinical data were collected by a trained investigator blinded to the echocardiographic analysis. Clinical and demographic data, including comorbidities, medications and relevant medical history, were collected at the recruitment visit preoperatively. Laboratory biochemical data including triglycerides, total cholesterol, low-density lipoproteins and high-density lipoproteins were extracted from patients’ records and the most recent preoperative test results were collected.

Ethnicity

Ethnicity was self-reported; patients were allowed to select more than one ethnicity. In the case of reporting multiple ethnicities, patients’ ethnicity was prioritised according to the New Zealand Ministry of Health’s ethnicity data protocol: 1) Māori, 2) Pacific, 3) Asian, 4) European. If a patient reported both Māori and/or Pacific and European ethnicity, he/she was allocated to the Māori/Pacific group. Only three potential participants self-reported their ethnicity as Asian—due to a lack of statistical power, they were not included in further analysis.

Anthropometric measurements

Anthropometric measurements were recorded preoperatively. BMI was calculated as weight in kilograms divided by height in square meters. Participants’ height was measured on bare feet to the nearest 0.1cm using a wall stadiometer (SECA 216; SECA, Hamburg, Germany). Weight was measured in a light gown to the nearest 0.1kg using a digital weighing scale (SECA 877; SECA, Hamburg, Germany).

Echocardiographic EAT measurement

Patients underwent comprehensive preoperative echocardiography using commercially available machines (Vivid E9 or E95, GE Healthcare, Chicago, US). Images were digitally acquired and measured according to the recommendations of the American Society of Echocardiography. Standard 2-D, M-Mode and Doppler measurement were conducted. EAT thickness was assessed in the parasternal long axis view using a standardised method based on that of Iacobellis and Willens. Epicardial fat was identified on the right ventricular free wall between the myocardium and the visceral layer of the pericardium; it was measured inner edge (visceral pericardium) to inner edge (RV free wall). EAT thickness was measured at end-systole in three cardiac cycles using the aortic annulus as a reference. A line was drawn between the aortic valve annulus and the right ventricular free wall (Figure 1). The point with maximal EAT thickness within one centimetre on either side of where this line intersected the RV free wall was identified. EAT thickness was measured perpendicular to the RV free wall at this point. Intra-observer and inter-observer variability were calculated from 21 randomly selected subjects with excellent agreement; inter-observer and intra-observer interclass correlation coefficients were both over 95%.
Data analysis

The study data was analysed based on patients’ self-reported ethnicity; patients were classified into two groups: NZE or Māori/Pacific. Māori and Pacific groups were combined due to low numbers. Patient characteristics were summarised and reported as mean (SD) for normally distributed variables and frequency (percentage) for categorical variables. Differences between study groups (NZE versus Māori/Pacific) were assessed by two tailed t-test, Chi-squared test or Fisher's exact test as appropriate.

The sample size was calculated based on previously available evidence showing moderate correlation between EAT and BMI; our study had 80% power to detect moderate correlation (R²=0.18) between EAT and BMI in the simple regression model. The multiple regression analysis had 80% power to detect effect size (f²) of 0.18 based on previously available data regarding the expected correlation between tested variables and study outcomes after adjusting for other covariates. Alpha of 0.05 was used as the cut-off for significance.

Simple univariate regression was used to test the relation between EAT as a dependent variable and independent variables, including age, sex, ethnicity, BMI, triglycerides, diabetes, hypertension and LV mass index. Relationships between EAT and other independent variables were tested in the overall study group as well as in each ethnic group separately. Multiple regression was used to further assess the relation between EAT and BMI; the overall model R² is reported. For multiple regression models, age, sex, hypertension, diabetes, BMI were a priori selected predictors and were included into the base model irrespective of statistical significance. Other potential predictors included current smoking and LV echocardiographic parameters; predictors that were found to be significantly associated with study outcomes in the univariate analyses were considered as potential independent variables to be included in model. Backward elimination was then used to exclude statistically insignificant predictors from the final model. Testing for ethnicity as an effect modifier on the correlation between EAT and BMI was carried out by including BMI, ethnicity and an interaction term between ethnicity and BMI in a multiple regression model; further adjustment for other covariates was done in the way explained above for fitting the final multiple regression model. For all fitted regression models, model assumptions were assessed; model diagnostics to assess for linearity, normality of residuals, homoscedasticity,

Figure 1: A) Parasternal long axis view showing epicardial adipose tissue (EAT), pericardial adipose tissue (PAT) and the right ventricle (RV). B) EAT measurement at end-systole with a reference line drawn from AV annulus and the RV free wall; EAT was measured at the point of maximal EAT thickness within 1cm of where the line met the RV free wall.
multicolinearity, influential observations and leverage points were conducted. Testing for influential observations and leverage points did not result in the exclusion of any observations. Statistical analyses were conducted using R (R version 3.5.3, R Foundation for Statistical Computing, Vienna, Austria).

Results

Characteristics of the study population

Data were analysed for 205 patients: 164 (80%) NZE and 41 (20%) Māori/Pacific (28 Māori and 13 Pacific patients). All patients were undergoing open heart surgery with the majority (78%) having CABG surgery. Characteristics of the study population are presented in Table 1. Overall, the mean (SD) age of the study population was 67.9 (10.12) years and 74.6% of the study population were males. The study population mean (SD) BMI was 30 (5.72) kg/m² with Māori/Pacific patients having higher BMI compared to NZE. Māori/Pacific patients were younger and more likely to have diabetes mellitus type 2 in comparison to NZE patients (Table 1). Apart from left ventricular internal diameter in diastole and left ventricular mass index, which were both higher in Māori/Pacific compared to NZE, no significant differences in echocardiographic parameters were found between the two study groups (Table 1).

EAT thickness and BMI

In the overall study population, a univariate regression model showed that higher BMI was significantly correlated with EAT thickness (β=0.44, 95% CI: 0.32-0.57; R²=0.2, p<0.001). However, this relationship was ethnicity-specific: a significant association between EAT thickness and BMI was only seen in NZE (β=0.55, 95% CI: 0.40-0.69; R²=0.26, p<0.001): no association was observed in Māori/Pacific patients (β=0.17, 95% CI: -0.08-0.42; R²=0.05, p=0.17) (Figure 2). After adjusting for age, sex, diabetes, hypertension and ethnicity using a multivariate regression model, EAT thickness was still significantly correlated with BMI in the overall study population (β=0.47, 95% CI: 0.34-0.60; R²=0.21, p<0.001). In NZE, BMI remained significantly correlated with EAT thickness after adjustment for age, sex, diabetes and hypertension (β=0.56, 95% CI: 0.41-0.71; R²=0.27, p<0.001).

Ethnicity modified the association between EAT and BMI with the interaction term showing statistical significance both before (β=-0.78, 95% CI: -1.39--0.17; R²=0.23, p<0.05) and after adjusting for age, sex, diabetes and hypertension (β=-0.82, 95% CI: -1.45--0.19; R²=0.24, p<0.05). BMI was still a significant predictor of EAT after including the interaction term in the final adjusted model (β=1.99, 95% CI: 1.18--2.8; R²=0.23, p<0.001).

EAT thickness and lipid parameters

Triglycerides were modestly, although statistically significantly, correlated with EAT thickness in the study population using a univariate regression model (β=0.24, 95% CI: 0.1--0.4; R²=0.06, p<0.001). This association differed according to ethnicity, being significant in NZE (β=0.32, 95% CI: 0.16--0.48; R²=0.1, p<0.001) and not significant in Māori/Pacific. Total cholesterol, HDL and LDL cholesterol were not significantly correlated with EAT thickness. Adjusting for age, sex, diabetes and the use of statins showed only modest modification of the association between EAT thickness and triglycerides (β=0.23, 95% CI: 0.08--0.38; R²=0.06, p<0.05).

EAT thickness and other covariates

EAT thickness showed no significant association with age, sex, diabetes, hypertension or current smoking. EAT thickness showed weak association with left ventricular posterior wall thickness (LVPW) (β=0.15, 95% CI: 0.01--0.3; R²=0.02, p<0.05), which was found insignificant after adjusting for ethnicity (R²=0.03, p =0.08). There was no significant association between EAT thickness and left ventricular internal diameter at end-diastole (LVIDD), interventricular septum thickness (IVS), LV mass index or LV ejection fraction.
Table 1: Characteristics of the study population overall and by ethnicity.

<table>
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<tr>
<th></th>
<th>NZE (n=164)</th>
<th>Māori/Pacific (n=41)</th>
<th>Total (n=205)</th>
<th>P-value</th>
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<tr>
<td>Age (years), mean(SD)</td>
<td>69.1 (9.5)</td>
<td>63.5 (11.4)</td>
<td>67.9 (10.1)</td>
<td>&lt;0.001*</td>
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<td>Sex</td>
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<tr>
<td>Male, n (%)</td>
<td>120 (73.2)</td>
<td>33 (80.5)</td>
<td>153 (74.6)</td>
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<td>Female, n (%)</td>
<td>44 (26.8)</td>
<td>8 (19.5)</td>
<td>52 (25.4)</td>
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<tr>
<td>BMI (kg/m²), mean (SD)</td>
<td>29.6 (5.5)</td>
<td>31.8 (6.2)</td>
<td>30.0 (5.7)</td>
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<td>BSA (m²), mean (SD)</td>
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<td>2.0 (0.2)</td>
<td>2.0 (0.2)</td>
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<td>Smoker, n (%)</td>
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<td>3 (7.3)</td>
<td>18 (8.8)</td>
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<td>Ex-smoker, n (%)</td>
<td>71 (43.3)</td>
<td>24 (58.5)</td>
<td>95 (46.3)</td>
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<td>Non-smoker, n (%)</td>
<td>78 (47.6)</td>
<td>14 (34.2)</td>
<td>92 (44.9)</td>
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<td>Type 2 diabetes, n (%)</td>
<td>32 (19.5)</td>
<td>14 (34.2)</td>
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<td>HbA1c (mmol/mol), mean(SD)</td>
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<td>42.7 (15.7)</td>
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<td>Triglycerides (mmol/L), mean(SD)</td>
<td>1.6 (0.7)</td>
<td>1.6 (0.8)</td>
<td>1.6 (0.8)</td>
<td>0.80a</td>
</tr>
<tr>
<td>Statin, n (%)</td>
<td>122 (74.9)</td>
<td>33 (80.5)</td>
<td>160 (75.6)</td>
<td>0.42b</td>
</tr>
<tr>
<td>Hypertension, n (%)</td>
<td>95 (57.9)</td>
<td>25 (61.0)</td>
<td>120 (58.5)</td>
<td>0.72b</td>
</tr>
<tr>
<td>SBP (mmHg), mean (SD)</td>
<td>135.9 (21.4)</td>
<td>137.1 (29.5)</td>
<td>136.2 (23.2)</td>
<td>0.97a</td>
</tr>
<tr>
<td>DBP (mmHg), mean (SD)</td>
<td>75.3 (12.7)</td>
<td>78.2 (16.4)</td>
<td>75.9 (13.5)</td>
<td>0.37a</td>
</tr>
<tr>
<td><strong>Echocardiography</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IVS (cm), mean (SD)</td>
<td>1.2 (0.2)</td>
<td>1.2 (0.2)</td>
<td>1.2 (0.2)</td>
<td>0.16a</td>
</tr>
<tr>
<td>LVPW (cm), mean (SD)</td>
<td>1.0 (0.2)</td>
<td>1.1 (0.2)</td>
<td>1.0 (0.2)</td>
<td>0.05a</td>
</tr>
<tr>
<td>LVIDD (cm), mean (SD)</td>
<td>4.8 (0.6)</td>
<td>5.0 (0.9)</td>
<td>4.9 (0.7)</td>
<td>0.03a</td>
</tr>
<tr>
<td>LVIDS (cm), mean (SD)</td>
<td>3.3 (0.7)</td>
<td>3.1 (1.0)</td>
<td>3.3 (0.8)</td>
<td>0.65a</td>
</tr>
<tr>
<td>EF (%), mean (SD)</td>
<td>54.7 (9.9)</td>
<td>55.3 (12.2)</td>
<td>54.8 (10.4)</td>
<td>0.98a</td>
</tr>
<tr>
<td>LV Mass Index (g/m²), mean (SD)</td>
<td>98.8 (27.0)</td>
<td>114.8 (35.3)</td>
<td>101.9 (29.4)</td>
<td>0.003a</td>
</tr>
<tr>
<td><strong>Surgery type</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAGB only, n (%)</td>
<td>106 (64.6)</td>
<td>29 (70.7)</td>
<td>135 (65.9)</td>
<td>0.46b</td>
</tr>
<tr>
<td>AV/MV surgery only, n (%)</td>
<td>34 (20.7)</td>
<td>7 (17.1)</td>
<td>41 (20.0)</td>
<td>0.6b</td>
</tr>
<tr>
<td>Combined surgery, n (%)</td>
<td>24 (14.6)</td>
<td>5 (12.2)</td>
<td>29 (14.2)</td>
<td>0.69b</td>
</tr>
<tr>
<td>Rheumatic heart disease, n (%)</td>
<td>2 (1.2)</td>
<td>2 (4.9)</td>
<td>4 (2.0)</td>
<td>0.18c</td>
</tr>
<tr>
<td>EAT thickness (mm), mean (SD)</td>
<td>6.2 (2.2)</td>
<td>6.0 (1.8)</td>
<td>6.1 (2.1)</td>
<td>0.61a</td>
</tr>
</tbody>
</table>

BMI, body mass index; BSA, body surface area; SBP, systolic blood pressure; DBP, diastolic blood pressure; IVS, interventricular septal thickness; LVPW, left ventricular posterior wall thickness; LVIDD, left ventricular internal diameter at end-diastole; LVIDS, left ventricular internal diameter at end-systole; EF, ejection fraction; CABG, coronary artery bypass grafting; AV, aortic valve; MV, mitral valve; EAT, epicardial adipose tissue.

*P-value, t-test between NZE and Māori/Pacific.

bP-value, Chi-square between NZE and Māori/Pacific.

cP-value Fisher’s exact test between NZE and Māori/Pacific.
Figure 2: Association between EAT thickness (mm) and BMI (kg/m²) by ethnicity. Line represents univariate linear regression.

Figure 3: Association between EAT thickness (mm) and triglycerides (mmol/L) by ethnicity. Line represents univariate linear regression.
Discussion

Our study showed important ethnic differences in the relationship between BMI and EAT thickness in a sample of high cardiovascular risk patients. Specifically, EAT correlated with BMI and triglycerides in NZE but not Māori/Pacific patients. This study extends on research into the disparity in cardiovascular disease risk between NZE and Māori/Pacific people that demonstrates differences in demographics as one of the underlying causes of higher cardiovascular disease risk in Māori/Pacific.\(^{11}\) Māori/Pacific patients in our study had higher BMI, lower age and a higher prevalence of type 2 diabetes. Further to these commonly described differences, we demonstrated a moderate, significant association between EAT thickness and BMI in NZE, that was not significant among Māori/Pacific people. The use of BMI as an indicator for cardiovascular disease risk among Māori/Pacific may be misleading and contribute to the disparate outcomes in Māori/Pacific people.

EAT is considered a visceral fat depot; thus, its thickness was hypothesised to correlate with BMI (as a measure of obesity).\(^{10,12,24}\) However, the association between EAT and BMI is inconsistent in previous research; some studies reported moderate to strong associations\(^ {29,32,33}\) while others showed either a weak or an insignificant association.\(^ {24,34,35}\) In addition, unlike other visceral fat depots, EAT adipocyte size is not related to BMI.\(^ {36}\) In a meta-analysis discussing the association between EAT and measures of obesity, a significant moderate relationship between EAT and BMI was highlighted,\(^ {24}\) which we confirmed in NZE.

Ethnic differences in visceral adipose tissue (VAT) as well as in the association between VAT and BMI have been previously highlighted.\(^ {37–40}\) In a multi-ethnic study, the association between visceral fat, BMI and waist circumference was investigated in a sample of African American, Hispanic and White men and women; the linear relationship slope between BMI and VAT was lowest in African Americans in comparison to Whites and Hispanics.\(^ {41}\) The impact of ethnicity on the association between EAT in particular and BMI has only been investigated in a limited number of studies. Ethnic differences in cardiovascular fat volumes (EAT and pericardial adipose tissue assessed by electron-beam CT scanning) as well as the association between EAT and measures of adiposity were found between Black and White midlife women in the US.\(^ {42}\) Similarly, ethnic differences in cardiac fat volume, assessed by echocardiography, and its association with BMI was shown in middle aged men of different ethnicities.\(^ {43}\) Along the same lines, a significant difference in the epicardial and pericardial fat thickness, assessed by echocardiography, between African American and non-Hispanic White men was reported.\(^ {44}\) Our findings are in agreement with previously reported findings showing ethnic differences in EAT thickness and its relationship with anthropometric measures.

Additionally, our findings build on the previously reported differences in body composition between Māori and Pacific people in New Zealand and NZE. In New Zealand, Māori were reported to be leaner in comparison to NZE for similar BMI.\(^ {44,45}\) In their study, Rush et al analysed the association between BMI, body fatness, fat distribution as well as other anthropometric and metabolic variables in a population including Māori, Pacific Island, European and Asian Indian adults in New Zealand, finding ethnic differences in body fatness and distribution.\(^ {46}\) This has led to a call to move away from simple BMI measurements as an assessment of adiposity as part of such screening programmes as the B4 School Check.\(^ {47}\)

While a moderate association was previously shown between triglycerides and EAT thickness,\(^ {30,46–50}\) we observed a weak relationship that was only significant in NZE. Although our findings are in agreement with other studies reporting weak or insignificant association between triglycerides and EAT,\(^ {44,51}\) several other confounding variables may have affected the strength of the relationship between triglycerides and EAT. Our analysis was adjusted for the intake of statins; however, the duration of treatment was not verified before having the lipid profile assessed.

The findings of our study should be interpreted within its limitations. The study was a retrospective analysis of participants, involving the extraction of clinical and demographic data from patients’ records.
Combining two separate groups (Māori and Pacific) may have led to obscuring important differences between these groups, and larger studies should ideally attempt to analyse groups separately. However, there was no obvious difference between the two groups (Figure 2). Data regarding anthropometric measurements such as waist circumference, waist to hip ratio as well as quantitative assessment of visceral adiposity and body composition were not available due to the nature of the study. While visceral fat has been previously shown to be correlated with dietary factors as well as lifestyle factors, the association between these factors and EAT has not been previously studied. Studying the impact of these factors on the association between EAT and BMI in different ethnic groups in New Zealand would necessitate further research including participants at a wide range of cardiovascular risk. Our sample was recruited from patients having open heart surgery, mostly CABG, which represents a special high-risk population. A dedicated formula to calculate the visceral fat from height and weight in Māori/Pacific is not available, to the best of the authors’ knowledge; using available formulae which are not ethnicity specific could have led to inaccurate calculations as differences in body composition between Māori/Pacific and NZE have been previously reported. Finally, our echocardiographic measurement of EAT has recognised limitations, with volumetric assessment by MRI or CT likely to provide a more accurate assessment of total epicardial adipose burden. However, echocardiography has the advantage of widespread availability, and EAT measurement is highly reproducible.

Our study is the first to investigate the differences in this relationship between NZE and Māori/Pacific people. The findings of our study corroborate those of other studies that have investigated differences in the relationship between BMI and EAT among other ethnic groups. Importantly, there are inequalities in cardiovascular risk reported among many of the ethnic groups where BMI is not correlated with EAT thickness. We also have shown that the association between BMI and EAT thickness was ethnicity specific; BMI was associated with EAT thickness in NZE patients, but not in Māori/Pacific patients. Our findings, in addition to previous research, indicate that the same level of BMI can carry different connotations of risk in different ethnic groups, with BMI likely being an inconsistent measure of obesity in Māori/Pacific patients.

Competing interests: Nil.

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“It is through shared conversation, that I understand”—Māori older adults’ experiences of medicines and related services in Aotearoa New Zealand

Joanna Hikaka, Rhys Jones, Carmel Hughes, Nataly Martini

**ABSTRACT**

**AIM:** An understanding of patients’ healthcare experiences and perceptions is essential for developing new health services. In Aotearoa New Zealand, inequities in health outcomes exist, with Māori experiencing worse health outcomes than non-Māori. This includes poorer access to, and quality of, prescribed medicines. This study aims to explore kaumātua (Māori older adults’) experiences of medicines and medicine-related services in New Zealand.

**METHOD:** This qualitative research applied kaupapa Māori theory and explored Māori older adults’ experiences of medicines and medicine-related services in New Zealand. Ten kaumātua from Auckland, New Zealand participated in semi-structured interviews. Reflexive thematic analysis was used to analyse data.

**RESULTS:** Three themes were generated: 1. diverse, multi-dimensional realities of medicine-taking for Māori with ageing; 2. medicines supply as a business transaction; and 3. self-determined agency of kaumātua supported by authentic healthcare partnerships. Kaumātua expressed their ability to retain power and control over their medicine therapy and their desire for this to occur within a supportive, authentic partnership model that involves them and their multiple healthcare providers.

**CONCLUSION:** Māori older adults have the ability, desire and right to control their medicines journey in a way that is relevant to their experiences of medicines. They value support from authentic healthcare partnerships in enabling this.

Patients’ experiences of healthcare services are important, not only in evaluating current services, but also for improving them. The centrality of patient experience to service design is explicit in Māori approaches to research and service development. The right of Māori to meaningfully participate in health is further guaranteed in law, under the Treaty of Waitangi, one of Aotearoa New Zealand’s founding documents, and supported in national policy. The need for inclusion of patients’ experiences and ideas throughout the health services development process has gained momentum in mainstream understanding of health service development in the last decade, often under the title of co-creation, co-production or co-design. Despite law and policy that requires Māori participation and partnership in health, New Zealand systems have failed to protect and facilitate that right. These failures in the health system (in addition to differential resource distribution influencing social determinants of health such as education, employment and housing)
occur across a wide spectrum of clinical contexts,6,7 and result in Māori experiencing poorer health outcomes including higher rates of chronic disease, and reduced life expectancy, compared to non-Māori.8 These inequities, contributing factors and disparate health outcomes are seen between Indigenous and non-Indigenous populations across the world.9 Past experiences of healthcare influence future engagement and there is a need for engagement to be guided by the patients’ needs rather than those of the clinicians.10

Although medicines are used to alleviate symptoms of disease and improve health and wellbeing outcomes, they are also associated with harm, with Māori bearing this burden disproportionately.11 Māori are more likely to be prescribed medicines associated with higher risk of adverse outcomes, and less likely to be prescribed medicines used to prevent chronic conditions, compared to non-Māori,12 a disparity which may be increasing over time.13 Ensuring optimal medicines use is essential for Māori older adults who identify medicine use as a major influence on their wellbeing.14

The way in which medicines-related care is delivered impacts people’s ability to access medicines. Patient-practitioner relationships, including those with the pharmacist, influence management of chronic medical conditions and medicines.15 In New Zealand, supply of prescription medicines is almost entirely via community pharmacies with over 1.3 million people visiting these 1,000-plus pharmacies every month.16 The delivery of medicines-related care from pharmacies may not be meeting the needs of Māori who report a perceived lack of cultural competence and ineffective communication leading to patient-perceived failures of care and poorer health outcomes.17 Examination of previous experiences of medicines and health services is important when understanding future service delivery and access. Negative experiences can adversely influence future engagement with, and trust in, health professionals and treatment plans, despite Māori perceiving themselves to be engaged, with proactive ‘health-seeking’ in their behaviour.18

Health services which support ‘optimal’ medicines use, which include pharmacist-facilitated medicines reviews, delivered within a culturally appropriate and safe model for Māori, has been identified as a key contributor to achieving health equity for Māori.19 Although pharmacists have traditionally been viewed in a technical capacity to facilitate the supply of medicines, there is growing realisation of the need for pharmacists to be utilising their full set of skills and supporting optimal medicines use.16 Medicines review services involve a structured and critical review of medicines by health professionals, in partnership with the patient. The aim of these reviews is to develop an agreed medicines treatment and monitoring plan that improves the quality, safety and effectiveness of medicines use.20

In New Zealand, medicines review services range from adherence-based interventions to a comprehensive review considering the full clinical picture and often in collaboration with multi-disciplinary teams.21 They occur in a range of settings including the community pharmacy, a patient’s home, within a primary healthcare organisation (including general practitioner (GP) practice), residential aged care facilities, in secondary care (in either the inpatient or outpatient setting) or other community settings (for example, community centres).

Pharmacist-facilitated medicines review services for older adults have been shown internationally to improve prescribing and reduce adverse drug events,22,23 however, there is little evidence to show the effectiveness of medicines review interventions for older adults in the New Zealand setting.24 At a national level, existing services do not explicitly respond to the needs of Māori in a way that is culturally safe or appropriate, and the contribution they may make to achieving health equity in New Zealand remains unknown.24

Our research group aims to develop a pharmacist-facilitated medicines review service for community-dwelling Māori older adults. This is a complex intervention due to the multiple interacting components and practitioners involved25 and multiple phases are required in the development of the intervention, including review of literature and the identification/development of the theory underpinning the change process for the intervention to be studied, through engagement with stakeholders.25
Understanding the needs and experiences of service users informs this and is central to kaupapa Māori service development.

The aim of this current study was to explore Māori older adults' experiences of medicines and medicine-related services in New Zealand.

Ethics approval was granted by Northern A Health and Disability Ethics Committee, New Zealand (17/NTA/271) and the Te Whānau o Waipareira Ethics Committee (2017), New Zealand.

Methods

A qualitative approach with application of kaupapa Māori theory was chosen to allow in-depth topic exploration within a culturally appropriate framework. Kaupapa Māori theory aims to normalise and centre research around Māori world views and ways of doing, and to give Māori power in the research process. It acknowledges the influence researchers have in shaping research processes and outcomes, and intends positive, transformative change for Māori. Kaupapa Māori theory may often be applied within methods and tools seen in mainstream Western research in a way that upholds the core principles of kaupapa Māori theory.

Recruitment, participants and data collection

Semi-structured interviews were conducted by the lead author (JH), with consented kaumātua (Māori older adults) who were volunteers recruited from two kaumātua groups in Waitematā District Health Board (WDHB), Auckland, New Zealand. The kaumātua groups met at least monthly, were open to those over the age of 55, and attended by registered members and guests. The purpose of the groups was to encourage social connection, and to inform, and gather support for relevant community activities. JH presented the research topic and asked for volunteers who met eligibility criteria. Kaumātua were eligible if they were: Māori; community-dwelling; 55 years or age or older; taking five or more medicines for at least three months. Those who were unable to give informed consent were excluded. The age inclusion was chosen as Māori experience onset of chronic conditions from an earlier age and services related to ‘older adults’ are often accessible to Māori at this younger age in New Zealand. Participants were able to invite family/support people to attend and be involved in the interview. Participants were asked to provide written consent face-to-face, prior to interview commencement. Interviews were conducted in a place of the participants’ choosing, and participants were given the choice to be interviewed and respond in either English or te reo Māori (Indigenous language of New Zealand). Participants were given a koha (gift for participation) and kai (food) to support the development of a reciprocal relationship and acknowledge the value of their participation. Whakawhanaungatanga (getting to know each other and establishing connections) occurred prior to and during interviews to encourage Māori cultural norms, recognise the importance of connections to land, people and place and support a more equal power relationship in the research process. Pseudonyms were used in place of the participants’ real names. Participants were given the option at point of consent to choose this for themselves or allow one to be assigned to them. Participants could choose any name. Where one was assigned, participants were informed of what it was and had the option to change it. This method allowed participants to choose how they were identified, to see themselves in the reporting of results but in an anonymised way and offered them more power in the process.

Demographic questions were asked in addition to 14 open-ended questions relating to participants’ experiences of medicines, and medicine-related health services, medicines education services and medicines review services. Interview questions were informed by review of the literature relating to patients’ experience of healthcare and pharmacy services; experience of these services by Māori; the research team’s experience of healthcare development and delivery. Participants were also asked questions relating to new service design including where the service should be delivered and by whom, what aspects would be important when designing the service, and what would be markers of service success.
Data analysis

Interviews were audio recorded, transcribed verbatim and checked for accuracy. Participants were given the opportunity to review transcripts, clarify points and remove aspects they did not want included in data analysis. Reflexive thematic analysis was used to analyse the data. This is a six phase process, where codes are inductively generated through the analysis process. Interview transcripts were read and coded by JH over a period of months in NVivo qualitative data analysis software (QSR International Pty Ltd. Version 12, 2018). Codes were then grouped together to generate themes, reviewed in the context of the ‘evidence’ (interview transcripts) and reformulated to ensure the themes captured distinct yet connected meaning. JH led the analysis of data with regular face-to-face meetings with RJ and NM to discuss data, codes and thematic development with decisions being made by consensus. Findings were presented to the kaumātua groups to allow for wider discussion and to seek validation of the findings. Quotes are inserted verbatim.

Positionality

Analysis was undertaken by JH, a Māori pharmacist with professional experience of providing medicine review services for Māori and non-Māori older adults within WDHB in the hospital and community setting. She also supported her own grandparents as they aged in relation to medicines management and navigating the health system. JH acknowledges the duality of her status as both an insider and outsider in the research. She is an insider in relation to Māori ethnic whakapapa (genealogical connections) and identity as well as being a community member and health user in WDHB, and an outsider being a researcher and health professional schooled mainly within Western and biomedical paradigms, as well as generationally, where most participants identified her in a relational position more akin to their children or grandchildren than with their generation.

Results

Interviews were conducted with 10 kaumātua between March and June 2018 with the majority of interviews taking place in the participants’ homes. Participants were recruited from two different kaumātua group meetings. Participants ranged in age from 68–90 years (median of 76 years) and were on a median of six regular medicines each (ranged from 5–13). All participants resided permanently in Auckland, New Zealand’s largest city, however had whakapapa (genealogical connection) to iwi (tribes) from across the North Island of New Zealand. Visits with participants were for a median time of 76 minutes (40–180 minutes) with the recorded interview taking a median of 26 minutes (15–72 minutes). All interviews were conducted in English with the majority including some te reo Māori words or phrases. None of the participants included family or support people in the interview, however, some interviews took place while family members were present in the house and could often hear the conversation.

Interview data was assembled into three themes: 1. diverse, multi-dimensional realities of medicine-taking for Māori with ageing; 2. medicines supply as a business transaction; 3. self-determined agency of kaumātua supported by authentic healthcare partnerships. In summary, Māori older adults wanted to be in control of their medicines journey in a way that reflected their individual needs and realities, and for control to be truly enabled, it had to occur within a context of an authentic partnership with health professionals and health services where they were provided with the information and support needed to make informed decisions.

Diverse, multi-dimensional realities of medicine-taking for Māori older adults

This theme covered Māori older adults’ experiences with medicines and medicines-related services and the impact these have on multiple dimensions of health, namely, physical, mental and spiritual states and social connectedness. The diversity, rather than homogeneity, of medicines-related experiences of Māori older adults across these dimensions was also explored. This theme discussed how participants’ identity as older adults influences medicines-related experiences.
Diverse, multi-dimensional experiences

The effects of medicines were described as both beneficial and harmful across these multiple dimensions of wellbeing, often simultaneously, and perceptions of medicines were guided by experience. Hinemoa described that being on medicines allowed her to do “everything”, while Hana reported that “everything’s bad” since starting medicines, with medicines playing “a horrible part” in her life. In keeping with the holistic view of Māori health and wellbeing, participants reported not only aspects relating to their physical health but also how medicines could affect other aspects, such as social connectedness, which they also regarded as important to overall wellbeing. Medicines therapy has a positive impact on mobility, thereby increasing the ability to participate in social interactions and activities.

“AA: What do medicines allow you to do?”

“To walk! And move around as well as I can. A lot of people say I’m good for 90 plus... but without those tablets I don’t think I would be able to do it.” (Ana, 90, female)

“I can walk around, can play sport, mix and mingle, go to the kaumātua hui (meeting). Be up and about.” (Wiki, 76, male)

However, adverse effects of medicines also impacted significantly on physical and mental wellbeing.

“I feel like my body has changed since I have taken my tablets... I don’t feel well, [it’s] all the time and I’m depressed... sometimes I don’t know whether it is better to die than to take them.” (Hana, 79, female)

Perception of self was also linked to medicine use. A number of participants described that their mana (self-esteem, pride, standing) was negatively impacted by taking medicines. This was linked to taking medicines in general and also the adverse effects resulting from them. Beth (75 years, female) reported that she had not told her family she was on medicines as it may have adversely affected her image of being “Super Nanny”. Mere described that one medicine caused extensive bruising and she thought that the cause of this bruising would be misinterpreted.

“...it looked like somebody had beaten me up, you know, I would be bruised all over the place.” (Mere, 70, female)

Participants expressed that these multiple aspects should be taken into account when medicines were prescribed:

“You would hope that the medicines you are getting is the best that is available for that, for your particular case.” (Mārama, 71, female)

However, this was inconsistent with how they saw services actually being delivered:

“We are all built differently and we are all, you know, we might all have the same, like, heart and a lung and a kidney and that, but we all kind of still function a little differently from one another, but they give one medicine to suit all human beings and I think that’s wrong.” (Hana, 79, female)

Participants’ views on medicines were not fixed through their life course. There was fluidity, whereby their experiences of medicines influenced their perception of, and trust in, medicines. For some, being on medicines increased trust, while the experience for most participants was that they were unable to notice a benefit from medicines and had questioned whether it was all “smoke and mirrors” (Weka, 68, male).

“To be honest with you, I never liked pills, I never believed in pills, but I have seen what it had done for me and so I have changed my attitude.” (Beth, 75, female)

“I am taking them regularly day and night so, you know, so, and I don’t know whether that is making that much difference. Or maybe it is and I just don’t know.” (Mārama, 71 years, female)

This data highlights the multi-dimensional impact of medicines-related experiences of kaumātua and the diversity of these experiences.

Older adult identity

Participants reported that their reality of being an older adult negatively impacted on treatment offered to them, both in terms of medicines prescribers chose to offer them and the way in which they were treated.

“I’m thinking all these blimmen doctors know what these pills are doing to people and in myself, I’m thinking, they just want to target the older people because older people are more likely to use all of those medicines than younger people so the idea is, use these older people as guinea pigs.” (Mere, 70 years, female)
“So, if you get some young person saying to you ‘well you’re old mate, put up with it’ it’s a bit self-deflating, you know, not so much a put down it’s just that it’s the way the message is delivered.” (Weka, 68 years, male)

Hana described how she was reluctant to discuss any medicine-related adverse effects with her doctor as “I think they'll only bung it off as old age or something”. (Hana, 79, female)

Participants did feel that age was an important consideration when prescribing and reviewing medicines. There was a general understanding that changes in the body with age meant that medicines would be handled differently by the body. However, they framed this in a more positive way—whereby extra care should be taken with people as they aged due to the changes occurring in the body.

“The body changes, and it changes really dramatically by the time you reach 80 anyway, so a lot of things are happening for kaumātua and kuia (older women) from say 70, 70 plus, and if we are surviving to say 80 plus, that’s a bonus, that’s good, so I suppose there needs to be some kind of, yeah, some kind of, how shall we say it, where that there’s a little centre, just like, however, however it is designed, that our kaumātua and kuia go and talk...” (Hōne, 78 years, male)

The quote from Hōne above not only reflects understanding of the biophysical changes of ageing, leading to changes in how the body processes medicines, but that there are cultural differences afforded with age which should influence the approaches we take in relation to service delivery.

Medicines supply as a business transaction

This theme explored medicines as a commodity, with the supply being undertaken as a task devoid of the professional relationship that is usually associated with the cultural and compassionate medicines therapy and healthcare. Also included in this theme was participants’ acceptance of this way in which services are delivered, with past experiences guiding expectations. This was demonstrated both through the way in which experiences of medicine supply services (usually through community pharmacies) were described and also when relaying markers of ‘good’ pharmacy services.

Medicines supply without healthcare relationship

Participants reported a lack of relationship development from their pharmacist and pharmacy staff. This did not appear to be viewed as a failing of their particular pharmacy, but a comment on the nature of pharmacy and medicine supply itself. Participants commented that the pharmacy interaction largely related to medicine supply, just a process that itself was the last step in a long chain required to get access to a medicine. People seemed to be treated “the same” within this process, with participants feeling like they were “just a number” (Hana, 79, female).

“To me they are, the way I see, they treat everybody the same, they greet everybody and, yeah, and [it’s just] a process.” (Richie, 82 years, female)

Wiki described that for him, the medicine supply process was removed from any other aspect of healthcare and that this could occur in a void of connectedness with pharmacy staff.

“I only go to get script medicines. I don’t know who they are, whether they are good or bad people.” (Wiki, 76 years, male)

In our study, few participants discussed experiencing the delivery of surrounding support and care from pharmacies although Hōne did describe appreciating his pharmacy service as he felt he was part of the “pharmacy whānau (family)”. Wiki described this in relation to the absence of poor interactions rather than the presence of meaningful ones.

“I don’t have much to do with them except to say there is a long waiting time. They don’t give you a hard time.” (Wiki, 76 years, male)

Acceptance of pharmacists as medicine suppliers

The general feeling among participants was that pharmacists were acting appropriately in this role as ‘medicine-supplier’. This view was informed by their experiences of pharmacy services, where the majority had not received medicines information or education support from within pharmacies. Although participants felt they needed more medicines-related information, it was not generally sought from pharmacists/pharmacies. Nor was it expected that this would, or should, come from pharmacists or
pharmacy staff, but from their GP or staff at the medical centre.

The concept of what made a ‘successful’ pharmacy service was explored in the interviews, with most participants valuing the services in relation to convenience, timely supply of medicines without error, which further supported the participants’ view of the transactional, medicine-supply nature of pharmacy services in New Zealand.

“They are very, very good, I will always, I recommend them to anybody, you know, they will attend to you immediately... and they have never [made a mistake], as far as I can tell—I always check my pills to make sure they are the right ones—they are not giving me something else, mmm, so they are very good pharmacists.” (Beth, 75 years, female)

Self-determined agency of kaumātua supported by authentic healthcare partnerships

This theme explored the desire and willingness of kaumātua to control their medicines-related health. To enable this, kaumātua needed to be given power within the healthcare partnership. Included in this theme was the concept that kaumātua valued the formation of authentic healthcare partnerships in order to exert this control. The desire, willingness and right to control medicines journey

Participants talked of their right to make decisions about their health—that health professionals were there to enable access but that ultimately it came back to allowing the patient to make the final decision for themselves:

“...a doctor is just there to prescribe, not to tell you... to take them or anything.” (Mārama, 71, female)

One participant expressed this by talking of the patient’s responsibility to look after their health and that medicines should only play a limited part of this.

“I don’t think [medicines] are meant to cure, I think we all have to cure ourselves and that’s our lifestyles, how to do that.” (Beth, 75, female)

For Weka, his feeling of responsibility was an act of self-preservation with the notion that an individual is their own best advocate:

“You realise as you get older unless you actually pursue it yourself, it’s... (shrugs).” (Weka, 69, male)

This sense of responsibility for their own health-led participants to seek further information. They offered numerous examples of situations where they assumed the role of leading conversations with health professionals about their medicines treatment. Examples below involve participants recounting conversations with their GPs.

“I said, ‘No I don’t want to take that other stuff, it makes me sick. All the time I feel sick’, and she said, ‘It’s alright’. I said, ‘Why I can’t take Disprin... Why can’t I take that?’ She said, ‘well it’s not as effective as the dabigatran’. I said ‘Oh, but I’ve heard it from other people, they take it, can I have it?’. “ (Mere, 70, female)

Participants also took control and sought information from other sources, with most accessing the internet as at least one source, to enable them to make decisions.

“Sometimes I look on the computer... But it doesn’t tell you a heck of a lot, you know for the side effects and that.” (Hana, 79, female)

Valuing authentic healthcare partnerships

Despite kaumātua expressing a desire and ability to control their medicines-related health, they wanted this to occur within an authentic healthcare partnership. One participant explained how a strong relationship with his pharmacist was formed when the pharmacist shared that he also took medicine:

“You occasionally run into chemists who will, what’s the word, enlighten you. So, they explain to you about various side effects and relevant information like ‘I’m a chemist. I’m around the same age as you and I have to take these pills as well’: “ (Weka, 69, male)

For Weka, the sharing information led to a shared relationship with his pharmacist—they were both ‘medicine-takers’ and health consumers, making it easier to take medicines information on board.

The perceived intent of the health professional also contributed to the ability to form a wellbeing partnership. It was important to participants that they felt that health professionals cared about them and their
wellbeing, which supported the development of trust. Participants also felt that they were good judges of character, experience that had come with age.

“Kuia (older female), kaumātua have been around for many years. They’ve been around and they know what a person brings. They know that ‘Hey, that person is sincere; that person wants to look after us’. Their experience of how they’ve dealt with people in the past—they can read people…” (Mere, 70, female)

To create an authentic partnership, the participant and health professional needed to be equally powerful and equally engaged in the interaction. Weka described this using a Māori phrase—“No te whitiwhiti kōrero, i mohio ai (it is through shared conversation, that I understand)”. Hōne also discussed the importance of talking; believing that adopting the equally powered ‘conversation’ model to medicines reviews services was central to the whole model.

“We are looking at sitting down and having a good little kōrero (talk) and bringing that kind of understanding, yeah. I think that, to me, that could be valid thing, aye. Never seen or heard before!” (Hōne, 78, male)

These partnerships had to extend beyond personal relationships—participants’ wellbeing did need to be central to the relationship of the healthcare partnership. Participants described non-malicious failures of care, whereby, despite the health professionals’ best intentions, the relationship did not provide outcomes which improved wellbeing. When describing this, participants talked of how they did not receive information needed to make decisions, or it was delivered in a way that was difficult to understand, thereby removing the ability of kaumātua to take control. Participants recognised that health professionals were “trying”; however, they were still left in a situation where they felt they were not receiving the appropriate healthcare.

The concept of partnership extended beyond two parties; participants had the expectation that all health professionals involved in a patient’s care were working in a connected and collaborative way. This expectation was expressed through confusion over conflicting information and difficulties in navigating the fragmented health system.

“I really don’t know who to listen to, because specialists say one thing, the doctors are saying one thing and the pharmacists are just making it up as they say, you know, just reading the prescription and doing as they are told.” (Hana, 79, female)

“I didn’t know what any of this was about, what services were available. They weren’t linked up. I didn’t know what (was happening) and no one wants to talk about it. I want to know the process to go through to get help.” (Wiki, 76, male)

The power that kaumātua felt in their relationships with health professionals and the health system, and therefore the amount of control participants assumed for themselves, was influenced by past experiences of medicines and medicines-related services. Hana described that medicines-related side effects influenced whether she would continue taking new medicines and how having information about potential benefits of the medicines allowed her to make a balanced, informed decision.

“That’s why I feel like just throwing them, like I did with the cholesterol stuff, you know, but I don’t think this one is a wise thing to do because it involves my heart.” (Hana, 79, female)

Participants recognised that their experiences guided their negotiated position and therefore that their desire for control may be different from others.

“[Other kaumātua say] ‘Oh what are you doing chasing them up about your heart condition, you know, just take your bloody pills and get on with your life.’ And, well, he doesn’t suffer from side effects, you know…” (Weka, 69, male)

**Discussion**

This study found that kaumātua medicines and medicines-related services impacted on their minds, bodies and social relationships. Pharmacists were viewed as acting appropriately in the role of medicine-supplier, with service success being based on operational tasks. Kaumātua expressed the ability, desire and right to control their medicines journey and valued authentic healthcare
relationships to support this. These findings are important when developing future pharmacist-facilitated medicines review for Māori older adults.

Māori models of wellbeing and health are holistically framed\textsuperscript{35,36} with consideration given physical, mental and spiritual states, as well as their impact on family and social connections. The multi-dimensional understanding, impact and required response is an important consideration when developing medicines-related services for kaumātua. This data highlights the multi-dimensional impact of medicine-related experiences by kaumātua and the need to understand the patient’s goals of therapy, and the level of potential for medicines-related harm they are willing to accept, to achieve these outcomes. It highlights deep understanding by kaumātua that what is ‘right’ for one person may not be appropriate for another, and the need for individualisation of medicines therapy. The multiple dimensions which contribute to and influence wellbeing are often incorporated into Māori service design and evaluation\textsuperscript{37,38} and will be important to consider when implementing and evaluating medicines review services for kaumātua.

The diversity of responses from participants around their experiences and the relevance placed on each of these dimensions of wellbeing by different individuals is also important to note. Although the comparison between Māori and non-Māori is useful for the purposes of examining health outcomes for Māori in the context of equity, it can lead to the homogenisation of Māori as one distinct, uniform group, which ignores the ‘diverse Māori realities’, also described as the ‘denial of a plurality’.\textsuperscript{39} In contrast, kaupapa Māori research centres on whakapapa (genealogical connections), makes space for the diversity of Māori\textsuperscript{41} and allows the acknowledgement of this diversity to be incorporated into research practices and health service design. To account for the diversity in experiences for Māori older adults, medicines review services need to be flexible enough to be able to respond in accordance to different needs of kaumātua.

The contrast between participants’ actual versus desired experience of aged-related medicines care is given further context if we explore the idea of Māori ageing within contemporary New Zealand society. In Western society, normative discourse talks of the ‘burden’ that the ageing population and older adults place on society. This is discussed in relation to both the increased care requirements, and through the financial burden associated with older adults’ lack of paid employment and increased healthcare utilisation.\textsuperscript{31} In Māori culture, older adults are often revered, with importance being placed on the ‘social and cultural capital’ they provide.\textsuperscript{32} This is not only important to their own family but also for the contribution to intergenerational development in the wider community. The right of Māori older adults to receive care that is appropriate to their needs is, therefore, not only important from a social justice perspective but also as it adds value to Māori society. The contribution that older adults make to society in New Zealand has been examined in a longitudinal cohort study of almost 1,000 Māori and non-Māori 80–90 year olds.\textsuperscript{33} This showed that up to one in five took part in either voluntary or paid work and 96% supported grandchildren (through a mixture of supports including financial support and shared parenting).\textsuperscript{33} The ‘older adults as a burden’ discourse fails to recognise the contribution older adults make to society and aspects of this are reflected in the way in which participants discussed the impact of age on their treatment options whereby they were expected to accept worsening health as a part of the ageing process and that they were valued less and could be ‘experimented’ on when it came to medicines use. This study shows how this discourse has been internalised and makes participants question whether value is placed on them as a member of contemporary society. Hōne also reflected on ageing past 80 as a ‘bonus’ which is indeed the lived reality for Māori men for whom life expectancy is 73 years (compared to 80.3 years for non-Māori).\textsuperscript{34} Poorer health outcomes for Māori, which are ultimately reflected in life expectancy statistics, remain the expected norm. This is despite New Zealand legislation and policy stating the need for equitable health outcomes. The health system and New Zealand society in general, need to refute
this reality and undertake change that is pro-equity and reaffirms to Māori that this should not, and will not, be accepted.

In developing pharmacist-led medicines review services, it is important to understand not only how patients will utilise the service, but also how they will judge success. Participants focused on operational tasks, such as correct and timely medicines supply, as important aspects of pharmacist care. This finding is in line with other research into patient preferences of community pharmacy attributes where it was found participants valued competence-based attributes (including checking for drug-drug interactions) over relationship-based attributes such as staff friendliness and courtesy. There was little expectation that medicines education would, or should, come from pharmacists or pharmacy staff. Instead, they relied on their GP or staff at the medical centre for this support, a finding which Krueget and Hermansen-Kobulnicky (2011) also reported.

Pharmacist-led medicines review services extend beyond information provision, and into optimising medicines use and medicine treatment recommendations. Public perception of pharmacists’ roles and capabilities is important to consider when developing medicines review services. It may have particular relevance in the implementation phase to improve acceptability of pharmacists as the deliverer of these services and in primary care where the majority of exposure to pharmacy services will be via community pharmacies operating within the dichotomy of being both a health professional and commercial retailer.

Increased understanding of the potential of pharmacists in clinical roles is also relevant in this population group—older adults—where generational differences in exposure to, and experience of, pharmacist services may exist, and be less reflective of the increased clinical roles pharmacists are now taking on; and Māori whom, compared to non-Māori, may have experienced poorer access to pharmacy services and self-perceived poorer quality of pharmacy care.

Participants’ desire to control their medicines’ journey was driven by a sense of responsibility to take charge of their healthcare, and their self-identified right to do so. They discussed factors which support redressing power imbalance in medicines management and the development of authentic partnerships between participants and healthcare professionals. Although participants felt medicines could be supplied outside of this partnership model, when it came to consultations, the provision of information, and health decision-making, this partnership was essential. The concept of whakawhanaungatanga relates to the process of making meaningful, respectful connections in a reciprocal way and is an important part of kaupapa Māori health services and research. Although it is often referred to as family connections, it extends into any relationship where people have a sense of belonging through shared stories and experiences. Establishing a connection with patients by undertaking whakawhanaungatanga (making a connection) in health professional engagements has previously been identified as important in healthcare delivery for Māori and is a key step in The Hui Process, a model designed to support clinicians to deliver culturally appropriate care to Māori.

The right for Māori to participate in their health and wellbeing is set out in the Treaty of Waitangi although failings to enact the Treaty across the health system means that enabled, active participation is not the reality for Māori. The control and responsibility sought by Māori older adults in this study provides a counter-narrative to discussions that often emerge in relation to Māori and healthcare. The dominant discourse is that the poorer health outcomes experienced by Māori can be blamed on individuals, and Māori cultural and societal norms. The effects of the normative nature of this discourse can be seen both in practicing clinicians as well as those training to become doctors and has implications for the care offered to Māori. Narratives of Māori non-adherence with medicines is an example of this and is relevant to this study. The subsequent blame placed on an individual for the associated disparate outcomes, occurs in a void of evidence and is in contrast to the World Health Organization’s position that non-adherence indicates health service failings at a systems level, rather than at a patient-level. Recommendations to remedy this include empowering patients to be involved in the management.
of their health conditions and outcomes. It is important that the accountability remains on the health system to facilitate patients' agency and control.

In this study, participants described the ability to ask questions, assume responsibility and make informed decisions, however, this required a high degree of self-advocacy, and often still relied the healthcare professional enablement. This finding is similar to other work, where Māori described that their ability to ask medicine-related questions and seek control was not the issue; the limiting factor was health professionals' skills and willingness to allow this to occur; in other words, the ability to give power to patients and form an authentic partnership.

Convenience sampling by use of volunteer participants is a potential limitation of this research. Participants were recruited from kaumātua groups, where members were already engaged to some extent in the local community. Therefore, it may not represent the voices of those most isolated from health and social services, or those in a space, be that physically, emotionally or spiritually, that makes it difficult to volunteer time for participation in research. In order to mitigate this issue, results were disseminated to large numbers of kaumātua in different forums to allow for wider consensus-building and validation of findings. Another potential limitation is the position of the primary researcher (JH) as an outsider—a researcher and health professional—which may have affected the extent to which participants felt safe and able to openly discuss their experiences. Her position as an insider, with shared Māori identity, supported culturally appropriate interactions may have allowed for more open discussion than would have been afforded to non-Māori researchers.

We have described that participants were prepared to take control of medicine-related decisions; however, this could not happen in a void of information. Participants often relied on their health professionals providing them with the information they needed to make decisions, and to support them through this process within a therapeutic partnership. Although the understanding of the importance of authentic therapeutic partnerships is not unique to Māori older adults, it is important to understand our participants' views on how this could be enacted for them, in their position as older Māori in contemporary New Zealand.

The experiences of Māori older adults with medicines and medicine-related service can be used to guide the development of pharmacist-facilitated medicines review services for Māori older adults. These services need to be reflective of the impact of medicines across the multiple dimensions of wellbeing, including social connectedness, physical and mental wellbeing, and be flexible enough to respond to the diverse needs of individuals. Service provision could happen independently of medicine supply; however, community pharmacy may provide a convenient access point to services for many. The service should provide Māori older adults with the medicines information they need to make decisions about their medicines therapy, tailored to their individual circumstances, needs and goals, and be provided within a supportive, authentic partnership model that involves the patient and their multiple healthcare providers.
Competing interests:
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Rheumatic fever recurrences in New Zealand 2010–14

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ABSTRACT

AIM: To describe the epidemiology and clinical characteristics of recurrences of acute rheumatic fever (ARF) in New Zealand 2010–14.

METHOD: Retrospective hospital chart review for ARF with repeat hospital admissions from 2010–14, to identify recurrences of ARF. Definitions of recurrence as per NZ Heart Foundation Guidelines.

RESULTS: There were 65 episodes of recurrent ARF among 60 patients. Māori 51%, Pacific 49%. Arthritis and carditis were the most common major manifestations. Median age at recurrence 21.6 years, (8–42 years), with 83% patients over 15 years. There were 841 first episodes of ARF in New Zealand in 2010–4. Overall New Zealand ARF recurrence rate was 7.2% (CI 5.5–8.9%). The recurrence rate was 4% for those under 16 years, 16% for those aged 16–20 and 25% for those >20 years (p < 0.05). Seventy-three percent of recurrences occurred in the Auckland region. Recurrences of ARF were strongly associated with RHD progression.

CONCLUSION: The risk of recurrence of ARF in New Zealand is low for children. In contrast, recurrences of ARF in New Zealand occur predominantly after age 15, and disproportionately in the Auckland DHBs. Current medical systems and registers may not be meeting the needs of adolescents and adults requiring secondary prophylaxis.

A cute rheumatic fever (ARF) is an uncommon autoimmune disease following a group A streptococcal (GAS) infection. Following an episode of ARF, individuals are at high risk of ARF recurrence, preventable by secondary prophylaxis with intramuscular benzathine penicillin. The New Zealand guideline for penicillin prophylaxis for those with no or mild rheumatic heart disease is to discontinue this at the age of 21, or after 10 years, whichever is the longer. Penicillin prophylaxis is continued to age 30 or 40 for those with moderate or severe rheumatic heart disease (RHD) when reassessed at aged 21.

New Zealand has a strong track record of penicillin prophylaxis delivery to prevent ARF recurrence via regional rheumatic fever (RF) registers and public health nurse administration of penicillin. Adherence rates are high in Northland, Auckland, Waikato, Lakes, Tairawhiti, Hawkes Bay and Wellington, where registers are active. The landmark study by Spinetto and colleagues showed that the failure rate of four-weekly intramuscular benzathine penicillin was very low at 0.07/100 patient years. There is anecdotal and published evidence that ARF recurrence for individuals on these registers is acceptably low: in Auckland in the 1990s and Waikato in 1998–2004 with recurrence rates of 5% and 10% respectively. Much less is known about penicillin prophylaxis adherence and ARF recurrence for individuals who are not on a register.

In New Zealand, reporting of first episodes of ARF and ARF recurrences to the Medical Officer of Health is mandatory. The Institute of Environmental Science and Research (ESR) monitors disease incidence on behalf of the Ministry of Health (MOH). When it was noted that there were approximately five times more repeat hospitalisations for ARF coded by ICD discharge data, compared
with the numbers of ARF recurrences reported, the MOH initiated an audit: repeat hospitalisations for ARF and ‘unexpected’ hospitalisations for RHD using the National Minimum Data Set (NMDS) were examined to ascertain the true burden of ARF recurrence in New Zealand, for 2010–2014 inclusive. That audit was undertaken by Technical Advisory Services (TAS) Limited who provided audit reports to each district health board (DHB) and produced a confidential national report to the MOH.

The aim of this audit was to define the epidemiology and clinical characteristics of ARF recurrences in New Zealand for 2010–14.

Methods

The MOH data set included ICD 9 and ICD 10 coding for ARF, RHD and valvular heart disease. A hospital chart review of the 375 repeat admissions for ARF, greater than six months apart, for 2010–14 was initially undertaken by TAS. A database of these repeat admissions was created detailing patient characteristics, hospital admission and follow-up data. The MOH engaged an experienced RF clinician (NW) to advise on the audit. Due to the nuances of ARF, it was apparent that an accurate evaluation of ARF recurrence would entail further review of the data by experienced RF clinicians. Such an expert panel was established (BP, EW, AL, MW, SB, NW). The TAS database, and clinical notes as required, were reviewed by the panel and episodes were classified as ARF recurrence or not. Evidence of a prior first episode of ARF was required for a diagnosis of recurrent ARF. Repeat admissions that were not an ARF recurrence were excluded. Finally, for consistency, two investigators (AD, NW) reviewed the data for classification and medical manifestations of ARF recurrence. Neither patients nor their primary healthcare providers were contacted. The public healthcare records of penicillin prophylaxis delivery and adherence were not accessed. The MOH Health Legal team approved the audit.

Definitions of recurrent and initial ARF were as per the 2006 New Zealand RF/RHD Guideline as available in the years 2010–14.3

**Definite recurrence:** in a patient with previous ARF or RHD, a recurrence required two major manifestations or one major and two minor manifestations or several minor manifestations, plus evidence of a preceding GAS infection. New Zealand guidelines also allow the WHO7 definition of recurrence for an individual with established RHD and two minor manifestations plus evidence of a preceding GAS infection. Elevated or rising streptococcal titres were accepted as evidence of GAS infection. Where the only evidence of GAS infection was a positive throat swab, the case was demoted to probable or possible recurrence as per the New Zealand guidelines.1 New onset Sydenham’s chorea and indolent carditis without evidence of a preceding GAS infection were accepted as definite ARF recurrence in individuals with previous ARF or RHD.

**Probable recurrence:** one major and two minor manifestations with the inclusion of evidence of a preceding GAS infection as a minor manifestation.8,9

**Possible recurrence:** when there was strong clinical suspicion of ARF recurrence, but there were insufficient symptoms and signs to meet the definite or probable definitions.

**Excluded cases:** Repeat hospital admissions of patients with ARF or RHD for any medical reason other than an ARF recurrence.

First episodes of ARF include indolent carditis and Sydenham’s chorea.1 The onset and duration of these forms of ARF is often uncertain with normalisation of inflammatory markers by time of diagnosis. These were assigned to the category of first episode of ARF unless there was a clear evidence of previous ARF or RHD. The echocardiographic term ‘acute on chronic RHD’ may be used at the time of first diagnosis of ARF, for example, when there is a degree of mitral stenosis. These cases were also not included as an ARF recurrence unless there was clear evidence of previous ARF or RHD.

**First episodes of ARF 2010–14**

Data for the numbers of first episodes of ARF, for 2010–14 were as notified to ESR (http://surv.esr.cri.nz/surveillance/annual_surveillance.php). Age and DHB data for these episodes was also provided on request. ESR also records the number of ARF recurrences notified.

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1 The onset and duration of these forms of ARF is often uncertain with normalisation of inflammatory markers by time of diagnosis. These were assigned to the category of first episode of ARF unless there was a clear evidence of previous ARF or RHD.

2 The echocardiographic term ‘acute on chronic RHD’ may be used at the time of first diagnosis of ARF, for example, when there is a degree of mitral stenosis. These cases were also not included as an ARF recurrence unless there was clear evidence of previous ARF or RHD.
The overall New Zealand ARF recurrence rate was calculated by the formula:

\[
\text{ARF recurrences} = \frac{\text{ARF recurrences} + \text{first episodes of ARF}}{\text{total episodes}}
\]

**Progression of RHD severity** related to the ARF recurrence was based on the comparison of any known pre-existing RHD severity with the severity at the time of ARF recurrence. Severity of RHD was based on available echocardiographic reports; echocardiographic images were not reviewed. Progression of valve disease was defined as an increase of one or more grades (eg, mild to moderate mitral regurgitation), or the need for cardiac intervention.

**Statistics:** Chi-squared test was used to determine differences in proportions between groups.

**Results**

There were 375 admissions with an ICD primary or secondary diagnosis coded as ARF, RHD or valvular heart disease with a previous first episode of ARF in the NMDS. After the review by TAS, 78 were deemed an ARF recurrence. (TAS report to the MOH, unpublished).

The 375 admissions were reviewed by the expert panel who assessed that there were 65 episodes of ARF recurrence. These form the study cohort.

**Epidemiology of ARF recurrences in New Zealand 2010–14**

There were 841 initial (first) episodes of ARF recorded by ESR in the years 2010–14. The New Zealand ARF recurrence rate was thus calculated as 65/65+841=7.2% (CI 5.5–8.9%). There was a marked difference in recurrence rate by age bracket; for those aged under 16 years the recurrence rate was 4% (CI=2.8–6.0%), for those aged 16–20 years the recurrence rate was 16% (CI=9.3–22.9%) and for those aged over 20 years the recurrence rate was 25% (CI=18.2–32.5%), (p<0.05).

**Recurrences by district health board**

The number of ARF recurrences and first episodes of ARF by DHB for 2010–14 were as follows, Northland (five recurrences: 82 first episodes of ARF), Waitemata (2: 52), Auckland (11: 68), Counties Manukau (35: 300), Waikato (2: 85), Lakes (1: 27), Bay of Plenty (1: 39), Taraiwhiti (2: 40), Hawkes

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**Figure 1:** Recurrences of ARF by age group, 2010–14.
Bay (0: 28), Taranaki (0: 5), Whanganui (2: 7), Capital Coast (2: 41), Hutt Valley (1: 30), South Island DHBs (1: 19). Overall, 73% (48/65) of ARF recurrences occurred in the three Auckland region DHBs. There were a significantly increased proportion of ARF recurrences compared to first episodes of ARF in the Auckland, Counties Manukau and Whanganui DHBs (p<0.05). Most (82%) patients with ARF recurrence lived in areas of greater neighbourhood deprivation (NZDep Index decile 8, 9 or 10).

Category of ARF recurrence

75% (49/65) ARF recurrences were definite, 11% (7/65) were probable and 14% (9/65) were possible, as per the New Zealand RF/RHD Guideline in place in the years 2010–14 (Table 1). The hospital clinicians, as distinct from the audit review panel, made the diagnosis of definite recurrence in 60/65 (92%) episodes, and probable or possible recurrence in 5/65 (8%) episodes. The frequency of major and minor manifestations are shown in Table 2.
<table>
<thead>
<tr>
<th>Table 1: Classification and clinical manifestations of ARF recurrences.</th>
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<tbody>
<tr>
<td><strong>Definite recurrence (n=49)</strong></td>
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<tr>
<td>2 Major (12)</td>
</tr>
<tr>
<td>Monoarthritis + carditis (4)</td>
</tr>
<tr>
<td>1 Major + 2 Minor (17)</td>
</tr>
<tr>
<td>Poliarthritis + 2 minor (1)</td>
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<tr>
<td>Monoarthritis + 2 minor (2)</td>
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<tr>
<td><strong>Sydenham’s chorea (3)</strong></td>
</tr>
<tr>
<td>WHO criteria (4)</td>
</tr>
<tr>
<td><strong>Probable recurrence (7)</strong></td>
</tr>
<tr>
<td>2 Major (2)</td>
</tr>
<tr>
<td>1 Major and 2 minor (1)</td>
</tr>
<tr>
<td>1 Major and 1 minor (2)</td>
</tr>
<tr>
<td>Several minor (2)</td>
</tr>
<tr>
<td>Polyarthralgia, fever + raised inflammatory markers (1)</td>
</tr>
<tr>
<td><strong>Possible recurrence (9)</strong></td>
</tr>
<tr>
<td>2 Major (1)</td>
</tr>
<tr>
<td>1 Major and 2 minor (7)</td>
</tr>
<tr>
<td>Carditis, polyarthralgia, fever + raised inflammatory markers (1)</td>
</tr>
<tr>
<td>Carditis, polyarthralgia, raised inflammatory markers (1)</td>
</tr>
<tr>
<td>Carditis, fever + raised inflammatory markers (1)</td>
</tr>
<tr>
<td>Monoarthritis, raised inflammatory markers + 1st degree heart block (1)</td>
</tr>
<tr>
<td>Monoarthritis, fever, raised inflammatory markers + prolonged PR interval (1)</td>
</tr>
<tr>
<td>Erythema marginatum (not accepted as sole major manifestation), Polyarthralgia, raised inflammatory markers(1)</td>
</tr>
<tr>
<td>Several minor (1)</td>
</tr>
</tbody>
</table>

*Positive throat swab, # Insufficient elevation of GAS serology to meet New Zealand guidelines criteria or Australian criteria, + met Australian GAS serology criteria.
Table 3: Miscellaneous reasons for failure of penicillin prophylaxis provision.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (years)</th>
<th>Reason for not initiating secondary antibiotic prevention</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>18</td>
<td>Incomplete initial work up/ misdiagnosis</td>
<td>Initial presentation aged 13 with polyarthralgia, raised inflammatory and raised strep titres. No echo. Represented with polyarthritis and carditis.</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>Misdiagnosis</td>
<td>Initial presentation age 10 with L) hip arthritis, raised inflammatory markers and GAS titres. Echo initially reported as normal. Presented two years later with severe carditis, and pericardial tamponade.</td>
</tr>
<tr>
<td>3</td>
<td>33</td>
<td>Health systems error</td>
<td>Known ARF patient on register adherent with prophylaxis. District nursing paper work misplaced and prophylaxis omitted for three months resulting in recurrence.</td>
</tr>
<tr>
<td>4</td>
<td>24</td>
<td>Multiple drug sensitivity</td>
<td>After RHD aortic valve surgery prophylaxis not recommenced at discharge. Recurrence three months later.</td>
</tr>
<tr>
<td>5</td>
<td>19</td>
<td>Miscommunication between health services/ health systems error</td>
<td>Not on prophylaxis due to multiple drug sensitivities</td>
</tr>
</tbody>
</table>

Echo: echocardiography; strep titres: group A streptococcal serology.

Table 2: Frequency of major and minor manifestations of ARF recurrences.

<table>
<thead>
<tr>
<th>Major criteria</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carditis</td>
<td>52% (34/65)</td>
</tr>
<tr>
<td>Polyarthritis</td>
<td>20% (13/65)</td>
</tr>
<tr>
<td>Monoarthritis</td>
<td>13.8% (9/65)</td>
</tr>
<tr>
<td>Erythema marginatum</td>
<td>1.5% (9.2/65)</td>
</tr>
<tr>
<td>Subcutaneous nodules</td>
<td>0% (0/65)</td>
</tr>
<tr>
<td>Sydenham’s chorea</td>
<td>4.65% (3/65)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minor criteria</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyarthralgia</td>
<td>52% (34/65)</td>
</tr>
<tr>
<td>Fever</td>
<td>43% (28/65)</td>
</tr>
<tr>
<td>Raised inflammatory markers</td>
<td>100% (65/65)</td>
</tr>
<tr>
<td>Prolonged PR interval</td>
<td>45% (29/65)</td>
</tr>
</tbody>
</table>
At the time of recurrence, 42 (65%) were non-adherent with penicillin prophylaxis. Eleven patients (17%) had stopped penicillin prophylaxis on medical recommendation (eight had completed a period of prophylaxis as per the New Zealand guidelines but three had not: one did not complete 10 years but was aged over 21 and two completed 10 years but not to age 21); five (8%) were receiving four-weekly penicillin prophylaxis, one was receiving three-weekly penicillin prophylaxis; and six (9%) had a recurrence for miscellaneous circumstances as detailed in Table 3. The median duration from diagnosis of first episode of ARF until ARF recurrence was 10.5 years (range seven months to 29.1 years). The median duration off penicillin prophylaxis in the 11 patients who were medically recommended to stop penicillin prophylaxis until ARF recurrence was two years (range three months to 16 years). The median duration off penicillin prophylaxis in those patients who were non-adherent (data available in 38/42) until ARF recurrence was two years (range six months to five years). The median age of those who were non-adherent with penicillin prophylaxis was 21.6 (range 13.2–38.6) years.

Clinical manifestations

Recorded clinical management

Given that the audit was based on ICD hospital discharge data all patients with episodes of ARF recurrence had been admitted to hospital. The median length of stay was four days (range 1–31 days). The hospital clinicians’ categorisation of ARF recurrence showed close concordance with the expert panel: definite recurrence was diagnosed in 60/65 episodes, and probable or possible recurrence in five episodes. Ninety-six percent (62/65) of the episodes of ARF recurrence had documented recommencement of penicillin prophylaxis at the time of discharge from hospital. However, in only 72% of these was the provider for penicillin prophylaxis copied into the discharge summary. Referral for clinic follow-up was documented in the discharge summary in 82% (53/65) of episodes.

Cardiac manifestations of the ARF recurrence

There were 34 episodes of carditis; 22 episodes complicating existing RHD and 12 episodes in patients without existing RHD. The predominant valve lesion in pre-existing, and new cases of RHD was mitral regurgitation (MR), in 33/34 (97%) episodes. 20/34 (59%) episodes had aortic regurgitation (AR). Four patients, median age 19 years, all with pre-existing RHD, required cardiac intervention during the audit period: one had severe mixed mitral and aortic valve disease, one had severe AR and heart failure, one had severe AR and moderate MR, and the fourth patient with pre-existing severe aortic and mitral valve disease underwent a pericardiocentesis for symptomatic pericarditis that resulted from the ARF recurrence.

Progression of RHD could be ascertained in 18 of the 22 cases of carditis complicating existing RHD (where echocardiogram reports could be reviewed). MR progressed in 17/18 episodes (94%). There was mild to moderate, or moderate to severe progression in 13/18 episodes (72%), with the remaining five cases being new mild MR in patients with previous AR. AR progressed in 6/18 episodes (33%). There was mild to moderate or moderate to severe progression in three episodes with the remaining three cases being new AR in patients with previous MR.

In the 12 patients without pre-existing RHD, MR was the most common lesion, recorded in 11/12 episodes; mild MR (n=10) and moderate MR (n=1). AR occurred in 5/12 episodes, mild AR (n = 4) and moderate AR (n=1). Overall 46% (30/65) recurrent episodes resulted in progression of RHD.

Discussion

This audit found that the ARF recurrence rate for 2010–14 in New Zealand was 7.2%. This is within the range reported for the Auckland region in the 1990s, and Waikato region in 1998–2004. The Waikato region reported the very low 3% rate for 2002–2011. While these rates are lower than those reported in other countries (12–40% from 2002–8 in Northern Territory, Australia; 21% in a series from Brazil), they are not cause for complacency. The ARF recurrence rate is a strong indicator of the effectiveness of secondary prevention programmes.

A striking finding of the audit was the median age of ARF recurrence of 21.6 years. Most (83%) ARF recurrences occurred in those aged 16 and over. The ARF recurrence
rate for those under 16 was low at 4% despite this being the age group with the highest risk for initial ARF; this reflects high adherence to penicillin prophylaxis for children on regional RF registers receiving penicillin from community nurses. Other studies have reported that the risk of ARF recurrence is associated with younger age, the first year after ARF diagnosis, and the failure of penicillin prophylaxis delivery. The strong message for healthcare professionals in New Zealand is that the relative risk of an ARF recurrence increases with age (highest for those over 20 years) despite the decreasing risk of first episode of ARF with age. This almost certainly reflects the lower adherence to penicillin prophylaxis in adolescents and young adults compared with the higher adherence in children.

The reasons for the unplanned discontinuation of penicillin prophylaxis in adolescents and young adults could not be ascertained by this audit. However, qualitative research by Anderson and colleagues gives new insights into the mismatch between health systems and the complexities of life for many Māori and Pacific families. Their research found that the transitioning of adolescents with RF/RHD to adult medical and nursing services needs to be addressed in more culturally appropriate ways and that the cost of medical and dental care is often a significant barrier for young adults. The reasons for the unplanned discontinuation of penicillin prophylaxis in adolescents and young adults could not be ascertained by this audit. However, qualitative research by Anderson and colleagues gives new insights into the mismatch between health systems and the complexities of life for many Māori and Pacific families. Their research found that the transitioning of adolescents with RF/RHD to adult medical and nursing services needs to be addressed in more culturally appropriate ways and that the cost of medical and dental care is often a significant barrier for young adults. Their research found that the transitioning of adolescents with RF/RHD to adult medical and nursing services needs to be addressed in more culturally appropriate ways and that the cost of medical and dental care is often a significant barrier for young adults. Their research found that the transitioning of adolescents with RF/RHD to adult medical and nursing services needs to be addressed in more culturally appropriate ways and that the cost of medical and dental care is often a significant barrier for young adults. Their research found that the transitioning of adolescents with RF/RHD to adult medical and nursing services needs to be addressed in more culturally appropriate ways and that the cost of medical and dental care is often a significant barrier for young adults.

Malcolm and colleagues have described their holistic approach to RF/RHD control in the Bay of Plenty. They recommend that a diagnosis of ARF recurrence should lead to “whole-hearted patient care and whānau follow-up” for these patients. This type of approach should help reduce the disease burden of ARF recurrence in New Zealand. 

Guidelines and definitions of RF recurrences

There were no changes in the definitions of ARF recurrence comparing the 2006 with the 2014 New Zealand RF/RHD Guidelines. However, the 2014 Guideline more clearly emphasises that the decision to discontinue penicillin prophylaxis should be made not only on the completed duration of penicillin, but also on the individual’s current RHD status after 10 years or aged 21. This audit revealed that 17% of ARF recurrences occurred after medical recommendation to discontinue penicillin prophylaxis compared with 10% reported in an earlier New Zealand study. This data, as well as the finding that the median time to recurrence in such patients was two years, supports not reducing the New Zealand RF/RHD Guideline’s recommended duration of penicillin prophylaxis.

Another important finding of this audit is that the clinical manifestations of an ARF recurrence are similar to first episodes of ARF with the majority of ARF recurrences fulfilling the definite recurrence criteria. One could argue that an ARF recurrence should be easier to diagnose than a first episode of ARF, given that the patient already has a diagnosis of RF or RHD.

There were seven episodes where the category of recurrence was classified as probable or possible based on the New Zealand RF/RHD Guideline GAS serology criteria that would have been classified as definite using the Australian Guideline criteria (Table 1). There have been recent calls to re-examine the New Zealand GAS criteria, which the next edition of the New Zealand RF/RHD Guideline needs to address.

The 2014 New Zealand RF/RHD Guideline’s criteria for ARF diagnosis were adjusted to include monoarthritis as a major criterion to improve sensitivity of the diagnostic criteria in the New Zealand setting. The application of earlier versions of the Jones criteria in high-risk settings have previously resulted in false negative diagnoses. In this audit, articular manifestations were seen in 86% of recurrences, with polyarthralgia being most commonly seen. The AHA 2015 revised Jones criteria for initial ARF have recommended polyarthralgia as a major criterion, and monoarthralgia as a minor criterion in high-risk groups. New Zealand data is needed for this to be adopted locally.

Severity of carditis in recurrences

It is well described that recurrences of rheumatic fever result in RHD progression. This was highlighted by our
audit with at least 46% patients either developing new RHD or developing progression of pre-existing RHD. This underscores the importance of addressing the barriers to penicillin prophylaxis in New Zealand to prevent progression of RHD.

ESR data

The number of ARF recurrences reported to ESR during the audit period was 70, similar to the 65 episodes identified by this audit. This confirms that ESR data on ARF recurrences appears to be reasonably robust and can used to monitor future trends of New Zealand ARF recurrence rates without the need for detailed chart review. This is in contrast to previously reported discrepancies of ICD discharge data, ESR data and regional registers for initial episodes of ARF.\(^\text{31,32}\) In part, this reflects the much higher numbers of initial episodes of ARF than recurrences of ARF.

Limitations

Only those case notes with ICD codes of ARF or RHD were reviewed in the audit. Those presentations where the differential of ARF was considered but not coded, or not considered, would not have been captured. The details of penicillin prophylaxis prescription and adherence were limited by the audit design. We were not able to ascertain whether transition to adult services or mobility between DHBs with or without RF registers were risk factors for penicillin prophylaxis non-adherence. The progression of RHD was graded by echocardiograms at the time of ARF recurrence, therefore immediate rather than long-term RHD outcomes have been reported.

Conclusion

This audit describes the epidemiology of ARF recurrences in New Zealand. Adolescents and young adults are significantly more likely to have recurrences than children. The audit confirms that ARF recurrences often lead to progression of RHD. Systems to improve adherence to penicillin prophylaxis need to be tailored in culturally appropriate ways, and inequities between DHB could be addressed by the development of a national RF/RHD register.

Competing interests:

Dr Galloway reports affiliation with Ministry of Health during the conduct of the study.

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Heart failure clinics improve use of evidence-based heart failure therapies in patients with reduced ejection fraction following acute coronary syndrome (ANZACS-QI 48)

Daniel Chan, Robert N Doughty, Janine Mazengarb, Andy McLachlan, Andrew J Kerr

ABSTRACT

AIMS: To describe the use of evidence-based heart failure therapies in patients with reduced left ventricular ejection fraction (LVEF) following acute coronary syndrome (ACS).

METHODS: Patients with ACS and LVEF ≤40% were identified from the All New Zealand Acute Coronary Syndrome Quality Improvement (ANZACS-QI) registry between June 2017 and May 2018. Data was obtained from retrospective review of clinical records. Dispensed medications were identified from pharmacy dispensing records and compared with target doses recommended in guidelines.

RESULTS: Of 292 patients, 28% were seen in cardiology heart failure (HF) clinic, 54% seen in general cardiology clinic and 17% were not seen in cardiology clinic. At one year post-discharge, 52% and 39% were dispensed ≥50% target dose of angiotensin converting enzyme inhibitor (ACEI)/angiotensin receptor blocker (ARB), and beta-blockers respectively. Seventy-one percent and 68% of patients were on maximally tolerated doses of ACEI/ARB and beta-blockers respectively. The highest rates of medication up-titration occurred in those seen in cardiology HF clinics. Seventy-four percent and 59% were dispensed ≥50% target dose of ACEI/ARB and beta-blocker respectively. Ninety-five percent and 89% were on maximally tolerated doses of ACEI/ARB and beta-blockers respectively. Thirteen percent were potentially eligible for primary prevention implantable cardiac defibrillator; however, only 24% of these eligible patients had one implanted by one year post-discharge.

CONCLUSIONS: Evidence-based HF therapies were underutilised in this regional cohort of patients with reduced LVEF post-ACS. Strategies to improve use of these therapies should focus on increasing the number of patients seen by HF clinics and reducing clinic waiting times.

Heart failure (HF) and reduced ejection fraction associated with an acute coronary syndrome (ACS) is associated with adverse prognosis.1–3 While clinical HF may occur in the setting of an ACS hospitalisation, asymptomatic LV systolic dysfunction carries substantial risk of subsequent development of clinical heart failure. Current clinical guidelines have given a class I recommendation for the use of angiotensin converting enzyme inhibitors (ACEI), angiotensin receptor blockers (ARB), beta-blockers and mineralocorticoid receptor antagonists (MRA) following ACS with
HF and/or reduced left ventricular ejection fraction (LVEF) of <40%. These medications often need to be initiated at a low dose during hospitalisation for ACS because of the presence of HF and/or borderline haemodynamic observations. Ideally these medications need to be up-titrated prior to discharge or in the early outpatient setting, to target doses that were shown to have clinical benefit in randomised controlled trials. Nurse-led medication up-titration clinics have an established role for patients with HF with reduced ejection fraction to achieve maximum tolerated doses of ACEi, ARB, beta-blockers and MRAs and are recommended in local guidelines.

Our previous study of a New Zealand-wide cohort of patients with ACS showed that rates of evidence-based HF therapies in those with reduced LVEF were low at one-year post discharge, with only 34% and 35% received ≥50% target doses of ACEi/ARB and beta-blockers respectively. While very few patients had documented contraindication or intolerance to these medications at baseline, the observational nature of this national cohort precluded understanding of potential reasons why target dosages of these medications were not achieved.

Implantable cardiac defibrillators (ICDs) are indicated for primary prevention of sudden cardiac death in patients with reduced LVEF following myocardial infarction. Previous international studies have demonstrated suboptimal rates of primary prevention ICD implantation at one year post-myocardial infarction. The current use of primary prevention ICD following acute coronary syndromes in New Zealand is unknown.

The aim of this study was to describe the use of evidence-based heart failure therapies in a population of patients with reduced LVEF following ACS.

Methods

Study population

Patients from the Auckland Region (defined as those residing in Waitemata, Auckland or Counties Manukau District Health Boards (DHBs)) were identified from the All New Zealand Acute Coronary Syndrome Quality Improvement (ANZACS-QI) registry. This web-based registry records a mandatory dataset for almost all patients who are admitted to a New Zealand public hospital with an ACS and have coronary angiography. Further details regarding this registry have been previously reported. Patients with confirmed ACS, who underwent coronary angiography between the dates of 1 June 2017 and 31 May 2018, and who had LVEF measured by echocardiogram during their index admission of less than 40% were included in this study. Patients were excluded from this study if they were a non-New Zealand resident, moved outside of the Auckland region within one year of index admission or if they died or received palliative care within three months of index admission. Patients were also excluded if there were discrepancies between the clinical record and that in ANZACS-QI.

Clinical variables

All data was collected via retrospective review of electronic clinical records by two authors (DC and JK). Baseline characteristics including demographics, comorbidities, ACS presentation and management in hospital were obtained from the discharge summary. Outpatient clinic follow-up within one year of discharge was recorded to be either in cardiology HF clinic, general cardiology clinic or no cardiology clinic. Cardiology HF clinics are nurse-led outpatient clinics under the supervision of a cardiologist, with goals including heart failure education and medication up-titration. General cardiology clinics may have been with either a cardiologist, registrar or nurse practitioner without involvement of specific HF services. Patients with no cardiology clinic follow-up may have been seen by other services (eg, renal medicine) during the follow-up period. Time to first clinical outpatient clinic follow up was recorded. New York Heart Association (NYHA) symptom class and cardiac rhythm was recorded at the last clinical encounter within one year post-discharge.

Echocardiogram reports from the index admission were reviewed for LVEF and the presence of moderate or severe right ventricular systolic impairment; at least one moderate or greater regurgitant or stenotic valvular lesion; and moderate or severe pulmonary hypertension. Time to first repeat echocardiogram after discharge, and LVEF recorded on the that echocardiogram were recorded if it occurred within one year of discharge.
Medications

Medication dispensing was identified from Test Safe community dispensing records, which captures virtually all dispensing of subsided medications from community pharmacies in New Zealand. Medications were deemed to be in patient possession if there was dispensing of a sufficient supply of medications to last until a pre-defined time point: at discharge, three months post-discharge and 12 months post-discharge. For example a patient would have been in possession of a medication at 12 months post-discharge, if a 30 day supply was dispensed at 11 months post-discharge, but not if dispensed at 10 months post-discharge.

Three classes of medications were investigated in this study; ACEi/ARBs, beta-blockers and MRAs. Sacubitril with valsartan (Entresto) was approved for use in New Zealand during the follow-up period in this study and was included under the ACEi/ARB medication class. Target doses of medications were used to standardise comparison of medications within the same class. Target doses of ACEi/ARB, beta-blockers and MRAs were based upon the 2016 ESC guidelines for the diagnosis and treatment of acute and chronic HF.\textsuperscript{6,11} Doses of medications were either classified as low dose (<50% of target dose), 50–99% of target dose or target dose (see Appendix Table 1).

Patients were defined to be on a maximally tolerated dose of a specific drug class if they were either dispensed ≥50% target dose, or if they had a documented reason why this medication could not be up-titrated further. Patients not on maximally tolerated doses could potentially have had their evidence-based HF therapy up-titrated further. Potential reasons for failure to up-titrater medications to ≥50% target doses were identified from review of all available hospital discharge summaries, outpatient clinic letters and laboratory results, up to one year post-discharge or death (whichever occurred first).

Possible reasons why target doses of medications are not achieved are based upon the European and New Zealand HF guidelines.\textsuperscript{6,11} Reasons for failure to achieve ≥50% target doses of ACEi/ARB were defined as renal impairment (sustained rise in creatinine >50%, creatinine >221µmol/L or eGFR <30mL/min/1.73m\textsuperscript{2}), hyperkalaemia (>5.0mmol/L), hypotension (systolic blood pressure <90mmHg), allergy or other drug intolerance. Reasons for failure to achieve ≥50% target doses of beta-blockers were defined as bradycardia (HR <60bpm), high-degree AV block, hypotension (systolic blood pressure <90 mmHg), allergy or other drug intolerance. Reasons for failure to achieve ≥50% target doses of MRAs were the same as for ACEi/ARB. Additionally MRAs were documented to not be indicated in some patients—MRAs are clinically indicated post-ACS if LVEF is ≤40% with HF or diabetes;\textsuperscript{4} and if LVEF ≤35% with NYHA II-IV symptoms.\textsuperscript{11}

Implantable cardiac defibrillators

Primary prevention ICDs were defined to be potentially clinically indicated in patients with NYHA class II–III symptoms and LVEF≤35% or NYHA class I and LVEF ≤30%, according to current clinical guidelines.\textsuperscript{4,5,12} Patients were deemed ineligible for primary prevention ICD if they were ≥75 years of age or if they had a condition associated with a reduced life expectancy of <18 months (eg, chronic kidney disease on renal replacement therapy, advanced malignancy, cognitive impairment, poor functional status requiring assistance with activities of daily living) consistent with New Zealand guidelines.\textsuperscript{13} Clinical records were reviewed for documentation of a primary prevention ICD (or cardiac resynchronisation therapy with defibrillator) implant, within one year of discharge. Patients with an ICD prior to index admission or who received a secondary prevention ICD were excluded.

Ethics

This study was deemed not to be within the scope of the Health and Disability Ethics Committee (HDEC) review and further ethics approval was not required. This study received locality approval from the respective DHB research offices.

Statistics

Categorical data are presented as frequency and percentage. Continuous variables are presented as mean ± standard deviation or median and interquartile range.
Results

Three hundred and fifty-nine patients were identified from the ANZACS-QI registry with an ACS, reduced LVEF and whom reside in one of the three Auckland region DHBs between 1 June 2017 and 31 May 2018. Sixty-seven patients (18.7%) were excluded from further analysis—27 died within three months of discharge, 25 did not have an LVEF >40% documented during their index admission, 12 did not reside in an Auckland region DHB and on review three did not have a diagnosis of ACS during index admission. The remaining 292 patients were included in the study. They all had at least one year of follow-up available. One hundred and twenty-three patients (42%) were from Waitemata DHB, 52 (18%) from Auckland DHB and 117 (40%) from Counties Manukau DHB.

Baseline characteristics and clinical follow-up (Table 1)

Eighty-three patients (28%) were seen at least once in cardiology HF clinic, 159 patients (54%) were seen in cardiology clinic and 50 patients (17%) had no cardiology clinic follow-up. Seventy-two percent of patients seen in nurse-led cardiology HF clinics were also seen by a cardiologist at a separate appointment. Median time to first outpatient clinic follow-up was shorter for those seen in cardiology HF clinics compared to general cardiology clinics (43 vs 75 days).

Patients seen in cardiology HF clinics were on average younger, more likely to be male and of New Zealand Māori or Asian ethnicity. They were also more likely to have diabetes, clinical heart failure (Killip Class ≥II) and have more severe LV impairment (LVEF ≤30%) on presentation. Median length of stay during the index admission was longer in those seen in cardiology HF clinics. In contrast patients with no cardiology clinic follow-up were older, more likely to be female and of European ethnicity. They were also more likely to have prior cardiovascular disease or renal disease, and less likely to receive revascularisation.

Only 156 patients (53%) had a repeat echocardiogram to reassess LVEF within one year of discharge. Rates were highest in those seen in cardiology HF clinics (72%) and lowest in those with no cardiology clinic follow-up (26%). However, patients seen in cardiology HF clinics had the longest median time to their first repeat echocardiogram (195 days).

Target doses of medications (Figure 1 and Appendix Tables 2–S4)

Rates of ACEi/ARB and beta-blocker dispensing on discharge were relatively high, 83% and 87% respectively. However, the number of patients discharged on ≥50% target doses of an ACEi/ARB were only 35% and 31% respectively. Only 18% of patients were dispensed a MRA on discharge.

At one year post-discharge, overall dispensing rates of ACEi/ARB, beta-blocker and MRA were similar to those at discharge—83%, 82% and 23% respectively. Dispensing rates were highest in those seen in cardiology HF clinics—92% on ACEi/ARB, 90% on beta-blockers and 41% on MRA. Rates were lowest in those with no cardiology clinic follow-up—64% on ACEi/ARB, 70% on beta-blockers, 10% on MRA. Dispensing rates were intermediate for those seen in general cardiology clinics.

More patients were dispensed ≥50% target dose of ACEi/ARB and beta-blockers at one year post-discharge—52% and 39% respectively. The highest medication up-titration was in patients seen in cardiology HF clinics—29% were dispensed ≥50% target dose of ACEi/ARB at discharge, increasing to 74% at one year. Thirty-three percent were dispensed ≥50% target dose of beta-blockers at discharge, increasing to 59% at one year. Less up-titration occurred in patients seen in general cardiology clinics, with only 48% and 34% achieving ≥50% target doses of ACEi/ARB and beta-blockers respectively at one year. No significant up-titration occurred in patients with no cardiology clinic follow-up.

Maximally tolerated doses of medications (Table 2 and Figure 2)

Seventeen percent of patients had a documented reason why their ACEi/ARB dose could not be dispensed or up-titrated. The most common reason was renal impairment or hyperkalaemia (8%). When taking this into account, 71% were on a maximally tolerated dose of ACEi/ARB at one year post-discharge or at time of death. Ninety-five percent of patients seen in cardiology HF clinic were on a maximally tolerated...
Table 1: Baseline characteristics.

<table>
<thead>
<tr>
<th></th>
<th>All n=292</th>
<th>Cardiology heart failure clinic n=83</th>
<th>General cardiology clinic n=159</th>
<th>No cardiology clinic n=50</th>
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<tbody>
<tr>
<td>Age (years), mean ± SD</td>
<td>66.4±11.4</td>
<td>64.4±10.8</td>
<td>66.5±11.7</td>
<td>69.6±10.6</td>
</tr>
<tr>
<td>Male</td>
<td>232 (79.5)</td>
<td>70 (84.3)</td>
<td>128 (80.5)</td>
<td>34 (68.0)</td>
</tr>
<tr>
<td>Ethnic group</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>NZ Māori</td>
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<td>11 (13.3)</td>
<td>14 (8.8)</td>
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<td>Pacific</td>
<td>54 (18.5)</td>
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<td>32 (20.1)</td>
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<td>Asian</td>
<td>51 (17.5)</td>
<td>20 (24.1)</td>
<td>26 (16.4)</td>
<td>5 (10.0)</td>
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<tr>
<td>European/Other</td>
<td>159 (54.5)</td>
<td>40 (48.2)</td>
<td>87 (54.7)</td>
<td>32 (64.0)</td>
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<tr>
<td>Prior CVD</td>
<td>108 (37.0)</td>
<td>24 (28.9)</td>
<td>64 (40.3)</td>
<td>20 (40.0)</td>
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<tr>
<td>Prior heart failure</td>
<td>24 (8.2)</td>
<td>8 (8.4)</td>
<td>13 (8.2)</td>
<td>4 (8.0)</td>
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<tr>
<td>Diabetes</td>
<td>121 (41.4)</td>
<td>42 (50.6)</td>
<td>59 (37.1)</td>
<td>20 (40.0)</td>
</tr>
<tr>
<td>eGFR (ml/min/1.73m²)</td>
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<tr>
<td>&lt;30</td>
<td>24 (8.2)</td>
<td>2 (2.4)</td>
<td>14 (8.8)</td>
<td>8 (16.0)</td>
</tr>
<tr>
<td>30–&lt;60</td>
<td>66 (22.6)</td>
<td>15 (18.1)</td>
<td>39 (24.5)</td>
<td>12 (24.0)</td>
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<tr>
<td>≥60</td>
<td>202 (69.2)</td>
<td>66 (79.5)</td>
<td>106 (66.7)</td>
<td>30 (60.0)</td>
</tr>
<tr>
<td>Killip Class</td>
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<td></td>
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<td></td>
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<tr>
<td>I</td>
<td>198 (67.8)</td>
<td>45 (54.2)</td>
<td>117 (73.6)</td>
<td>36 (72.0)</td>
</tr>
<tr>
<td>II–IV</td>
<td>94 (32.2)</td>
<td>38 (45.8)</td>
<td>42 (26.4)</td>
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</tr>
<tr>
<td>GRACE Score</td>
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<td></td>
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<tr>
<td>&lt;1%</td>
<td>21 (7.2)</td>
<td>4 (4.8)</td>
<td>16 (10.1)</td>
<td>1 (2.0)</td>
</tr>
<tr>
<td>1–3%</td>
<td>107 (36.6)</td>
<td>29 (34.9)</td>
<td>56 (35.2)</td>
<td>22 (44.0)</td>
</tr>
<tr>
<td>≥3%</td>
<td>164 (56.2)</td>
<td>50 (60.2)</td>
<td>87 (54.7)</td>
<td>27 (54.0)</td>
</tr>
<tr>
<td>Type of ACS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STEMI</td>
<td>112 (38.4)</td>
<td>34 (41.0)</td>
<td>61 (38.4)</td>
<td>17 (34.0)</td>
</tr>
<tr>
<td>NSTE-ACS</td>
<td>180 (61.6)</td>
<td>49 (59.0)</td>
<td>98 (61.6)</td>
<td>33 (66.0)</td>
</tr>
<tr>
<td>Revascularisation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCI</td>
<td>163 (55.8)</td>
<td>48 (57.8)</td>
<td>90 (56.6)</td>
<td>25 (50.0)</td>
</tr>
<tr>
<td>CABG</td>
<td>57 (19.5)</td>
<td>19 (22.9)</td>
<td>31 (19.5)</td>
<td>7 (14.0)</td>
</tr>
<tr>
<td>Left ventricular ejection fraction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35–40%</td>
<td>132 (45.2)</td>
<td>17 (20.5)</td>
<td>87 (54.7)</td>
<td>28 (56.0)</td>
</tr>
<tr>
<td>30–35%</td>
<td>68 (23.3)</td>
<td>22 (26.5)</td>
<td>31 (19.5)</td>
<td>15 (30.0)</td>
</tr>
<tr>
<td>25–30%</td>
<td>55 (18.8)</td>
<td>26 (31.3)</td>
<td>26 (16.4)</td>
<td>3 (6.0)</td>
</tr>
<tr>
<td>&lt; 25%</td>
<td>37 (12.7)</td>
<td>18 (21.7)</td>
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<tr>
<td>Echocardiography variables</td>
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<td></td>
<td></td>
<td></td>
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<td>≥ moderate RV impairment</td>
<td>54 (18.5)</td>
<td>16 (19.3)</td>
<td>31 (19.5)</td>
<td>7 (14.0)</td>
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<tr>
<td>≥ moderate valvular disease</td>
<td>44 (15.1)</td>
<td>10 (12.0)</td>
<td>24 (15.1)</td>
<td>10 (20.0)</td>
</tr>
<tr>
<td>≥ moderate pulmonary HTN</td>
<td>23 (7.9)</td>
<td>4 (4.8)</td>
<td>12 (7.5)</td>
<td>7 (14.0)</td>
</tr>
<tr>
<td>Length of stay (days), median (IQR)</td>
<td>7 (4–13)</td>
<td>8 (4–15)</td>
<td>7 (4–12)</td>
<td>5 (3–13)</td>
</tr>
</tbody>
</table>

NB: All values are frequency (%) unless otherwise specified.
CVD = cardiovascular disease; eGFR = glomerular filtration rate estimated by the Chronic Kidney Disease Epidemiology Collaboration equation; STEMI = ST elevation myocardial infarction; NSTEMI = non-ST elevation myocardial infarction; PCI = percutaneous coronary intervention; CABG = coronary artery bypass grafting; RV=right ventricular; HTN = hypertension.
Figure 1: Achievement of target doses at discharge, three months and a year.
### Table 2: Reasons why target doses of medications were not achieved.

<table>
<thead>
<tr>
<th></th>
<th>All n=292</th>
<th>Cardiology heart failure clinic n=83</th>
<th>General cardiology clinic n=159</th>
<th>No cardiology clinic n=50</th>
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</thead>
<tbody>
<tr>
<td><strong>ACEi/ARB</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Maximal tolerated dose</td>
<td>207 (70.9)</td>
<td>79 (95.2)</td>
<td>105 (66.0)</td>
<td>23 (46.0)</td>
</tr>
<tr>
<td>CKD/hyperkalaemia</td>
<td>22 (7.5)</td>
<td>5 (6.0)</td>
<td>11 (6.9)</td>
<td>6 (12.0)</td>
</tr>
<tr>
<td>Hypotension</td>
<td>19 (6.5)</td>
<td>7 (8.4)</td>
<td>12 (7.5)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Allergy/intolerance</td>
<td>9 (3.1)</td>
<td>4 (4.8)</td>
<td>4 (2.5)</td>
<td>1 (2.0)</td>
</tr>
<tr>
<td>Unknown</td>
<td>85 (29.1)</td>
<td>4 (4.8)</td>
<td>54 (34.0)</td>
<td>27 (54.0)</td>
</tr>
<tr>
<td><strong>Beta-blockers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximal tolerated dose</td>
<td>197 (67.5)</td>
<td>74 (89.2)</td>
<td>106 (66.7)</td>
<td>17 (34.0)</td>
</tr>
<tr>
<td>Bradycardia</td>
<td>58 (19.9)</td>
<td>19 (22.9)</td>
<td>37 (23.3)</td>
<td>2 (4.0)</td>
</tr>
<tr>
<td>Hypotension</td>
<td>6 (2.1)</td>
<td>1 (1.2)</td>
<td>4 (2.5)</td>
<td>1 (2.0)</td>
</tr>
<tr>
<td>Allergy/intolerance</td>
<td>15 (5.1)</td>
<td>4 (4.8)</td>
<td>11 (6.9)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Unknown</td>
<td>95 (32.5)</td>
<td>9 (10.8)</td>
<td>53 (33.3)</td>
<td>33 (66.0)</td>
</tr>
<tr>
<td><strong>MRA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximal tolerated and indicated dose</td>
<td>186 (63.7)</td>
<td>57 (68.7)</td>
<td>106 (66.7)</td>
<td>23 (46.0)</td>
</tr>
<tr>
<td>Not indicated</td>
<td>101 (34.6)</td>
<td>25 (30.1)</td>
<td>61 (38.4)</td>
<td>15 (30.0)</td>
</tr>
<tr>
<td>CKD/hyperkalaemia</td>
<td>32 (11.0)</td>
<td>7 (8.4)</td>
<td>19 (11.9)</td>
<td>6 (12.0)</td>
</tr>
<tr>
<td>Allergy/intolerance</td>
<td>10 (3.4)</td>
<td>4 (4.8)</td>
<td>6 (3.8)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Unknown</td>
<td>106 (36.3)</td>
<td>26 (31.3)</td>
<td>53 (33.3)</td>
<td>27 (54.0)</td>
</tr>
<tr>
<td>Not indicated</td>
<td>101 (34.6)</td>
<td>25 (30.1)</td>
<td>61 (38.4)</td>
<td>15 (30.0)</td>
</tr>
</tbody>
</table>

NB: All values are frequency (%) unless otherwise specified.
ACEi = angiotensin converting enzyme inhibitor; ARB = angiotensin receptor blocker; CKD = chronic kidney disease.

### Figure 2: Heart failure medication doses at 12 months post-discharge.
dose of ACEi/ARB, compared to 66% seen in general cardiology clinic and 46% not seen in cardiology clinic.

Twenty-seven percent of patients had a documented reason why their beta-blocker dose could not be dispensed or uptitrated. The most common reason for inability to up-titrate beta-blockers was bradycardia (20%). When taking this into account, 68% were on a maximally tolerated dose of beta-blocker at one year post-discharge or at time of death. Eighty-nine percent of patients seen in cardiology HF clinic were on the maximally tolerated dose of beta-blocker, compared to 67% seen in general cardiology clinic and 34% not seen in cardiology clinic.

Fourteen percent of patients had a documented reason why a MRA could not be dispensed or up-titrated. MRAs were not indicated in 35% of patients in this study. When taking this into account, 64% of patients received a maximally tolerated and indicated dose of MRAs.

Primary prevention implantable cardiac defibrillator (Table 3)

Very few patients (13%) were eligible for primary prevention ICD implantation. The most common reasons for ineligibility were not meeting clinical indications (66%), age ≥75 years (32%) or life-limiting condition (17%). Seventeen patients received a secondary prevention ICD within one year of their index admission. Only nine patients (24% of potentially eligible patients) received a primary prevention ICD within one year of their index admission. The large majority of these patients were seen in Cardiology HF clinics (seven patients), the remaining were seen in general cardiology clinic.

Discussion

In a regional cohort of patients with ACS and reduced LVEF, there was underutilisation of evidence-based therapies for treatment and prevention of clinical heart failure. Proportions of patients dispensed ≥50% target dose of ACEi/ARB or beta-blockers at one year post-discharge were low (52% and 39% respectively), although these proportions were somewhat higher for those considered to be receiving maximally tolerated dosages of these medications (71% and 68% respectively). Importantly, those patients who attended a cardiology HF clinic rather than a general cardiology clinic were more likely to achieve ≥50% target dose of ACEi/ARB or beta-blockers. Furthermore, around 90% attending cardiology HF clinics achieved the maximum tolerated dose of both compared with only two-thirds in general cardiology clinics. Only 3% received an ICD implant for primary prevention within one year of discharge.

<table>
<thead>
<tr>
<th></th>
<th>All n=292</th>
<th>Cardiology heart failure clinic n=83</th>
<th>General cardiology clinic n=159</th>
<th>No cardiology clinic n=50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ineligible for primary prevention ICD</td>
<td>254 (87.0)</td>
<td>66 (79.5)</td>
<td>143 (89.9)</td>
<td>45 (90.0)</td>
</tr>
<tr>
<td>ICD prior to admission</td>
<td>6 (2.1)</td>
<td>0 (0.0)</td>
<td>5 (3.1)</td>
<td>1 (2.0)</td>
</tr>
<tr>
<td>Secondary prevention ICD</td>
<td>17 (5.8)</td>
<td>6 (7.2)</td>
<td>10 (6.3)</td>
<td>1 (2.0)</td>
</tr>
<tr>
<td>NYHA class ≥II and LVEF ≥35%</td>
<td>193 (66.1)</td>
<td>44 (53.0)</td>
<td>115 (72.3)</td>
<td>34 (68.0)</td>
</tr>
<tr>
<td>OR NYHA class I and LVEF ≥30%</td>
<td>50 (17.1)</td>
<td>3 (3.6)</td>
<td>29 (18.2)</td>
<td>18 (36.0)</td>
</tr>
<tr>
<td>Life limiting condition</td>
<td>92 (31.5)</td>
<td>18 (21.7)</td>
<td>54 (34.0)</td>
<td>20 (40.0)</td>
</tr>
<tr>
<td>Age ≥75 years</td>
<td>6 (2.1)</td>
<td>0 (0.0)</td>
<td>5 (3.1)</td>
<td>1 (2.0)</td>
</tr>
<tr>
<td>Eligible for primary prevention ICD</td>
<td>38 (13.0)</td>
<td>17 (20.5)</td>
<td>16 (10.1)</td>
<td>5 (10.0)</td>
</tr>
<tr>
<td>Patients who received primary prevention ICD within one year of discharge*</td>
<td>9 (23.7)</td>
<td>7 (41.2)</td>
<td>2 (12.5)</td>
<td>0 (0.0)</td>
</tr>
</tbody>
</table>

NB: All values are frequency (%) unless otherwise specified.

* Frequency is of those who were eligible for primary prevention ICD.
Target doses versus maximally tolerated doses

Current clinical guidelines give a class I recommendation for the use of ACEi/ARB, beta-blockers and MRAs in patients with reduced LVEF following ACS, to reduce both morbidity and mortality.4,5 This is based upon evidence from randomised clinical trials where the majority of patients were on target doses. For example, 79% of patients were on target doses of captopril in the SAVE trial,14 74% of patients were on target doses of carvedilol in the CAPRICORN trial15 and the mean dose of eplerenone was 42.6mg (>80% target dose) in the EPHESUS trial.16 However, an evidence-practice gap is seen in ‘real-world’ registries where few patients are able to achieve target doses. Only 34% and 35% of patients with reduced LVEF were on ≥50% target doses of ACEi/ARB and beta-blockers respectively one year post-ACS in a nationwide New Zealand cohort.7 Similar findings are seen PREMIER/TRIUMPH ACS registries with only 32% of patients with LV dysfunction achieving goal doses of ACEi/ARB one year following ACS.17 These findings are also seen in cohorts of patients with chronic HF.18 Further medication up-titration may not be possible in patients due to comorbidities and drug intolerances. It may be unreasonable to aim for target doses of medications in all patients with reduced LVEF. In this study, 17% and 27% of patients had clear documented reasons why their ACEi/ARB and beta-blocker respectively, could not be up-titrated to ≥50% target doses.

In this retrospective study, the highest proportion of patients on target doses of evidence-based HF therapy were observed in patients seen in cardiology HF clinics. The majority of patients seen in cardiology HF clinics were on maximally tolerated doses of ACEi/ARB (95%) and beta-blockers (89%), however fewer patients in this group achieved ≥50% target dose of ACEi/ARB (74%) or beta-blocker (59%). This suggests that aiming for target doses of evidence-based HF therapies in all patients may not be achievable, even with intensive outpatient follow-up provided in cardiology HF clinics. It may be more reasonable to aim for all patients to be on maximally tolerated dose, rather than target doses of ACEi/ARB and beta-blockers.

Improving use of heart failure therapies via HF clinics

There is still room for improvement in the use of evidence-based HF therapies in patients with reduced LVEF post-ACS in this study. Patients not seen in cardiology HF clinic had lower rates of both patients on ≥50% target dose of ACEi/ARB or beta-blockers and patients on maximally tolerated doses of ACEi/ARB or beta-blockers. This study suggests that improved utilisation of evidence-based HF therapies could possibly be achieved by more patients being seen in cardiology HF clinics.

A multidisciplinary team (MDT) approach, including nurse-led HF clinics is considered the gold standard model for the delivery of HF care and is recommended by the European Society of Cardiology11 and Cardiac Society of Australia and New Zealand.4 Previous studies have demonstrated that patients seen in MDT HF clinics are more likely to reach target doses of beta-blockers19 and achieve optimal cardiac medication therapy in shorter time periods.20 MDT HF services also improve clinical outcomes. A local randomised controlled trial of integrated HF management improved quality of life and reduced total hospital admissions.21 Planned referral to nurse-led HF clinics was associated with reduced mortality but not HF hospitalisation in the SwedeHF registry.22 Reduction in both mortality and morbidity was observed in a Cochrane meta-analysis of nurse-led up-titration services.23 It is unclear whether the clinical benefit of MDT HF services arises from improved medication up-titration, or from other interventions such as patient education, self-management, cardiac rehabilitation, more frequent clinical assessment and psychological support.24

However, cardiology HF clinics are a limited resource. In this study only 28% of patients were seen in cardiology HF clinics, however they appear to be appropriately utilised for patients with high-risk features such as more severe clinical heart failure and severe left ventricular systolic impairment. Although patients seen in cardiology HF clinics had shorter times to their first outpatient appointment, median time to first follow-up was still over seven weeks. Furthermore, a significant amount of medication up-titration appears to occur between 3 and 12 months post-discharge, suggesting...
that there are barriers to quicker up-titration such as delays to repeat follow-up assessments. These delays to medication up-titration may result in adverse clinical outcomes. The patients included in this study were high-risk patients with reduced LVEF following ACS and it is reasonable that their medications should be up-titrated in the early outpatient setting, rather than primary care. Further resource allocation is required to reduce waiting times for outpatient follow-up, and to allow a greater proportion of patients to be seen in nurse-led HF clinics.

**Implantable cardiac defibrillators**

In this study, 13% of patients were eligible for, and only 3% received an ICD implantation for, primary prevention. This is comparable to other cohorts of patients with reduced LVEF following ACS. In the TRUIMPH registry of patients with acute myocardial infarction and LVEF <40%, only 2.4% of patients underwent ICD implantation by one year. In a retrospective study of Medicare beneficiaries with an LVEF 35% post-myocardial infarction, the one-year ICD implantation rate was 8.1%. In both studies earlier outpatient clinic follow-up was associated with a higher rate of ICD implantation. ICD implantation for primary prevention post-ACS with reduced LVEF is recommended 40 days after ACS to reduce mortality. Median time to first clinic follow-up and reassessment of LVEF were beyond 40 days in this study, suggesting that there are potential missed opportunities to improve rates of primary prevention ICD implants in this population.

**Strengths and limitations**

This study was a retrospective analysis of hospital based electronic records of patients admitted with an ACS. This was a complete annual cohort of patients from three large metropolitan DHBs that provide care for approximately 35% of the total New Zealand population. Primary care records were not available and patients were not contacted, hence reasons why medications could not be up-titrated may be unreported in this study. In this observational study there are differences in the characteristics of the patients seen in each group and we can’t be certain that some of the differences in attainment of target doses was not due to unrecorded reasons for not up-titrating medication. Nevertheless, the proportions of patients with definite reasons not to up-titrate were similar for the cardiology HF clinic and general cardiology clinic groups. Only medication dispensing was recorded and adherence to heart failure therapies was not obtainable. Lastly, the effect of medication up-titration on clinical outcomes was not recorded and outside of the scope of this study.

**Conclusions**

Evidence-based heart failure therapies were underutilised in this cohort of patients with reduced LVEF post-ACS with only half of patients being dispensed on ≥50% target doses of ACEi/ARB and few patients receiving primary prevention ICDs. However, the majority of patients seen in cardiology HF clinics were dispensed maximally tolerated doses of ACEi/ARB and beta-blockers. Strategies to improve use of these proven therapies should focus on increasing the number of patients seen in cardiology HF clinics and reducing clinic waiting times.
Appendix Table 1: Guideline-recommended doses.

<table>
<thead>
<tr>
<th>Drug Type</th>
<th>Starting dose</th>
<th>≥50% target dose</th>
<th>Target dose</th>
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</thead>
<tbody>
<tr>
<td>Angiotensin converting enzyme inhibitor/angiotensin receptor blocker</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Captopril</td>
<td>6.25mg tds</td>
<td>25mg tds</td>
<td>50mg tds</td>
</tr>
<tr>
<td>Enalapril</td>
<td>2.5mg bd</td>
<td>10mg bd</td>
<td>20mg bd</td>
</tr>
<tr>
<td>Lisinopril</td>
<td>2.5–5mg daily</td>
<td>10mg daily</td>
<td>20mg daily</td>
</tr>
<tr>
<td>Cilazapril</td>
<td>0.5mg daily</td>
<td>2.5mg daily</td>
<td>5mg daily</td>
</tr>
<tr>
<td>Quinapril</td>
<td>2.5mg bd</td>
<td>5mg bd</td>
<td>10mg bd</td>
</tr>
<tr>
<td>Perindopril</td>
<td>2mg daily</td>
<td>4mg daily</td>
<td>8mg daily</td>
</tr>
<tr>
<td>Candesartan</td>
<td>4–8mg daily</td>
<td>16mg daily</td>
<td>32mg daily</td>
</tr>
<tr>
<td>Losartan</td>
<td>12.5mg daily</td>
<td>50mg daily</td>
<td>100mg daily</td>
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<td>Sacubitril with valsartan</td>
<td>24/26mg bd</td>
<td>49/51mg bd</td>
<td>97/103mg bd</td>
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<td>Beta-blocker</td>
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<tr>
<td>Metoprolol CR</td>
<td>23.75mg daily</td>
<td>95mg daily</td>
<td>190mg daily</td>
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<td>Bisoprolol</td>
<td>1.25mg daily</td>
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<td>10mg daily</td>
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<td>Carvedilol</td>
<td>3.125mg bd</td>
<td>12.5mg bd</td>
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<tr>
<td>Mineralocorticoid receptor antagonist</td>
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<td></td>
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</tr>
<tr>
<td>Spironolactone</td>
<td>12.5–25mg daily</td>
<td>25mg daily</td>
<td>50mg daily</td>
</tr>
<tr>
<td>Eplerenone</td>
<td>25mg daily</td>
<td>25mg daily</td>
<td>50mg daily</td>
</tr>
<tr>
<td><strong>bd</strong> = twice daily, <strong>tds</strong> = three times daily.</td>
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</table>

Appendix Table 2: ACEI/ARB up-titration.

<table>
<thead>
<tr>
<th>Time Point</th>
<th>Total, n (%)</th>
<th>Cardiology heart failure clinic, n=83</th>
<th>General cardiology clinic, n=159</th>
<th>No cardiology clinic, n=50</th>
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</thead>
<tbody>
<tr>
<td><strong>Discharge</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doses, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Nil</td>
<td>243 (83.2)</td>
<td>72 (86.7)</td>
<td>133 (83.6)</td>
<td>38 (76.0)</td>
</tr>
<tr>
<td>- Low dose</td>
<td>140 (47.9)</td>
<td>48 (57.8)</td>
<td>73 (45.9)</td>
<td>19 (38.0)</td>
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<td>12 (14.5)</td>
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<tr>
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</tr>
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<td>Doses, n (%)</td>
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<td>10 (20.0)</td>
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<td>72 (45.3)</td>
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<td>29 (18.2)</td>
<td>9 (18.0)</td>
</tr>
<tr>
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<td>39 (24.5)</td>
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</tr>
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<tr>
<td>Doses, n (%)</td>
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<td></td>
</tr>
<tr>
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<tr>
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<td>44 (27.7)</td>
<td>9 (18.0)</td>
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### Appendix Table 3: Beta-blocker up-titration.

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<td>n=292</td>
<td>n=83</td>
<td>n=159</td>
<td>n=50</td>
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<tr>
<td><strong>Discharge</strong></td>
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<tr>
<td>Total, n (%)</td>
<td>254 (87.0)</td>
<td>75 (90.4)</td>
<td>137 (86.2)</td>
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<tr>
<td>- 50–99% target dose</td>
<td>68 (23.3)</td>
<td>23 (27.8)</td>
<td>35 (22.0)</td>
<td>10 (20.0)</td>
</tr>
<tr>
<td>- Target dose</td>
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<td>12 (7.5)</td>
<td>6 (12.0)</td>
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<td><strong>3 months post discharge</strong></td>
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<tr>
<td>Total, n (%)</td>
<td>259 (88.7)</td>
<td>76 (91.6)</td>
<td>142 (89.3)</td>
<td>41 (82.0)</td>
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<td>Doses, n (%)</td>
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<td>28 (9.6)</td>
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<td>14 (8.8)</td>
<td>5 (10.0)</td>
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<td><strong>12 months post discharge</strong></td>
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<td></td>
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<td>Total, n (%)</td>
<td>240 (82.2)</td>
<td>75 (90.4)</td>
<td>130 (81.8)</td>
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<td>Doses, n (%)</td>
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<td>- 50–99% target dose</td>
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<td>38 (23.9)</td>
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<tr>
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<td>5 (10.0)</td>
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<tr>
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### Appendix Table 4: Mineralocorticoid antagonist up-titration.

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<td>n=159</td>
<td>n=50</td>
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<td><strong>Discharge</strong></td>
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<td></td>
</tr>
<tr>
<td>Total, n (%)</td>
<td>53 (18.2)</td>
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<td>6 (12.0)</td>
</tr>
<tr>
<td>Doses, n (%)</td>
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<tr>
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<td>64 (77.1)</td>
<td>131 (82.4)</td>
<td>44 (88.0)</td>
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<tr>
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<td>23 (7.9)</td>
<td>6 (7.2)</td>
<td>12 (7.5)</td>
<td>5 (10.0)</td>
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<tr>
<td>- 50–99% target dose</td>
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<td>13 (15.7)</td>
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<td>0 (0.0)</td>
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<tr>
<td><strong>3 months post discharge</strong></td>
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<tr>
<td>Total, n (%)</td>
<td>66 (22.6)</td>
<td>28 (33.7)</td>
<td>32 (20.1)</td>
<td>6 (12.0)</td>
</tr>
<tr>
<td>Doses, n (%)</td>
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<td>226 (77.4)</td>
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<td>127 (79.9)</td>
<td>44 (88.0)</td>
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<tr>
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<td>0 (0.0)</td>
<td>0 (0.0)</td>
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<tr>
<td><strong>12 months post discharge</strong></td>
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<td></td>
</tr>
<tr>
<td>Total, n (%)</td>
<td>68 (23.3)</td>
<td>34 (41.0)</td>
<td>29 (18.2)</td>
<td>5 (10.0)</td>
</tr>
<tr>
<td>Doses, n (%)</td>
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</tr>
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<td>4 (8.0)</td>
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<tr>
<td>- 50–99% target dose</td>
<td>41 (14.0)</td>
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<td>21 (13.2)</td>
<td>1 (2.0)</td>
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<tr>
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<td>17 (5.8)</td>
<td>17 (5.8)</td>
<td>6 (3.8)</td>
<td>8 (16.0)</td>
</tr>
</tbody>
</table>
Competing interests:
Dr Mazengarb and Dr Chan are supported by the Middlemore Hospital Cardiac Trust outside the submitted work; Dr Chan holds the AH Couch Research Scholarship; Dr Doughty holds the New Zealand Heart Foundation Chair of Heart Health.

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URL:

REFERENCES:


Energy-dense vs routine enteral nutrition in New Zealand Europeans, Māori, and Pacific Peoples who are critically ill

Alice L Reid, Marianne J Chapman, Sandra L Peake, Rinaldo Bellomo, Andrew R Davies, Adam M Deane, Michael Horowitz, Sally Hurford, Kylie Lange, Lorraine Little, Diane M Mackle, Stephanie N O’Connor, Jeffrey J Presneill, Emma J Ridley, Patricia J Williams, Paul J Young, on behalf of the TARGET Investigators and the Australian and New Zealand Intensive Care Society Clinical Trials Group

ABSTRACT

AIMS: To evaluate the effect of energy-dense vs routine enteral nutrition on day-90 mortality by ethnic group in critically ill adults.

METHODS: Pre-planned subgroup analysis of the 1,257 New Zealanders in a 4,000-participant randomised trial comparing energy-dense enteral nutrition (1.5kcal/mL) with routine enteral nutrition (1kcal/mL) in mechanically ventilated intensive care unit (ICU) patients. The primary purpose of this analysis was to evaluate responses to study treatment by ethnic group (European, Māori, and Pacific Peoples) using ethnicity data recorded in the clinical records. The secondary purpose was to compare the characteristics and outcomes of patients by ethnic group. The primary outcome was day-90 mortality.

RESULTS: Among 1,138 patients included in the primary outcome analysis, 165 of 569 (29.0%) assigned to energy-dense nutrition and 156 of 569 patients (27.4%) assigned to routine nutrition died by day 90 (odds ratio; 1.06; 95% CI, 0.92–1.22). There was no statistically significant interaction between treatment allocation and ethnicity with respect to day-90 mortality. Day-90 mortality rates did not vary statistically significantly by ethnic group.

CONCLUSIONS: Among mechanically ventilated adults in New Zealand ICUs, the effect on day-90 mortality of energy-dense vs routine enteral nutrition did not vary by ethnicity.

Over 14,000 critically ill patients are admitted to New Zealand intensive care units (ICUs) annually.1 Nutrition therapy is an essential standard of care for all patients who require life support (invasive mechanical ventilation) as calorie deficits in such patients are associated with poor outcomes.2,3 Enteral nutrition delivered through a nasogastric tube is preferred to parenteral nutrition, but typically results in delivery of only ~60% of guideline-recommended calories.4,5

The Augmented vs Routine approach to Giving Energy Trial (TARGET) was a multicentre randomised double-blind clinical trial comparing energy-dense nutrition (1.5kcal/mL) with routine nutrition (1kcal/mL) in 4,000 critically ill adults from 46 ICUs in Australia and New Zealand.6 Use of energy-dense nutrition resulted in delivery of guideline-recommended calories in a large-scale clinical trial for the first time but failed to reduce day-90 mortality or affect a number of important secondary outcomes compared with routine nutrition.6
International guidelines recommend the use of weight-based equations to estimate energy requirements and these are the most frequently used in clinical practice.

Ethnic differences in body composition, socioeconomic status and patterns of prior nutritional intake as well as differences in the prevalence of diseases like obesity and type 2 diabetes mean that it is plausible the calorie requirements of critically ill adults vary by ethnicity. However, whether ethnicity is an important determinant of treatment response when energy-dense nutrition is used to deliver guideline-recommended calories is unknown. This information is important to understanding whether the TARGET results are generalisable to different ethnic groups in New Zealand.

Accordingly, we conducted a pre-planned analysis of the 1,257 participants who were enrolled in the 11 New Zealand ICUs that participated in TARGET. The principal aim of this analysis was to establish whether the effect of energy-dense nutrition on patient outcomes varied by ethnic group. Our hypothesis was that for day-90 mortality there would be a statistically significant interaction between ethnicity and treatment allocation. Our secondary aim was to report the mortality of enrolled participants by ethnic group adjusted for treatment allocation and important baseline covariates.

Method

Trial design
TARGET was an investigator-initiated, randomised, parallel group, double-blind superiority trial. This report outlines the findings from a pre-planned subgroup analysis of response to treatment by ethnicity, which was approved by the Northern B New Zealand Health and Disability Ethics Committee, only included New Zealand participants; ethnicity data were not collected for Australian participants. Details of TARGET trial design are available in the previously published study protocol, statistical analysis plan, and in the primary manuscript.

Patient population
Mechanically ventilated adults, aged 18 or older, who were to commence or had commenced enteral nutrition in the previous 12 hours, and were anticipated to require enteral nutrition in ICU beyond the calendar day following recruitment were eligible for inclusion. Exclusion criteria included a requirement for specific nutritional therapy or when a treating clinician considered the goal feeding rate was clinically contraindicated. As part of baseline data collection, New Zealand study participants had a single ethnicity based on prioritised ethnicity tables recorded from the clinical records.

For this analysis, we excluded patients who were not categorised into one of the three largest ethnic groups (New Zealand European, Māori and Pacific Peoples).

Randomisation and study treatment
Eligible participants were randomised in a 1:1 ratio to 1.5kcal/mL (energy-dense nutrition) or 1kcal/mL (routine nutrition). Randomisation was undertaken using permuted block method with variable block size, stratified by site, via a secure centralised web-based system. Nutrition was delivered via the enteral route at a goal rate of 1mL/kg ideal body weight per hour in both groups, with a maximum goal rate of 100mL per hour, to be achieved within 48 hours. The study feeds were supplied by Fresenius Kabi Deutschland, Germany in identical 1,000mL bags with study-specific labels. Further information regarding feed content is available in the TARGET manuscript. The trial enteral nutrition was administered for up to 28 days, until the patient discontinued enteral nutrition, died or was discharged from ICU, whichever occurred first.

Outcome measures

Primary outcome
The primary outcome was all-cause mortality at day 90 following randomisation.

Secondary outcomes
Secondary outcomes included survival time to day 90; proportion of patients who had each of the following within 28 days of randomisation: vasopressor support; renal replacement therapy in ICU, positive blood cultures to day 28 after randomisation, intravenous antimicrobials to day 28 after randomisation.
Statistical analysis

This analysis was conducted in accordance with a pre-prepared plan. Power calculations were not performed because the number of New Zealand participants in TARGET was determined by the available sample. We conducted analyses on a modified intention to treat population that included all randomised New Zealand participants except those who withdrew consent for the use of all data or were lost to follow up before consent could be obtained and those both who did not meet all eligibility criteria and did not receive any study treatment.

Normally distributed and non-normally distributed continuous variables are reported as mean ± standard deviation and median (interquartile range) respectively. Categorical variables are reported as count and percentages. Baseline characteristics were compared using analysis of variance or Kruskall-Wallis tests for continuous variables with Dunnett posthoc tests when significant and chi-square tests with Bonferonni-adjusted posthoc tests when significant.

The primary outcome, mortality at day 90, was evaluated using logistic regression with results reported as odds ratios with 95% confidence intervals (CIs). As a sensitivity analysis, modified Poisson regression was also used to estimate the relative risks and 95% CIs.

We present survival time as Kaplan–Meier curves and used a Cox proportional-hazards model to calculate hazard ratios for survival. The proportion of patients who had vasopressor support, renal replacement therapy in ICU, positive blood cultures and intravenous antimicrobials were evaluated using logistic regression. A differential effect of treatment across ethnicity groups was evaluated by including the interaction between ethnicity and treatment allocation in all models. Analyses of the independent effects of ethnicity on mortality at day 90 were adjusted for treatment group, and site, as well as the pre-defined covariates of age, ICU admission APACHE-II score, body mass index, gender and admission type and reported as odds ratios and 95% CIs.

Analyses were conducted using SPSS Statistics 25 (IBM Corp, 2017).

Results

Patient characteristics

From June 2016 to November 2017, we enrolled 1,268 patients from 11 adult medical-surgical ICUs in New Zealand into TARGET. A total of 569 patients assigned to energy-dense nutrition and 569 patients assigned to routine nutrition were included in the primary outcome analysis (Figure 1). The energy-dense and routine enteral nutrition groups generally had similar baseline characteristics overall and when treatment groups were compared for New Zealand European, Māori and Pacific Peoples separately (Table 1). However, there were a number of highly statistically significant differences in the baseline characteristics of patients from different ethnic groups. Compared with New Zealand Europeans, Māori and Pacific Peoples were younger, had higher body mass index, were relatively more likely to have end-stage renal failure and insulin-treated diabetes mellitus (Table 2).

Primary outcome

Day-90 mortality by treatment group for each ethnic group is shown in Table 3. There was no statistically significant interaction between study treatment allocation and ethnicity for all-cause mortality at day 90 following randomisation (Table 3 and Figure 2).

A total of 246 of 805 European participants (30.6%), 41 of 189 Māori participants (21.7%), and 34 of 144 Pacific participants (23.6%) had died by day 90. Compared with European participants, the adjusted odds ratio for day-90 mortality for Māori participants was 0.93 (95%CI, 0.56–1.54; \( P=0.79 \)). Compared with European participants, the adjusted odds ratio for day-90 mortality for Pacific participants was 0.80 (95%CI, 0.53–1.22; \( P=0.30 \)).

Secondary outcomes

There was no statistically significant interaction between study treatment allocation and ethnicity for survival time following randomisation (Figure 3). There was no statistically significant interaction between ethnicity and treatment allocation for the proportion of patients who had each of the following within 28 days of randomisation: vasopressor support; renal replacement therapy in ICU; positive blood cultures; and intravenous antimicrobials (Table 3).
Figure 1: Screening, randomisation and follow-up.

Met inclusion criteria (n=1695):
- Met a TARGET exclusion criteria (n=379):
  - Received enteral or parenteral nutrition for greater than 12 hours during this ICU admission (n=112)
  - Had a specific nutritional therapy (n=87)
  - Were expected to die imminently (n=81)
  - Had a contraindication of enteral nutrition study goal rate (n=61)
  - Had an underlying disease making life expectancy of >90 days unlikely (n=30)
  - Were previously enrolled (n=6)
  - Had acute burns covering ≥15% of body surface area (n=2)

Did not consent (n=13)

Not enrolled for other reasons (n=35)

Randomised (n=1268)

- Excluded from modified intention to treat population (n=6):
  - Did not consent to use of data (n=5)
  - Did not fulfll eligibility criteria and did not receive study treatment (n=1)

randomised to energy-dense nutrition (n=633)

- Were not in one of the three major ethnic groups (n=52):
  - Asian (n=42)
  - Middle Eastern / Latin American / African (n=3)
  - Other (n=7)

Primary outcome not available (n=8):
- Withdrew consent for ascertainment of the primary outcome (n=2)
- Lost to follow-up (n=4)

Excluded from modified intention to treat population (n=5):
- Did not consent to use of data (n=5)

randomised to standard nutrition (n=635)

- Were not in one of the three major ethnic groups (n=54):
  - Asian (n=40)
  - Middle Eastern / Latin American / African (n=4)
  - Other (n=10)

Primary outcome not available (n=7):
- Withdrew consent for ascertainment of the primary outcome (n=7)

Primary outcome analysed (n=569)

Abbreviations: ICU: intensive care unit.
Table 1: Characteristics of the patients at baseline by ethnicity and treatment group.

<table>
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<tr>
<th>Characteristic</th>
<th>All patients</th>
<th>NZ European (n=576)</th>
<th>Māori (n=414)</th>
<th>Pacific Peoples (n=99)</th>
<th>Energy-dense nutrition (n=97)</th>
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</thead>
<tbody>
<tr>
<td>Age –yr</td>
<td>57.1±16.6 (n=575)</td>
<td>57.8±16.9 (n=576)</td>
<td>59.3±16.3 (n=414)</td>
<td>60.8±16.3 (n=401)</td>
<td>59.3±16.3 (n=91)</td>
</tr>
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<td>Male sex –no. (%)</td>
<td>378 (66%)</td>
<td>373 (65%)</td>
<td>268 (70%)</td>
<td>266 (66%)</td>
<td>53 (58%)</td>
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<tr>
<td>Actual weight –kg</td>
<td>88.0±23.0 (n=574)</td>
<td>90.0±25.1 (n=576)</td>
<td>84.1±19.7 (n=414)</td>
<td>85.1±19.7 (n=401)</td>
<td>97.5±30.6 (n=91)</td>
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<td>Ideal body weight –kg *</td>
<td>66.4±10.4 (n=575)</td>
<td>66.2±10.3 (n=576)</td>
<td>67.1±10.5 (n=414)</td>
<td>66.4±10.2 (n=401)</td>
<td>65.5±10.1 (n=91)</td>
</tr>
<tr>
<td>Body mass index –g/m²†</td>
<td>28.7±7.6 (n=575)</td>
<td>30.5±8.5 (n=576)</td>
<td>28.1±6.0 (n=414)</td>
<td>28.8±6.7 (n=401)</td>
<td>33.1±9.7 (n=91)</td>
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<tr>
<td>ICU admission category – no/total no. (%)</td>
<td>366 (64%)</td>
<td>366 (64%)</td>
<td>279 (67%)</td>
<td>262 (65%)</td>
<td>52 (57%)</td>
</tr>
<tr>
<td>Chronic cardiovascular disease – no. (%)</td>
<td>21 (4%)</td>
<td>30 (5%)</td>
<td>12 (3%)</td>
<td>23 (6%)</td>
<td>7 (8%)</td>
</tr>
<tr>
<td>Chronic respiratory disease – no. (%)</td>
<td>19 (3%)</td>
<td>21 (4%)</td>
<td>13 (3%)</td>
<td>16 (4%)</td>
<td>1 (1%)</td>
</tr>
<tr>
<td>Hepatic failure or cirrhosis – no. (%)</td>
<td>7 (1%)</td>
<td>8 (1%)</td>
<td>6 (1%)</td>
<td>8 (2%)</td>
<td>1 (1%)</td>
</tr>
<tr>
<td>End-stage renal failure, n (%)</td>
<td>6 (1%)</td>
<td>7 (1%)</td>
<td>2 (0.5%)</td>
<td>2 (0.5%)</td>
<td>2 (2%)</td>
</tr>
<tr>
<td>Metastatic cancer or haematological malignancy – no. (%)</td>
<td>8 (1%)</td>
<td>12 (2%)</td>
<td>7 (2%)</td>
<td>12 (3%)</td>
<td>1 (1%)</td>
</tr>
<tr>
<td>Immune disease or immunosuppression – no. (%)</td>
<td>18 (3%)</td>
<td>19 (3%)</td>
<td>14 (3%)</td>
<td>17 (4%)</td>
<td>3 (3%)</td>
</tr>
<tr>
<td>Insulin dependent diabetes mellitus – no. (%)</td>
<td>18 (3%)</td>
<td>35 (6%)</td>
<td>18 (4%)</td>
<td>14 (3%)</td>
<td>4 (3%)</td>
</tr>
<tr>
<td>APACHE-II score ‡</td>
<td>21.7±8.5 (n=575)</td>
<td>22.1±8.8 (n=576)</td>
<td>21.8±8.9 (n=414)</td>
<td>22.3±8.9 (n=401)</td>
<td>22.1±8.1 (n=91)</td>
</tr>
<tr>
<td>ANZ Risk Of Death</td>
<td>0.2±0.2 (n=574)</td>
<td>0.2±0.2 (n=576)</td>
<td>0.2±0.2 (n=414)</td>
<td>0.2±0.2 (n=401)</td>
<td>0.2±0.2 (n=91)</td>
</tr>
<tr>
<td>Time from ICU admission to randomisation (hours)</td>
<td>13.2 (n=574)</td>
<td>12.3 (n=575)</td>
<td>12.5 (n=414)</td>
<td>11.8 (n=401)</td>
<td>13.6 (n=91)</td>
</tr>
<tr>
<td>Sepsis at randomisation – no. (%)</td>
<td>202 (35%)</td>
<td>206 (36%)</td>
<td>151 (36%)</td>
<td>151 (38%)</td>
<td>30 (33%)</td>
</tr>
<tr>
<td>Organ support at randomisation – no. (%)</td>
<td>574 (100%)</td>
<td>573 (100%)</td>
<td>413 (100%)</td>
<td>398 (100%)</td>
<td>91 (100%)</td>
</tr>
<tr>
<td>Invasive ventilation – no. (%) §</td>
<td>394 (69%)</td>
<td>383 (66%)</td>
<td>281 (68%)</td>
<td>257 (64%)</td>
<td>62 (68%)</td>
</tr>
<tr>
<td>Vasopressor infusion – no. (%)</td>
<td>50 (9%)</td>
<td>38 (7%)</td>
<td>32 (8%)</td>
<td>24 (6%)</td>
<td>6 (7%)</td>
</tr>
<tr>
<td>Acute renal replacement therapy – no. (%)</td>
<td>85.5±18.1 (n=99)</td>
<td>85.5±18.1 (n=99)</td>
<td>85.5±18.1 (n=401)</td>
<td>85.5±18.1 (n=401)</td>
<td>85.5±18.1 (n=99)</td>
</tr>
</tbody>
</table>

Plus-minus values are expressed as mean ± SD.

* Ideal body weight was calculated from patient height, determined in the supine position as follows for men, ideal body weight in kg = 50 + 0.91 (height in cm - 152.4); for females, ideal body weight in kg = 45.5 + 0.91 (height in cm - 152.4).

† Body-mass index is the weight in kilograms divided by the square of the height in meters.

‡ Scores on the Acute Physiology and Chronic Health Evaluation (APACHE) II range from 0 to 71, with higher scores indicating more severe disease and a higher risk of death. The score was calculated with the values recorded for each variable during the 24 hours before randomisation that would result in the highest score.

§ n=4 subjects had missing data for this item (1 in the energy-dense group; 3 in the routine nutrition group).
Table 2: Characteristics of TARGET study patients by ethnicity.*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>NZ European (N=815)</th>
<th>Māori (N=190)</th>
<th>Pacific Peoples (N=146)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age -yr</strong></td>
<td>60.0±16.3</td>
<td>50.6±16.2***</td>
<td>51.6±16.1***</td>
</tr>
<tr>
<td>Male sex –no. (%)</td>
<td>554 (68%)</td>
<td>118 (62%)</td>
<td>79 (54%)**</td>
</tr>
<tr>
<td><strong>Actual weight –kg</strong></td>
<td>84.6±19.7</td>
<td>96.0±28.9***</td>
<td>104.2±30.3***</td>
</tr>
<tr>
<td>Ideal body weight –kg †</td>
<td>66.8±10.3</td>
<td>65.5±10.2</td>
<td>64.7±10.4*</td>
</tr>
<tr>
<td><strong>Body mass index –g/m² ‡</strong></td>
<td>28.4±6.4</td>
<td>32.6±9.3***</td>
<td>35.9±11.0***</td>
</tr>
<tr>
<td><strong>ICU admission category</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-operative –no. (%)</td>
<td>541 (66%)</td>
<td>112 (59%)</td>
<td>78 (53%)</td>
</tr>
<tr>
<td>Emergency operative –no. (%)</td>
<td>150 (18%)</td>
<td>42 (22%)</td>
<td>31 (21%)</td>
</tr>
<tr>
<td>Elective operative –no. (%)</td>
<td>124 (15%)</td>
<td>35 (18%)</td>
<td>37 (25%)**</td>
</tr>
<tr>
<td><strong>Co-existing medical conditions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic cardiovascular disease –no. (%)</td>
<td>35 (4%)</td>
<td>14 (7%)</td>
<td>2 (1%)</td>
</tr>
<tr>
<td>Chronic respiratory disease –no. (%)</td>
<td>29 (4%)</td>
<td>1 (1%)</td>
<td>10 (7%)</td>
</tr>
<tr>
<td>Hepatic failure or cirrhosis –no. (%)</td>
<td>14 (2%)</td>
<td>1 (1%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>End-stage renal failure, n (%)</td>
<td>4 (0.5%)</td>
<td>4 (2%)*</td>
<td>5 (3%)***</td>
</tr>
<tr>
<td>Metastatic cancer or haematological malignancy –no. (%)</td>
<td>19 (2%)</td>
<td>1 (1%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Immune disease or immunosuppression –no. (%)</td>
<td>31 (4%)</td>
<td>3 (2%)</td>
<td>3 (2%)</td>
</tr>
<tr>
<td>Insulin dependent diabetes mellitus –no. (%)</td>
<td>32 (4%)</td>
<td>16 (8%)*</td>
<td>18 (12%)***</td>
</tr>
<tr>
<td>APACHE-II score §</td>
<td>22.1±8.7</td>
<td>22.3±8.0</td>
<td>20.8±9.0</td>
</tr>
<tr>
<td>ANZ Risk Of Death</td>
<td>0.23±0.23</td>
<td>0.20±0.21</td>
<td>0.19±0.23</td>
</tr>
<tr>
<td>Time from ICU admission to randomisation (hours), median (IQR)</td>
<td>12.3 (5.1–24.7)</td>
<td>12.7 (5.7–26.6)</td>
<td>14.2 (6.6–28.3)</td>
</tr>
<tr>
<td>Sepsis at randomisation –no. (%)</td>
<td>302 (37%)</td>
<td>56 (29%)</td>
<td>50 (34%)</td>
</tr>
<tr>
<td><strong>Organ support at randomisation –no. (%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Invasive ventilation –no. (%)¶</td>
<td>811 (100%)</td>
<td>190 (100%)</td>
<td>146 (100%)</td>
</tr>
<tr>
<td>Vasopressor infusion –no. (%)</td>
<td>538 (66%)</td>
<td>136 (72%)</td>
<td>103 (71%)</td>
</tr>
<tr>
<td>Acute renal replacement therapy –no. (%)</td>
<td>56 (7%)</td>
<td>17 (9%)</td>
<td>15 (10%)</td>
</tr>
</tbody>
</table>

Plus-minus values are expressed as mean ± SD.
* Statistically significant differences between groups compared to the NZ European reference category are indicated by * for P<0.05, ** for P<0.01, and *** for P<0.001.
† Ideal body weight was calculated from patient height, determined in the supine position as follows for men, ideal body weight in kg = 50 + 0.91 (height in cm - 152.4); for females, ideal body weight in kg = 45.5 + 0.91 (height in cm - 152.4).
‡ Body-mass index is the weight in kilograms divided by the square of the height in meters.
§ Scores on the Acute Physiology and Chronic Health Evaluation (APACHE) II range from 0 to 71, with higher scores indicating more severe disease and a higher risk of death. The score was calculated with the values recorded for each variable during the 24 hours before randomisation that would result in the highest score.
¶ n=4 NZ European subjects had missing data for this item.
**Table 3:** Primary and secondary outcome variables.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Energy dense nutrition</th>
<th>Routine nutrition</th>
<th>Estimate of difference (95% CI)</th>
<th>Odds ratio</th>
<th>Relative risk</th>
<th>Interaction P value*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Day 90 mortality</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Zealand European</td>
<td>128/410 (31.2%)</td>
<td>118/395 (29.9%)</td>
<td>1.07 (0.79–1.44)</td>
<td>1.05 (0.85–1.29)</td>
<td>0.64</td>
<td></td>
</tr>
<tr>
<td>Māori</td>
<td>22/90 (24.4%)</td>
<td>19/99 (19.2%)</td>
<td>1.36 (0.68–2.73)</td>
<td>1.27 (0.74–2.19)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pacific Peoples</td>
<td>16/69 (21.7%)</td>
<td>19/75 (25.3%)</td>
<td>0.82 (0.38–1.77)</td>
<td>0.86 (0.47–2.19)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Received vasopressors in the ICU — no/total no. (%) †</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Zealand European</td>
<td>346/414 (83.6%)</td>
<td>341/399 (85.5%)</td>
<td>0.87 (0.59–1.27)</td>
<td>0.98 (0.92–1.04)</td>
<td>0.91</td>
<td></td>
</tr>
<tr>
<td>Māori</td>
<td>76/91 (83.5%)</td>
<td>86/99 (86.9%)</td>
<td>0.77 (0.34–1.71)</td>
<td>0.96 (0.85–1.08)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pacific Peoples</td>
<td>59/70 (84.3%)</td>
<td>64/76 (84.2%)</td>
<td>1.01 (0.41–2.45)</td>
<td>1.00 (0.87–1.15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Received renal replacement therapy in the ICU — no/total no. (%) †</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Zealand European</td>
<td>95/414 (22.9%)</td>
<td>72/399 (18.0%)</td>
<td>1.35 (0.96–1.91)</td>
<td>1.27 (0.97–1.67)</td>
<td>0.94</td>
<td></td>
</tr>
<tr>
<td>Māori</td>
<td>17/91 (18.7%)</td>
<td>16/99 (16.2%)</td>
<td>1.19 (0.56–2.53)</td>
<td>1.16 (0.62–2.15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pacific Peoples</td>
<td>17/70 (24.3%)</td>
<td>14/76 (18.4%)</td>
<td>1.42 (0.64–3.15)</td>
<td>1.32 (0.70–2.47)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Received intravenous antimicrobials in ICU — no/total no. (%) ‡</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Zealand European</td>
<td>68/414 (16.4%)</td>
<td>65/400 (16.3%)</td>
<td>1.01 (0.70–1.47)</td>
<td>1.01 (0.74–1.38)</td>
<td>0.53</td>
<td></td>
</tr>
<tr>
<td>Māori</td>
<td>17/91 (18.7%)</td>
<td>12/99 (12.1%)</td>
<td>1.67 (0.75–3.71)</td>
<td>1.54 (0.78–3.05)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pacific Peoples</td>
<td>10/70 (14.3%)</td>
<td>11/76 (14.5%)</td>
<td>0.99 (0.39–2.49)</td>
<td>0.99 (0.45–2.18)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Had positive blood cultures in the ICU — no/total no. (%) †</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Zealand European</td>
<td>314/414 (75.8%)</td>
<td>298/400 (74.5%)</td>
<td>1.08 (0.78–1.48)</td>
<td>1.02 (0.94–1.10)</td>
<td>0.94</td>
<td></td>
</tr>
<tr>
<td>Māori</td>
<td>68/91 (74.7%)</td>
<td>70/99 (70.7%)</td>
<td>1.23 (0.65–2.33)</td>
<td>1.06 (0.89–1.26)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pacific Peoples</td>
<td>49/70 (70.0%)</td>
<td>52/76 (68.4%)</td>
<td>1.08 (0.53–2.18)</td>
<td>1.02 (0.82–1.27)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Interaction P values for comparisons of differences in proportions by treatment group and ethnicity are based on the logistic regression model (P values from sensitivity analyses based on the Poisson regression model were similar).
† Data were missing for two subjects in the routine nutrition group.
‡ Data were missing for one subject in the routine nutrition group.

Abbreviations: ICU: intensive care unit; ANZ: Australia and New Zealand; APACHE: Acute Physiology and Chronic Health Evaluation.

**Figure 2:** Primary outcome—day 90 mortality by ethnicity.*

![Graph showing primary outcome—day 90 mortality by ethnicity.](image)

* There was no statistically significant interaction between treatment effect and ethnicity; interaction P value from logistic regression model equals 0.64; interaction P value from modified Poisson regression model equals 0.63.
Figure 3: Survival by ethnicity and treatment group.*

A. Ethnicity: European.

Hazard ratio 1.05
(95% CI, 0.82 to 1.34)

B. Ethnicity: Māori

Hazard ratio 1.32
(95% CI, 0.71 to 2.44)

C. Ethnicity: Pacific peoples

Hazard ratio 0.86
(95% CI, 0.44 to 1.69)

* There was no statistically significant interaction between treatment effect and ethnicity; interaction P value from Cox proportional hazards regression equals 0.64.
Discussion

In this pre-planned subgroup analysis of New Zealand participants enrolled in a large multicentre critical care nutrition trial comparing energy-dense and routine nutrition we found no evidence of a statistically significant interaction between treatment group assignment and ethnicity for day-90 mortality. There was also no evidence of a differential treatment effect based on ethnicity for a range of secondary outcomes, including patients who received vasopressor support, renal replacement therapy, positive blood cultures or receiving intravenous antimicrobials.

While previous studies have suggested that empiric calculations of energy requirements may be inaccurate in non-Caucasians populations, our findings suggest that despite differences in calculated energy requirements, patient outcomes with energy-dense vs routine nutrition do not vary among the New Zealand’s most common ethnic groups. The absence of inter-ethnicity heterogeneity of treatment response was confirmed in analyses adjusting for important baseline covariates. As our study had relatively few exclusion criteria, our findings are generalisable to patients who receive enteral nutrition in New Zealand ICUs, irrespective of their ethnicity.

Equity of outcomes among patients admitted to New Zealand ICUs has not been reported previously. In the New Zealand TARGET study cohort, the observed day 90 mortality was 21.7%, 23.6%, and 30.6% for Māori, Pacific Peoples, and New Zealand European respectively. There were a number of important differences in the baseline characteristics of patients by ethnic group including that Māori and Pacific Peoples were younger, had higher body mass index and more frequently had insulin-treated diabetes mellitus and end-stage renal failure than New Zealand European participants. The day-90 mortality rate of Māori and Pacific Peoples did not differ significantly from New Zealand European mortality rate in analyses adjusting for important baseline covariates, including illness severity. Notably, given the observed differences in the rates of insulin-treated diabetes mellitus and end-stage renal failure by ethnic group, adjustment for illness severity was based on the APACHE-II score, which accounts for comorbid conditions including end-stage renal failure and for acute physiological derangements such as hyperglycaemia, which is the major predictor of mortality in patients with diabetes mellitus who are critically ill. These data provide a degree of reassurance that Māori and Pacific patients who are admitted to New Zealand ICUs have similar mortality outcomes to New Zealand European patients. However, it is notable that relatively few studies evaluating the independent association between ethnicity and outcome among New Zealanders admitted to ICU have been undertaken and it is uncertain whether the cohort of patients enrolled in TARGET is representative.

Our study is noteworthy because it is the first time that the potential impact of ethnicity on outcome has been systematically evaluated in a large-scale intensive care randomised clinical trial; it has some limitations. We did not record data on socioeconomic status, which may be an important confounding variable. Because participants were critically unwell, documented ethnicity could not be verified reliably by asking participants and the ethnicity documented in the clinical records, or the prioritisation of ethnicity made at the time of data collection may have been inaccurate. However, ethnicity data and prioritised ethnicity data are routinely recorded for Ministry of Health reporting purposes in the New Zealand health system, and ethnicity data are usually available in clinical records, having been documented during previous healthcare encounters. Randomisation was not stratified by ethnicity; however, the groups were well balanced and sensitivity analyses adjusting for important baseline covariates was consistent with the unadjusted analyses. Categorisation in ethnic groups was performed on a post-hoc basis; however, different methods of categorisation were not feasible because other ethnic group categories were too small to allow for meaningful analysis to occur. This also means it is uncertain whether the effects of energy dense vs routine enteral nutrition are similar for other ethnic groups. Confidence intervals around treatment effect estimates were relatively large, particularly...
in the Māori and Pacific subgroups, and do not exclude the possibility of clinically important treatment effects in individual subgroups. However, the absence of statistically significant heterogeneity in an analysis including more than 1,100 New Zealand participants constitutes high-level evidence that treatment responses to energy-dense nutrition do not vary among the three major ethnic groups in New Zealand.

In conclusion, our findings do not support the hypothesis that in critically ill adults the effect of energy-dense nutrition on day-90 mortality varies for European, Māori and Pacific ethnic groups in New Zealand.

Competing interests:
Mrs Mackle reports grants from Health Research Council of NZ during the conduct of the study; Dr Ridley reports grants from Baxter Healthcare Corporation, personal fees from Nutricia Australia, personal fees from Baxter Australia, outside the submitted work.

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The 2019 Global Health Security Index (GHSI) and its implications for New Zealand and Pacific regional health security

Matt Boyd, Michael G Baker, Cassidy Nelson, Nick Wilson

ABSTRACT

It is important for all countries to secure themselves against infectious disease threats, including potential global catastrophic biological risks. The Global Health Security Index (GHSI), first published in 2019, is a comprehensive, objective assessment of health security capabilities across 195 States Parties to the International Health Regulations. The GHSI is a broader assessment than the World Health Organization Joint External Evaluation and emphasises public documentation of preparedness as well as sustainable capabilities. New Zealand scored 54/100 on the GHSI (35th in the world). But also worryingly, the range of scores for New Zealand’s Pacific neighbours was 19.2–27.8, highlighting potential regional vulnerabilities. Clearly, the New Zealand Government needs to do more to ensure its own optimal preparedness for global biological threats, and document these preparations to assure the international community. But it should also provide additional overseas development assistance (bringing this assistance up to 0.7% of GNI as per UN recommendations) and work with Pacific Nations to enhance health security in the region.

Recent events such as the 2019 measles epidemic in New Zealand and the South Pacific, as well as the emergence of a novel coronavirus in China in 2019 (COVID-19), underscore that all countries must ensure capabilities to prevent, detect and rapidly respond to public health emergencies. Countries need to have a robust health system, be compliant with international norms, and work to improve their risk environment. The GHSI is the first comprehensive assessment and benchmarking of these health security capabilities across 195 States Parties to the International Health Regulations (IHR) 2005 and was published in 2019. In this viewpoint article, we present New Zealand’s GHSI score along with a breakdown of items where New Zealand scored poorly. We also profile the results from Pacific Nations, with the aim of highlighting ways in which New Zealand health policymakers might act to enhance regional health security.

Global catastrophic biological risks (GCBRs)

The GHSI emphasises the importance of addressing global catastrophic biological risks. Catastrophic biological risks have been defined as: “those events in which biological agents—whether naturally emerging or re-emerging, deliberately created and released, or laboratory engineered and escaped—could lead to sudden, extraordinary, widespread disaster beyond the collective capability of national and international governments and the private sector to control. If unchecked, GCBRs would lead to great suffering, loss of life and sustained damage to national governments, international relationships, economies, societal stability or global security”.

Plausible GCBRs include natural pandemics such as non-seasonal influenza, emergence of a new and dangerous zoonotic pathogen, accidental release of a known virus such as...
smallpox or a novel bioengineered pathogen, as well as deliberate release of one of the preceding biological agents.

The threat of a major global pandemic is probably growing due to increased human exposure to zoonotic organisms (eg, in animal markets and through deforestation), increased availability of advanced bioengineering methods and synthetic biology, and little oversight of dual-use biotechnologies of concern. However, advances in the biotechnology industry are also likely to be some of our best defences against GCBRs, such as through improving the quality and development timeline for diagnostics, vaccines and treatments for novel pathogen threats.

International action on health security

All WHO members automatically became parties to the IHR (2005), which entered into force on 15 June 2007. However, although every member state has signed on to the IHR, fewer than 20% of countries reported in 2012 that they had fully achieved compliance with the IHR. The Global Health Security Agenda subsequently aimed to address these shortcomings through resource investment. Sixty-seven countries (not including New Zealand) have now signed on to this Agenda. The US has contributed US$1 billion to this project across five years 2014–19 and has helped over 30 nations.7 Finally, the Global Preparedness Monitoring Board was set up in response to the Ebola outbreak of 2014–16, and concluded in their 2019 Annual Report that we live in “A World at Risk” and urged political action on seven recommendations.8 The GHSI supplements and benchmarks all these activities.

The Global Health Security Index

GHSI is a broader and more comprehensive measure than existing assessments such as the Joint External Evaluation (JEE), which New Zealand undertook in November 2018 with the World Health Organization (WHO).9 The GHSI emphasises that public health capabilities must be regularly exercised and that countries need to be transparent about their capabilities.

To score the GHSI, the evaluators (based at the Nuclear Threat Initiative, Johns Hopkins University and the Economist Intelligence Unit) used published and publicly available data sources with the idea that this ought to encourage nations to document and publicise their preparations. Unpublished documents were not considered sufficient evidence. Binary, and other scoring methods, were used across 140 variables in 34 indicators across six categories. Advantages of this method are repeatability, objectivity and its aspirational nature. The method prioritises published information, functional systems, testing of systems and appropriate financing.5

The analysis shows that collective international preparedness is weak and that political, socioeconomic and environmental vulnerabilities can amplify these deficiencies. These findings have particular implications for New Zealand and the rest of the South Pacific, which we describe below.

Unpacking New Zealand’s GHSI score

New Zealand scored 54.0 out of 100. This relatively low score could be particularly problematic given that one recent analysis indicates that New Zealand is the second most optimal island nation refuge for humanity in the case of pandemics that threaten human extinction.10

Recent experience suggests that some of the shortcomings in New Zealand’s score are likely to be valid. The second report of the Havelock North Drinking Water Inquiry described a long list of failings,11 including the erosion and fragmentation of New Zealand’s public health institutions.12 These deficiencies are reflected in New Zealand’s GHSI score and are potentially compounded by even poorer preparations of neighbouring countries such as Fiji (GHSI score 25.7) and the Cook Islands (20.4), as discussed below.

New Zealand performed well in a number of GHSI indicators, although even in the areas that follow there is room for improvement. These include good scores within the Prevention category for ‘antimicrobial resistance’ (83.3/100), which includes good planning, surveillance and testing, as well as high immunisation rates (94.7); good scores in the Detection category for ‘laboratory systems’ (66.7), although the capacity of the laboratory systems
could be improved; good scores in the Rapid Response category for ‘emergency preparedness’ (75) as well as ‘risk communication’ (100), ‘communication infrastructure’ (96.6) and ‘trade and travel restrictions’ (100); good scores in the Health System category for ‘medical countermeasures’ (66.7) and ‘capacity to test and approve new countermeasures’ (75); good scores in Compliance with International Norms for ‘cross-border agreements on public and animal health emergency response’ (100) as well as ‘international commitments’ (100), and finally, good scores for the Risk Environment category, including: ‘political and security risks’ (92.9), ‘socioeconomic resilience’ (97.4), ‘infrastructure adequacy’ (83.3) and ‘public health vulnerabilities (74.1).

However, there are also a number of important gaps. Gaps in New Zealand’s capabilities across the 34 indicators of the GHSI are displayed in Table 1. We note that the authors of the GHSI invited countries to respond to draft scores in May/June 2019; however, only 16 countries responded with additional data and references. New Zealand did not respond to this data validation request.

GHSI vs the Joint External Evaluation (JEE)

The New Zealand Ministry of Health undertook a JEE of preparedness for significant health threats in 2018. The JEE assesses a country’s ability across the categories of prevention, detection and responding to a threat. Reporting following this exercise suggests that New Zealand performed reasonably well, demonstrating ‘sustainable capacity’ for 49% of the indicators. Ideally the New Zealand Ministry of Health website would link to this report.

A critical step following the JEE is to prepare and publish a National Action Plan for Health Security and commit funding to addressing identified gaps. New Zealand has not yet taken this important step, unlike Australia. Key issues emerging from the JEE include a need to focus on strengthening national action around antimicrobial resistance (AMR), enhancing surveillance and risk assessment, addressing critical human resource needs and building risk communication capacity, as well as supporting sustainable IHR implementation in Pacific Island countries and territories.

Interestingly, the JEE gives New Zealand 5/5 for ‘biosecurity/biosafety’ but the GHSI scored New Zealand at 28/100 for biosecurity and 50/100 for biosafety (biosafety is not represented in Table 1 because the table only lists the categories where New Zealand scored <50/100). These scores suggest that either: (i) substantial preparations by New Zealand have not been described in published documents, or (ii) there are still many ways New Zealand can improve its health security beyond the factors evaluated in the JEE.

The GHSI adds additional assessment in the categories of health system, compliance with international norms and risk environment to the JEE’s foundational assessments of prevention, detection and response. The GHSI is also an involuntary, independent assessment that gives additional weight to capabilities (in addition to capacities), background indicators and government transparency.

New Zealand needs to act locally to enhance its health security capabilities

Where they do not merely reflect a lack of published documentation, some gaps in New Zealand’s GHSI are worrisome and suggest a long-term pattern of under-resourcing and/or neglect. For example, New Zealand is one of the only high-income countries that lacks a field epidemiology training programme, which is reflected in its low score for ‘epidemiology workforce’. This is precisely the workforce that is needed to develop and drive many of the systems required to prevent and manage pandemic threats. Another example is the need to ensure health and surveillance data are not merely collected, but are digitised, standardised, interoperable, shared appropriately (including de-identified public health authority access) and used to inform decisions.
Table 1: New Zealand’s GHSI scores by category, with ranking among 195 countries and the 13 (of 34) indicators where New Zealand scores below 50 out of 100, along with the present authors’ views of possible mitigating actions New Zealand could take.

<table>
<thead>
<tr>
<th>GHSI component</th>
<th>Performance</th>
<th>Viewpoint authors’ summary of why New Zealand scored poorly on these indicators and suggested potential actions to improve New Zealand’s performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall score</td>
<td>54.0 (rank 35\textsuperscript{th})</td>
<td>(refer to original GHSI data to see scores and detailed evidence considered by the GHSI authors at question-level: <a href="https://www.ghsindex.org/report-model/">https://www.ghsindex.org/report-model/</a>)</td>
</tr>
<tr>
<td>Prevention</td>
<td>55.0 (rank 27\textsuperscript{th})</td>
<td></td>
</tr>
<tr>
<td>1.3 Biosecurity</td>
<td>28.0 (global average [GA] = 16.0)</td>
<td>Reasons: Inadequate data on dangerous pathogens in New Zealand. Insufficient capacity to test for dangerous pathogens without culturing them (eg, anthrax can only be tested at the national animal laboratory). No evidence of standardised biosecurity training. Inadequate personnel checks, laws and end-user checks when accessing/transporting dangerous pathogens. Potential actions: Develop an integrated national strategy with well-defined agency responsibilities and coordination mechanisms (eg, record dangerous pathogens and inventories, consolidate inventories, legislation that addresses handling and security of dangerous pathogens, ensure PCR diagnostic testing available for key threats, training, vetting, and regulation to control cross-border transfer).</td>
</tr>
<tr>
<td>1.5 Dual-use research and culture of responsible science</td>
<td>0 (GA=1.7)</td>
<td>Reasons: Inadequate assessment, regulation and oversight of dual-use research with no agency responsible. Potential actions: Integrated strategy (see biosecurity above).</td>
</tr>
<tr>
<td>Detection and reporting</td>
<td>36.7 (107\textsuperscript{th})</td>
<td>New Zealand is below the average score for all 195 countries on this domain</td>
</tr>
<tr>
<td>2.2 Real-time surveillance and reporting</td>
<td>48.3 (GA=39.1)</td>
<td>Reasons: No evidence of a national commitment to share data, electronic health records not universal or interoperable, no evidence of daily event-based surveillance analysis, though these data are collected. Potential actions: Invest in improved public health surveillance infrastructure, including real-time reporting of hospitalisations and deaths from a range of infectious disease syndromes.</td>
</tr>
<tr>
<td>2.3 Epidemiology workforce</td>
<td>25 (GA=42.3)</td>
<td>Reasons: Inadequate numbers of trained epidemiology field staff, no training programme. Comment: We note there is no specific field epidemiology training programme in New Zealand but some such training is part of the specialty training in public health medicine, eg, for future Medical Officers of Health. Potential actions: Establish a New Zealand field epidemiology training programme (albeit this could be in collaboration with an existing New Zealand or Australian programme), ensure integration with animal health professionals/One Health approach.</td>
</tr>
<tr>
<td>2.4 Data integration between human/animal/environmental health sectors</td>
<td>0 (GA=29.7)</td>
<td>Reasons: Unclear mechanisms for ministries to share animal/human/wildlife surveillance data. Potential actions: Establish a national public health agency to manage surveillance, prevention and control of a wide range of hazards with strong integrating mechanisms with animal health and environmental agencies.</td>
</tr>
<tr>
<td>Rapid response</td>
<td>58.1 (21\textsuperscript{st})</td>
<td></td>
</tr>
<tr>
<td>3.2 Exercising response plans</td>
<td>0 (GA=16.2)</td>
<td>Reasons: No published evidence of biological-focused IHR exercise with WHO in the past year nor of a bio-focused exercise to identify gaps/best practices. Potential actions: Conduct more regular multi-agency response exercises to a full range of potential hazards. Annual exercises with the WHO may be over-demanding; however, regular exercise of capability is important.</td>
</tr>
<tr>
<td>3.3 Emergency response operation</td>
<td>33.3 (GA=23.6)</td>
<td>Reasons: No evidence that the National Crisis Management Centre (NCMC) or the National Health Coordination Centre are required to conduct public health emergency drills at least once per year, no evidence of activation within 120min of identified emergency/scenario. Potential actions: Require relevant annual drills and testing of response activation time, publish reports on these.</td>
</tr>
<tr>
<td>3.4 Linking public health and security authorities</td>
<td>0 (GA=22.6)</td>
<td>Reasons: No published evidence of joint exercises/procedures for potential deliberate biological events. Potential actions: Implement multiple strategies, including establishing an integrated national public health agency (see above), high-level links with National Emergency Management Agency (NEMA), joint exercises (see above).</td>
</tr>
<tr>
<td>Health system</td>
<td>45.2 (32\textsuperscript{nd})</td>
<td></td>
</tr>
</tbody>
</table>
Table 1: New Zealand's GHSI scores by category, with ranking among 195 countries and the 13 (of 34) indicators where New Zealand scores below 50 out of 100, along with the present authors' views of possible mitigating actions New Zealand could take (continued).

<table>
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<tr>
<th>GHSI component</th>
<th>Performance</th>
<th>Viewpoint authors' summary of why New Zealand scored poorly on these indicators and suggested potential actions to improve New Zealand's performance</th>
<th>Reasons:</th>
<th>Potential actions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 Health capacity in clinics, hospitals and community care centres</td>
<td>45.7 (GA=24.4)</td>
<td></td>
<td>New Zealand has 360 doctors per 100,000 people which converts to an index score of 46.6/100, 280 hospital beds per 100,000 people (19.7/100) and no evidence of a health workforce strategy to address human resource shortfalls.</td>
<td>Take real action to address health workforce shortfalls, including planning to designate existing bed capacity (e.g., residential care, field hospitals) to cope with surge demand. Demands by the GHSI for high workforce and bed numbers come at a high cost, and potentially there are community-based approaches to activating capacity in a crisis (home testing, hotel beds, a voluntary workforce of recovered and retired individuals).</td>
</tr>
<tr>
<td>4.3 Healthcare access</td>
<td>45.8 (GA=38.4)</td>
<td></td>
<td>Lack of published evidence for a plan to prioritise protection and care for healthcare workers during an emergency.</td>
<td>Establish an adequately resourced national strategy and clear national leadership (see public health agency above), consider local manufacturing options for PPE to be activated in an emergency if global supply chains fail.</td>
</tr>
<tr>
<td>4.5 Infection control practices and availability of equipment</td>
<td>0 (GA=20.8)</td>
<td></td>
<td>Lack of published evidence of monitoring healthcare associated infections, also, although there are some stockpiles, there is no published plan to address routine and public health emergency personal protective equipment (PPE) supply issues.</td>
<td>Conduct regular external assessments and reviews of outbreaks/epidemics with accountability for implementing agreed system improvements.</td>
</tr>
<tr>
<td>Compliance with International norms</td>
<td>59.4 (39th)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.4 JEE and PVS</td>
<td>0 (GA=17.7)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk environment</td>
<td>77.2 (23rd)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.4 Environmental risks</td>
<td>32.2 (GA=52.9)</td>
<td></td>
<td>Largely urban population, high natural disaster risk</td>
<td>Implement multiple strategies, including establishing an integrated national public health agency (see above).</td>
</tr>
</tbody>
</table>

Existing components of the New Zealand health system and security structures could broaden their focus and expand their activities to include aspects of the GHSI. This widening must come with appropriate resourcing. Pandemic planning should consider: threats other than influenza, enhancing vaccine development and manufacturing capabilities, enhancing the biotechnology community through research funding, more rapid responses to sentinel cases, preapproved funding for emergency use, joining up the departments across government responsible for the ‘bio’ and those responsible for the ‘security’ in biosecurity, considering what kinds of unprecedented threat might require a qualitatively different kind of response (e.g., the question of an ‘ordinary pandemic’ versus a GCBR). There are economic and prudential arguments that New Zealand ought to plan for border closure under some scenarios and the border control experience with the COVID-19 pandemic needs to be reviewed in a post-pandemic national inquiry.
New Zealand should also regularly host and collaborate on simulation exercises, such as the 2017–18 all of government ‘Exercise Pomare’, because, as the GHSI emphasises, capabilities need to be exercised annually. Simulations and walk-throughs might reveal legal changes or communication channels that are needed, and might identify funding gaps. Simulation exercises need to include 21st Century health security risks such as deliberate biological events.

Additionally, New Zealand’s epidemiological and public health workforce needs surge capacity so that it can manage peaks in demand, and also work on preparation, prevention and enhancing infrastructure at other times. Prior to establishing a New Zealand field epidemiology training programme, New Zealand health workers could be sent to an established field epidemiology programme in Australia or another international location. It would also be important to review the needs for other public health workforce groups that are critical for an effective response, including health protection, health promotion, public health nursing, specialist microbiology, toxicology, public health informatics, emergency management and logistics, and perhaps a volunteer workforce of recovered (infected but now well) and retired individuals.

Given that Australia substantially outperforms New Zealand on the GHSI (scoring 75.5/100), there are likely to be many fruitful opportunities to share knowledge and processes across the Tasman. For example, the discrepancy in biosecurity scores may be partially attributable to the fact that Australia maintains a register of all facilities which handle dangerous pathogens and requires background checks on all persons who have access to sensitive biological materials, including pathogens with pandemic potential. For real-time surveillance improvements, New Zealand could examine the reporting structure of the National Notifiable Diseases Surveillance System (NNDSS) and Communicable Diseases Network Australia (CDNA) and integrate relevant aspects. Similarly, New Zealand could consider an Australasian Inter-Service Incident Management System (AIIMS) equivalent, to ensure standard operating procedures and regular exercises between public health and security authorities, including for deliberate biological events.

GHSI and regional health security in the South Pacific

Turning from New Zealand’s GHSI score to the scores of our neighbours, we note that Pacific Island nations systematically score much lower (Table 2).

Table 2: Global health security index (GHSI) scores of selected Pacific Nations and rank out of 195 countries.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Sovereign South Pacific nation</th>
<th>GHSI Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Australia</td>
<td>75.5</td>
</tr>
<tr>
<td>35</td>
<td>New Zealand</td>
<td>54.0</td>
</tr>
<tr>
<td>(85–86)</td>
<td>Global average</td>
<td>40.2</td>
</tr>
<tr>
<td>155</td>
<td>Papua New Guinea</td>
<td>27.8</td>
</tr>
<tr>
<td>162</td>
<td>Samoa</td>
<td>26.4</td>
</tr>
<tr>
<td>165</td>
<td>Vanuatu</td>
<td>26.1</td>
</tr>
<tr>
<td>168</td>
<td>Fiji</td>
<td>25.7</td>
</tr>
<tr>
<td>171</td>
<td>Tonga</td>
<td>25.1</td>
</tr>
<tr>
<td>181</td>
<td>Tuvalu</td>
<td>21.6</td>
</tr>
<tr>
<td>182</td>
<td>Nauru</td>
<td>20.8</td>
</tr>
<tr>
<td>183</td>
<td>Solomon Islands</td>
<td>20.7</td>
</tr>
<tr>
<td>184</td>
<td>Niue*</td>
<td>20.5</td>
</tr>
<tr>
<td>185</td>
<td>Cook Islands*</td>
<td>20.4</td>
</tr>
<tr>
<td>189</td>
<td>Kiribati</td>
<td>19.2</td>
</tr>
</tbody>
</table>

* Jurisdictions with constitutional links to New Zealand, ie, their citizens are also New Zealand citizens.

The pattern of scoring for sovereign island nations in the Pacific is remarkably consistent with scores ranging from 18–28/100. There is a common pattern. Taking the Cook Islands as a representative example, key gaps in the scores include insufficient evidence of:

- laws requiring a prescription for antibiotic use (animal or human)
- a department/agency, laws or plans for surveillance of zoonotic disease
- significant biosecurity or biosafety measures
- an appropriate epidemiology workforce
- emergency preparedness and response planning
- exercising of response plans
• emergency response operation
• linking of public health and security authorities
• risk communication
• medical countermeasures and personnel deployment
• communications with healthcare workers during a public health emergency
• infection control practices and availability of equipment (which in practice means monitoring healthcare associated infections, and having a plan to address routine and public health emergency PPE supply issues)
• a Joint External Evaluation and Performance of Veterinary Services (PVS) assessment
• financing secured to address gap analysis resulting from JEE/PVS

But GHSI scores may have a glass ceiling

There is a question as to whether low-income nations, especially those with a small population, could ever achieve a full GHSI score (100/100) given the comprehensive nature of the metric. Such a ‘glass ceiling’ could arise simply because of the lack of resources or expertise available to ensure such things as personnel checks when transporting hazardous materials, or capacity to exercise response plans, or assess dual-use science (if it even takes place in some nations). However, it is also possible that deliberate events could exploit these vulnerabilities.

The authors of the GHSI have made publicly available an interactive spreadsheet where the user can explore various insights and analytics. Although the GHSI authors find a moderate correlation between GDP per capita and overall score (r=0.45), the GHSI of the very low-income nations range from GHSI less than 15 to greater than 50. There is obviously more determining GHSI than just finance. There is also little correlation between population size and GHSI (r=0.15). It is possible that Global Health Security Agenda aid has played a role here, but this hypothesis would need to be explored further. Nevertheless, there may be a case for a modified GHSI system to be developed for small or low-income jurisdictions in the future. A realistic regional benchmark could be developed, with input from New Zealand, so that Pacific Island nations can address their GHSI scores within the context of local resources and capabilities. Regional collaborating organisations might also be a viable way for small states to achieve some of the more specialised capabilities (eg, South Pacific Community).

New Zealand’s responsibility to the Pacific

New Zealand has special constitutional commitments to three Pacific jurisdictions, two of which were scored in the GHSI (Cook Islands and Niue). Tokelau is likely to exhibit the same gaps in its health security measures as these other Pacific jurisdictions.

A number of other Pacific nations are the origin of large volumes of travel to and from New Zealand. Ensuring health security in places such as Samoa and Fiji would help to strengthen regional health security. Given that infectious diseases do not respect international borders, the New Zealand Government perspective of enlightened self-interest might lead to resources being allocated to help such nations improve their GHSI scores.

The US made a commitment to assist at least 30 countries over five years to achieve the targets of the Global Health Security Agenda (GHSA) by investing more than $1 billion in resources (7). In each of these countries, the host governments partnered with the US to establish a five-year country roadmap to achieve and sustain each of the targets of the GHSA. New Zealand is not a GHSA contributor but could become one and could emulate this approach in the wider South Pacific, potentially in partnership with resourcing provided by Australia’s $240 million investment (2017–22) in the Indo-Pacific Centre for Health Security. Such a strategy should additionally see Pacific nations empowered to draft their own comprehensive preparedness plans to guide their health security responses during events such as the COVID-19 pandemic.

According to New Zealand’s Ministry of Foreign Affairs and Trade (MFAT), the purpose of the country’s overseas development assistance (ODA) is to ‘develop shared prosperity and stability in the Pacific and beyond’.24 However, although the dollar
value of this ODA has increased since 2011, the ratio between ODA and Gross National Income (GNI) has fallen from 0.52% in 1975 to 0.28% in 2011 and to 0.23% in 2017. This level is in contrast to the UN target of 0.7% of GNI for ODA.25 New Zealand is clearly not donating enough in development assistance, and the GHSI as well as recent measles and COVID-19 health threats now identify a clear target for aid that would benefit everyone.

Without appropriate external assistance, nations such as Samoa are at risk of being afflicted by repeats of the measles epidemic of 2019–2020, for which MFAT has apologised in 2019 (for cases from New Zealand), and the devastation of the 1918–19 influenza pandemic, for which New Zealand Prime Minister Helen Clark apologised.

The Ebola pandemic in West Africa threatened political stability in the affected regions. Pacific regional stability could be similarly threatened. Calculators such as the IHR costing tool can be used to estimate the cost of sustainable capacity development to prevent, detect, and respond to public health threats, as defined by the IHR. New Zealand could target aid in ways that will allow Pacific nations to comply with the IHR and at the same time improve their GHSI. If New Zealand continues to give less and less ODA while its own GNI rises, then this neglect will likely further contribute to regional inequality and poor regional health security.

The Centers for Disease Control and Prevention (CDC) has a Global Rapid Response Team to help ensure global health security. This allows expertise to be deployed as and where needed should emergencies arise.26 New Zealand could set up a similar regional rapid response team to support the capability of smaller nations to respond in maximal fashion as needed. This task could be shared with Australia, potentially through the Australian ARM network.

As well as targeting aid to enhance the indicators where nations score poorly, New Zealand could offer to help implement the following:

- Five-year country-specific roadmaps (for Pacific nations, starting with those New Zealand has special constitutional relations with).
- Assisting Pacific nations to ensure their populations are vaccinated against common threats (some nations have a population of under 20,000 people, which is the equivalent of vaccinating one electorate in New Zealand).
- Establish data sharing agreements for public health surveillance data monitoring with these nations.
- Analyse cost-effectiveness and plan travel restrictions in the event of a catastrophic event. Because it is likely that small island nations are one of the few situations where border closure or extreme limitations on traveller numbers could sometimes be effective in pandemic control.27
- Advance GHSA’s mandate to build capacity to prevent, detect and respond to infectious diseases, and thereby contain threats at their source, through community engagement.28

Looking to the future

We should all care about the GHSI. It provides an objective global measure of each country’s capacity and capability to enact the IHR, thereby going beyond the more subjective and voluntary JEE. The GHSI also illustrates how the health system, and the approach to international norms and risk environment of each country, could contribute to or prevent harm in a biological catastrophe. As such, the GHSI should be treated as a measuring stick with the aim being to lift New Zealand’s score from 54.0 to as near to 100/100 as practically possible. It may be that important international metrics such as the GHSI are the sort of thing that a standalone New Zealand Public Health Agency could oversee.29

The GHSI should also be evaluated following the 2020 COVID-19 pandemic to assess any correlations between countries’ scores and the responses they were able to effect, as well as any relationships between scores and local epidemic outcomes. This external validation will be important for the Index. It is already apparent from the response of the country with the highest score (the US), that politicisation of the
event and time critical decisions, such as around which testing kits are authorised for a particular outbreak, can risk undermining strong underlying capability. The implications of this kind of interaction should be further explored.

We recognise that there are a number of barriers to overcome in ensuring health security for New Zealand and the Pacific. We acknowledge that there are pressing immediate issues such as the threat of climate change and sea level rise; the non-communicable disease crisis; and the risk of some nations becoming failed states. But as we have illustrated above, some of the pressing issues (such as the 2019 measles epidemic) could have been prevented by undertaking the measures we suggest here. We also note the focus of New Zealand’s ODA on economic and security issues. Health underpins both of these, and major insults to the health of nations can destabilise economies and democratic governments.

The risk of a GCBR means that New Zealand must maximise internal preparation by considering ways to address the gaps identified by the GHSI, but New Zealand as a high-income country also has a moral obligation to assist Pacific nations who may lack the resourcing to ensure robust preparations. Such assistance would protect both ourselves and the region. Agencies tasked with enacting recommendations like those in this viewpoint could turn to the advice published by organisations such as the Cambridge University Centre for the Study of Existential Risk for practical advice on how to incorporate concern for global catastrophe into everyday policy.30 The COVID-19 pandemic needs to be seen as a warning, a dress rehearsal for a future GCBR, and policy needs to be proactive, not reactive. We must realise that in future extreme cases we may not be able to merely ‘scale up’ existing plans.

**Competing interests:** Nil.

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**URL:**

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Infantile B12 deficiency with severe thrombocytopenia—an under-recognised public health problem?

Vivek Rajasekaran, Joanna Sheriff, Helen Moore, Hamish McCay, Mark Winstanley

Although vitamin B12 deficiency is a well-established cause of severe anaemia with macrocytosis in infants, severe thrombocytopenia has been less commonly reported. In this report, we describe an uncommon case of an infant with severe vitamin B12 deficiency presenting with severe anaemia and thrombocytopenia, and discuss its implications as a potentially preventable public health problem.

Case report
An exclusively breastfed eight-month-old girl, who had been unsuccessful with attempts to wean on to solids, presented to the emergency room unwell with fever. She was diagnosed with a right lower lobe pneumonia. Incidentally, she was remarkably pale with mucosal bleeding and fine petechiae on her trunk and limbs. Further history revealed black tarry stools typical of melaena.

On examination, the infant was found to be generally irritable with central hypotonia and significant gross, fine motor delay. At rest, the infant was floppy with frog-leg posturing. She was unable to pull to sit and showed marked head lag, poor head control. She was also unable to track objects of interest or bring her arms to midline and reach for objects. She was also found not to mimic facial expressions or have a social smile.

Laboratory investigations show a severe macrocytic anaemia, thrombocytopenia along with profoundly low B12 levels (Table 1). Although folate and iron studies were within normal range, she was also found to have vitamin D deficiency with hypocalcemia.

The blood film showed marked red cell anisopoikilocytosis with tear drop poikilocytes, stippled cells, macrocytes, many fragmented cells and occasional dysplastic nucleated red cells (Figure 1).

Figure 1: Typical blood film features of severe B12 deficiency.
Table 1: Laboratory investigations.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Reference range</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haemoglobin</td>
<td>105–135g/dl</td>
<td>38</td>
</tr>
<tr>
<td>Red blood cell count</td>
<td>4–5.3x10E12/L</td>
<td>1.21</td>
</tr>
<tr>
<td>White cell count</td>
<td>6.4–17x10E9/L</td>
<td>9.68</td>
</tr>
<tr>
<td>Platelet count</td>
<td>150–175x10E9/L</td>
<td>19</td>
</tr>
<tr>
<td>Mean corpuscular volume</td>
<td>69–84fl</td>
<td>97</td>
</tr>
<tr>
<td>Mean corpuscular haemoglobin</td>
<td>22–29pg</td>
<td>31</td>
</tr>
<tr>
<td>Reticulocytes</td>
<td>10–100x10E9/L</td>
<td>46</td>
</tr>
<tr>
<td>Nucleated red blood cells</td>
<td>&lt;0.1x10E9/L</td>
<td>0.27</td>
</tr>
<tr>
<td>Folate</td>
<td>5–45nmol/L</td>
<td>26.3</td>
</tr>
<tr>
<td>B12</td>
<td>170–800pmol/L</td>
<td>20</td>
</tr>
<tr>
<td>Lactate dehydrogenase (LDH)</td>
<td>140–280U/L</td>
<td>1,980</td>
</tr>
<tr>
<td>Vitamin D (25 hydroxycholecalciferol)</td>
<td>&gt;50nmol/L</td>
<td>3</td>
</tr>
<tr>
<td>Calcium</td>
<td>2.1–2.9mmol/L</td>
<td>2.09</td>
</tr>
<tr>
<td>Phosphate</td>
<td>1–2.5mmol/L</td>
<td>0.32</td>
</tr>
<tr>
<td>Ferritin</td>
<td>15–80ng/ml</td>
<td>340</td>
</tr>
<tr>
<td>Albumin</td>
<td>32–45g/L</td>
<td>32</td>
</tr>
<tr>
<td>Alkaline phosphatase(ALP)</td>
<td>80–450U/L</td>
<td>215</td>
</tr>
</tbody>
</table>

Platelet count was low but morphologically normal. White blood cells showed occasional hypersegmented neutrophils and rare dysplastic forms. The blood film features were consistent with severe B12 deficiency. However, the presence of significant red cell fragmentation and raised LDH levels raised the possibility of pseudothrombotic microangiopathy.

A diagnosis of nutritional B12 deficiency was made. Further history from the patient’s mother, who was of Indian ethnicity, revealed that she had been adhering to a strict vegan diet since childhood, devoid of all animal-based products owing to cultural reasons. Mother was tested and noted to be severely B12 deficient as well. Although known to be vegan, no B12 supplementation was given during antenatal care.

Our patient was treated with daily subcutaneous B12 injections. Evidence of marrow recovery was seen with reticulocytosis day 4 post-treatment. Follow-up blood counts were stable and neurological improvement was noticed prior to discharge, with improved general tone and less irritability.

On follow-up at one month she was noted to have achieved new gross and fine motor milestones. She was more alert, less irritable, able to pull to sit with support, was tracking objects in front of her and was bringing her arms up to reach for objects. The patient was discharged with ongoing B12 supplementation to be guided by a dietician. The family subsequently moved out of town and was referred to their local paediatric service for ongoing developmental follow-up.

Discussion

We have reported symptomatic anaemia and thrombocytopenia as a severe manifestation of infantile B12 deficiency. Our patient presented late, with the full spectrum of haematological and neurological manifestations.

Thrombocytopenia, although less common, has also been attributed to B12 deficiency. Severe B12 deficiency has been reported to trigger pseudo-thrombotic microangiopathy(pseudo-TMA).
causing haemolytic anaemia and thrombocytopenia.1 This well-described clinicopathological entity, which represents 2.5% of haematological disorders associated with B12 deficiency, presents similar to haemolytic uraemic syndrome (HUS), occasionally with its accompanying renal manifestations.2

Serum B12 levels are a poorly sensitive marker of early deficiency and clinical manifestations of this can be subtle in infants. Hence, we believe that infantile B12 deficiency is more widespread and under-recognised. Serum methylmalonic acid (MMA) and homocysteine levels have been used as a sensitive functional marker of early B12 deficiency.3,4 However, these measurements are not routinely tested for or available in many community labs in New Zealand.

In most cases, infantile B12 deficiency is a consequence of maternal deficiency.5 Healthy newborns acquire B12 stores trans-placentally that typically last the first few weeks of life. Hence, exclusively breastfed newborns are dependent upon the B12 content of breastmilk. The B12 content of breastmilk is largely dependent on the mother’s current B12 intake rather than stores.6 As a consequence, exclusive breastfed infants of B12 deficient mothers, who are not supplemented, present in the first few months of life with severe deficiency.

Although the precise incidence of B12 deficiency in infants is unknown, an American newborn screening program reported a rate of 0.88/100,000 births (95% CI 0.60–1.26).7 With the increased uptake of vegan lifestyles in the last decade among women and increased emphasis on exclusive breastfeeding in the developed world, we expect infantile B12 deficiency to be on the rise. Current guidelines by RANZCOG recommend B12 supplementation in pregnancy and lactation for vegan mothers. Unfortunately, we do not have data on rates of compliance to this guidance across the varied settings of antenatal care in hospitals and communities in New Zealand. We have highlighted this case to bring awareness to infantile B12 deficiency as a preventable public health issue.

In summary, we would like to highlight infantile B12 deficiency and its potentially severe manifestations if left untreated. Infantile B12 deficiency is an important preventable public health problem that can be difficult to detect but can be managed with appropriate antenatal screening and supplementation of at-risk pregnant women.

Competing interests: Nil.

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Post-partum duodenal perforation
Angelo Di Bartolo, Sikhar Sircar, Rose Mitchell

This case highlights the diagnostic conundrum when women present with non-specific symptoms for a surgical acute abdomen in post-partum period.

Case report

A 31-year-old mother (KS) was booked under the midwives. Her pregnancy was low risk and she had a normal delivery. However, a post-partum haemorrhage followed and she was conservatively managed with syntometrine and syntocinon infusion. Bleeding settled and her vital signs were normal.

KS was on regular analgesics and normal diet by day 1. However, she made limited progress with pubic symphisis pain and was unable to be discharged even by day 3.

By day 4, KS developed a gradual onset of right upper quadrant pain. Her abdomen was soft on palpation. Blood results were unremarkable. Ten hours later, midwifery team sought further medical review. KS started complaining of vomiting and worsening pain. Bloods suggests stable haemoglobin, rising white cell count (11.5/L), normal Neutrophil and serum lactate. CRP was 17. Abdomen was felt to be tender but not peritonitic. Thirty minutes later, KS started bilious vomiting.

Her care was discussed with obstetric consultant on call and an urgent CT scan was arranged. Working diagnosis was of probable endometritis. CT finding is as below.

The general surgical team was immediately consulted. KS was taken to theatre.

Figure 1: Axial CT scan suggested duodenal perforation with trans-luminal air and localised fat stranding in front of duodenum.
Figure 2: Coronal: Trans-luminal gas identified. Note post-partum uterus.

Figure 3: The suction canula in the duodenum demonstrating the perforation.
for a diagnostic laparoscopy. Intraoperative finding revealed a perforated anterior duodenal ulcer with biliary and fibrin material within the abdomen. Repair was done through a small midline laparotomy with transverse closure of the defect with omental patch over the duodenum.

Discussion

Peptic ulcer perforation disease is rare in post-partum period. Literature search suggests less than 50 cases published in English language.1,6,7 Though the true incidence of PUD in post-partum may be more common than reported due attribution of common PUD symptoms to those of which are experienced during post-partum,3 mortality and morbidity rates are universally high.1,5–7 Common risk factors still apply to the post-partum mothers including Helicobacter pylori infection, use of non-steroidal anti inflammatory medication (NSAID), alcohol consumption and smoking.3 In this case, apart from the stress of childbirth, only post-partum use of NSAID was noted.

There are a number of unproven hypotheses for lowered incidence of peptic ulcer in pregnancy, namely related with high oestrogen concentration and increased plasma histaminase secreted from placenta.4 These effects will be lacking in the post-partum period.

Post-partum abdominal laxity is known to mask the classical sign of peritonism. The immediate post-partum period can also distract from traditional symptoms and signs. However, perforated peptic ulcer is associated with high maternal mortality and morbidity. Prompt surgical intervention is necessary to limit morbidity.5,6 The case report highlights need of prompt and targeted imaging when necessary and multi-disciplinary team approach. In this case, the mother underwent surgery within two hours of CT scans, emphasising the above learning points.

Competing interests:
Nil.

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Towards a better world after COVID-19

Phil Bagshaw, Sue Bagshaw

Open letter to: The Council of Medical Colleges in New Zealand; all New Zealand medical colleges; all specialist medical associations; The New Zealand Medical Association; The Association of Salaried Medical Specialists; The New Zealand Tertiary Education Union; The New Zealand Resident Doctors’ Association.

Recorded human history has not followed a linear course. Nodal points of significant change have occurred, when the collective human consciousness has been focused by sudden positively progressive or devastatingly destructive events. It is abundantly clear that such a nodal point has been reached by the current world crisis precipitated by the COVID-19 pandemic.

We all appreciate the world has been getting into an increasing mess for years, with no plans for a more hopeful future.¹ Now, however, from many national and international sources come the strong feelings that the time is ripe for a sea-change.²⁻⁵ It is vital that this sentiment is harnessed for positive change; the window of opportunity might be short lived. It should not be allowed to ebb away, like the Arab Spring, which failed because of no clear plan for a better way forward.

We propose that the New Zealand medical profession, through its representative bodies, should show leadership by using our collective efforts to promote obviously necessary social change, first by agreeing among ourselves, then engaging with doctors in other countries to do the same. Our purpose should not be politically driven but should be about a reawakening of the spirit of caring for our whole natural world, our communities and our patients. And our reasons for action should be based on our concerns for the inter-connected future of all of these. The world needs a new story of hope, cooperation and progress.⁶

If you agree with us, an urgent conference of all the listed New Zealand representative bodies is needed to define and sponsor an international action plan. Are you all going to act now?

Competing interests: Nil.

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Orthopaedic Prophylaxis and Development

By D. S. WYLIE, C.M.G., C.B.E., F.R.C.S.

I am afraid that the title of this short paper of mine is not sufficiently explicit, but I had some difficulty in choosing a title at short notice which adequately expressed what was in my mind. Most of us who have seen service overseas have come back firmly convinced of the necessity for teamwork where such is possible, and also of the necessity for our work to be more developed on special lines than it has been in the past if we desire to achieve two objectives, and they are, firstly, an improved service for the community and, secondly, the attainment of a higher degree of knowledge and efficiency for ourselves. The day has gone when the medical practitioner could hope to keep himself abreast of progress in all branches of professional activity, whether medical or surgical, and it seems to me that Orthopaedic Surgery, or that branch of Surgery which deals with the prevention and treatment of Deformities, whether such be congenital or acquired, must be treated as one requiring treatment by us in New Zealand as a special branch of Surgery. The knowledge which has been brought back to New Zealand by the various Officers of the New Zealand Medical Corps who have had special training in the United Kingdom in Orthopaedic work, and especially in the application of the various methods of treatment grouped under the heading of Physio-Therapy should continue to be made use of for the benefit of the civilian population of the country after the present pressing requirements of the returned disabled soldiers have been satisfied, and it is with this object I am venturing to address you this morning.

In the past it has been difficult to attain good results in the treatment of deformities owing to a variety of reasons, the chief of which are:

1. The length of time taken and the continuity of supervision necessary to obtain good results. Many of these patients can not be kept sufficiently long in hospital owing to demands on beds, and those belonging to the poorer sections of the community cease to persevere with treatment in very many instances, with results disastrous to the patients' chances of cure.

2. The inevitable tendency of many Deformities, after apparently successful treatment, to relapse unless kept under close and skilled observation.

3. The difficulty in the past which has existed in procuring appliances and proper splints for these cases.

4. The great difficulty which has existed in procuring efficient Physio-Therapeutic treatment. As you know, properly qualified masseuses or masseurs have been few and far between, and an atmosphere of semi-quackery had developed, especially regarding the electrical part of treatment, which was difficult to combat.

5. The fifth reason has been the very small number of surgeons qualified to treat these cases with success.

No branch of Surgery, in my opinion, is more difficult than that relating to Deformities, for, apart from the knowledge and judgment required in determining the type of operation required for any particular case, a very great deal has to be done in supervising and carrying out special work both before and after operation—e.g., all branches of physiotherapy, viz., baths, massage, electricity, gymnastics, S.R.E., and also special plaster work, splintage, etc. If a Surgeon can not give his whole attention to the pre and post-operative special treatment required for Orthopaedic cases and in ensuring that his cases get it, he is committing a surgical crime in operating at all. The difficulties which have been with us in the past can now, in my opinion, be overcome if we make proper use of our
opportunities. As you know, efficient Orthopaedic centres exist at the Military Hospitals at Christchurch, Trentham, and Auckland, in the Military Wing of the Dunedin Hospital, and at the Military Hospital at Rotorua, and the staff and equipment of these centres should become part and parcel of our civil hospital organisation and not allowed to disappear as military hospital activities cease. This can be effected, I believe, in the following ways:–

1. As you are aware, a large number of masseuses have been trained here in New Zealand during the past two years at Dunedin, and latterly at Christchurch, Rotorua, and Trentham. They have been trained under close skilled medical supervision and the general standard attained has been satisfactory. As military work ceases, I consider, these masseuses should be stationed at every hospital in New Zealand, according to number of beds, size of district, etc. There they will be able to be of inestimable service in carrying out treatment in all types of recent injury, in dealing with the remote effects of injuries, and in applying the various kinds of Physio-Therapeutic treatment of many acute and chronic medical cases. They will, of course, act on the instructions of the various medical men concerned, and should also be available for work outside the smaller hospitals, should their time not be fully employed in hospital. In the past, as I have said before, Physio-Therapeutic treatment in New Zealand has been too much in the hands of the partially-trained individual, who has invested it in many places with the halo of mystery which so many of the public like and apparently desire. Now medical men will have the opportunity of dealing with masseurs who have been accustomed to working with medical men and who do not wish to do otherwise.

2. The difficulty of obtaining proper splints and special surgical appliances, which previously in New Zealand has been a very real one, can be overcome by the civil hospitals concerned taking over the splint shops, equipment, and staff and carrying on for themselves, the smaller hospitals in their districts, and for individual medical men. The splint-makers concerned are highly skilled men whose services must not be lost to the community. Two of them received a very special and thorough training at the M.O.H. at Shepherds’ Bush, and the result of this training is reflected in the character of the work, which you will have an opportunity of seeing in another room in the building during the week. Meanwhile, and pending the taking over of the workshops, it is proposed that in these shops splints, special appliances, etc., are to be made for any civil hospital or private practitioner requiring them. A circular has been prepared and is in process of distribution showing the way to get these splints and the prices which will have to be paid. This arrangement has been made possible by the Director-General of Medical Services and the Director of Vocational Training. Unfortunately the procedure which a private individual has to go through to get these splints is unnecessarily cumbersome, but nothing less complicated could be arranged, despite the best endeavours of the Director of Vocational Training and myself. In New Zealand we are prone to talk of red tape as though it were an exclusive possession of the authorities in the United Kingdom, but I can assure you that some departments in New Zealand have nothing to be ashamed of in comparison. An exhibition of splints, etc., is now being held in one of the rooms in this building, and it is hoped that everyone will take advantage of the opportunity thus presented of seeing the nature of the work which can now be done in New Zealand.

3. So far as the cases themselves are concerned, definite Orthopaedic departments should be established at each of our four large hospitals. Skilled Surgeons, skilled Physio-Therapy experts, Nurses, Orderlies well up in all details of plaster work, and Masseuses will all be available and should be used. The policy of
concentrating these cases under the care of one or two men at each main hospital will, I am sure, be attended by the procuring of vastly better results than have been possible in the past. So far as patients from country districts are concerned, and especially the remoter districts, I hope that a scheme will be evolved which will provide for the gradual transformation of one of the military hospitals (e.g., King George V. at Rotorua) into a hospital where these cases can be received and treated. The vast majority of the cases will be children, and at a place like Rotorua they can, while receiving proper surgical treatment, also, when possible, be receiving their education and instruction in various handicrafts. The provision of a hospital like this is necessary, as these cases can not be treated properly in the smaller hospitals, and the large hospitals will have quite enough to do in dealing adequately with the cases of their own districts, where to-day many cases are receiving no treatment at all, and one of the first problems to be solved is the way to get into touch with the crippled or deformed child for whom much can be done, who is at present getting no treatment and urgently requires it. I do not think that the objection which will be raised to the taking of these children from their homes will hold good, for I am sure the majority of parents will only be too glad to send these crippled children anywhere, so long as efficient treatment is being provided. In this connection I would draw your attention to the paper by Sir R. Jones in the “British Medical Journal” of 11th October, 1919, in which he showed that in one single district at Home with a population of 671,000, one in every 594 of this number was a crippled child requiring treatment, and although these figures would require modifying for New Zealand, owing to the smaller number of deformities due to Rickets and Surgical Tuberculosis, even then it would seem that we have a very large number of cases hidden in our midst for whom something must be done. Sir R. Jones estimated that one bed should be provided for each 2000 of population; that for New Zealand means the provision of, roughly, 500 beds, so you will see that even for our small country the problem is no incon siderable one.

It is with the object of stimulating interest in orthopaedic work generally that this short paper has been written.

URL:
Proceedings of the Waikato Clinical Campus Biannual Research Seminar

Wednesday 11 March 2020

Ablation of ventricular arrhythmias at Waikato Hospital

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2Tauranga Hospital, Tauranga.

Background
Catheter ablation can be an effective treatment strategy for patients with ventricular tachycardia (VT) or frequent premature ventricular complexes (PVCs). The goal is to improve quality of life as well as mortality.

Objectives
We aimed to characterise our population of patients who have undergone ablation for ventricular arrhythmias over the past six years, and report outcomes of this procedure.

Methods
We analysed data from consecutive patients who underwent VT/PVC ablation from January 2014–February 2020. Medical and cardiac implantable electronic device records were reviewed.

Results
A total of 121 procedures were performed in 100 patients. There were 73 males and 27 females, mean age 60±13 years. The aetiology of ventricular arrhythmias was ischaemia in 33 (33 males), non-ischaemic in 63 (38 males) and mixed aetiology in four (two males). A single procedure was performed in 83 patients, 12 patients had two procedures and five had three procedures (17 patients had ≥1 procedure, giving a 14% redo rate). No ablation was done in four patients (inability to locate PVC origin in a patient with multiple different morphologies, inadvertent aortic puncture with no sequelae, PVC focus adjacent to His bundle, cardiogenic shock during anaesthesia). Endocardial ablation was done in 96 patients and three patients also underwent epicardial ablation (one patient underwent two epicardial procedures including one open chest procedure). General anaesthesia was used in 46% of cases, conscious sedation was used in 54%. Sixty-two percent were elective procedures and 38% were done acutely. The overall acute success rate was 91%, falling to 75% at three months, 73% at six months and 68% at 12 months. Average procedure time was 180±64 minutes, fluoroscopy time 15±12 minutes, ablation time 22±19 minutes. The 30-day complication rate post-procedure was 5.8%, occurring in seven patients. These complications were two deaths, three pericardial effusions requiring pericardiocentesis, one stroke with full recovery, one groin haematoma which did not require intervention. During the analysis period nine patients died during follow up: Mortality was 4.4% at three months, 6.3% at six months, 9.1% at 12 months.

Conclusion
In patients with ventricular arrhythmias, ablation is a safe and feasible option to reduce defibrillator therapy, hospital admissions, heart failure and mortality, but repeated procedures are often needed. Our results are comparable to international standards.

Pain relief options in labour: remifentanil PCA vs epidural

Dr Jignal Bhagvandas,1 Mr Richard Foon2

1Whangarei Hospital, Whangarei; 2Waikato Hospital, Hamilton.

Objective
Remifentanil is commonly used in obstetrics due to its fast metabolism time. It is an attractive option for IV patient-controlled analgesia (PCA) in labour. We compared the efficacy of IV Remifentanil PCA with epidural during labour.

Method
Using a retrospective approach, we identified a total of 285 patients requiring Remifentanil PCA presenting to Waikato delivery suite between the years 2017 to 2019. The primary outcome measured was an assessment of patients requiring further epidural analgesia post-Remifentanil PCA. Secondary outcomes included number requiring caesarean section, instrumental use and number with a PPH or tear. This was compared to 285 patients requiring epidural analgesia.

Results
We found 24% (68 of 285) of Remifentanil patients required an epidural post-PCA for further pain relief. Of the epidural patients, 1.75% (5 of 285) required a second epidural after failing their first (RR 13.6, 95% CI 5.57–33.22, P=0.0001, P<0.05). Nineteen percent (53 of 285) of Remifentanil patients required caesarean section delivery compared to 31% (89 of 285) of epidural patients (RR 0.595, 95% CI 0.442–0.802, P=0.0006, P<0.05). Four percent (12 of
Aortic size index predicts survival in patients with abdominal aortic aneurysm

Su-Ann Yee,1 Zoe Vincent,2 Andrew Hill,3 Greg Jones,4 Manar Khashram5

1Faculty of Medical and Health Sciences, University of Auckland, Auckland; 2Department of Vascular Surgery, Auckland City Hospital, Auckland; 3Vascular Research Group, Department of Surgical Sciences University of Otago, Dunedin; 4Department of Vascular Surgery, Waikato Hospital, Hamilton; 5Department of Surgery University of Auckland, Auckland.

Objective
Most factors influencing abdominal aortic aneurysm (AAA) survival are well documented, however some predictors such as BMI have produced contradictory results. It is well established that increased AAA diameter is associated with increased mortality and rupture. Our hypothesis was to evaluate if the effect of AAA size relative to body size has an impact on survival after AAA repair.

Methods
This was a retrospective study evaluating patients with a threshold (>5cm) AAA from Auckland City Hospital and Waikato Hospital. Multisource data was used to acquire patient information, including body size measurements close to the time of surgery. Logistic regression and Cox-proportional models were used to analyse the 30-day mortality and late survival, respectively.

Results
There were 1,060 patients, with a median age of 75 years and 77% were females. AAA diameter and body size measurements were not associated with 30 day mortality. The median follow-up was 4.5 years. AAA diameter was a risk for late survival (Hazard ratio [HR]: 1.18, 95% confidence interval [CI]: 1.06–1.30). Increased weight, body mass index and body surface area were all protective against mortality (HR: 0.99, CI: 0.98–0.99; HR: 0.98, CI: 0.5–0.99; HR: 0.46, CI: 0.25–0.83). ASI values ranged from 1.4–7cm/ m² and increased ASI was associated with increased mortality (HR: 1.4, CI: 1.2–1.7).
Conclusion
Patients with a large AAA and a smaller BSA had worse overall survival. Aortic size index may be a better predictor of survival than using absolute AAA diameter and body size measurements separately.

Metformin adherence in Waikato patients with type 2 diabetes, and association with HbA1c levels
Christopher Mayo,1 Lynne Chepulis,2 Rawiri Keenan,2,3 Brittany Morison,2 Ryan Paul,2,3 Ross Lawrenson2,3
1Faculty of Medical and Health Sciences, University of Auckland; 2Waikato Medical Research Centre, University of Waikato, Hamilton; 3Waikato District Health Board, Hamilton.

Aims and objectives
Many patients with type 2 diabetes (T2D) continue to have poor glycaemic control, and this has been associated with poor medication adherence. The aim of this study was to assess patient adherence to metformin, the gold standard first-line treatment.

Methods
Prescription, clinical and demographic data were collected from the patient management system of 10 different general practices in the Waikato region for Sept 2016–March 2018. Data were extracted for all repeat metformin users aged >15 years who had a diagnosis of T2D of >12 months. NHI-matched dispensed medication data was obtained from the Pharmaceutical Collection (PHARMS). Good metformin adherence was defined as a medication possession ratio (MPR) of >0.8 and was assessed 1) using PHARMS data alone and 2) by comparing prescribing to dispensing information.

Results
One thousand five hundred and ninety-five patients were included for analysis (median age of 65 years; 55.5% male; 52.0% urban), including 49.0% receiving metformin only and 12.0% receiving metformin and insulin. Overall, 77.6% of patients had a metformin MPR of >0.8 and the median time between prescriptions was 95.4 days. The proportion of patients meeting the MPR target was significantly higher in NZ European (vs Māori and Pasifika), in those who had a CVD-related hospital admission and in older patients (all p<0.001). For patients who received 5–7 metformin prescriptions during the study period (full 90-day prescribing adherence; n=1,127) 86.2% were fully adherent with 100% of all metformin prescriptions being dispensed. Prescription adherence did not differ by gender, ethnicity or rurality. HbA1c levels were significantly higher in patients with a MPR <0.8 and in those who were <100% adherent to prescriptions.

Conclusions
In general, adherence to metformin was good, though inequities in prescribing do exist. Poorer glycaemic control was associated with reduced medication adherence.

Preventing ventilator-induced lung injury
Kevin Stewart,1 Professor Anthony Phillips,2,3 Dr Jiwon Hong,2,3 Professor John Windsor3
1Principal Academic Staff Member, Wintec, Hamilton; 2Applied Surgery and Metabolism Laboratory, School of Biological Sciences, University of Auckland, Auckland; 3Surgical and Translational Research Centre, Department of Surgery, University of Auckland, Auckland.

Background
Mechanical ventilation is commonly used in intensive care units for supplying supplementary oxygen to critically ill people. However, mechanical ventilation itself often damages the recipient’s lungs. This damage is termed ventilator-induced lung injury (VILI) and is associated with poor clinical outcomes. There are currently no effective pharmacological treatments for VILI prevention or treatment in routine clinical use.

Method
This study investigated two drugs aimed at therapeutic targets in mechanically ventilated lungs using an isolated perfused rat lung preparation (Hugo Sachs Elektronik/Harvard Apparatus IPL-2). Respiratory parameters were recorded using ADInstruments PowerLab and LabChart software. A hyperbaric model of VILI was developed. Lungs were maintained at normal tidal volume for 10 min using positive pressure ventilation (between +3 to +15 cmH₂O), and then hyperinflated by increasing the peak end-inspiratory pressure to +50 cmH₂O for a period of 1 hour. After this, a 90-minute measurement period was undertaken at normal negative breathing pressures (-2 to -12 cmH₂O). In treatment experiments (n=7), the drug was added to the recirculating perfusate seven minutes prior to lung hyperinflation. Findings were compared to determine whether drug treatment reduced the severity of VILI.

Results
The VILI model optimisation was successful, with hyperinflation resulting in an increase in tidal volume from 2.0–4.8mL and a corresponding steady rise in lung weight by 16% associated with visible oedema in the lower lung lobes. The abnormal increased lung weight was sustained over the following 90-minute normal ventilation period as well. In the drug treatment group the weight gain and tissue oedema were significantly less severe in the hyperinflation injury period and normal ventilation periods after drug treatment.

Conclusion
It was found possible to pharmacologically attenuate the severity of experimental VILI using biochemical methods.

This research was supported by Wintec, the University of Auckland and the Waikato Medical Research Foundation.

URL:
The New Zealand nuclear veteran and families study, exploring the options to assess heritable health outcomes

David McBride, John Dockerty, Robin Turner, Guy Austin, Toby Calvert, Natasha Fasi, Ryder Fuimaono, Timothy Galt, Sam Jackson, Leanda Lepiaio, Bill Liu, Darren Ritchie, Nicolas Theis

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In the first published version of this manuscript, an incorrect author list was published. The following is the correct list of authors:

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This was resolved online and in the PDF, as well as the online PubMed citations, on 29 May 2020.

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