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EDITORIAL

The dangers of public–private partnerships in secondary healthcare

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Summary

The looming spectres of public–private partnerships for hospitals and the resulting decline of government responsibility for comprehensive secondary healthcare in Aotearoa New Zealand

Philip Bagshaw, John D Potter, Sue Bagshaw

Public–private partnerships are used by some governments to build, and sometimes maintain and occasionally run, public hospitals. They can be superficially attractive, as they allow governments easier financial borrowing and access to business expertise. However, the short-term gains often come with long-term pains. The boundary between private business and government responsibilities for providing free, fair access to hospital healthcare become blurred. This has often led, in the UK, Australia, Europe and other places, to failed private hospitals closing or requiring government bailouts. It can also lead to a slow decline into a US-style private hospital system, which is prohibitively expensive and has an unacceptable disparity of standards of care between the haves and have-nots.

Informed consent—patients' understanding of risk

Tyson R Wijohn, Ruth M Newcombe, Julia Reynolds, Seif El-Jack, Guy P Armstrong

Informed consent aims to convey to patients the chance of a successful medical procedure or treatment. However, the probabilities related to informed consent are difficult to grasp, because humans prefer certainty over uncertainty. This study found that many patients reasonably understood the probability concepts involved. However, older patients and those of Asian ethnicity did not do so well. The latter may be due to English being a second language for some patients. Spending more time consenting older patients and use of interpreters when English is a second language could help patients make informed decisions.

Major trauma in working-age adults in New Zealand

Monica F Judge, Bridget Kool, Ian Civil

From 2017 to 2020, 4,186 people aged between 20 and 65 years old were admitted to a New Zealand hospital with a major injury. The majority of those injured were male. More than half of the injuries were traffic related. Rates of injury were higher among Māori than in non-Māori in this age group.

Rural–urban variation in the utilisation of publicly funded healthcare services: an age-stratified population-level observational study

Garry Nixon, Gabrielle Davie, Jesse Whitehead, Rory Miller, Brandon de Graaf, Talis Liepins, Ross Lawrenson, Sue Crengle

Rural New Zealanders are considerably less likely to be admitted to a hospital than their urban peers. This is unexpected because of the poorer health outcomes in rural areas and because it is opposite to the pattern that is seen in similar countries. The reasons are unclear, but it raises the possibility that rural people have poorer access to hospital services.

Raise the Flag II: sepsis mortality before and after the introduction of a whole-of-system quality improvement programme at a tertiary hospital in New Zealand

Paul J Huggan, Katherine M Walland, Chunhuan Lao, Anna Gwynne, Daniel Dobbins, Robert Martynoga

Sepsis (also known as septicaemia, or blood poisoning) is common in New Zealand, and is a common cause of death in hospital. Early recognition and urgent treatment with antibiotics can be lifesaving. In this study at Waikato Hospital, we showed that a programme of quality improvement aimed at changing clinician behaviour was associated with a reduction in the chance of dying.

Perceived barriers to self-collected HPV testing for cervical cancer screening, and knowledge of HPV: a survey of primary healthcare smear-takers across Aotearoa New Zealand

Sarah Ingamells, Rebecca Bell, Janine Nip, Carrie Innes, Sarah Te Whaiti, Alex Tino, Lynn McBain, John McMenamin, Ben Hudson, Melanie Gibson, Bev Lawton, Peter Sykes

Cervical cancer remains a burden within Aotearoa New Zealand. A group of viruses (human papilloma virus—HPV for short) cause over 99% of cervical cancer. We have now transitioned to HPV testing to try to reduce inequity and improve outcomes for our wāhine. However, we found that there is ongoing need for education around HPV within smear-takers in Aotearoa New Zealand.

Heart Rhythm New Zealand consensus statement on the practical management of cardiac implanted electronic devices in the peri-operative environment

Emma Guglietta, Sharron Denekamp, Susan Sinclair, Lucy Harris, Paula Bishop, Nivashni Naidoo, Timothy Holliday, Matthew Chacko, Ross Downey, Janice Swampillai, Andrew Martin, Matthew Webber

Cardiac implanted electronic devices include pacemakers, defibrillators, cardiac resynchronisation devices and implantable loop recorders. Pacemakers treat slow heart rhythms, also known as bradycardias, by providing an electrical impulse to make the heart contract. Defibrillators treat life-threatening fast heart rhythms, known as ventricular tachycardias/fibrillation, by either interrupting the electrical circuit with a series of fast electrical impulses, or electrically resetting the heart with a shock; they can also act as pacemakers. Cardiac resynchronisation therapy uses a pacemaker's electrical stimulus to coordinate the heart contraction to be more effective. Implantable loop recorders are implanted monitors designed to record and diagnose abnormal heart rhythms. Electrosurgery is used during surgery to cut skin/tissue and control bleeding.

2023 position statement on improving management for patients with heart failure in Aotearoa New Zealand

Robert N Doughty, Gerry Devlin, Selwyn Wong, Helen McGrinder, Julie Chirnside, Lia Sinclair, Melinda Copley, Wil Harrison, Mayanna Lund, Corina Grey, Daman Kaur, Raewyn Fisher, Daniel Chan for the Heart Failure Working Group, the Cardiac Society of Australia and New Zealand (NZ Region) and the New Zealand Heart Foundation

Heart failure, the end result of many different forms of heart disease, remains a common and important health problem. Access to appropriate medications in a timely manner is essential to improve the outcomes for people with heart failure. The healthcare workforce for providing timely care needs to be available for all patients across Aotearoa New Zealand.

An uncommon case of rhabdomyolysis in severe hypothyroidism

Sujatha Kamalaksha, Nicole McGrath, Chuen Siang Low, Sanjib Ghosh

Rhabdomyolysis (rapid muscle breakdown) is not an uncommon presentation. Thyroid function tests are recommended in all patients presenting with muscle weakness as hypothyroidism (under active thyroid) could predispose rhabdomyolysis, usually triggered by dehydration, drugs including medications and intense exercise.

Improved antenatal HIV screening coverage with a switch from opt-in to opt-out testing in the northern region of New Zealand

Gary N McAuliffe, Rose Forster, Lesley Voss, Rupert Handy, Subha Rajanaidu, Jacek Kolodziej, Jeannie Oliphant, Matt R Blakiston

All women in New Zealand are supposed to be offered HIV testing as part of routine pregnancy care. Unfortunately, we found that more than 15% of women in the Auckland and Northland regions did not get HIV testing done, which risked babies being born with preventable HIV infection. We changed this by making simple changes to the way HIV testing in pregnancy is offered to bring it in line with the other tests women already receive. We showed that this improved the number of women who now get tested for HIV in pregnancy. We recommend that there is an urgent review of how HIV testing in pregnancy is delivered across New Zealand to identify and close gaps like this.

The looming spectres of public–private partnerships for hospitals and the resulting decline of government responsibility for comprehensive secondary healthcare in Aotearoa New Zealand

Philip Bagshaw, John D Potter, Sue Bagshaw

Governments are often short of capital for the provision of costly infrastructure projects. Such infrastructure aims to provide a long-term benefit to society; however, the cost is upfront, so methods of funding that spread the cost over a longer period are attractive to governments. Public–private partnerships (PPPs) are one way of achieving this and may extend beyond the costs of construction and maintenance to the delivery of services as well. PPPs, in general, are best described as structured cooperations between public and private partners in the planning, construction or operation of infrastructure, in which they share or redistribute risks, costs, benefits, resources and responsibilities.[1] The potential for PPPs to be used increasingly in Aotearoa New Zealand for the provision of hospital-level secondary healthcare has been recently raised in our news media. From that report, it was clear that knowledge of this type of development is not well understood by the public and our medical profession[2]—hence the need for this editorial.

In the provision of hospital-level secondary healthcare, PPPs can take different forms (Table 1).[3]

These range from franchising arrangements, where a public authority contracts with a private company to manage an existing hospital to the DBFO model, where a private consortium is responsible for the designing, building, financing and operating of a hospital, based on some public authority's requirements.[3] Another recent iteration is the Private Financial Initiative, in which private money is provided for projects at commercial rates of interest, which are higher than governments are usually required to pay.[4,5] The benefit to the government is that this loan does not sit on its balance sheet, as it is allocated to the private provider.

As in many other countries, Aotearoa New Zealand uses multiple public–private service arrangements in healthcare.[2] These include: 1) private support services, such as hospital food supplies, cleaners, pathology services and pharmaceutical supplies, 2) temporary or permanent specific elective clinical procedures, such as outsourced hernia or hip surgery, contracted to private hospitals to address growing public hospital waiting lists, 3) outsourcing complete clinical services such as all midwifery in some regions, and 4) healthcare research done by large accounting firms,[6] which nonetheless also work profitably against the health of the population.[7]

Pros and cons of extending PPP models into secondary healthcare

Are PPPs part of an overall plan to stealthily reduce government responsibilities for healthcare? In Aotearoa New Zealand, GP practices are being increasingly taken over by private companies.[8,9] Is our government looking to turn its attention to PPPs to reduce its responsibilities for secondary healthcare?

The academic literature is divided over the ways to evaluate the performances of PPPs and whether they are effective in the long term.[3,10] Others have shown that empirical evidence around risk management and appropriateness in "sensitive service delivery such as medical services" is lacking.[11] Many advantages have been claimed for PPPs, including financial ones already mentioned, which spread the risk of large,

Table 1: Models of public–private partnership in hospital provision.

Model	Description
Franchising	Public authority contracts a private company to manage existing hospital
DBFO (design, build, finance, operate)	Private consortium designs facilities based on public authority's specified requirements, builds the facility, finances the capital cost and operates their facilities
BOO (build, own, operate)	Public authority purchases services for fixed period (say 30 years) after which ownership remains with private provider
BOOT (build, own, operate, transfer)	Public authority purchases services for fixed period after which ownership reverts to public authority
BOLB (buy, own, lease back)	Private contractor builds hospital; facility is leased back and managed by public authority
Alzira model	Private contractor builds and operates hospital, with contract to provide care for a defined population

(Reproduced with permission from the author and World Health Organization [WHO]).[3]

complex projects such as building and maintaining hospitals. The injection of capital from the private sector reduces government debt in the short term and claims are made that the private sector is more efficient. Private hospitals are said to provide faster throughput, greater choice of clinician and reductions in waiting times, leading to higher patient satisfaction.

Conversely, governments can always borrow money at cheaper rates. Private companies may inject capital but that usually comes with high interest rates, which taxpayers have to cover.[4] Efficiency of the private sector provision is hard to evaluate because relevant data are often shrouded under claims of commercial sensitivity. Claims are also made that the private sector provides greater efficiency in healthcare delivery but, for surgical services, for instance, the private sector rarely offers to undertake the more costly delivery of acute care or the care of more complicated cases. In addition, if clinical complications occur, private patients are regularly transferred to the public system to address problems and carry the additional cost. There are numerous examples of failed PPP projects that then must be bailed out by governments.[4,12]

To manage the maintenance of infrastructural quality and standards of clinical care that are needed for sustainable healthcare delivery, PPPs require complex and protracted contractual agreements. These reduce the ability to keep pace with the frequently changing secondary healthcare environment and decrease the ability to respond flexibly. Furthermore, PPP contracts become saleable on the open market, with potential private profit at every transfer and zero benefit to the taxpayer or patient.[13] Both real increasing costs and cutting corners to keep within budget reduce quality of healthcare delivery, impairing care and causing suffering.[14] Finally, the cost of training staff is rarely undertaken by private providers, which undermines the long term general sustainability of healthcare provision.

Health-outcome measures are crucial to deciding whether changes in the funding of healthcare are appropriate. A systematic review concluded

that there was no improvement in the quality of healthcare following privatisation and that most financial system-level changes resulted in either inconclusive or deleterious outcomes.[15] A study in Italy concluded that there was no benefit from higher private spending and that a greater proportion of spending on private services resulted in increased avoidable mortality; in contrast, each additional €100 per capita of public spending was associated with a 1.5% reduction in avoidable mortality.[16]

Private and public systems differ markedly in their purposes and functions. The goal for business is profit and dividends to shareholders. The government's goal is to provide necessary care for its citizens. Many countries, including Aotearoa New Zealand since 1939, believe that one of the responsibilities of a civilised, democratic polity is to provide free, accessible, sustainable and equitable healthcare to all its citizens,[17] although we still continue to fall well short on equity for Māori, Pasifika and those living in poverty. One key challenge lies in who is responsible for meeting the cost. Governments are charged with the responsibility of raising funds through taxes. Business raises funds by passing costs to individuals. Problems arise when individuals cannot afford the care. Insurance schemes mitigate this: the healthy pay in advance for medical care. Problems arise when individuals cannot afford the insurance.

What to learn from past experience?

In the UK, governments have been steadily reducing their responsibility for providing free, fair access to secondary healthcare.[13,18] In a long series of legislative changes, the NHS has been progressively dismantled until it is increasingly exhibiting similarities to the healthcare system in the US.[19] Closer to home, we must never forget that the draconian attempt at introducing a business model into hospital-level healthcare in Aotearoa New Zealand in the 1990s was a spectacular failure, for which the perpetrators have not been held to account.[20] Any stealthy introduction of PPPs in the funding and provision of hospital-level care into Aotearoa New Zealand would repeat, in slow motion, this failed experiment, with most of the consequences of the serious damage suffered by future generations.

Conclusions

The provision of secondary elective healthcare in a democratic country like ours can exist happily and productively with a comprehensive free and fair public hospital system working alongside a separate, user-pays private hospital system. The clear margins between the two systems get blurred when private companies try to capture trade from the public system or when governments decide to abrogate their responsibilities to provide free, fair comprehensive secondary elective services by sharing the costs, risks and benefits with the private sector. Experiences in the UK, Europe, Australia and elsewhere around the world have shown that these two developments have almost invariably led to short-term gain and long-term pain: a slow decline into a prohibitively expensive healthcare system and an unacceptable disparity of standards of care between the haves and the have-nots.

COMPETING INTERESTS
Nil.

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Informed consent—patients' understanding of risk

Tyson R Wijohn, Ruth M Newcombe, Julia Reynolds, Seif El-Jack, Guy P Armstrong

ABSTRACT

AIMS: The central concept of informed consent is communication of the chance of a successful outcome. The risks and benefits are probabilistic concepts derived from populations; they do not map with any certainty to the individual. We tested patients' comprehension of basic probability concepts that are needed for informed consent.

METHODS: Patients (n=478) completed five questions designed to test risk estimates that are relevant to informed consent. The questions posed non-medical scenarios to avoid patients associating them with their clinical care. The questionnaire was in English and was only offered to patients whose nurse felt that they had sufficient English literacy to understand the questions.

RESULTS: Out of a possible total of five correct answers, Asian patients scored lowest, and significantly less than Pākehā/Europeans (average total score 2.6±1.7 vs 3.6±1.4, p<0.001, 95% confidence interval 0.5 to 1.38). The total score for Māori/Pasifika was intermediate (3.2±1.4), yet they had the lowest deprivation index. This discordant finding may be due to poorer English literacy among Asian participants. On multiple linear regression, Asian ethnicity and advancing age were the independent predictors of a low score. Socio-economic deprivation decile and sex were not.

CONCLUSIONS: When answering questions constructed according to best practice, many (but not all) patients have reasonable risk comprehension. Further improvement could target older patients, those of Asian ethnicity and probably all patients where English is a second language. Liberal use of interpreters is suggested.

Patient informed consent is integral to the practice of medicine. The central concept of informed consent is communication of the chance of a successful outcome. The risks and benefits of different therapeutic options are discussed. However, these are probabilistic concepts derived from populations. They do not map to the individual in a way that gives the certainty that we humans prefer. Risk literacy is not universal, as documented in a literature that spans medicine, behavioural psychology and economics.[1–3] We tested patients' comprehension of risk as it relates to informed consent.

Methods

Five questions were constructed that evaluated the understanding of probabilistic concepts that are relevant to informed consent. The questions posed non-medical scenarios to avoid patients associating them with their clinical care. The form of the questions reflect how verbal and written consent is obtained at Te Whatu Ora – Waitematā. They were refined for readability and representativeness with feedback from colleagues and a random sample of laypersons. The average reading ease was 85.2 out of 100, indicating "easily understood by 11- to 12-year-olds".[4] The final version was offered to cardiology patients in various settings, including Te Whatu Ora – Waitematā cardiology inpatients and outpatients awaiting cardiac catheterisation, and at a private cardiac catheterisation laboratory waiting area. The questionnaire was in English and clinical staff were instructed to only canvas participation from patients they judged to have sufficient facility with English. Interpreters were not used. Patients were asked to answer the questions without help from whānau or support persons. The study was approved by the local ethics committee.

Questionnaire

What follows are the questions. Each is accompanied by an explanation of purpose that was not included in the version administered to patients.[5,6]

1. Your plumber has told you that the greater the percentage (%) blockage in your pipes, the greater the need to get them fixed. Which percentage (%) blockage has the highest chance of needing to be fixed?

33%	50%	99%	Unsure

Percentages are often used to present risk to patients. This assesses basic understanding of how risk changes as percentages change.

2. You have seven cards, each with a different day of the week. You pick one card at random.
   What is the likelihood of choosing a Wednesday?

1/7	2/7	3/7	Unsure

Frequencies are the preferred way to present risks to patients. This assesses basic understanding of what a frequency means.

3. Which of the following indicates a greater chance of meeting your favourite movie star at your local cafe?

1 in 10	1 in 100	1 in 1,000	Unsure

This assesses how risk increases with increasing frequency.

4. The chance of catching a fish with your hands is 3 in 1,000.
   10,000 people try catching a fish with their hands. How many are likely to catch a fish?

   ____ people

This assesses how a frequency is applied to calculate expected number of complications.

5. The chance of a person winning a raffle is 4 in a 1,000.
   What is the chance of ***not*** winning the raffle?

4 in a 1,000	100 in a 1,000	996 in a 1,000	Unsure

Both positive and negative framing should be used to describe risk. This assesses understanding of the relationship between positive and negative framing.

Analysis

Demographics were obtained using the National Health Identifier for each patient. Socio-economic deprivation was assessed according to domicile with the New Zealand Index of Deprivation 2018 (NZDep2018).[7] Questions left blank or marked "unsure" were classified as wrong, as only patients judged to have adequate literacy were offered participation ("intention to participate" analysis). Significance was defined as $p<0.05$. SPSS® version 29.0.0.0 (241) was used for analysis. Each correct answer was awarded one point. The total questionnaire score for each patient was the summed score for the five questions (range 0–5). The analysis focussed on the total score, using analysis of variance (ANOVA) with Bonferroni correction for comparison between groups of differing sex, ethnicity and age >70. Pearson's correlation was used to assess for any linear relationship of the total questionnaire score with numeric age and socio-economic decile. Multiple linear regression was used to build a predictive model for total score. Sub-group analysis for individual questions was carried out using Chi-square with Bonferroni correction. Training effect was evaluated by administering the questionnaire a second time to 21 patients, at a variable (unrecorded) number of days after their initial exposure.

Results

Of the 478 respondents, 12 were from a private cardiac facility. The remainder were from Te Whatu Ora – Waitematā public hospitals, mainly North Shore Hospital. Eleven respondents chose to remain anonymous. Anonymous patients were not more likely to leave questions blank. Blank answers varied from 3.6% (Q1, Q2) to 5.6% (Q3). Sixteen patients gave a reason for leaving questions blank, seven cited language (five Asian, two Other European) and three were not comfortable with numbers.

Baseline characteristics are in Table 1. Female respondents comprised 31% of the total, Māori comprised 7%, patients over age 70 comprised 44% and those over age 75 comprised 28%.

Results for the total questionnaire score are in Table 2. Asian patients scored lowest, and significantly worse than Pākehā/Europeans (total score 2.6±1.7 vs 3.6±1.4, $p<0.001$, 95% confidence interval 0.5 to 1.38). See Figure 1. Yet, Asian patients' deprivation decile was intermediate, at 4.9, compared with 6.2 for Māori/Pasifika and 4.2

Table 1: Baseline characteristics of the 478 patients.

Demographic		n (%)
Age	≤70	256 (54%)
	>70	211 (44%)
	Anonymous	11 (2%)
Sex	Female	150 (31%)
	Male	317 (66%)
	Anonymous	11 (2%)
Deprivation index	Upper tertile (1–3)	171 (36%)
	Mid tertile (4–6)	187 (39%)
	Low tertile (7–10)	105 (22%)
	Anonymous or data not available	15 (3%)
Ethnicity	Asian	47 (10%)
	Māori/Pasifika	70 (15%)
	Pākehā/European	349 (73%)
	Anonymous or data not available	12 (3 %)

Table 2: Total questionnaire score.

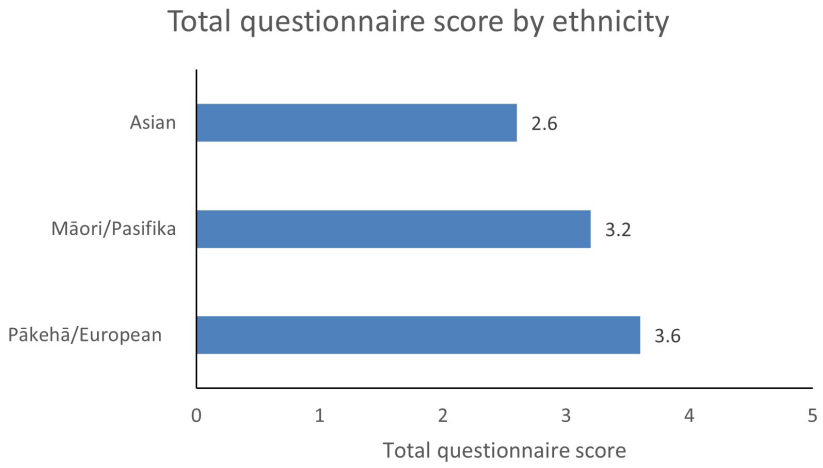
Demographic		Mean ± std deviation
Total		3.4±1.4 (range 0–5)
Age	≤70	3.6±1.4
	>70	3.2±1.5
	Anonymous	3.4±1.6
Sex	Female	3.3±1.4
	Male	3.5±1.4
	Anonymous	3.4±1.6
Deprivation index	Upper tertile (1–3)	3.5±1.4
	Mid tertile (4–6)	3.4±1.4
	Low tertile (7–10)	3.3±1.5
	Anonymous	3.3±1.8

Table 2 (continued): Total questionnaire score.

Ethnicity	Asian	2.6±1.7*
	Māori/Pasifika	3.2±1.4
	Pākehā/European	3.6±1.4*
	Anonymous	3.3±1.6

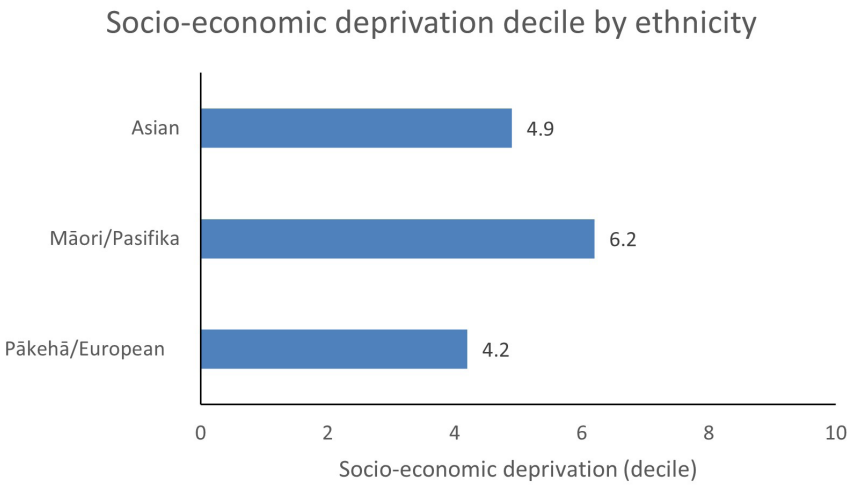
*ANOVA with Bonferroni correction, p<0.001

Figure 1: Overall questionnaire score by ethnicity.



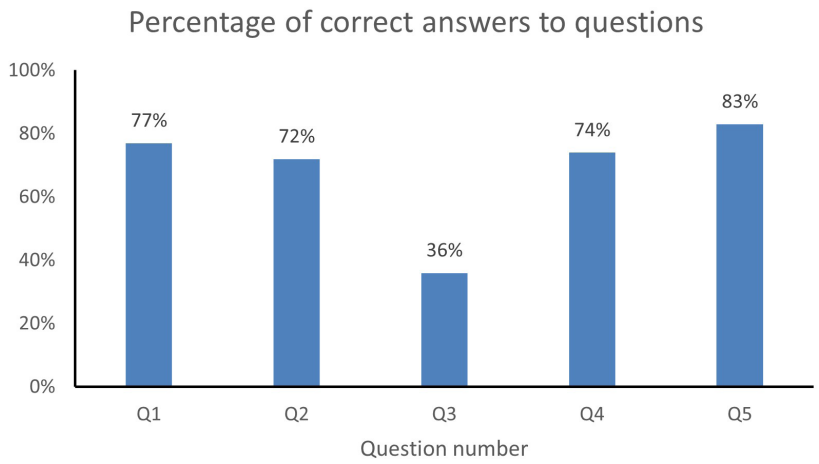
* Asians scored less than Pākehā/European, p<0.001.

Figure 2: Socio-economic deprivation decile by ethnicity.



Differences not significant.

Figure 3: Percentage of correct answers to questions.



*Percent correct for question three was less than for the other questions, p<0.001.

for Pākehā/Europeans. See Figure 2.

Multiple linear regression was run to predict total questionnaire scores from age, socio-economic deprivation score, sex and ethnicity. The prediction was statistically significant with $F(6, 455) = 9.08$, $p<0.001$, R^2 0.11. Age ($p<0.001$) and ethnicity ($p=0.001$) contributed significantly to the model, but deprivation score and sex did not. These findings were robust; they did not change with different methods or different orders of entering variables.

Regarding individual questions, the proportion of correct answers ranged from 36% for question three to 83% for question five (Figure 3). The Appendix contains tables of scores for individual questions by sub-group. The significant differences for individual questions are similar to those for total questionnaire scores, with significantly lower scores for Asian ethnicity (compared with Pākehā/European, 3/5 questions) and age >70 (2/5 questions).

There was no evidence of a learning effect, with no change in overall score when the questionnaire was answered a second time ($p=0.5$).

Discussion

This study tests risk comprehension in patients judged by their nurse to have sufficient English literacy to understand and answer the questionnaire.

Asian patients scored lower than other ethnic groups. Given that their social deprivation index was not the lowest, we surmise that this is due to other factors. Even though their nurse felt that they had sufficient English skills, it is likely that risk concepts need a higher level of literacy. Also, there are reports that Asian people perceive risk differently to Westerners.[8]

The total score for Māori/Pasifika was significantly lower than Pākehā/Europeans', but not as poor as Asian ethnicity.

Besides Asian ethnicity, the other independent predictor of a low score was advancing age.

Question three had the poorest proportion of correct responses, at only 36%. This is notable as it was testing the most evidence-based format of presenting risk as a frequency.[5] However, the denominator varied, and other researchers have found poorer comprehension when this is done.[9] This is a reminder to keep the same denominator throughout the informed consent process.

The other four questions had a correct response rate of 72–83%. This was from questions as a stand-alone event. Evidence suggests that comprehension of risk improves when consenting is a process, rather than a single event. It should include not only written information but also discussion with the consenting doctor to put risks and benefits into context, plus time for questions. It may be that risk presented as "two in a 1,000 chance of a serious complication" would be better comprehended if spelt out in full, as "out of every 1,000 patients undergoing this procedure, around

two will experience a serious complication".

Thus, it is likely that correct understanding would be higher still after these patients underwent the entire consent process. This is encouraging for the studied group of patients. However, we can surmise that patients not included in this study because their nurse felt that they had insufficient English comprehension would fare worse. Asians were the only ethnic group where the proportion doing the questionnaire differed from the proportion going through the cardiac catheterisation facility. Asians comprised 10% of the questionnaire population, but 15% through the cardiac catheterisation facility. This suggests that nurses informally assessed one in three Asians to have insufficient comprehension and did not offer questionnaire participation. Thus, many non-participants were Asian with poor English literacy. This supports liberal use of interpreters for informed consent, although we are yet to administer the questionnaire to a sample of interpreters.

Evidence summary of strategies to improve patient comprehension of risk[1,5,6,9–12]

- Start off with the bottom-line message before presenting details and numbers.
- Explain the risk as well as the reasons for it.
- Use numerical estimates but also images (pie charts for risks greater than 1%, icon arrays for risks less than 1%).
- Qualitative descriptions (high/medium/low or likely/unlikely) in verbal discussion can help place numerical estimates into context, but they are subjective—"low" risk can mean different things to the doctor and patient, and can lead patients to misinterpret risk.
- It may help to provide a benchmark risk for comparison, such as the risk of a car accident or drowning.
- Use non-unitary numerators if using frequencies and the same denominator for all frequencies.
- Use absolute, not relative, risk.
- Use both positive and negative framing.
- If possible, individualise risks by showing how they differ in sub-groups, e.g., inpatient versus outpatient, risks with age (best done during discussion with, and tailored to, the individual patient).
- Avoid the "lawyer's list" of all imaginable complications. Less is more when it comes to risk comprehension.
- Multimedia can improve comprehension.

Limitations

The questionnaire was only in the English language. We did not record the time taken to complete the questionnaire; this may have varied between groups. Patients' highest level of education was not sought, so as not to reduce participation because of associated shame (whakamā).[13] This study focussed on numerical estimates of risk, as these are integral to the concept of informed consent. However, this is only part of the overall process of clinical informed consent. Patients' comprehension of the questions may have differed if the written questionnaire was supplemented with verbal discussion. Healthcare and legal professionals place great emphasis on patient exposure to numeric risk estimates, as tested in this study. However, even educated, numerate individuals tend to base their decision on the overall gist of the information, as conveyed descriptively, which includes the flavour of the human interaction between patient and consenter.[5,6,14,15] Of course, this exposes the patient to any bias in the verbal presentation.

Conclusions

When answering questions constructed according to best practice, many (but not all) patients have reasonable risk comprehension. Further improvement could target older patients, those of Asian ethnicity and probably all patients where English is a second language. Liberal use of interpreters is suggested.

COMPETING INTERESTS
Nil.

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Appendices: Tables—individual question scores in sub-groups

Appendix Table 1: Response to individual questions grouped by age.

Age (n)	Q1 (%)	Q2 (%)	Q3 (%)	Q4 (%)	Q5 (%)
Not specified (11)	64	64	36	82*	91
≤70 (256)	78	76	*43**	*80*[§]	86
>70 (211)	76	67	*27**	*67*[§]*	78

Superscripts *[§] indicate pairs that differ significantly from each other.

Appendix Table 2: Response to individual questions grouped by sex.

Sex (n)	Q1 (%)	Q2 (%)	Q3 (%)	Q4 (%)	Q5 (%)
Not specified (11)	64	64	36	82	91
Female (150)	74	72	*27**	75	80
Male (317)	79	72	*40**	74	84

Superscript * indicate pairs that differ significantly from each other.

Appendix Table 3: Response to individual questions grouped by ethnicity.

Ethnicity (n)	Q1 (%)	Q2 (%)	Q3 (%)	Q4 (%)	Q5 (%)
Asian (47)	*62**	*49**	19	64	68*
Māori/Pasifika (70)	66[§]	64	40	66	81
Not specified (12)	67	67	33	75	92
Pākehā/European (349)	*81*[§]*	*76**	37	77	*85**

Superscripts *[§] indicate pairs that differ significantly from each other.

Appendix Table 4: Response to individual questions grouped by socio-economic decile.

Decile (n)	Q1 (%)	Q2 (%)	Q3 (%)	Q4 (%)	Q5 (%)
High 1–3 (171)	75	79*	33	78*	85
Mid 4–7 (187)	77	70	35	76	81
Low 7–10 (105)	80	65*	39	64*	82

Superscripts * indicate pairs that differ significantly from each other.

Major trauma in working-age adults in New Zealand

Monica F Judge, Bridget Kool, Ian Civil

ABSTRACT

AIM: To describe the demographic and injury profile of major trauma among 20–65-year-old New Zealanders.

METHODS: A retrospective analysis of routinely collected data from the New Zealand Major Trauma Registry for the period 1 July 2017 to 30 June 2020 was conducted. Sex, age and ethnicity-based rates were then calculated using census-based population estimates to compare the rates of injury across different demographic groups.

RESULTS: Of the 4,186 major trauma incidents among 20–65-year-olds in New Zealand during the 3-year period reviewed, 235 died (5.6%). Males accounted for 77% of those injured. Māori (New Zealand's Indigenous population) had significantly higher rates of major trauma (79.2 per 100,000; 95% confidence interval [CI] 74.4–84.3) compared to non-Māori (44.4 per 100,000; 95% CI 42.9–46.0). The most common cause of injury was transport-related incidents (63%; n=2,632/4,186), followed by falls (19%; n=788/4,186).

CONCLUSIONS: Demographic characteristics have a significant relationship with major trauma injuries among 20–65-year-old New Zealanders. Continued injury prevention efforts focussing on males, Māori and transport incidents are required. Interventions that improve the safety of roads, such as lane separators, speed limits and raised intersections, should be implemented in high-crash-risk areas to reduce risk.

Major trauma is one of the leading causes of death in New Zealand.[1,2] Injuries contribute to approximately 500,000 hospitalisations a year, resulting in a large burden on New Zealand's health system.[3–6] In 2012, the New Zealand Trauma Network (Te Hononga Whētuki ā-Motu) was formed and included the establishment of the New Zealand Trauma Registry (Te Rēhita Whētuki o Aotearoa) (NZTR). The registry enables the centralised collection of information about the characteristics and outcomes of major trauma in New Zealand.[7] Data on any patient admitted to hospital with an Injury Severity Score (ISS) of greater than 12, or any death following an injury, are captured by the registry; information gathered includes patient demographic characteristics, injury incident details, processes of care and outcomes.

Injury among working-age adults is common,[8–10] and carries with it significant impacts for society due to the productive contribution of this age group.[10] Studies from the United States of America (USA) have demonstrated the long-term adverse effects of work-related injuries,[10–12] and highlighted their contribution to income inequality.[11] Data from the European Union estimate that over one third of unintentional injuries among working-age adults (18–64 years) could be reduced.[13] There is limited published information available about the epidemiology of injury among working-age New Zealanders. Therefore, the aim of this research is to describe the patterns of major trauma in the 20–65-year-old population of New Zealand using data from the NZTR. While this age group excludes younger workers (16–19-year-olds), it hopes to describe the current state of injuries in the study population. This information can be used to inform future injury prevention interventions targeting the working-age population to reduce the morbidity and mortality associated with these injuries.

Methods

A retrospective analysis of routinely collected data from the NZTR for the period 1 July 2017 to 30 June 2020 was conducted. Patients aged between 20 and 65 years with major trauma who presented at any New Zealand public hospital were included in the study. This classification was used to exclude the youngest (18–20) and oldest workers, because major trauma injuries are often disproportionately present in these youngest and oldest groups.[14] Major trauma is identified in the NZTR using the Abbreviation Injury Scale (AIS, 2005/2008), to classify injury severity.[7] In the AIS, six distinct anatomical regions are used, and each injury is scored from 1 to 6, with a score of 6 denoting an unsurvivable injury. An ISS is then

derived by squaring the scores from the three most severely injured anatomical regions. An ISS between 13 and 75 is considered major trauma; therefore, patients with an ISS greater than 12 were included in this study. Event episodes were the unit of study, such that trauma events resulting in a hospital visit were the cases used in the study.[15]

Variables of interest obtained from the NZTR included: demographic (age, sex, ethnicity—dichotomised as Māori [New Zealand's Indigenous population]: non-Māori), injury event information (mechanism, date, time and place of injury), type and severity of injury, length of hospital stay and discharge destination. Self-identified ethnicity data in the NZTR are obtained from a patient's National Health Index number (unique health identifier). As per the New Zealand Manatū Hauora – Ministry of Health's Ethnicity Data Protocol,[16] patients can list up to two ethnicities. For the purposes of this study, ethnicity data were then prioritised. For example, patients who identified as both Māori and European were recorded as Māori in the dataset. Differences in patterns of injury among Māori and non-Māori were investigated as this has been identified as a gap in current research.[17]

For the calculation of rates, population estimates were obtained using the 2018 New Zealand Census data.[18] Sex- and age-based rates used the 2018 population counts to create annualised rates across the 3 years of data. The ethnicity-based rates used the 2018 population estimates, as the most current estimates available. The statistical coding package R (version 4.0.3) was used for data analysis.[19] Descriptive analysis was carried out to produce Chi-squared tests, using categorical variables for ethnicity, ISS score, injury type (blunt force, penetrating or burn) and age group. Where Chi-squared analysis was unsuitable because of small sample sizes in subsets (between ISS score and injury type), Fisher's exact tests were instead carried out.

Ethics approval for the research was granted by the The University of Auckland's Human Participant's Ethics Committee (Reference: 3459), and access to the data was granted by the NZTR Data Governance Group.

Results

There were 4,186 major trauma incidents among 20–65-year-olds in New Zealand during the 3-year data collection period (Table 1). In 76.6% (n=3,206/4,186) of these cases the patients were male. Māori had a significantly higher rate of major trauma (79.2 per 100,000; 95% confidence interval [CI] 74.4–84.3) compared to non-Māori (44.4 per 100,000; 95% CI 42.9–46.0). Māori had a higher rate of trauma than non-Māori in every age group studied, with significantly higher rates in the 25–30 year (91.7/100,000 cf. 43.7/100,000) and the 45–49-year age groups (74.7/100,000 cf. 40.5/100,000). Māori had significantly higher ISS scores on average (Chi-squared p<0.01) than non-Māori, and higher rates of injury for all injury mechanisms (Chi-squared p<0.01). This was most marked for penetrating trauma (Māori 5.90/100,000 cf. non-Māori 1.94/ 100,000).

The 60–65-year age group experienced the highest mortality rates (4.4 per 100,000; 95% CI: 3.2–6.1). However, the 30–34-year age group had the highest median ISS score (18; interquartile range [IQR] 14–25). The age groups with the highest annualised rate of major trauma caused by assault and self-harm were the younger age groups (25–29, 8.5/100,000, and 20–24 years, 8.0/100,000). Males had consistently higher rates of trauma across all age groups.

The most common cause of major trauma in 20–65-year-olds was traffic-related incidents (n=2,632/4,186; 62.9%), followed by falls (n=788/4,186; 18.8%) (Table 2). Fifty-four percent (n=2,254/4,186) of major traumas occurred on streets or highways, while 14.9% (n=624/4,186) occurred at home. Of note, home injuries accounted for 19.2% (n=45/235) of mortalities. The majority (n=3,904/4,186; 93.3%) of major traumas were blunt-force injuries, and unintentional (n=3,617/4,186; 86.4%). A greater proportion of patients with intentional injuries died than those with unintentional injuries (7.0% cf. 5.3%). Injuries that occurred on streets or highways had the highest median ISS (17; IQR 14–25) and the highest median length of stay in acute care (8 days, range 14 minutes–366 days). The median length of stay in acute care was 7.1 days (IQR 3.8–13.1). Nineteen percent of people had a length of stay of up to 3 days, 30.4% 5–7 days, and 50% stayed longer than a week. The median length of stay for those patients who died in hospital was 1.9 days (IQR 0.39–5.1 days, or between 9.4 hours and 5.1 days).

Seventy five percent of major traumas (n=3,219/4,186) had an ISS in the lower range of 13–24 (Table 3). Injuries scoring ISS >49 accounted for 1.6% of all injuries and 15.7% of all deaths. There was an association between ethnicity and injury severity (Chi-squared p<0.01), with

Table 1: Demographic profile of major trauma among 20–65-year-olds (1 July 2017 to 30 June 2020), n=4,186.*

Variables	Total n (%)	Rate per 100,000 (95% CI)	Survived n (%)	Rate per 100,000 (95% CI)	Died n (%)	Rate per 100,000 (95% CI)
Total events	**4,186**	**49.5 (48.0–51.0)**	**3,951 (94.4%)**	**46.7 (45.3–48.2)**	**235 (5.6%)**	**2.8 (2.4–3.2)**
Sex						
Female	980 (23.4%)	22.8 (21.4–24.3)	922 (94.1%)	21.5 (20.1–22.9)	58 (5.9%)	1.3 (1.0–1.7)
Male	3,206 (76.6%)	77.0 (74.4–79.7)	3,029 (94.5%)	72.7 (70.2–75.4)	177 (5.5%)	4.3 (3.7–4.9)
Ethnicity						
Māori	971 (23.2%)	79.2 (74.4–84.3)	904 (93.1%)	73.7 (69.1–78.7)	68 (7.0%)	5.5 (4.4–7.0)
Non-Māori	3,215 (76.8%)	44.4 (42.9-46.0)	3,047 (94.8%)	42.1 (40.6–43.6)	167 (5.2%)	2.3 (2.0–2.7)
Age group (in years)						
20–24	547 (13.1%)	55.7 (51.3–60.6)	518 (94.7%)	52.8 (48.4–57.5)	31 (5.7%)	3.2 (2.2–4.5)
25–29	536 (12.8%)	50.4 (46.3–54.8)	510 (95.1%)	47.9 (43.9–52.3)	27 (5.0%)	2.5 (1.7–3.7)
30–34	436 (10.4%)	44.8 (40.8–49.2)	411 (94.3%)	42.2 (38.3–46.5)	25 (5.7%)	2.6 (1.7–3.8)
35–39	319 (7.6%)	35.5 (31.8–39.6)	307 (96.2%)	34.1 (30.5–38.2)	12 (3.8%)	1.3 (0.8–2.3)
40–44	386 (9.2%)	43.7 (39.5–48.2)	363 (94.0%)	41.1 (37.0–45.5)	23 (6.0%)	2.6 (1.7–3.9)
45–49	437 (10.4%)	44.8 (40.8–49.2)	404 (92.4%)	41.4 (37.6–45.7)	33 (7.6%)	3.4 (2.4–4.8)
50–54	490 (11.7%)	52.1 (47.7–56.9)	475 (96.9%)	50.5 (46.2–55.3)	15 (3.1%)	1.6 (1.0–2.6)
55–59	543 (13.0%)	58.4 (53.7–63.5)	507 (93.4%)	54.5 (50.0–59.5)	36 (6.6%)	3.9 (2.8–5.4)
60–65	492 (11.8%)	60.5 (55.4–66.1)	456 (92.7%)	56.1 (51.1–61.4)	36 (7.3%)	4.4 (3.2–6.1)

CI = confidence interval.
* Rates are annualised across the 3 years of data, using the New Zealand Census population counts for the 2018 population of adults aged 20–65 years.

Table 2: Characteristics and outcomes of major trauma among 20–65-year-olds (1 July 2017 to 30 June 2020), n=4,186.

Variables	Total n (%)	Rate per 100,000 (95% CI)	Survived n (%)	Rate per 100,000 (95% CI)	Died n (%)	Rate per 100,000 (95% CI)
Mechanism of injury						
Transport incident	2,591 (61.9%)	30.6 (29.5–31.8)	2,468 (95.3%)	29.2 (28.0–30.3)	123 (4.7%)	1.5 (1.2–1.7)
Car occupant	1,032 (24.7%)	12.1 (11.4–12.9)	973 (94.3%)	11.5 (10.8–12.2)	59 (5.7%)	0.7 (0.5–0.9)
Motorcyclist	645 (15.4%)	7.6 (7.1–8.2)	613 (95.0%)	7.2 (6.7–7.8)	32 (5.0%)	0.4 (0.3–0.5)
Bicyclist	359 (8.6%)	4.2 (3.8–4.7)	351 (97.8%)	4.2 (3.7–4.6)	8 (2.2%)	0.09 (0.04–0.2)
Pedestrian	147 (3.5%)	1.7 (1.5–2.0)	135 (91.8%)	1.6 (1.3–1.9)	12 (8.2%)	0.14 (0.07–0.2)
Fall	762 (18.2%)	9.0 (8.4–9.7)	713 (93.5%)	8.4 (7.8–9.1)	49 (6.5%)	0.6 (0.4–0.8)
Fall from building	133 (3.2%)	1.6 (1.3–1.9)	125 (94.0%)	1.5 (1.2–1.8)	8 (6.0%)	0.1 (0.05–0.2)
Fall via slipping	102 (2.4%)	1.2 (1.1–1.5)	94 (92.2%)	1.1 (0.9–1.4)	8 (7.8%)	0.1 (0.05–0.2)
Fall from ladder	92 (2.2%)	1.1 (0.9–1.3)	87 (94.6%)	1.1 (0.8–1.3)	5 (5.4%)	0.07 (0.03–0.2)
Fall involving a pedestrian conveyance.*	65 (1.6%)	0.8 (0.6–1.0)	62 (95.4%)	0.7 (0.6–0.9)	3 (4.6%)	0.03 (0.01–0.1)
Assault	423 (10.1%)	5.0 (4.5–5.5)	399 (94.3%)	4.7 (4.3–5.2)	24 (5.7%)	0.3 (0.2–0.4)
Self-harm	107 (2.6%)	1.3 (1.0–1.5)	94 (87.9%)	1.1 (0.9–1.4)	13 (12.1%)	0.2 (0.1–0.3)
Other**	303 (7.2%)	3.6 (3.2–4.0)	277 (91.4%)	3.3 (2.9–3.7)	26 (8.6%)	0.3 (0.2–0.5)
Place of injury occurrence						
Street and highway	2,254 (53.9%)	26.6 (25.6–27.8)	2,126 (94.3%)	25.1 (24.1–26.2)	128 (5.7%)	1.5 (1.3–1.8)
Home	624 (14.9%)	7.4 (6.8–8.0)	579 (92.8%)	6.8 (6.3–7.4)	45 (7.2%)	0.5 (0.4–0.7)
Sports/athletics area	277 (6.6%)	3.3 (2.9–3.7)	270 (97.5%)	3.2 (2.8–3.6)	7 (2.5%)	0.1 (0.04–0.2)

Table 2 (continued): Characteristics and outcomes of major trauma among 20–65-year-olds (1 July 2017 to 30 June 2020), n=4,186.

Variables	Total n (%)	Rate per 100,000 (95% CI)	Survived n (%)	Rate per 100,000 (95% CI)	Died n (%)	Rate per 100,000 (95% CI)
Beach/forest/country	242 (5.8%)	2.9 (2.5–3.2)	233 (96.3%)	2.8 (2.4–3.1)	9 (3.7%)	0.1 (0.1–0.2)
Farm	231 (5.5%)	2.7 (2.4–3.1)	226 (97.8%)	2.7 (2.3–3.0)	5 (2.2%)	0.1 (0.02–0.1)
Industrial/construction	102 (2.4%)	1.2 (1.0–1.5)	90 (88.2%)	1.0 (0.9–1.3)	12 (11.8%)	0.1 (0.1–0.2)
Trade/service area	90 (2.2%)	1.0 (0.9–1.3)	87 (96.7%)	1.0 (0.8–1.3)	3 (3.3%)	0.03 (0.01–0.1)
Other***	366 (8.7%)	4.3 (3.9–4.8)	340 (92.9%)	4.0 (3.6–4.5)	26 (7.1%)	0.3 (0.2–0.4)
Dominant injury type						
Blunt force	3,904 (93.26%)	46.1 (44.7–47.6)	3,704 (94.9%)	43.8 (42.4–45.2)	200 (5.1%)	2.4 (2.1–2.7)
Burn	64 (1.53%)	0.8 (0.6–1.0)	48 (75%)	0.6 (0.4–8)	16 (25.0%)	0.2 (0.1–0.3)
Penetrating	218 (5.21%)	2.6 (2.3–2.9)	199 (91.3%)	2.3 (2.0–2.6)	19 (8.7%)	0.2 (0.1–0.4)
Intent						
Unintentional	3,617 (86.4%)	42.7 (41.4–44.2)	3,426 (94.7%)	40.5 (39.2–41.9)	191 (5.3%)	2.3 (2.0–2.6)
Intentional	540 (12.9%)	6.4 (5.9–6.9)	503 (93.1%)	5.8 (5.4–6.4)	37 (6.9%)	0.43 (0.3–0.6)

CI = confidence interval.
*Pedestrian conveyances including and not limited to roller skates, skateboards, scooters, skis and ice skates.
**Other = animate mechanical forces (e.g., being bitten by a horse), inanimate mechanical forces (e.g., being crushed between objects, being struck by a falling object), injury by fire, smoke, forces of nature, electrocutions, injuries of undetermined intent, accidents while engaged in sport, accidental poisoning and accidents unspecified.
***Other = areas of water in a natural environment (e.g., lakes, rivers), residential institutions, schools and other educational institutions, public administration buildings and unspecified places of occurrence.

Table 3: Demographic profile by Injury Severity Score among 20–65-year-olds (1 July 2017 to 30 June 2020), n=4,186.

	Low (ISS 13–24) n (%)	**Medium (ISS 25–48) n (%)**	**High (ISS >49) n (%)**
Total	**3,158 (75.4%)**	**960 (22.9%)**	**68 (1.6%)**
Died	42 (17.9%)	156 (66.4%)	37 (15.7%)
Sex			
Female	724 (73.9%)	242 (24.7%)	14 (1.4%)
Male	2,434 (75.9%)	718 (22.4%)	54 (1.7%)
Ethnicity			
Māori	698 (71.0%)	255 (26.3%)	18 (2.8%)
Non-Māori	2,460 (76.5%)	705 (21.9%)	50 (1.6%)
Age group (in years)			
20–24	400 (73.1%)	138 (25.2%)	9 (1.6%)
25–29	385 (71.8%)	146 (27.2%)	5 (0.9%)
30–34	315 (72.2%)	111 (25.5%)	10 (2.3%)
35–39	236 (74.0%)	79 (24.8%)	4 (1.3%)
40–44	286 (74.1%)	89 (23.1%)	11 (2.8%)
45–49	332 (76.0%)	97 (22.2%)	8 (1.8%)
50–54	397 (81.0%)	90 (18.4%)	3 (0.6%)
55–59	416 (76.6%)	115 (21.2%)	12 (2.2%)
60–64	391 (79.5%)	95 (19.3%)	6 (1.2%)
Length of stay			
<1 day	99 (57.2%)	51 (29.5%)	23 (13.3%)
1–3 days	508 (83.8%)	94 (15.5%)	4 (0.7%)
4–7 days	755 (83.9%)	142 (15.8%)	3 (0.3%)
>7 days	1,478 (69.5%)	612 (28.8%)	37 (1.7%)
Mechanism of injury			
Transport incident	1,989 (76.8%)	559 (21.6%)	43 (1.6%)
Fall	569 (74.7%)	184 (24.1%)	9 (1.1%)
Assault	319 (75.4%)	101 (23.9%)	3 (0.7%)
Self-harm	65 (60.7%)	35 (32.7%)	7 (6.6%)

Table 3 (continued): Demographic profile by Injury Severity Score among 20–65-year-olds (1 July 2017 to 30 June 2020), n=4,186.

	Low (ISS 13–24) n (%)	**Medium (ISS 25–48) n (%)**	**High (ISS >49) n (%)**
Total	**3,158 (75.4%)**	**960 (22.9%)**	**68 (1.6%)**
Other*	216 (71.3%)	81 (26.7%)	6 (2.0%)
Dominant injury type			
Blunt force	2,983 (76.4%)	864 (22.1%)	57 (1.5%)
Burn	25 (39.1%)	31 (48.4%)	8 (12.5%)
Penetrating	150 (68.8%)	65 (29.8%)	3 (1.4%)

*Other = animate mechanical forces (e.g., being bitten by a horse), inanimate mechanical forces (e.g., being crushed between objects, being struck by a falling object), injury by fire, smoke, forces of nature, electrocutions, injuries of undetermined intent, accidents while engaged in sport, accidental poisoning and accidents unspecified.

a greater portion of Māori having injuries with medium and high ISS scores (28.3%) compared to non-Māori (23.3%). Overall, there was a significant difference in ISS score between Māori and non-Māori (Chi-squared p<0.01). There was also an association between age group and ISS score (Chi-squared p<0.01).

There was an association between injury severity and the dominant injury type (Fisher's exact test p<0.01) with high ISS scores having a larger portion of burn injuries than other score groups.

Of note, there was a decreased rate of major traumas in the first 6 months of 2020, which may potentially be linked to the COVID-19 pandemic and the related quarantine behaviours.[20] The rate of major traumas in January to June 2020 was 13.9 per 100,000 compared to 15.4 per 100,000 in the same period of 2019. Particularly noticeable was a decrease in April 2020, with 87 major traumas compared to 131 in April 2019.

Discussion

This study aimed to describe the patterns of major trauma among 20–65-year-olds in New Zealand based on analysis of routinely collected data. The excess risk of males compared to females was consistent across all age groups, ethnicity and injury causes. Younger and older age groups within the 20–65-year group also faced excess risk, but from different causes of injury. The findings have highlighted the excess injury risk Māori are exposed to compared to non-Māori, with significantly higher rates of major trauma, more severe trauma and higher mortality rates.

The strengths of this study include the use of population-level routinely collected data, with injury mechanism codes present for over 99% of patients. However, the findings need to be considered in light of several limitations. The absence of information about patient disability and other factors such as comorbidities that may place individuals at increased risk of injury/complicate the treatment of injuries was unable to be assessed. The aggregation of non-Māori ethnicity data into one group obscures the exploration of any trends that may be present in other ethnicities.[17] The NZTR records binary sex definitions but not gender identity, which restricts the investigation of patterns of major trauma among the LGBTQ+ community. This is a complicated problem for a number of reasons, with issues of privacy and transparency meaning that the collection of gender information in any healthcare context can be difficult,[21,22] and more so in an urgent care setting. Future efforts to integrate gender information into electronic health records may improve visibility of LGBTQ+ patients and enable future research into major trauma trends in this community.[23] Research into injury among people identifying as LGBTQ+

patients in New Zealand is required given emerging trends internationally.[24] Without the data on patient gender identity in New Zealand, emerging trends are difficult to identify. Giordano et al. suggests that in the context of traumatic brain injuries, binary sex definitions are not sufficient to guide clinical decisions and that a broader model of gender identity is essential in trauma care for the recovery of patients.[25] Our study looked at 20–65-year-olds, and therefore excluded younger adults or those over 65 years of age who may be working. This means that the study population falls short of encapsulating the full working-age population and cannot be used to describe this population. Additionally, we did not have data on whether the injuries were work-related, what the patient employment status was or blood alcohol levels. These are important potential areas for future study.

The findings of this study are consistent with findings from international studies. Cameron et al. examined the epidemiology of major trauma in Victoria, Australia, looking at 2,944 trauma admissions over a 1-year period from 1992–1993, where 1,076 of these cases were major trauma admissions with ISS scores greater than 15.[26] Cameron et al. found similar sex ratios, blunt force was the most common cause of major trauma accounting for 87.5% of injuries, and that streets/highways were the most common place of occurrence of major trauma, accounting for 56% of cases.[26] In the Cameron et al. study, 7.5% of the cases died, compared to 5.8% in the present study. However, the Cameron et al. study used ISS >15 to define major trauma,[26] whereas the present study used ISS >12. Previous research by Palmer et al., in an epidemiological study looking at 37,760 major trauma patients from the Victoria State Trauma Registry, found an ISS >12 functions similarly to an ISS >15 when mortality is a primary outcome.[27] The decreased rate of injuries in this population during the COVID-19 lockdown periods is consistent with other New Zealand and international studies that have noted declines in injury rates during the pandemic.[20]

The difference in trauma rates between Māori and non-Māori populations in this study mirrors international evidence of elevated trauma rates in Indigenous populations. In the present study, Māori had 1.67 times the rate of major trauma injuries resulting in hospitalisation compared to non-Māori. Similar findings have been found in Australia, the USA and Canada.[28–31] A study that jointly looked at routinely collected mortality data from the National Center of Health Statistics in the USA and the Australian Bureau of Statistics from 1990–1992 looked at 3,731 Native American and 540 Aboriginal injury-related deaths and compared them to non-Indigenous population injury death rates, finding that Indigenous people had approximately 2–3 times the injury mortality rates of the non-Indigenous populations of their countries.[28] An Australian descriptive analysis of hospitalisation data from the Health Outcomes Information and Statistical Toolkit (HOIST) database from 1999 to 2003 also showed that the Indigenous population had a higher rate of injury-related death across all ages younger than 65.[29] Additionally, compared to their non-Indigenous counterparts, Indigenous people aged 25–44 years were twice as likely to be hospitalised, and five times as likely to be hospitalised for assault. A 2004 study using hospital discharge data on injuries resulting in hospitalisation among First Nation communities (n=211,834) compared to non-First Nation communities (n=861,836) in Ontario reported a 2.5 times higher incidence rate of injury among First Nation communities.[30] Many of these studies cite factors such as socio-economic inequalities and pre-existing comorbidities resulting in elevated risk of injury, and risk of complications from injury resulting in poorer health outcomes.[28] Interventions to improve these disparities need to be culturally appropriate and target these underlying causes of injury by improving socio-economic disparities and inequities. Specific, targeted interventions have been used, for example, in Australia to reduce barriers to care for Indigenous women with violence-related head injuries.[31] More research into barriers to accessing hospital care is an important step towards reducing inequities in trauma rates.

Isles et al. analysed the first year of the NZTR data, which included 1,300 patient admissions from the North Island of New Zealand, and found similar findings to the present study in regard to the elevated incidence of major trauma among Māori, with a rate of 69 major traumas per 100,000 people among Māori of all ages (cf. 971/4,186 in the present study, where only 20–65 year olds were considered), and 31 per 100,000 in non-Māori.[8]

The pre-dominance of blunt trauma in the present study is consistent with the findings of a review of major trauma in Australasia that found 90% of major trauma in the general New Zealand population was a result of blunt-force trauma, slightly less than the 93% in this study, which

only looked at 20–65 year olds.[1] Cameron et al.[26] reported 56% of major traumas were road transport incidents, Isles et al.[8] reported 50%, while the present study was slightly higher at 61.4%.

Published literature highlights the prevalence of major trauma death prior to arrival at hospital. Lilley et al. examined 7,522 injury-related deaths that occurred in New Zealand between 2008 and 2012, and found that 80% of these deaths occurred in a pre-hospital setting.[32] The burden of pre-hospital deaths in the Lilley study was highest among males, and those aged 25–54 years, suggesting the current study will be an underestimation of the true burden of young adult injury, in particular among males.

Curtis et al. provides an in-depth discussion on the economic cost of injury, highlighting that injuries incur many indirect costs, such as the cost of time off work, loss of production, equipment damage and insurance costs.[1] These costs are not insignificant; in 2008 the estimated economic and social cost of injury in New Zealand was estimated to be NZ$6 billion a year.[33] Beyond these monetary costs, it is the much harder to measure human costs, such as loss of life, loss of health, disability and impacts on family structures.[1] Adults frequently perform caregiving roles for the older and younger generation, so injury in this population has a flow-on effect in a community setting—the impact of grief on families also leads to secondary healthcare interactions to deal with the repercussions on mental health.[1]

Given the pre-dominance of traffic-related injury in this study, continued research efforts into evidence-based prevention initiatives are required. New Zealand research by Hosking et al. highlighted that it is essential for road safety interventions to prioritise vulnerable groups, such as Māori and younger adults.[34] A systematic review by Bunn et al. showed that traffic calming measures such as speed bumps and lane separators had the potential to reduce road traffic injuries, especially in urban areas.[35] Interventions to reduce falls would also reduce major trauma injuries; 237 out of 589 fall injuries were caused by falls from buildings or from ladders and so may be preventable with safer infrastructure.

Conclusion

This study has highlighted the patterns of major trauma in the New Zealand among 20–65-year-olds. Injury occurred more commonly in males, Māori, and the younger and older people within the 20–65-year span. Future research is needed to investigate the patterns of major trauma among the working-age population in minority groups in New Zealand, including multivariate analyses to investigate the relationship between age, mechanism of injury and socio-economic status. The findings of this study confirm the necessity for continued injury prevention efforts in New Zealand, with a particular emphasis on developing initiatives for Māori by Māori.

COMPETING INTERESTS
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Rural–urban variation in the utilisation of publicly funded healthcare services: an age-stratified population-level observational study

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ABSTRACT

AIM: To compare age-stratified public health service utilisation in Aotearoa New Zealand across the rural–urban spectrum.

METHODS: Routinely collected hospitalisation, allied health, emergency department and specialist outpatient data (2014–2018), along with Census denominators, were used to calculate utilisation rates for residents in the two urban and three rural categories in the Geographic Classification for Health.

RESULTS: Relative to their urban peers, rural Māori and rural non-Māori had lower all-cause, cardiovascular, mental health and ambulatory sensitive (ASH) hospitalisation rates. The age-standardised ASH rate ratios (major cities as the reference, 95% CIs) across the three rural categories were for Māori 0.79 (0.78, 0.80), 0.83 (0.82, 0.85) and 0.80 (0.77, 0.83), and for non-Māori 0.87 (0.86, 0.88), 0.80 (0.78, 0.81) and 0.50 (0.47, 0.53). Residents of the most remote communities had the lowest rates of specialist outpatient and emergency department attendance, an effect that was accentuated for Māori. Allied health service utilisation by those in rural areas was higher than that seen in the major cities.

CONCLUSIONS: The large rural–urban variation in health service utilisation demonstrated here is previously unrecognised and in contrast to comparable international data. New Zealand's most remote communities have the lowest rates of health service utilisation despite high amenable mortality rates. This raises questions about geographic equity in health service design and delivery and warrants further in-depth research.

In Aotearoa New Zealand, it is possible to monitor geographic variation in secondary health service utilisation due to the presence of a unique identifier for every health service user, well-maintained national administrative health datasets and a single public healthcare system. Contemporary monitoring has included "bench marking" the performance of the country's 20 district health boards (DHBs).[1] Regional disparities in the range and quality of health services that were identified have been termed a "postcode lottery" and were an important driver of the current health system reforms.[2] Despite the possibility that even greater variation may exist between urban and rural areas (either within a DHB or at a national level), few rural–urban analyses have been undertaken.

The evidence that does exist is contradictory. The NZ Health Survey 2002/2003, which used self-reported data from approximately 13,000 respondents, failed to demonstrate significant rural–urban differences in hospitalisation rates or access to a medical specialist.[3] In contrast, the *Rural Health: Challenges of Distance, Opportunities for Innovation* report published by the National Health Committee in 2010 used Mānatu Hauora – Ministry of Health administrative datasets and reported age-adjusted utilisation rates that were higher for rural than urban dwellers: outpatient services (11% higher), emergency department (ED) visits (20% higher) and public hospital use (excluding ED) (20% higher).[4] There is some evidence of lower rural utilisation rates for individual services at a regional level; for example, CT scanning in the Southern Region.[5]

A rural–urban classification designed specifically for use in health research and policy in New Zealand, the Geographic Classification for Health (GCH), was published in August 2022.[6] The GCH taxonomy comprises two urban categories, major urban centres (U1) and regional cities (U2), and three rural categories (R1, R2 and R3) that denote increasing rurality and remoteness. The GCH has "unmasked" rural–urban differences in

health outcomes that were obscured when other rural–urban classifications were used.[7] Mortality disparities identified by the GCH differ considerably across age bands, with younger rural residents having higher mortality rates than their urban peers, but older rural residents having mortality rates similar to or slightly lower than their urban peers.[8] Rural Māori have consistently poorer health outcomes than rural non-Māori, frequently exceeding the ethnic inequities observed in the urban context.[9]

In June 2022, New Zealand's parliament passed into law the *Pae Ora (Healthy Futures) Bill*.[10] After intense pressure from the rural health sector, the legislation was altered at its final reading to include provision for a Rural Health Strategy, which was subsequently released in July 2023.[11] The Strategy is a high-level document that will give rise to specific rural health policy and plans in the coming years. Accurate data on rural–urban variation in health service utilisation is now needed to provide an evidence base for this policy and health service planning.

The objective of this paper is to compare age-standardised and age-stratified utilisation rates across broad categories of publicly funded health services to identify areas of significant rural–urban health service variation that warrant further detailed examination.

Methods

This population-level observational study used deidentified routinely collected data from two New Zealand government agencies: Manatū Hauora – Ministry of Health and Statistics New Zealand (Stats NZ).

Numerators

Extracts of two administrative data collections were obtained from Manatū Hauora – Ministry of Health. This included data for 2015–2019 from the National Minimum Dataset (NMDS) of hospital discharges and the National Non-Admitted Patient Collection (NNPAC) of outpatient and ED attendances. Both datasets included the person's age at time of event, sex, ethnicity (Māori or non-Māori) and domicile (geographical unit representing the area encompassing their residential address, approximately 2,000 residents in each). Outcome measures derived from the NMDS were all-cause hospitalisations as well as cardiovascular (CVD), cancer, injury, mental and behavioural disorders and ambulatory sensitive hospitalisations (ASH). ASH are defined as hospitalisations of people less than 75 years of age "*resulting from diseases sensitive to prophylactic or therapeutic interventions that are deliverable in a primary healthcare setting*".[12] Rural patients are frequently transferred between institutions in order to access appropriate specialist care. This can result in the "overcounting" of rural events. To account for this, contemporaneous admissions for an individual were grouped as part of a single continuous episode of care.[13] Outcome measures derived from NNPAC were all specialist outpatient and ED attendances, and allied health outpatient events. The Allied Health indicator comprised of all NNPAC events with allied health purchase units, with the exclusion of community radiology. The service descriptions and their frequencies are presented in Appendix Table 1.

Age was categorised as follows: 0–29, 30–44, 45–59, 60–74 or 75+ years. Ethnicity was categorised as Māori or non-Māori. If any of the ethnicities recorded were Māori, the individual was classified was Māori.

Denominators

Census usually resident population counts for 2013 and 2018, aggregated, simultaneously, by age, sex, ethnicity and rurality, were obtained from Stats NZ. Age was obtained in 15-year bands. Census ethnicity was categorised as "Māori" or "non-Māori" using the same process used for the Manatū Hauora – Ministry of Health data. Annual estimates for 2015–2019 in each of the combinations of these variables (age [5], ethnicity [2] and rurality [5]) were obtained from linear interpolation of the Census 2013 and Census 2018 counts. Total person-years for each of the combinations was obtained from these annual estimates.

Rural–urban status

Rural and urban areas were defined according to the recently published five-level Geographic Classification for Health (GCH).[14] Using the domicile concordance file, the relevant GCH category was assigned to each individual's domicile code.[15]

Statistical analysis

In order to combine the numerator and denominator datasets, the person-level numerator dataset was collapsed, with counts of each outcome produced for each combination of the age (5), ethnicity (2) and rurality (5) categories (50 rows).

Crude rates were calculated separately for the total population, Māori and non-Māori for the age-strata within each of the outcome variables, per 100,000 person-years for the 6 NMDS outcomes and per 1,000 person-years for the 3 NNPAC outcomes. Incidence rate ratios (IRRs) and 95% Confidence intervals (CIs) per age group and outcome were calculated using Poisson regression and represent the ratio of the incidence rate in one of the GCH categories (U2, R1, R2, R3) divided by the incidence rate in U1 (reference category). For each outcome an overall age-standardised rate was calculated; the 2001 Census Māori population was used as the standard population for these directly standardised rates.

Data were prepared using SAS software version 9.4 for Linux.[16] Analysis was undertaken using Stata/SE v17.[17] Figures were produced using R.[18]

Results

There was an average of 1,079,000 all-cause hospitalisations per year for the period 2015–2019; 61% of hospitalisations were for residents of U1 (major cities), 20% were for U2 residents and 12%, 5% and 1% were for R1, R2 and R3 residents respectively. Of the 6.3 million specialist appointments per year, 56% were for U1 residents and 23%, 14%, 6% and 1% for U2, R1, R2 and R3 residents respectively. There were on average, 705,000 ED attendances per year, of which 53%, 26%, 13%, 7% and 1% were for U1, U2, R1, R2 and R3 residents respectively. Allied Health events were less likely to be for U1 residents; of the 980,000 per year, 41% were for U1 residents, 36% were for U2 residents and 14%, 8% and 1% were for R1, R2 and R3 residents respectively.

Age-standardised and age-stratified hospitalisation rates for each GCH category are presented separately for Māori (Appendix Table 2), non-Māori (Appendix Table 3) and for the total New Zealand population (Appendix Table 4). Age-standardised hospitalisation incidence rate ratios (IRRs) with U1 as the reference are presented in Figure 1. Results for non-admitted patient events are presented in the same format in Appendix Table 5, Appendix Table 6 and Figure 2.

For Māori, all-cause hospitalisation rates were highest for those living in U2 areas (regional centres), with the exception of 60+ years, where U1 and U2 rates were the same (Appendix Table 2). Māori all-cause hospitalisation rates for all rural strata were lower than the equivalent age-specific urban strata, the exception being R3 residents aged 75+ years, where all-cause hospitalisations were the same as those in the urban categories. A very similar pattern of lower rural hospitalisation rates was observed for non-Māori, with the exception of the 15–29-year-old age group in the R1 and R2 categories where the rates were higher than U1 but less than U2 (Appendix Table 3).

When the New Zealand population was considered as a whole, a clear gradient of reducing all-cause hospitalisation across the rural categories became apparent. Using U1 as the reference, within each age strata the rate for R2 residents was lower than R1, and the R3 rate lower again (Appendix Table 2). The rate for U2 residents was, however, 5% higher than for U1. Based on these data, if rural residents (R1, R2 and R3) had experienced the same crude rate of all-cause hospitalisation as those living in the cities (U1 and U2), the total number of hospitalisations nationwide would have risen by an average of 5,191 per year (or 0.5%).

Māori CVD hospitalisation rates for rural residents were lower than for U1 residents for 15/18 of the age by GCH combinations (6 age groups x 3 rural categories). At times the difference was large; for example, residents of R3 aged 60–74 years were 27% less likely (20% -33%) to have a CVD hospitalised episode of care than U1 residents of the same age. A similar pattern was observed for non-Māori.

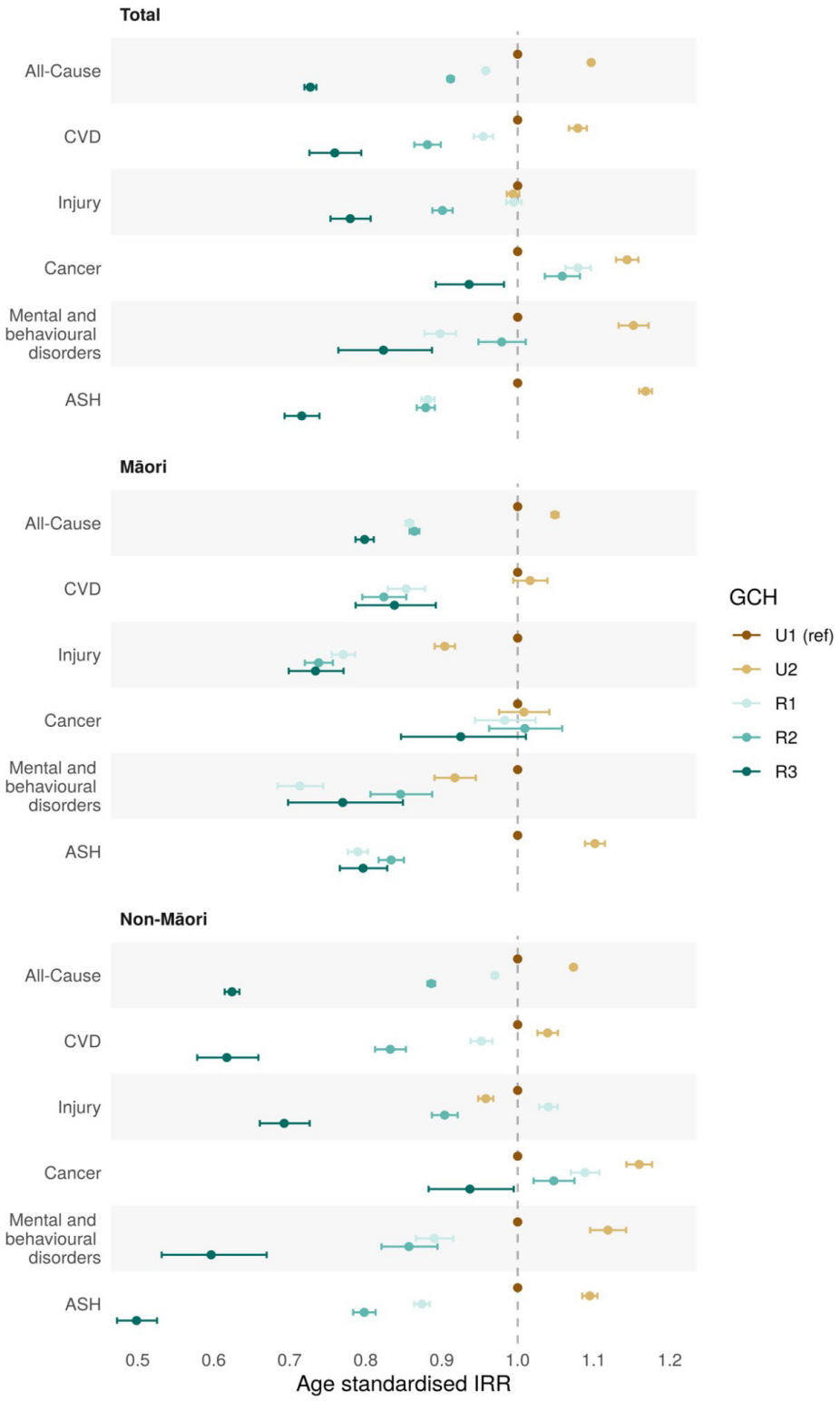
Māori living outside the major cities (U2 and R1–R3) had lower injury-related hospitalisation rates. A slightly different pattern was observed for non-Māori aged 15–44 years, who for those living in U2, R1 and R2 (but not R3) had injury-related rates of hospitalised episodes of care that were similar to or higher than the U1 rates.

For Māori and non-Māori there was no clear pattern of rural–urban variation in cancer hospitalisations, with the possible exception of the lower rural rates in the paediatric (0–14 year) population.

Rates of mental health and behavioural disorder hospitalised episodes of care were lower overall in the rural categories for both Māori and non-Māori. The overall age-adjusted rates for rural Māori, relative to U1 Māori, were estimated to be 0.71 (R1), 0.85 (R2) and 0.77 (R3).

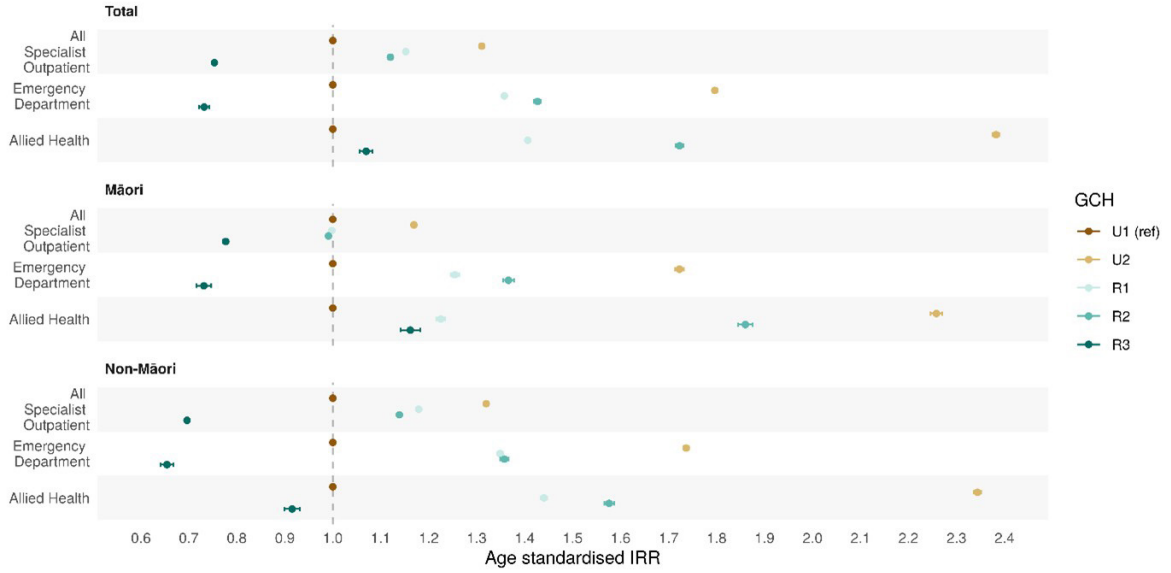
Ambulatory sensitive hospitalisation (ASH) rates for Māori across all rural strata were lower than U1 with IRRs that are consistently less than 0.9. In contrast, ASH rates for Māori living in U2 were at least 6% higher than the rates for Māori U1 residents. Non-Māori exhibit the same pattern

Figure 1: New Zealand total population, Māori and non-Māori, age-standardised hospitalised episodes of care incidence rate ratios by GCH category (IRRs; using U1 as reference).



ASH = Ambulatory Sensitive Hospitalisations. GCH = Geographic Classification for Health

Figure 2: New Zealand total population, Māori and non-Māori, age-standardised outpatient event rate ratios by GCH category (IRRs; using U1 as reference).



GCH = Geographic Classification for Health

with the exception of two strata (U2 10–14 years and R1 15–29 years) where the ASH rate was estimated to be similar to that of U1 residents. For non-Māori, a strong gradient of declining ASH rates across the GCH spectrum from U2 to R3 was evident. For each age strata, the rate for R3 residents was lower than for R2, R2 lower than R1, and R1 lower than U2. For example, in those aged 45–59 years the U2 to R3 IRRs were 1.09 (U2), 0.84 (R1), 0.76 (R2) and 0.43 (R3) respectively.

Residents of U2 communities had the highest utilisation rates for all three categories of non-admitted events, both for Māori and non-Māori. In some circumstances the rate for residents of U2 was triple that for U1 residents; Allied Health service utilisation in the 75+ year-old age group was one example of this. ED utilisation is also much higher for U2 residents, particularly in the 15–29-year-old strata where the IRR for Māori is 1.73 and for non-Māori 2.03.

Residents of R3 communities had the lowest rates of specialist outpatient and ED utilisation, with disparities most apparent in the middle years of life. Examples include the ED IRR for Māori aged between 30 and 59 years of 0.64 and the specialist outpatient IRR for non-Māori aged 45–79 years of 0.59, both compared to the respective rate for U1 residents. Non-Māori in R1 and R2 communities had specialist outpatient utilisation rates that were overall slightly higher than those in U1 but lower than those in U2. On the other hand, Māori aged 30–74 years in these communities had rates that were lower than respective age-strata for U1 Māori. For example, the IRR for 60–74-year-old R1 Māori is 0.90 compared to 60–74-year-old U1 Māori. Residents of R1 and R2 communities had ED utilisation rates that were consistently higher than U1 but lower than U2. The largest differences were seen for 15–29-year-old non-Māori living in R1 and R3 and >75-year-old Māori in R2; IRRs are 1.66, 1.63 and 1.83 respectively.

The utilisation of Allied Health services by residents in R1 and R2 areas were consistently higher than in U1 communities and in some instances approximated the U2 rate. As an example, Māori aged 15–29 years in R2 had a utilisation rate three times higher than U1 (2.99; CI 2.94–3.05); in comparison, the U2:U1 IRR for Māori of the same age group was 2.62 (CI 2.60–2.64).

Discussion

This study identified considerable variation in the rates of publicly funded health service utilisation across the New Zealand rural–urban spectrum. Regional centres (U2) had, overall, the highest hospitalisation rates, and rural areas the lowest. This was most evident for all-cause hospitalisations and ASH where, for non-Māori, clear gradients of declining rates of hospitalised

episodes of care with increasing rurality were apparent. ASH rates for some age strata in R3 communities were less than half the comparable U1 rates. Mental health, CVD and injury-related hospitalisation rates are also lower for residents of rural areas compared to U1 areas for the majority of strata, with cancer-related admissions proving an exception. Rates of non-admitted events were consistently higher for residents in U2 areas compared to U1 and all three rural categories. R3 communities had the lowest rates of specialist outpatient and ED utilisation. The pattern was more complex for R1 and R2 communities, where ED attendance was higher than that seen in U1, but for Māori, at least in the middle years of life, specialist outpatient attendance was lower. Allied Health service utilisation in rural areas was higher than in U1 but less than U2. No consistent pattern of variation was evident across the age strata within GCH categories.

The strengths of this study include the use of a fit-for-purpose geographic classification and the recency of the available data. Primary care utilisation data is a crucial piece of the puzzle, and its absence is a major limitation of this study. The utilisation of all the services considered in this study will be influenced by access to, and the quality of, primary care. Improved primary care data collection should be a priority for the new unified health system. It is the experience of rural health professionals that patients move between urban and rural areas, and between rural areas, in response to age and illness. Since the GCH category used was obtained from patients' addresses at the time the healthcare event occurred, this may go some way to explaining the variation in healthcare utilisation observed.[8] This migration and its effect on health data along with primary care utilisation will be the subject of research planned for the near future.[24] Possible differences in coding practice between rural and urban hospitals may also impact these rural–urban analyses.

The findings of lower rural hospitalisation rates in this study are consistent with one other New Zealand-based study that noted an association between proximity to care and higher ASH rates for children,[19] but stand in contrast to wider existing New Zealand (that report similar or higher rural rates)[3,4] and international literature (that report higher rural rates). Potentially preventable hospitalisation (PPH) rates, a similar measure to ASH, are between 1.8 and 2.6 times higher in rural and remote Australia than those seen in major cities.[20, 21] In line with our findings and older New Zealand data, rural resident ED attendance exceeds the urban rates in Australia; something that, along with the higher PPH rates has been attributed to poor access to acute primary care for rural Australians.[22] Canadian rural hospitalisation and ED rates mirror those seen in Australia.[23] In addition, rural Canadians have lower rates of specialist outpatient attendance.

Considerable care needs to be taken when interpreting these results from a policy perspective. For example, it should not be assumed that the lower rural ASH rates are indicative of access to quality primary and preventive care or healthier rural communities. These rural communities have New Zealand's highest amenable mortality rates.[8] Low ASH rates in this context are more likely to reflect a complex interaction of need, rural models of healthcare delivery and access, and may in part be a consequence of the widespread closure of rural hospital beds that occurred during previous health reforms.[25] Equally, the differences in access to Allied Health and specialist outpatient services need further in-depth research in order to understand the causes of the differences, and their implications for policy and service delivery. The high rural:urban mortality rate ratios for the younger age strata[8] were not matched with higher rates of health service utilisation in this study. This is unexpected and suggests that hospitalisation rates may not be reliable indicators of morbidity in the New Zealand rural context. Other health systems factors that differ between rural and urban areas may be impacting hospitalisation rates. Examples include the structure of the workforce, with a high proportion of locums and international medical graduates in rural areas, and the availability and uptake of private healthcare.[26,27]

Until recently, many rural communities shared a DHB with their nearest regional city (U2). The magnitude of the disparities identified in this study are at their greatest when U2 and rural communities are compared. This suggests that greater attention could have been paid to monitoring rural–urban variation within DHBs, rather than focussing on differences between DHBs. Variation in the utilisation of health services between neighbouring rural and urban communities may be larger than the variation between DHBs, and as such a greater example of "postcode lottery".

The R3 category, which covers 39% of New Zealand's land area but only 1% of the total population, is home to some of our most vulnerable

communities. It has the highest proportion of Māori (33%), and the highest proportion of residents living in the most deprived New Zealand Index of Deprivation (*NZDep*) quintile (Māori 73%, non-Māori 39%).[28,9] There is evidence that the Māori:non-Māori health outcome "equity gap" is greater in rural areas.[9] An association between rurality and higher amenable mortality rates (an effect more pronounced in younger age strata, for Māori and for more remote communities) has previously been demonstrated.[8] This study adds evidence of lower levels of actualised access to secondary care, either as inpatients or specialist outpatient clinics, for the same populations, and in doing so also raises questions about geographic equity in health service design and delivery.

This study has demonstrated large, and previously unrecognised, rural–urban differences in public health service utilisation in New Zealand. These differences are in marked contrast to those seen in comparable countries and warrant further exploration. New Zealand's new unitary health-care system and rural health strategy has created an opportunity to address any health disadvantage for rural communities that may be occurring as a result of these differences in health service utilisation.

COMPETING INTERESTS
The authors have no conflicts of interest to report.

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Appendices

Appendix Table 1: Distribution of events extracted from the National Non-Admitted Patient Collection (2015–2019) and included in the Allied Health Indicator.

Purchase unit description	Frequency	Percent
Dietetics	96,575	11.6
Occupational therapy	131,529	15.8
Optometrist clinic	14,004	1.7
Orthoptist	28,625	3.5
Physiotherapy	407,291	49.0
Podiatry	35,553	4.3
Prosthetic eyes	369	<1
Prosthetic services	436	<1
Psychologist services—non mental health	21,721	2.6
Social work	55,463	6.7
Speech therapy	38,909	4.7

Appendix Table 2: Māori population: frequencies and rates of hospitalised episodes of care for 2015–2019 (IR; per 100k person-years) and incidence rate ratios (IRRs; U1=ref) by GCH category.

Episodes of care	U1 (Ref.)		U2				R1				R2				R3			
	n	IR	n	IR	IRR	95% CI	n	IR	IRR	95% CI	n	IR	IRR	95% CI	n	IR	IRR	95% CI
All Cause																		
Overall*	439,520	23,145	243,489	24,279	1.05	(1.04 , 1.05)	110,979	19,846	0.86	(0.86 , 0.87)	73,328	19,862	0.86	(0.86 , 0.87)	19,172	18,210	0.79	(0.79 , 0.81)
0–14 years	114,542	19,688	64,909	20,854	1.06	(1.05 , 1.07)	28,290	16,531	0.84	(0.83 , 0.85)	18,362	17,078	0.87	(0.85 , 0.88)	3,983	15,536	0.79	(0.76 , 0.81)
15–29 years	104,961	21,532	53,302	23,529	1.09	(1.08 , 1.10)	23,446	20,313	0.94	(0.93 , 0.96)	14,129	19,948	0.93	(0.91 , 0.94)	2,842	17,635	0.82	(0.79 , 0.85)
30–44 years	73,867	22,657	37,867	23,194	1.02	(1.01 , 1.04)	16,110	18,691	0.82	(0.81 , 0.84)	10,009	18,739	0.83	(0.81 , 0.84)	2,249	17,540	0.77	(0.74 , 0.81)
45–59 years	73,529	26,395	40,276	27,078	1.03	(1.01 , 1.04)	18,676	21,392	0.81	(0.80 , 0.82)	12,588	21,572	0.82	(0.80 , 0.83)	3,729	20,968	0.79	(0.77 , 0.82)
60–74 years	53,590	45,125	33,393	45,237	1.00	(0.99 , 1.02)	17,201	37,421	0.83	(0.82 , 0.84)	12,690	37,920	0.84	(0.82 , 0.86)	4,219	35,451	0.79	(0.76 , 0.81)
75+ years	19,031	69,741	13,742	70,407	1.01	(0.99 , 1.03)	7,256	62,065	0.89	(0.87 , 0.91)	5,550	60,755	0.87	(0.85 , 0.90)	2,150	68,778	0.99	(0.94 , 1.03)
CVD																		
Overall*	22,295	955	13,131	953	1.02	(0.99 , 1.04)	6,590	794	0.85	(0.83 , 0.88)	4,369	786	0.82	0.80, 0.85)	1,437	800	0.84	(0.79 , 0.89)
0–14 years	882	152	542	174	1.15	(1.03 , 1.28)	177	103	0.68	(0.58 , 0.80)	145	135	0.89	(0.75 , 1.06)	28	109	0.72	(0.49 , 1.05)
15–29 years	1,123	230	504	222	0.97	(0.87 , 1.07)	200	173	0.75	(0.65 , 0.87)	122	172	0.75	(0.62 , 0.90)	23	143	0.62	(0.41 , 0.94)
30–44 years	2,446	750	1,242	761	1.01	(0.95 , 1.09)	589	683	0.91	(0.83 , 1.00)	370	693	0.92	(0.83 , 1.03)	95	741	0.99	(0.80 , 1.21)
45–59 years	7,143	2,564	3,991	2,683	1.05	(1.01 , 1.09)	1,933	2,214	0.86	(0.82 , 0.91)	1,256	2,152	0.84	(0.79 , 0.89)	418	2,350	0.92	(0.83 , 1.01)
60–74 years	7,539	6,348	4,584	6,210	0.98	(0.94 , 1.01)	2,496	5,430	0.86	(0.82 , 0.89)	1,629	4,868	0.77	(0.73 , 0.81)	553	4,647	0.73	(0.67 , 0.80)
75+ years	3,162	11,588	2,268	11,620	1.00	(0.95 , 1.06)	1,195	10,222	0.88	(0.83 , 0.94)	847	9,272	0.80	(0.74 , 0.86)	320	10,237	0.88	(0.79 , 0.99)
Injury																		
Overall*	56,228	3,026	25,942	2,735	0.90	(0.89 , 0.92)	12,006	2,331	0.77	(0.76 , 0.79)	7,375	2,233	0.74	(0.72 , 0.76)	1,922	2,113	0.73	(0.70 , 0.77)
0–14 years	13,477	2,316	6,335	2,035	0.88	(0.85 , 0.91)	2,896	1,692	0.73	(0.70 , 0.76)	1,730	1,609	0.69	(0.66 , 0.73)	417	1,626	0.70	(0.64 , 0.77)
15–29 years	19,034	3,905	8,597	3,795	0.97	(0.95 , 1.00)	3,980	3,448	0.88	(0.85 , 0.91)	2,324	3,281	0.84	(0.80 , 0.88)	498	3,090	0.79	(0.72 , 0.87)
30–44 years	10,372	3,181	4,712	2,886	0.91	(0.88 , 0.94)	2,027	2,352	0.74	(0.70 , 0.78)	1,211	2,267	0.71	(0.67 , 0.76)	304	2,371	0.75	(0.66 , 0.84)
45–59 years	7,670	2,753	3,501	2,354	0.85	(0.82 , 0.89)	1,632	1,869	0.68	(0.64 , 0.72)	1,099	1,883	0.68	(0.64 , 0.73)	357	2,007	0.73	(0.66 , 0.81)
60–74 years	3,823	3,219	1,780	2,411	0.75	(0.71 , 0.79)	925	2,012	0.63	(0.58 , 0.67)	669	1,999	0.62	(0.57 , 0.67)	199	1,672	0.52	(0.45 , 0.60)
75+ years	1,852	6,787	1,017	5,211	0.77	(0.71 , 0.83)	546	4,670	0.69	(0.63 , 0.76)	342	3,744	0.55	(0.49 , 0.62)	147	4,702	0.69	(0.59 , 0.82)
Cancer																		
Overall*	10,368	453	6,062	457	1.01	(0.98 , 1.04)	3,476	445	0.98	(0.94 , 1.02)	2,434	457	1.01	(0.96 , 1.06)	739	419	0.93	(0.85 , 1.01)
0–14 years	745	128	319	102	0.80	(0.70 , 0.91)	181	106	0.83	(0.70 , 0.97)	116	108	0.84	(0.69 , 1.02)	12	47	0.37	(0.21 , 0.65)
15–29 years	492	101	234	103	1.02	(0.88 , 1.20)	155	134	1.33	(1.11 , 1.59)	86	121	1.20	(0.96 , 1.51)	7	43	0.43	(0.20 , 0.91)
30–44 years	1,074	329	562	344	1.04	(0.94 , 1.16)	269	312	0.95	(0.83 , 1.08)	187	350	1.06	(0.91 , 1.24)	62	484	1.47	(1.14 , 1.90)
45–59 years	3,352	1,203	1,864	1,253	1.04	(0.98 , 1.10)	1,046	1,198	1.00	(0.93 , 1.07)	775	1,328	1.10	(1.02 , 1.19)	188	1,057	0.88	(0.76 , 1.02)
60–74 years	3,606	3,036	2,324	3,148	1.04	(0.98 , 1.09)	1,379	3,000	0.99	(0.93 , 1.05)	1,003	2,997	0.99	(0.92 , 1.06)	357	3,000	0.99	(0.89 , 1.10)
75+ years	1,099	4,027	759	3,889	0.97	(0.88 , 1.06)	446	3,815	0.95	(0.85 , 1.06)	267	2,923	0.73	(0.63 , 0.83)	113	3,615	0.90	(0.74 , 1.09)
Mental and behavioural disorders																		
Overall*	14,246	749	6,645	687	0.92	(0.89 , 0.94)	2,752	535	0.71	(0.68 , 0.74)	2,048	634	0.85	(0.81 , 0.89)	474	577	0.77	(0.70 , 0.85)
0–14 years	512	88	210	67	0.77	(0.65 , 0.90)	91	53	0.60	(0.48 , 0.76)	79	73	0.83	(0.66 , 1.06)	12	47	0.53	(0.30 , 0.94)
15–29 years	5,848	1,200	2,645	1,168	0.97	(0.93 , 1.02)	1,196	1,036	0.86	(0.81 , 0.92)	763	1,077	0.90	(0.83 , 0.97)	197	1,222	1.02	(0.88 , 1.17)
30–44 years	4,261	1,307	1,799	1,102	0.84	(0.80 , 0.89)	698	810	0.62	(0.57 , 0.67)	596	1,116	0.85	(0.78 , 0.93)	97	757	0.58	(0.47 , 0.71)
45–59 years	2,441	876	1,371	922	1.05	(0.98 , 1.12)	433	496	0.57	(0.51 , 0.63)	391	670	0.76	(0.69 , 0.85)	128	720	0.82	(0.69 , 0.98)
60–74 years	900	758	459	622	0.82	(0.73 , 0.92)	195	424	0.56	(0.48 , 0.65)	163	487	0.64	(0.54 , 0.76)	30	252	0.33	(0.23 , 0.48)
75+ years	284	1,041	161	825	0.79	(0.65 , 0.96)	139	1,189	1.14	(0.93 , 1.40)	56	613	0.59	(0.44 , 0.78)	10	320	0.31	(0.16 , 0.58)
ASH																		
Overall*	74,458	4,024	43,390	4,433	1.10	(1.09 , 1.11)	17,499	3,177	0.79	(0.78 , 0.80)	11,934	3,354	0.83	(0.82 , 0.85)	3,153	3,205	0.80	(0.77 , 0.83)
0–14 years	25,607	4,401	15,144	4,865	1.11	(1.08 , 1.13)	6,217	3,633	0.83	(0.80 , 0.85)	4,202	3,908	0.89	(0.86 , 0.92)	1,003	3,912	0.89	(0.83 , 0.95)
15–29 years	12,664	2,598	6,650	2,935	1.13	(1.10 , 1.16)	2,328	2,017	0.78	(0.74 , 0.81)	1,351	1,907	0.73	(0.69 , 0.78)	299	1,855	0.71	(0.64 , 0.80)
30–44 years	10,558	3,238	5,822	3,566	1.10	(1.07 , 1.14)	2,049	2,377	0.73	(0.70 , 0.77)	1,469	2,749	0.85	(0.80 , 0.90)	289	2,250	0.69	(0.62 , 0.78)
45–59 years	14,570	5,230	8,479	5,700	1.09	(1.06 , 1.12)	3,446	3,947	0.75	(0.73 , 0.78)	2,472	4,235	0.81	(0.78 , 0.85)	716	4,023	0.77	(0.71 , 0.83)
60–74 years	11,060	9,313	7,296	9,884	1.06	(1.03 , 1.09)	3,459	7,525	0.81	(0.78 , 0.84)	2,441	7,294	0.78	(0.75 , 0.82)	847	7,113	0.76	(0.71 , 0.82)

*For "Overall", age standardised rates and age-standardised IRRs are presented; these were calculated using the 2001 Census Māori population as the standard population.

Appendix Table 3: Non-Māori population: frequencies and rates of hospitalised episodes of care for 2015–2019 (IR; per 100k person-years) and incidence rate ratios (IRRs; U1=ref) by GCH category.

Episodes of care	U1 (Ref.)		U2				R1				R2				R3			
	n	IR	n	IR	IRR	95% CI	n	IR	IRR	95% CI	n	IR	IRR	95% CI	n	IR	IRR	95% CI
All Cause																		
Overall*	2,847,980	18,932	860,367	20,323	1.07	(1.07 , 1.08)	547,875	18,367	0.97	(0.97 , 0.97)	######	16,781	0.89	(0.88 , 0.89)	29,494	11,815	0.62	(0.61 , 0.63)
0–14 years	459,393	20,284	102,139	19,152	0.94	(0.94 , 0.95)	65,926	17,411	0.86	(0.85 , 0.87)	24,193	15,618	0.77	(0.76 , 0.78)	3,323	11,248	0.55	(0.54 , 0.57)
15–29 years	407,098	14,719	102,155	19,481	1.32	(1.31 , 1.33)	60,169	18,020	1.22	(1.21 , 1.23)	21,510	16,332	1.11	(1.09 , 1.12)	2,789	10,881	0.74	(0.71 , 0.77)
30–44 years	458,893	17,236	105,141	18,856	1.09	(1.09 , 1.10)	65,082	16,740	0.97	(0.96 , 0.98)	24,432	15,208	0.88	(0.87 , 0.89)	3,426	10,532	0.61	(0.59 , 0.63)
45–59 years	445,332	17,581	134,034	19,400	1.10	(1.10 , 1.11)	86,862	16,955	0.96	(0.96 , 0.97)	35,318	16,084	0.91	(0.90 , 0.92)	5,127	11,412	0.65	(0.63 , 0.67)
60–74 years	540,749	32,201	199,029	33,564	1.04	(1.04 , 1.05)	135,706	29,860	0.93	(0.92 , 0.93)	62,505	28,586	0.89	(0.88 , 0.90)	9,086	21,151	0.66	(0.64 , 0.67)
75+ years	536,515	68,557	217,869	70,357	1.03	(1.02 , 1.03)	134,130	64,367	0.94	(0.93 , 0.94)	54,796	62,574	0.91	(0.90 , 0.92)	5,743	48,624	0.71	(0.69 , 0.73)
CVD																		
Overall*	196,214	611	69,965	635	1.04	(1.03 , 1.05)	47,452	582	0.95	(0.94 , 0.97)	18,049	509	0.83	(0.81 , 0.85)	2,323	377	0.62	(0.58 , 0.66)
0–14 years	3,555	157	806	151	0.96	(0.89 , 1.04)	459	121	0.77	(0.70 , 0.85)	174	112	0.72	(0.61 , 0.83)	35	118	0.75	(0.54 , 1.05)
15–29 years	5,277	191	1,041	199	1.04	(0.97 , 1.11)	617	185	0.97	(0.89 , 1.05)	222	169	0.88	(0.77 , 1.01)	41	160	0.84	(0.62 , 1.14)
30–44 years	11,796	443	2,572	461	1.04	(1.00 , 1.09)	1,577	406	0.92	(0.87 , 0.96)	561	349	0.79	(0.72 , 0.86)	61	188	0.42	(0.33 , 0.54)
45–59 years	33,999	1,342	9,627	1,393	1.04	(1.01 , 1.06)	6,636	1,295	0.97	(0.94 , 0.99)	2,496	1,137	0.85	(0.81 , 0.88)	318	708	0.53	(0.47 , 0.59)
60–74 years	62,575	3,726	23,604	3,981	1.07	(1.05 , 1.08)	16,602	3,653	0.98	(0.96 , 1.00)	6,941	3,174	0.85	(0.83 , 0.87)	1,049	2,442	0.66	(0.62 , 0.70)
75+ years	79,012	10,096	32,315	10,436	1.03	(1.02 , 1.05)	21,561	10,347	1.02	(1.01 , 1.04)	7,655	8,742	0.87	(0.85 , 0.89)	819	6,934	0.69	(0.64 , 0.74)
Injury																		
Overall*	316,451	2,091	77,657	2,003	0.96	(0.95 , 0.97)	55,772	2,175	1.04	(1.03 , 1.05)	21,269	1,890	0.90	(0.89 , 0.92)	3,044	1,449	0.69	(0.66 , 0.73)
0–14 years	45,426	2,006	8,943	1,677	0.84	(0.82 , 0.86)	6,782	1,791	0.89	(0.87 , 0.92)	2,241	1,447	0.72	(0.69 , 0.75)	326	1,103	0.55	(0.49 , 0.61)
15–29 years	66,270	2,396	14,231	2,714	1.13	(1.11 , 1.15)	10,285	3,080	1.29	(1.26 , 1.31)	3,666	2,783	1.16	(1.12 , 1.20)	513	2,001	0.84	(0.77 , 0.91)
30–44 years	43,102	1,619	9,352	1,677	1.04	(1.01 , 1.06)	7,165	1,843	1.14	(1.11 , 1.17)	2,563	1,595	0.99	(0.95 , 1.03)	426	1,310	0.81	(0.74 , 0.89)
45–59 years	46,306	1,828	11,740	1,699	0.93	(0.91 , 0.95)	9,131	1,782	0.97	(0.95 , 1.00)	3,551	1,617	0.88	(0.85 , 0.92)	612	1,362	0.75	(0.69 , 0.81)
60–74 years	42,285	2,518	12,376	2,087	0.83	(0.81 , 0.85)	9,309	2,048	0.81	(0.80 , 0.83)	4,068	1,860	0.74	(0.72 , 0.76)	659	1,534	0.61	(0.56 , 0.66)
75+ years	73,062	9,336	21,015	6,786	0.73	(0.72 , 0.74)	13,100	6,287	0.67	(0.66 , 0.69)	5,180	5,915	0.63	(0.62 , 0.65)	508	4,301	0.46	(0.42 , 0.50)
Cancer																		
Overall*	136,285	418	53,322	485	1.16	(1.14 , 1.18)	35,841	455	1.09	(1.07 , 1.11)	15,494	438	1.05	(1.02 , 1.07)	2,424	392	0.94	(0.88 , 0.99)
0–14 years	2,741	121	494	93	0.77	(0.70 , 0.84)	349	92	0.76	(0.68 , 0.85)	134	87	0.71	(0.60 , 0.85)	20	68	0.56	(0.36 , 0.87)
15–29 years	2,220	80	584	111	1.39	(1.27 , 1.52)	525	157	1.96	(1.78 , 2.15)	152	115	1.44	(1.22 , 1.69)	35	137	1.70	(1.22 , 2.38)
30–44 years	6,856	258	1,909	342	1.33	(1.26 , 1.40)	1,025	264	1.02	(0.96 , 1.09)	465	289	1.12	(1.02 , 1.23)	82	252	0.98	(0.79 , 1.22)
45–59 years	24,063	950	8,110	1,174	1.24	(1.20 , 1.27)	5,435	1,061	1.12	(1.08 , 1.15)	2,254	1,026	1.08	(1.03 , 1.13)	400	890	0.94	(0.85 , 1.03)
60–74 years	48,633	2,896	19,969	3,368	1.16	(1.14 , 1.18)	14,543	3,200	1.10	(1.08 , 1.13)	6,785	3,103	1.07	(1.04 , 1.10)	1,174	2,733	0.94	(0.89 , 1.00)
75+ years	51,772	6,616	22,256	7,187	1.09	(1.07 , 1.10)	13,964	6,701	1.01	(0.99 , 1.03)	5,704	6,514	0.98	(0.96 , 1.01)	713	6,037	0.91	(0.85 , 0.98)
Mental and behavioural disorders																		
Overall*	60,602	369	16,203	413	1.12	(1.10 , 1.14)	10,162	328	0.89	(0.87 , 0.92)	3,635	316	0.86	(0.82 , 0.89)	461	220	0.60	(0.53 , 0.67)
0–14 years	1,703	75	386	72	0.96	(0.86 , 1.08)	229	60	0.80	(0.70 , 0.92)	74	48	0.64	(0.50 , 0.80)	12	41	0.54	(0.31 , 0.95)
15–29 years	17,282	625	3,984	760	1.22	(1.17 , 1.26)	1,974	591	0.95	(0.90 , 0.99)	775	588	0.94	(0.88 , 1.01)	105	410	0.66	(0.54 , 0.79)
30–44 years	12,813	481	2,966	532	1.11	(1.06 , 1.15)	1,630	419	0.87	(0.83 , 0.92)	658	410	0.85	(0.79 , 0.92)	97	298	0.62	(0.51 , 0.76)
45–59 years	11,811	466	3,515	509	1.09	(1.05 , 1.13)	1,869	365	0.78	(0.75 , 0.82)	902	411	0.88	(0.82 , 0.94)	110	245	0.53	(0.44 , 0.63)
60–74 years	7,577	451	2,425	409	0.91	(0.87 , 0.95)	1,742	383	0.85	(0.81 , 0.89)	627	287	0.64	(0.59 , 0.69)	71	165	0.37	(0.29 , 0.46)
75+ years	9,416	1,203	2,927	945	0.79	(0.75 , 0.82)	2,718	1,304	1.08	(1.04 , 1.13)	599	684	0.57	(0.52 , 0.62)	66	559	0.46	(0.36 , 0.59)
ASH																		
Overall*	315,631	2,591	91,074	2,837	1.09	(1.09 , 1.10)	52,510	2,265	0.87	(0.86 , 0.88)	20,966	2,068	0.80	(0.78 , 0.81)	2,570	1,292	0.50	(0.47 , 0.53)
0–14 years	79,578	3,514	18,528	3,474	0.99	(0.97 , 1.00)	11,234	2,967	0.84	(0.83 , 0.86)	4,235	2,734	0.78	(0.75 , 0.80)	537	1,818	0.52	(0.48 , 0.56)
15–29 years	43,261	1,564	11,351	2,165	1.38	(1.36 , 1.41)	5,289	1,584	1.01	(0.98 , 1.04)	1,917	1,456	0.93	(0.89 , 0.97)	208	810	0.52	(0.45 , 0.59)
30–44 years	44,057	1,655	11,157	2,001	1.21	(1.18 , 1.23)	5,601	1,441	0.87	(0.85 , 0.90)	2,048	1,274	0.77	(0.74 , 0.81)	244	749	0.45	(0.40 , 0.51)
45–59 years	65,258	2,576	19,481	2,820	1.09	(1.08 , 1.11)	11,088	2,164	0.84	(0.82 , 0.86)	4,278	1,948	0.76	(0.73 , 0.78)	500	1,113	0.43	(0.40 , 0.47)
60–74 years	83,477	4,971	30,558	5,153	1.04	(1.02 , 1.05)	19,299	4,246	0.85	(0.84 , 0.87)	8,489	3,882	0.78	(0.76 , 0.80)	1,082	2,519	0.51	(0.48 , 0.54)

*For "Overall", age standardised rates and age-standardised IRRs are presented; these were calculated using the 2001 Census Māori population as the standard population. No standardisation was undertaken for the age-stratified results.

Appendix Table 4: Total New Zealand population: overall age-standardised and age-stratified unadjusted episodes of care hospitalisation rates for 2015–2019 (IR; per 100k person-years) and incidence rate ratios (IRRs; using U1 as reference) by GCH category.

Episodes of care	U1 (Ref.)		U2				R1				R2				R3			
	n	IR	n	IR	IRR	95% CI	n	IR	IRR	95% CI	n	IR	IRR	95% CI	n	IR	IRR	95% CI
All Cause																		
Overall*	3,287,500	19,405	1,103,856	21,280	1.10	(1.09 , 1.10)	658,854	18,589	0.96	(0.96 , 0.96)	296,082	17,690	0.91	(0.91 , 0.92)	48,666	14,110	0.73	(0.72 , 0.74)
0–14 years	573,935	20,162	167,048	19,779	0.98	(0.98 , 0.99)	94,216	17,137	0.85	(0.84 , 0.86)	42,555	16,216	0.80	(0.80 , 0.81)	7,306	13,240	0.66	(0.64 , 0.67)
15–29 years	512,059	15,740	155,457	20,702	1.32	(1.31 , 1.32)	83,615	18,609	1.18	(1.17 , 1.19)	35,639	17,596	1.12	(1.11 , 1.13)	5,631	13,488	0.86	(0.83 , 0.88)
30–44 years	532,760	17,828	143,008	19,838	1.11	(1.11 , 1.12)	81,192	17,094	0.96	(0.95 , 0.97)	34,441	16,089	0.90	(0.89 , 0.91)	5,675	12,514	0.70	(0.68 , 0.72)
45–59 years	518,861	18,455	174,310	20,760	1.12	(1.12 , 1.13)	105,538	17,601	0.95	(0.95 , 0.96)	47,906	17,236	0.93	(0.93 , 0.94)	8,856	14,122	0.77	(0.75 , 0.78)
60–74 years	594,339	33,055	232,422	34,856	1.05	(1.05 , 1.06)	152,907	30,554	0.92	(0.92 , 0.93)	75,195	29,825	0.90	(0.90 , 0.91)	13,305	24,254	0.73	(0.72 , 0.75)
75+ years	555,546	68,597	231,611	70,360	1.03	(1.02 , 1.03)	141,386	64,245	0.94	(0.93 , 0.94)	60,346	62,402	0.91	(0.90 , 0.92)	7,893	52,842	0.77	(0.75 , 0.79)
CVD																		
Overall*	218,509	641	83,096	692	1.08	(1.07 , 1.09)	54,042	612	0.95	(0.94 , 0.97)	22,418	565	0.88	(0.86 , 0.90)	3,760	487	0.76	(0.73 , 0.79)
0–14 years	4,437	156	1,348	160	1.02	(0.96 , 1.09)	636	116	0.74	(0.68 , 0.81)	319	122	0.78	(0.70 , 0.87)	63	114	0.73	(0.57 , 0.94)
15–29 years	6,400	197	1,545	206	1.05	(0.99 , 1.11)	817	182	0.92	(0.86 , 0.99)	344	170	0.86	(0.77 , 0.96)	64	153	0.78	(0.61 , 1.00)
30–44 years	14,242	477	3,814	529	1.11	(1.07 , 1.15)	2,166	456	0.96	(0.91 , 1.00)	931	435	0.91	(0.85 , 0.98)	156	344	0.72	(0.62 , 0.85)
45–59 years	41,142	1,463	13,618	1,622	1.11	(1.09 , 1.13)	8,569	1,429	0.98	(0.95 , 1.00)	3,752	1,350	0.92	(0.89 , 0.95)	736	1,174	0.80	(0.75 , 0.86)
60–74 years	70,114	3,899	28,188	4,227	1.08	(1.07 , 1.10)	19,098	3,816	0.98	(0.96 , 0.99)	8,570	3,399	0.87	(0.85 , 0.89)	1,602	2,920	0.75	(0.71 , 0.79)
75+ years	82,174	10,147	34,583	10,506	1.04	(1.02 , 1.05)	22,756	10,340	1.02	(1.00 , 1.03)	8,502	8,792	0.87	(0.85 , 0.89)	1,139	7,625	0.75	(0.71 , 0.80)
Injury																		
Overall*	372,679	2,219	103,599	2,205	0.99	(0.99 , 1.00)	67,778	2,207	0.99	(0.99 , 1.00)	28,644	1,999	0.90	(0.89 , 0.91)	4,966	1,730	0.78	(0.75 , 0.81)
0–14 years	58,903	2,069	15,278	1,809	0.87	(0.86 , 0.89)	9,678	1,760	0.85	(0.83 , 0.87)	3,971	1,513	0.73	(0.71 , 0.76)	743	1,346	0.65	(0.61 , 0.70)
15–29 years	85,304	2,622	22,828	3,040	1.16	(1.14 , 1.18)	14,265	3,175	1.21	(1.19 , 1.23)	5,990	2,957	1.13	(1.10 , 1.16)	1,011	2,422	0.92	(0.87 , 0.98)
30–44 years	53,474	1,789	14,064	1,951	1.09	(1.07 , 1.11)	9,192	1,935	1.08	(1.06 , 1.11)	3,774	1,763	0.99	(0.95 , 1.02)	730	1,610	0.90	(0.84 , 0.97)
45–59 years	53,976	1,920	15,241	1,815	0.95	(0.93 , 0.96)	10,763	1,795	0.93	(0.92 , 0.95)	4,650	1,673	0.87	(0.85 , 0.90)	969	1,545	0.80	(0.76 , 0.86)
60–74 years	46,108	2,564	14,156	2,123	0.83	(0.81 , 0.84)	10,234	2,045	0.80	(0.78 , 0.81)	4,737	1,879	0.73	(0.71 , 0.75)	858	1,564	0.61	(0.57 , 0.65)
75+ years	74,914	9,250	22,032	6,693	0.72	(0.71 , 0.73)	13,646	6,201	0.67	(0.66 , 0.68)	5,522	5,710	0.62	(0.60 , 0.63)	655	4,385	0.47	(0.44 , 0.51)
Cancer																		
Overall*	146,653	424	59,384	485	1.14	(1.13 , 1.16)	39,317	457	1.08	(1.06 , 1.10)	17,928	448	1.06	(1.04 , 1.08)	3,163	396	0.93	(0.89 , 0.98)
0–14 years	3,486	122	813	96	0.79	(0.73 , 0.85)	530	96	0.79	(0.72 , 0.86)	250	95	0.78	(0.68 , 0.88)	32	58	0.47	(0.33 , 0.67)
15–29 years	2,712	83	818	109	1.31	(1.21 , 1.41)	680	151	1.82	(1.67 , 1.97)	238	118	1.41	(1.23 , 1.61)	42	101	1.21	(0.89 , 1.64)
30–44 years	7,930	265	2,471	343	1.29	(1.23 , 1.35)	1,294	272	1.03	(0.97 , 1.09)	652	305	1.15	(1.06 , 1.24)	144	318	1.20	(1.01 , 1.41)
45–59 years	27,415	975	9,974	1,188	1.22	(1.19 , 1.25)	6,481	1,081	1.11	(1.08 , 1.14)	3,029	1,090	1.12	(1.08 , 1.16)	588	938	0.96	(0.89 , 1.04)
60–74 years	52,239	2,905	22,293	3,343	1.15	(1.13 , 1.17)	15,922	3,182	1.10	(1.08 , 1.11)	7,788	3,089	1.06	(1.04 , 1.09)	1,531	2,791	0.96	(0.91 , 1.01)
75+ years	52,871	6,528	23,015	6,992	1.07	(1.05 , 1.09)	14,410	6,548	1.00	(0.98 , 1.02)	5,971	6,174	0.95	(0.92 , 0.97)	826	5,530	0.85	(0.79 , 0.91)
Mental and behavioural disorders																		
Overall*	74,848	416	22,848	479	1.15	(1.13 , 1.17)	12,914	373	0.90	(0.88 , 0.92)	5,683	407	0.98	(0.95 , 1.01)	935	342	0.82	(0.76 , 0.89)
0–14 years	2,215	78	596	71	0.91	(0.83 , 0.99)	320	58	0.75	(0.67 , 0.84)	153	58	0.75	(0.64 , 0.88)	24	43	0.56	(0.37 , 0.84)
15–29 years	23,130	711	6,629	883	1.24	(1.21 , 1.28)	3,170	706	0.99	(0.96 , 1.03)	1,538	759	1.07	(1.01 , 1.12)	302	723	1.02	(0.91 , 1.14)
30–44 years	17,074	571	4,765	661	1.16	(1.12 , 1.19)	2,328	490	0.86	(0.82 , 0.90)	1,254	586	1.03	(0.97 , 1.09)	194	428	0.75	(0.65 , 0.86)
45–59 years	14,252	507	4,886	582	1.15	(1.11 , 1.19)	2,302	384	0.76	(0.72 , 0.79)	1,293	465	0.92	(0.87 , 0.97)	238	380	0.75	(0.66 , 0.85)
60–74 years	8,477	471	2,884	433	0.92	(0.88 , 0.96)	1,937	387	0.82	(0.78 , 0.86)	790	313	0.66	(0.62 , 0.71)	101	184	0.39	(0.32 , 0.48)
75+ years	9,700	1,198	3,088	938	0.78	(0.75 , 0.82)	2,857	1,298	1.08	(1.04 , 1.13)	655	677	0.57	(0.52 , 0.61)	76	509	0.42	(0.34 , 0.53)
ASH																		
Overall*	390,088	2,778	134,464	3,246	1.17	(1.16 , 1.18)	70,009	2,450	0.88	(0.87 , 0.89)	32,900	2,410	0.87	(0.87 , 0.89)	5,723	1,989	0.72	(0.69 , 0.74)
0–14 years	105,185	3,695	33,672	3,987	1.08	(1.07 , 1.09)	17,451	3,174	0.86	(0.85 , 0.87)	8,437	3,215	0.87	(0.85 , 0.89)	1,540	2,791	0.76	(0.72 , 0.79)
15–29 years	55,925	1,719	18,000	2,397	1.39	(1.37 , 1.42)	7,617	1,695	0.99	(0.96 , 1.01)	3,268	1,614	0.94	(0.91 , 0.97)	507	1,213	0.71	(0.65 , 0.77)
30–44 years	54,615	1,828	16,979	2,355	1.29	(1.27 , 1.31)	7,650	1,610	0.88	(0.86 , 0.90)	3,516	1,642	0.90	(0.87 , 0.93)	532	1,173	0.64	(0.59 , 0.70)
45–59 years	79,828	2,839	27,959	3,330	1.17	(1.16 , 1.19)	14,534	2,424	0.85	(0.84 , 0.87)	6,749	2,428	0.86	(0.83 , 0.88)	1,216	1,938	0.68	(0.65 , 0.72)
60–74 years	94,537	5,258	37,854	5,676	1.08	(1.07 , 1.09)	22,758	4,547	0.86	(0.85 , 0.88)	10,930	4,335	0.82	(0.81 , 0.84)	1,929	3,515	0.67	(0.64 , 0.70)

*For "Overall", age standardised rates and age-standardised IRRs are presented; these were calculated using the 2001 Census Māori population as the standard population. No standardisation was undertaken for the age-stratified results.

Appendix Table 5: Frequencies and rates of non-admitted patient events for 2015–2019 (IR; per 1000 person-years) and incidence rate ratios (IRRs; U1=ref) by GCH category.

Non-admitted patient events	U1 (Ref.)		U2				R1				R2				R3			
	n	IR	n	IR	IRR	95% CI	n	IR	IRR	95% CI	n	IR	IRR	95% CI	n	IR	IRR	95% CI
Māori																		
All Specialist Outpatient																		
Overall*	2,192,998	1,205	1,385,001	1,468	1.17	(1.17, 1.17)	677,243	1,308	1.00	(1.00, 1.00)	461,941	1,388	0.99	(0.99, 0.99)	109,074	1,248	0.78	(0.77, 0.78)
0–14 years	402,494	692	296,045	951	1.37	(1.37, 1.38)	135,051	789	1.14	(1.13, 1.15)	77,821	724	1.05	(1.04, 1.05)	12,001	468	0.68	(0.66, 0.69)
15–29 years	284,934	585	162,549	718	1.23	(1.22, 1.24)	72,559	629	1.08	(1.07, 1.08)	45,171	638	1.09	(1.08, 1.10)	7,647	474	0.81	(0.79, 0.83)
30–44 years	324,186	994	178,077	1091	1.10	(1.09, 1.10)	80,299	932	0.94	(0.93, 0.94)	47,953	898	0.90	(0.89, 0.91)	11,462	894	0.90	(0.88, 0.92)
45–59 years	559,467	2008	318,204	2139	1.07	(1.06, 1.07)	161,667	1,852	0.92	(0.92, 0.93)	115,004	1,971	0.98	(0.98, 0.99)	25,824	1,452	0.72	(0.71, 0.73)
60–74 years	482,470	4063	313,011	4240	1.04	(1.04, 1.05)	168,319	3,662	0.90	(0.90, 0.91)	126,348	3,776	0.93	(0.92, 0.94)	38,544	3,239	0.80	(0.79, 0.81)
75+ years	139,447	5110	117,115	6000	1.17	(1.17, 1.18)	59,348	5,076	0.99	(0.98, 1.00)	49,644	5,434	1.06	(1.05, 1.07)	13,596	4,349	0.85	(0.84, 0.87)
Emergency Department																		
Overall*	313,820	172	275,893	293	1.72	(1.71, 1.73)	109,262	211	1.25	(1.25, 1.26)	76,734	231	1.37	(1.36, 1.38)	10,522	120	0.73	(0.72, 0.75)
0–14 years	88,511	152	85,195	274	1.80	(1.78, 1.82)	35,184	206	1.35	(1.33, 1.37)	24,745	230	1.51	(1.49, 1.53)	2,790	109	0.72	(0.69, 0.74)
15–29 years	104,482	214	84,116	371	1.73	(1.72, 1.75)	32,254	279	1.30	(1.29, 1.32)	20,110	284	1.32	(1.30, 1.34)	2,886	179	0.84	(0.81, 0.87)
30–44 years	57,774	177	47,862	293	1.65	(1.63, 1.67)	16,974	197	1.11	(1.09, 1.13)	11,786	221	1.25	(1.22, 1.27)	1,459	114	0.64	(0.61, 0.68)
45–59 years	40,984	147	35,581	239	1.63	(1.60, 1.65)	14,277	164	1.11	(1.09, 1.13)	10,365	178	1.21	(1.18, 1.23)	1,667	94	0.64	(0.61, 0.67)
60–74 years	17,779	150	17,852	242	1.62	(1.58, 1.65)	7,840	171	1.14	(1.11, 1.17)	7,099	212	1.42	(1.38, 1.46)	1,316	111	0.74	(0.70, 0.78)
75+ years	4,290	157	5,287	271	1.72	(1.65, 1.79)	2,733	234	1.49	(1.42, 1.56)	2,629	288	1.83	(1.74, 1.92)	404	129	0.82	(0.74, 0.91)
Allied Health																		
Overall*	252,549	139	321,129	340	2.26	(2.25, 2.27)	99,457	192	1.23	(1.22, 1.23)	100,709	303	1.86	(1.85, 1.87)	18,548	212	1.16	(1.14, 1.18)
0–14 years	53,466	92	50,052	161	1.75	(1.73, 1.77)	17,115	100	1.09	(1.07, 1.11)	11,502	107	1.16	(1.14, 1.19)	2,000	78	0.85	(0.81, 0.89)
15–29 years	34,325	70	41,573	184	2.61	(2.60, 2.64)	12,086	105	1.49	(1.46, 1.52)	14,937	211	2.99	(2.94, 3.05)	1,716	106	1.51	(1.44, 1.59)
30–44 years	35,669	109	43,539	267	2.44	(2.40, 2.47)	11,071	128	1.17	(1.15, 1.20)	11,893	223	2.04	(1.99, 2.08)	2,013	157	1.43	(1.37, 1.50)
45–59 years	60,815	218	75,960	511	2.34	(2.31, 2.36)	21,712	249	1.14	(1.12, 1.16)	22,465	385	1.76	(1.74, 1.79)	4,103	231	1.06	(1.02, 1.09)
60–74 years	52,247	440	75,387	1021	2.32	(2.30, 2.35)	25,128	547	1.24	(1.22, 1.26)	26,731	799	1.82	(1.79, 1.26)	5,543	466	1.06	(1.03, 1.09)
75+ years	16,027	587	34,618	1774	3.02	(2.96, 3.08)	12,345	1,056	1.80	(1.76, 1.84)	13,181	1,443	2.46	(2.40, 2.51)	3,173	1,015	1.73	(1.66, 1.80)
Non-Māori																		
All Specialist Outpatient																		
Overall*	15,324,673	1,208	5,734,071	1,787	1.32	(1.32, 1.32)	3,713,238	1,631	1.18	(1.18, 1.18)	1,561,613	1,605	1.14	(1.14, 1.14)	169,568	905	0.70	(0.69, 0.70)
0–14 years	1,650,083	729	560,805	1052	1.44	(1.44, 1.45)	362,750	958	1.31	(1.31, 1.32)	145,341	938	1.29	(1.28, 1.32)	17,620	596	0.82	(0.81, 0.83)
15–29 years	1,283,301	464	360,353	687	1.48	(1.48, 1.49)	203,866	611	1.32	(1.31, 1.32)	76,887	584	1.26	(1.25, 1.27)	8,878	346	0.75	(0.73, 0.76)
30–44 years	1,768,777	664	473,913	850	1.28	(1.28, 1.28)	274,581	706	1.06	(1.06, 1.07)	109,392	681	1.02	(1.02, 1.03)	12,939	398	0.60	(0.59, 0.61)
45–59 years	2,924,266	1154	914,740	1324	1.15	(1.14, 1.15)	609,450	1,190	1.03	(1.03, 1.03)	253,205	1,153	1.00	(0.99, 1.00)	30,549	680	0.59	(0.58, 0.60)
60–74 years	4,060,916	2418	1,610,536	2716	1.12	(1.12, 1.13)	1,127,455	2,481	1.03	(1.02, 1.03)	498,857	2,281	0.94	(0.94, 0.95)	61,443	1,430	0.59	(0.59, 0.60)
75+ years	3,637,330	4648	1,813,724	5857	1.26	(1.26, 1.26)	1,135,136	5,447	1.17	(1.17, 1.17)	477,931	5,458	1.17	(1.17, 1.18)	38,139	3,229	0.69	(0.69, 0.70)
Emergency Department Attendances																		
Overall*	1,562,716	123	655,567	204	1.74	(1.73, 1.74)	351,769	155	1.35	(1.34, 1.35)	155,853	160	1.36	(1.35, 1.37)	14,796	79	0.65	(0.64, 0.67)
0–14 years	359,988	159	132,402	248	1.56	(1.55, 1.57)	71,985	190	1.20	(1.19, 1.21)	30,119	194	1.22	(1.21, 1.24)	2,543	86	0.54	(0.52, 0.56)
15–29 years	408,663	148	157,091	300	2.03	(2.02, 2.04)	82,038	246	1.66	(1.65, 1.68)	31,672	240	1.63	(1.61, 1.65)	3,099	121	0.82	(0.79, 0.85)
30–44 years	278,814	105	107,187	192	1.84	(1.82, 1.85)	55,426	143	1.36	(1.35, 1.37)	22,312	139	1.33	(1.31, 1.34)	2,334	72	0.69	(0.66, 0.71)
45–59 years	235,875	93	104,751	152	1.63	(1.62, 1.64)	57,325	112	1.20	(1.19, 1.21)	25,979	118	1.27	(1.25, 1.29)	2,629	59	0.63	(0.60, 0.65)
60–74 years	170,116	101	89,152	150	1.48	(1.47, 1.50)	51,474	113	1.12	(1.11, 1.13)	27,256	125	1.23	(1.21, 1.25)	2,935	68	0.67	(0.65, 0.70)
75+ years	109,260	140	64,984	210	1.50	(1.49, 1.52)	33,521	161	1.15	(1.14, 1.17)	18,515	211	1.51	(1.49, 1.54)	1,256	106	0.76	(0.72, 0.81)
Allied Health																		
Overall*	1,777,788	140	1,444,581	450	2.34	(2.34, 2.35)	564,850	248	1.44	(1.43, 1.45)	288,914	297	1.58	(1.57, 1.59)	31,799	170	0.92	(0.90, 0.93)
0–14 years	209,429	92	85,193	160	1.73	(1.71, 1.74)	44,817	118	1.28	(1.27, 1.29)	17,237	111	1.20	(1.18, 1.22)	1,617	55	0.59	(0.56, 0.62)
15–29 years	146,445	53	84,685	161	3.05	(3.02, 3.08)	32,243	97	1.82	(1.80, 1.85)	15,991	121	2.29	(2.26, 2.33)	1,959	76	1.44	(1.38, 1.51)
30–44 years	207,548	78	112,915	202	2.60	(2.58, 2.62)	44,348	114	1.46	(1.45, 1.48)	20,460	127	1.63	(1.61, 1.66)	2,442	75	0.96	(0.93, 1.00)
45–59 years	316,604	125	214,996	311	2.49	(2.48, 2.50)	93,424	182	1.46	(1.45, 1.50)	44,684	203	1.63	(1.61, 1.64)	5,348	119	0.95	(0.93, 0.98)
60–74 years	453,706	270	399,328	673	2.49	(2.48, 2.50)	171,730	378	1.40	(1.39, 1.41)	91,029	416	1.54	(1.53, 1.55)	10,981	256	0.95	(0.93, 0.96)
75+ years	444,056	567	547,464	1768	3.12	(3.10, 3.13)	178,288	856	1.51	(1.50, 1.52)	99,513	1,136	2.00	(1.99, 2.02)	9,452	800	1.41	(1.38, 1.44)

*For "Overall", age standardised rates and age-standardised IRRs are presented; these were calculated using the 2001 Census Māori population as the standard population.

Appendix Table 6: Total New Zealand population: overall age-standardised and age-stratified unadjusted rates of non-admitted patient events (IR; per 1,000 person-years) and incidence rate ratios (IRRs; using U1 as reference) by GCH category.

Non-admitted patient events	U1 (Ref.)		U2				R1				R2				R3			
	n	IR	n	IR	IRR	95% CI	n	IR	IRR	95% CI	n	IR	IRR	95% CI	n	IR	IRR	95% CI
Total New Zealand population																		
All Specialist Outpatient																		
Overall*	17,517,671	1,207	7,119,072	1,715	1.31	(1.31, 1.31)	4,390,481	1,571	1.15	(1.15, 1.15)	2,023,554	1,550	1.12	(1.12, 1.12)	278,642	1,014	0.75	(0.75, 0.76)
0–14 years	2,052,577	721	856,850	1015	1.41	(1.40, 1.41)	497,801	905	1.26	(1.25, 1.26)	223,162	850	1.18	(1.17, 1.18)	29,621	537	0.74	(0.74, 0.75)
15–29 years	1,568,235	482	522,902	696	1.44	(1.44, 1.45)	276,425	615	1.28	(1.27, 1.28)	122,058	603	1.25	(1.24, 1.26)	16,525	396	0.82	(0.81, 0.83)
30–44 years	2,092,963	700	651,990	904	1.29	(1.29, 1.29)	354,880	747	1.07	(1.06, 1.07)	157,345	735	1.05	(1.04, 1.05)	24,401	538	0.77	(0.76, 0.78)
45–59 years	3,483,733	1239	1,232,944	1468	1.19	(1.18, 1.19)	771,117	1,286	1.04	(1.04, 1.04)	368,209	1,325	1.07	(1.07, 1.07)	56,373	899	0.73	(0.72, 0.73)
60–74 years	4,543,386	2527	1,923,547	2885	1.14	(1.14, 1.14)	1,295,774	2,589	1.02	(1.02, 1.03)	625,205	2,480	0.98	(0.98, 1.03)	99,987	1,823	0.72	(0.72, 0.73)
75+ years	3,776,777	4663	1,930,839	5866	1.26	(1.26, 1.26)	1,194,484	5,428	1.16	(1.16, 1.17)	527,575	5,456	1.17	(1.17, 1.17)	51,735	3,464	0.74	(0.74, 0.75)
Emergency Department																		
Overall*	1,876,536	129	931,460	224	1.80	(1.79, 1.80)	461,031	165	1.36	(1.35, 1.36)	232,587	178	1.43	(1.42, 1.43)	25,318	92	0.73	(0.72, 0.74)
0–14 years	448,499	158	217,597	258	1.64	(1.63, 1.64)	107,169	195	1.24	(1.23, 1.25)	54,864	209	1.33	(1.32, 1.34)	5,333	97	0.61	(0.60, 0.63)
15–29 years	513,145	158	241,207	321	2.04	(2.03, 2.05)	114,292	254	1.61	(1.60, 1.62)	51,782	256	1.62	(1.61, 1.64)	5,985	143	0.91	(0.89, 0.93)
30–44 years	336,588	113	155,049	215	1.91	(1.90, 1.92)	72,400	152	1.35	(1.34, 1.36)	34,098	159	1.41	(1.40, 1.43)	3,793	84	0.74	(0.72, 0.77)
45–59 years	276,859	98	140,332	167	1.70	(1.69, 1.71)	71,602	119	1.21	(1.20, 1.22)	36,344	131	1.33	(1.31, 1.34)	4,296	69	0.70	(0.68, 0.72)
60–74 years	187,895	105	107,004	160	1.54	(1.52, 1.55)	59,314	119	1.13	(1.12, 1.14)	34,355	136	1.30	(1.29, 1.32)	4,251	77	0.74	(0.72, 0.76)
75+ years	113,550	140	70,271	213	1.52	(1.51, 1.54)	36,254	165	1.17	(1.16, 1.19)	21,144	219	1.56	(1.54, 1.58)	1,660	111	0.79	(0.76, 0.83)
Allied Health																		
Overall*	2,030,337	140	1,765,710	425	2.38	(2.38, 2.39)	664,307	238	1.41	(1.40, 1.41)	389,623	298	1.72	(1.71, 1.73)	50,347	183	1.07	(1.06, 1.08)
0–14 years	262,895	92	135,245	160	1.73	(1.72, 1.75)	61,932	113	1.22	(1.21, 1.23)	28,739	110	1.19	(1.17, 1.20)	3,617	66	0.71	(0.69, 0.73)
15–29 years	180,770	56	126,258	168	3.03	(3.00, 3.05)	44,329	99	1.78	(1.76, 1.79)	30,928	153	2.75	(2.72, 2.78)	3,675	88	1.58	(1.53, 1.64)
30–44 years	243,217	81	156,454	217	2.67	(2.65, 2.68)	55,419	117	1.43	(1.42, 1.45)	32,353	151	1.86	(1.84, 1.88)	4,455	98	1.21	(1.17, 1.24)
45–59 years	377,419	134	290,956	347	2.58	(2.57, 2.59)	115,136	192	1.43	(1.42, 1.44)	67,149	242	1.80	(1.79, 1.81)	9,451	151	1.12	(1.10, 1.15)
60–74 years	505,953	281	474,715	712	2.53	(2.52, 2.54)	196,858	393	1.40	(1.39, 1.41)	117,760	467	1.66	(1.65, 1.67)	16,524	301	1.07	(1.05, 1.09)
75+ years	460,083	568	582,082	1768	3.11	(3.10, 3.12)	190,633	866	1.52	(1.52, 1.53)	112,694	1,165	2.05	(2.04, 2.06)	12,625	845	1.49	(1.46, 1.51)

*For "Overall", age standardised rates and age-standardised IRRs are presented; these were calculated using the 2001 Census Māori population as the standard population. No standardisation was undertaken for the age-stratified results.

Raise the Flag II: sepsis mortality before and after the introduction of a whole-of-system quality improvement programme at a tertiary hospital in New Zealand

Paul J Huggan, Katherine M Walland, Chunhuan Lao, Anna Gwynne, Daniel Dobbins, Robert Martynoga

ABSTRACT

AIMS: To study in-patient mortality before and after the introduction of a whole-of-system sepsis quality improvement programme at a tertiary hospital in New Zealand.

METHODS: The "Raise the Flag" sepsis quality improvement programme was launched in 2018. Discharge coding data were used to identify sepsis cases between May 2015 and July 2021.

RESULTS: Of 4,268 cases of sepsis identified, 81% were over 55 years old, 34% were of Māori or Pacific Island ethnicity, 61% had significant co-morbid illness and over two thirds (68%) lived in the two highest quintiles of socio-economic deprivation. The adjusted odds of in-patient mortality were lower in the post-launch period (adjusted odds ratio [aOR] 0.83, 95% confidence interval [CI] 0.7–0.98, p<0.05), and were higher in association with age (aOR 1.04 for every additional year of age, 95% CI 1.03–1.05, p<0.01), socio-economic status (aOR 1.47 comparing the highest quintile of socio-economic deprivation with the lowest, 95% CI 1.06–2.04, p=0.02) and comorbidity (aOR 2.42 comparing a comorbidity score of 1 with a score of 0, 95% CI 2.1–3.52, p<0.01).

CONCLUSION: In patients with a sepsis diagnosis, the odds of in-patient death were lower following the launch of the Raise the Flag sepsis quality improvement programme.

Ensuring reliable recognition and early resuscitation of sepsis in frontline health services should be a priority globally and for New Zealand, a country with high rates of invasive bacterial infection.[1–7] For example, the incidence of invasive skin and soft tissue infection caused by *Staphylococcus aureus* rose from 81 to 140 cases per 100,000 population between 2000 and 2011, while rates of invasive Group A beta-haemolytic streptococcal disease rose from 4 to 9 per 100,000 population between 2002 and 2016.[3,4] Using discharge coding data collected between 1989 and 2008, Baker et al. demonstrated a 5% increase in the proportion of hospital admissions caused by infectious diseases. The risk of infection-related hospital admission at least doubled in association with ethnic group (Māori or Pacific Island), socio-economic deprivation and age (below age 5 or above age 70).[5] In this context, it would be logical to expect an increase in the number of acute presentations with sepsis, which is currently defined as a "*life-threatening illness due to a dysregulated host response to infection*".[6] In a study conducted in the Waikato Region, Huggan et al. reported that sepsis admissions were more frequent in 2012 compared with 2008 (age-standardised rate ratio [ASRR] 1.62, 95% confidence interval [CI] 1.18–2.24), and that sepsis was over three times more likely among people of Māori ethnicity (ASRR 3.22, 95% CI 2.85–3.65).[7]

At our hospital in 2016, a group of clinicians with expertise in sepsis management was tasked with improving sepsis management in publicly funded facilities in the Waikato Region. This led to the design and implementation of a whole-of-system quality improvement intervention, known as "Raise the Flag". The Raise the Flag programme led to an early but non-sustained improvement in the delivery of an acute sepsis resuscitation bundle.[8] Beyond immediate resuscitation efforts, however, the programme encouraged a culture of prioritising sepsis management and removing barriers to this objective. We therefore hypothesised that the Raise the Flag programme could impact

sepsis mortality independently of immediate resuscitation practice, and conducted a retrospective study of this outcome using discharging coding data.

Methods

Of the Waikato resident population at the 2018 New Zealand Census (n=458,202), 24% identified as Māori (n=109,488).[9] Waikato Hospital is the tertiary referral centre for four public hospitals in the Waikato Region. In 2015, 10% of New Zealand's emergency department presentations were managed across this hospital network (105,347/1,062,047). Sixty-eight percent of these were direct to the Waikato Hospital emergency department (n=72,070).[10]

In 2016, a multi-disciplinary Sepsis Action Group (SAG) was established by the Waikato District Health Board Quality and Patient Safety executive. By 2017, the group included infectious disease, intensive care, paediatric medicine, emergency medicine, rural medicine, intensive care nursing, quality improvement, public relations, communications and graphic design experts. Consumer and resident medical officer representatives were also appointed. The group received advice from experts in Māori health and reported to the Waikato Hospital Iwi Māori Council.

The position of sepsis nurse coordinator was established in 2018, and a sepsis recognition and action tool was introduced to all acute care facilities in August of that year. The tool listed high-risk findings necessitating urgent treatment and, on the reverse, specified six actions to be completed urgently, ideally within 60 minutes. These actions were i) administer oxygen if required, ii) give fluid if required, iii) measure serum lactate, iv) send blood cultures, vi) give appropriate antibiotics and vi) measure urine output.[8]

Alongside introduction of the tool, concerted efforts were made to increase health workforce awareness of sepsis as a product of health in-equity, and a major cause of mortality. Dedicated educational resources were offered to all staff, including an e-learning package, while mandatory orientation to the programme was included in new staff orientation. Summary resuscitation outcomes were shared with staff in newsletters and grand rounds. The sepsis nurse coordinator provided *in situ* education and training for frontline staff. Senior clinical leaders within individual departments, termed "sepsis champions", were recruited to promote programme adoption and to explore barriers to timely recognition and treatment of sepsis. Continuous improvement based on this feedback led to the post-launch development of new resources. These included an acute abdomen pathway (based on the need to prioritise abdominal imaging and transfer to theatre in abdominal sepsis), a hypoperfusion pathway (to define intensive care unit [ICU] referral criteria and indications for use of vasoactive medications) and a multi-media design package to increase programme visibility in clinical and non-clinical areas. Māori and Pacific ethnicities were added as an "amber flag" to the sepsis recognition and action tool early in 2020 based on concern for higher prior probability of infection and sepsis as a cause of acute illness. Changes in programme and policy were communicated to staff by the SAG within the wider communication and education efforts given above, and through the network of sepsis champions.

This was a low-risk observational study, registered prospectively with the local audit committee, but was considered out-of-scope for a Health and Disability Ethics Committee review. Programme evaluation was informed by Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.[11]

Sepsis cases were identified in discharge coding data from May 2015 to July 2021 using the New Zealand Sepsis Indicator (NZSI), developed to mirror traditional approaches to the study of sepsis epidemiology.[12] The NZSI makes use of the International Statistical Classification of Diseases and Related Health Problems 10th Revision, Australasian Modification (ICD-10-AM). It identifies primary discharge codes specifying sepsis (i.e., A40.0 Sepsis due to streptococcus, group A), which are associated with secondary codes defining organ failure (i.e., N17 Acute renal failure).[12] Eighty-six percent of patients identified by the NZSI meet current clinical criteria for sepsis.[7,12]

Although quality improvement efforts covered paediatric admissions, earlier work suggests that the NZSI performs poorly in identifying paediatric sepsis cases.[6,12] Patients aged 15 and over are admitted to adult services at Waikato Hospital so were exposed to the intervention. For these reasons, we included in this study all acute, overnight admissions to Waikato Hospital of patients aged 15 and over. To avoid potential bias introduced by the need for transport for definitive care, we excluded cases presenting to other hospitals in our network in this analysis. The

primary outcome was in-hospital mortality measured at acute hospital discharge. This excludes time in convalescent care and rehabilitation facilities. Secondary outcomes of interest were: 30- and 90-day mortality; need for ICU admission; ICU length of stay (LOS); and acute in-patient LOS. Exposures measured were: age; prioritised ethnicity; an address-based measure of socio-economic deprivation; and the Charlson Comorbidity Index (calculated using a method validated for use in discharge coding data).[13,14] Based on the study of Burrell et al., we divided time exposure into two periods, an extended baseline period (May 2015 to July 2019) and a post-implementation period (August 2019 to June 2021).[1]

A final record extract was undertaken on 16 October 2021, which included mortality data through to 30 September 2021. Regional population estimates derived from the 2018 New Zealand Census were used to estimate age-standardised sepsis incidence. The Chi-squared test was used to compare categorical variables with results considered significant at a p-value of less than 0.05. Binary logistic regression was used to calculate adjusted odds ratios [aOR] and 95% confidence intervals [CI] for individual variables (gender, age, ethnicity, socio-economic status, Charlson Comorbidity Index score and year of admission) against outcomes of interest (in-patient, 30- and 90-day mortality). For independent variables included in the binary logistic regression, missing values were coded as "unknown". This was to avoid excluding patients with missing values in some variables and to include all patients in the analysis. All data analyses were performed in IBM SPSS statistics version 27 (New York, United States).

Results

Four thousand, two hundred and sixty-eight sepsis cases were identified and are described in Table 1. There were 2,432 cases in the extended baseline period and 1,836 in the post-implementation period. Sepsis was more common among men (58%), those aged over 55 (81%) and in the presence of significant comorbidity based on a Charlson score ≥1 (61%). Over two thirds (68%) of all cases were recorded as living in the two highest quintiles of socio-economic deprivation. One third (34%) of all patients were of Māori or Pacific ethnicity. The majority of patients (81.5%) were managed on the general wards without ICU admission. The proportion of patients with no comorbidity was higher in the post-implementation period (proportion of patients with a Charlson score of 0, 41.9% vs 36.1%, p=<0.01). In the total study population, in-patient mortality was 20% (838/4,268). Table 2 demonstrates that crude mortality was lower in the post-implementation period (in-hospital mortality 17.4% vs 21.3%, p<0.01). There was no crude difference in ICU or in-patient LOS.

The results of binary logistic regression are shown in Table 3. Admission during the post-implementation period was associated with reduced odds of in-hospital mortality (odds ratio [OR] 0.83, 95% CI 0.7–0.98, p <0.05). There was weak evidence of lower 30-day mortality (OR 0.86, 95% CI 0.74–1.00, p=0.051). There was no evidence of a difference in 90-day mortality (OR 0.90, 95% CI 0.78–1.04, p=0.152). There was a significant association between mortality and socio-economic deprivation. Among cases in the fifth (compared with the first) quintile of deprivation, odds of in-patient mortality were 1.47 (95% CI 1.06–2.04, p=0.02). Increasing age was strongly associated with mortality. The adjusted odds of patient death increased by 1.03 for every additional year of age (95% CI 1.03–1.05, p<0.01). Comorbidity was also a significant determinant of mortality. For example, compared to a comorbidity score of 0, the odds of in-patient mortality were increased by 2.72 for a comorbidity score of 1 (95% CI 2.10–3.52, p<0.01), and by 4.76 for a score of 3 or more (95% CI 3.81–5.95, p<0.01). There was no statistically significant evidence of an association between non-Māori, non-Pacific ethnicities and either an increased or a decreased risk of mortality (i.e., aOR for in-patient mortality 1.16, 95% CI 0.95–1.41, p=0.15).

Discussion

Following implementation of a sepsis quality improvement programme, after adjusting for important confounding variables such as age and comorbidity, we observed a 17% reduction in the odds of in-patient mortality among patients with sepsis (aOR 0.83, 95% CI 0.70–0.98, p=0.03). A weak association persisted at 30 days (OR 0.86, 95% CI 0.74–1.00, p=0.05), but not at 90 days (OR 0.90, 95% CI 0.78–1.04, p=0.15). We observed no change in ICU or in-patient hospital LOS following the intervention. Socio-economic deprivation was independently associated with increased mortality at all time points (i.e., aOR for 90-day mortality comparing the highest with the lowest quintile of deprivation 1.39, 95% CI 1.05–1.85, p<0.05).

We report what we believe to be the largest

Table 1: Sepsis cases identified between February 2015 and June 2021, Waikato Hospital.

Characteristic	Baseline n (%)		Post-implementation n (%)		Total n (%)		P-value
Sex							
Female	1,041	(42.8)	738	(40.2)	1,779	(41.7)	0.23
Male	1,391	(57.2)	1,098	(59.8)	2,489	(58.3)	
Ethnicity							
Māori/Pacific	827	(34.0)	621	(33.8)	1,448	(33.9)	0.99
Non-Māori and non-Pacific	1,605	(66.0)	1,215	(66.2)	2,820	(66.1)	
Age group (years)							
15–54	449	(19.2)	315	(17.8)	764	(18.6)	0.69
55–74	956	(40.8)	709	(40.1)	1,665	(40.5)	
75+	936	(40.0)	744	(42.1)	1,680	(40.9)	
Unknown	91		68		159		
NZ Deprivation Index (quintile)							
1 (least deprived)	199	(8.2)	168	(9.2)	367	(8.6)	0.38
2	168	(6.9)	138	(7.5)	306	(7.2)	
3	419	(17.3)	285	(15.6)	704	(16.5)	
4	726	(30.0)	569	(31.1)	1,295	(30.4)	
5 (most deprived)	912	(37.6)	672	(36.7)	1,584	(37.2)	
Unknown	8		4		12		
Charlson Comorbidity Index score							
0	878	(36.1)	770	(41.9)	1,648	(38.6)	<0.01
1	372	(15.3)	274	(14.9)	646	(15.1)	
2	494	(20.3)	356	(19.4)	850	(19.9)	
3+	688	(28.3)	436	(23.7)	1,124	(26.3)	
ICU admitted							
No	1,981	(81.5)	1,502	(81.8)	3,483	(81.6)	0.77
Yes	451	(18.5)	334	(18.2)	785	(18.4)	
Total	2,432		1,836		4,268		

ICU = intensive care unit

Table 2: Crude mortality and length of intensive care unit and hospital stay before and after introduction of the Raise the Flag sepsis programme at Waikato Hospital.

Characteristic	Baseline n=2,432	Post-implementation n=1,836	Total n=4,268	P-value
In-patient mortality n (%)	517 (21.3)	319 (17.4)	836 (19.6)	<0.01
Mortality at 30 days n (%)	728 (29.9)	472 (25.7)	1,200 (28.1)	<0.01
Mortality at 90 days n (%)	846 (34.8)	569 (31.0)	1,415 (33.2)	<0.01
ICU LOS (days)				
Median (IQR)	2.4 (1.3–5.7)	2.2 (1.3–4.6)	2.3 (1.3–5.4)	0.47
Acute in-patient LOS (days)				
Median (IQR)	7.3 (3.8–14.9)	7.1 (3.5–14.3)	7.3 (3.7–14.6)	0.74

Data relate to 4,268 adult sepsis cases identified in administrative data from February 2015 to June 2021 in the Waikato Region, New Zealand.
ICU= intensive care unit; IQR = interquartile range; LOS = length of stay

single-centre study of sepsis outcomes conducted in New Zealand. Strengths of our approach include the use of administrative data to allow continuous reporting of incidence and clinical outcomes over a 6-year period. In earlier work using this approach we demonstrated that 86% of patients satisfy contemporary sepsis definitions.[12] We are therefore confident that the significant majority of patients identified here presented with a critical illness. In this context, a crude reduction of 4% in acute mortality is clinically relevant and is consistent with the reported outcomes of state-wide sepsis quality improvements in Australia.[1,2] This study adds to these findings by adjusting for important confounding variables, including differences in age and comorbidity between the pre- and post-launch periods. This strengthens the argument that the association of quality improvement programmes with reduced odds of in-patient mortality are due to the programmes themselves, rather than to changes in underlying patient vulnerability.

The limitations of this study include its retrospective design, and use of a dataset lacking clinical granularity. This means that we have not been able to measure all confounding variables known to affect mortality, and are therefore unable to determine if observed improvements in mortality relate to residual confounding. We acknowledge that the observation period includes the early stages of the COVID-19 pandemic, which in New Zealand was managed by significant restrictions on population movement and association, with as yet unknown impacts on the underlying causes of sepsis. Our observation period may have been too short to document significant improvements in LOS. Finally, we acknowledge that no observational study reporting an association between an intervention and an outcome can prove causation.

Beyond immediate resuscitation efforts, clinicians managing sepsis provide a range of interventions and complex therapies, each representing an opportunity to expedite and improve resuscitation and treatment. Successful sepsis care relies not just on a single intervention, such as introduction of a resuscitation bundle, but on a raft of education and process changes that raise awareness and lead to changes in process and prioritisation. For example, although the proportion of patients admitted to the ICU during

Table 3: Adjusted odds ratios and 95% confidence intervals for mortality using binary logistic regression in 4,268 adult sepsis cases admitted to Waikato Hospital, 2015–2021.

Characteristic	In-patient mortality	Mortality at 30 days	Mortality at 90 days
Sex			
Female	Reference	Reference	Reference
Male	0.86 (0.73–1.01)	0.87 (0.75–1.01)	0.89 (0.77–1.03)
Ethnicity			
Māori/Pacific	Reference	Reference	Reference
Non-Māori and non-Pacific	1.16 (0.95–1.41)	1.04 (0.87–1.24)	0.97 (0.82–1.15)
Age (years, continuous)	1.03 (1.02–1.03)**	1.04 (1.03–1.05)**	1.04 (1.03–1.04)**
NZ Deprivation Index (quintile)			
1 (least deprived)	Reference	Reference	Reference
2	1.36 (0.90–2.06)	1.21 (0.83–1.77)	1.36 (0.95–1.96)
3	1.45 (1.02–2.07)*	1.43 (1.04–1.96)*	1.44 (1.06–1.95)*
4	1.30 (0.93–1.81)	1.30 (0.97–1.74)	1.44 (1.09–1.91)*
5 (most deprived)	1.47 (1.06–2.04)*	1.37 (1.02–1.83)*	1.39 (1.05–1.85)*
Unknown			
Charlson Comorbidity Index score			
0	Reference	Reference	Reference
1	2.72 (2.10–3.52)**	2.53 (2.00–3.19)**	2.55 (2.04–3.17)**
2	1.98 (1.53–2.57)**	2.36 (1.89–2.95)**	2.66 (2.16–3.28)**
3+	4.76 (3.81–5.95)**	6.37 (5.22–7.78)**	7.24 (5.98–8.77)**
Sepsis group based on time			
Before August 2019	Reference	Reference	Reference
From August 2019	0.83 (0.70–0.98) p=0.03	0.86 (0.74–1.00) p=0.05†	0.90 (0.78–1.04) p=0.15

All variables in the table were included in the regression model, and all odds ratios are adjusted for other variables.
*signifies a p-value <0.05
**signifies a p-value <0.01.
†Exact p-value = 0.051

their hospital stay did not change in this analysis, Walland et al. reported a sustained increase in the odds of direct transfer to ICU following a sepsis diagnosis after the programme launch in 2018 (aOR 2.81, 95% CI 1.13–6.97, p=0.03).[8] Early ICU access for patients with sepsis may be an important determinant of outcome in resuscitation-eligible groups. Sepsis mortality is lower in the USA where a higher proportion of cases are admitted to ICU, compared to European settings where ICU admission is less common.[15] Measures of ICU access are associated with outcomes in critical illness. In one study, a delay in ICU transfer of 6 hours or more was associated with a 30% increase in the adjusted odds of 30-day mortality.[16] In another, the opening of an ICU within a large metropolitan emergency department reduced the odds of mortality at 30 days by 15%.[17]

We observed that the majority of patients with sepsis are managed outside intensive care, across a range of clinical specialties. This implies that improvements in sepsis care rely significantly on care in environments remote to critical care services. Real-world evaluations of practice have shown that staff working outside an ICU are poorly adherent to sepsis resuscitation bundles. For example, in a study using annual point-prevalence studies in 14 Welsh hospitals, the full sepsis resuscitation bundle was completed in 14% of eligible patients (223/1,651), but in 11% (190/1,651) none of the bundle elements were completed.[18] Those patients seen by a critical care outreach team received the complete bundle in 32% of cases (54/170). In Australia and New Zealand, where rapid response teams operate, sepsis is the most frequent reason for their activation.[19,20] Critical care outreach may be key to the delivery of the immediate resuscitation steps on which most quality improvement efforts are typically focussed.

We are not surprised to report that improvements in in-patient mortality were no longer sustained by day 90. After 30 days, sepsis deaths are rarely related to sepsis-associated organ failure, suggesting that late mortality is mediated by the interaction of a proximate sepsis event with its ultimate underlying causes (i.e., medical comorbidity, major trauma or advanced age).[21] This does not clearly explain why the adjusted odds of mortality were higher at all time points for those living in the highest quintile of socio-economic deprivation. Although the association between increasing neighbourhood socio-economic deprivation and sepsis mortality is well recognised, this is the first time, to our knowledge, that this has been reported in New Zealand.[22] Increased mortality among those experiencing socio-economic deprivation is likely to be mediated in part by unmeasured confounding factors, such as smoking. However, the possibility of deficits in the quality of care and follow-up following critical illness is an important topic for further research.

In summary, this is the first report from New Zealand demonstrating an association with reduced in-hospital mortality following the launch of a whole-of-system sepsis quality improvement intervention. For all patients, sepsis outcomes are worsened by increasing age, comorbidity and exposure to socio-economic deprivation. This study therefore directs attention to chronic illness and the social determinants of health as drivers of preventable sepsis morbidity and mortality. Investment in sepsis quality improvement has the potential to improve short-term sepsis outcomes.

COMPETING INTERESTS
Nil.

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Perceived barriers to self-collected HPV testing for cervical cancer screening, and knowledge of HPV: a survey of primary healthcare smear-takers across Aotearoa New Zealand

Sarah Ingamells, Rebecca Bell, Janine Nip, Carrie Innes, Sarah Te Whaiti, Alex Tino, Lynn McBain, John McMenamin, Ben Hudson, Melanie Gibson, Bev Lawton, Peter Sykes

ABSTRACT

AIMS: Cervical cancer remains a burden within Aotearoa New Zealand, with 2022 screening rates sitting 12.7% below target. The National Cervical Screening Programme has changed to primary human papillomavirus (HPV) testing for all screen-eligible people, with the aim for home self-testing. Little is known about the readiness of primary care for the change to self-testing and its associated challenges. A pilot HPV cervical cancer screening programme is being conducted in 17 practice centres. The aim of this study is to explore smear-taker knowledge at these centres about the use of primary HPV testing for cervical cancer screening.

METHODS: This is an ethically approved questionnaire study, with data from a structured web-based questionnaire sent to all smear-takers at the pilot centres.

RESULTS: We achieved a total completion rate of 57.8%. The average score for "Knowledge of HPV" was 56.5% (range=20–100%). The challenges to patient home HPV self-testing were felt to be overall "not at all" to "mildly challenging". Up to 73.3% of participants identified ongoing needs for further education.

CONCLUSIONS: The findings indicate knowledge deficits regarding HPV testing for cervical cancer screening and a desire for the provision of further education. Overall, respondents felt that no major barriers to implementing HPV self-testing would occur.

Cervical cancer is diagnosed in around 160 people per year in Aotearoa New Zealand, with 50 dying of the disease.[1] The National Cervical Screening Programme (NCSP) has set a 3-year coverage target of 80% of eligible people to be screened. However, in 2022 screening rates sat at 67.3%. Coverage rates by ethnicity were 78% for non-Māori and 62% for Māori, highlighting ongoing disparities within the screening programme.[2]

Primary human papillomavirus (HPV) testing is now established as a more sensitive screening method than cervical cytology. Modelling predicts that the introduction of primary HPV screening in Aotearoa New Zealand will reduce cervical cancer incidence by 12–16%.[3] In September 2023, the NCSP changed the primary screening method of cervical cancer screening from cervical cytology to HPV testing, offering screen-eligible people the primary option of a self-collected HPV test.[4] This self-collected HPV test is offered at the clinic; this has not yet been rolled out for self-testing at home.[5]

Previous research indicates that people find HPV self-collection to be highly acceptable,[6–9] particularly as a home-testing option within under- or never-screening populations, with the exciting opportunity to reduce inequities in cervical cancer incidence and outcomes in this under-served population.[9]

Additionally, clinicians strongly support HPV screening, both for clinician and patient-collected samples.[10,11] However, some concerns exist about HPV testing, particularly with regards to accuracy.[12,13] Additionally, knowledge about HPV, its causative role in cervical cancer and its reliability as a primary screening tool has been shown to be lacking across primary care providers,[11,12,14] including in Aotearoa New Zealand.[12]

Little is known about the readiness of primary care across the country for the roll-out of primary HPV self-testing for cervical cancer screening and the anticipated challenges that this change will bring. It is important to ensure that primary care staff have adequate knowledge around the

reasons behind the change to HPV screening, and for potential logistical challenges to be addressed, both for primary care practices and their patients.

Within Aotearoa New Zealand, a pilot HPV cervical cancer screening programme ("Let's Test for HPV") was conducted in 17 "pilot-centre" general practices. The aim of this study was to explore extent of knowledge about the role of HPV in cervical cancer and the use of primary HPV testing for cervical cancer screening among smear-takers at these pilot centres.

Further objectives were to identify learning needs (to enable the creation of tailored learning packages regarding the new NCSP guideline) and identify potential barriers to the HPV screening programme to inform the NCSP national roll-out and therefore proactively address foreseeable challenges.

Methods

This is a questionnaire study, with data from a closed structured web-based questionnaire (please see Appendix 1 for further questionnaire details). Ethical approval was gained prior to the initiation of the study from the University of Otago Ethics Committee (D22/175.). The "Let's Test for HPV" Māori advisory group was consulted to provide feedback and approve the questionnaire. A Māori Health Advancement Review was undertaken by the University of Otago. Input on the questionnaire design was gathered from key stakeholders (general practitioners and practice nurses who were not potential participants in the study) following a questionnaire pre-test by these stakeholders. Previous questionnaires used for exploring HPV knowledge were reviewed by the study team and not felt to be appropriate to answer the specific aims and objectives of this study.[12,14–16] Questions were designed to cover three main knowledge areas: general HPV knowledge, benefits of HPV testing over traditional cervical cytology and clinical management of HPV results. Further questions were asked about logistical barriers, recall responsibility and educational needs. All questions were multiple choice, with space for free text when "other" was an option.

The questionnaire was sent via individual email link to an online questionnaire platform (SurveyMonkey) to all potential participants, who were all smear-takers at the practices taking part in the "Let's Test for HPV" study. The 17 practices are located in Canterbury, Wellington and Whanganui. Prior to the study, these practices had received an educational document covering HPV and the role of HPV testing for cervical screening, as well as links to further educational resources. The questionnaire invitation was sent out in a rolling fashion from 5 August 2022. The individual email link was only valid for one questionnaire completion. The use of an individual email link reduced the risk of non-invited participants completing the questionnaire. Email reminders were sent out to those who had yet to complete the questionnaire for 8 weeks. After this point, participants were felt to have declined and the questionnaire was closed (final closure date was 22 November 2022).

Participant information was given on the opening page of the questionnaire, and participants gave informed consent at the start of the questionnaire. Answers to the knowledge questions were provided at the end of the questionnaire, with participants unable to return to the questionnaire from this final page. There were no adaptive questions within the questionnaire. There was a total of 23 questions, split into four sections. All questions (except the last question, which was a free-text question for any further comments) were mandatory and enforced using JavaScript.

Data were then collated, and summary statistics prepared using Microsoft Excel. Ethnicity was recorded as total response ethnicity (no participants reported more than one ethnicity).[17] Free-text answers were descriptively analysed.

Results

Of the 116 invitations, responses were received from 73 people, of which 67 completed the whole questionnaire. This gave a partial completion rate of 62.9% and a total completion rate of 57.8%. All supplied data have been analysed to value all supplied data. The average time taken to complete the questionnaire was 7 minutes and 57 seconds.

Demographics

Respondent ages ranged widely and were most frequently in the 55–64-year age group (30.1% of total). They predominantly identified as female (87.7%) and NZ European (72.6%). Please see Table 1 for further demographics information.

Most participants identified their work role as a practice nurse (52.1%), followed by general practitioner (31.5%) and nurse practitioner (6.9%). Survey respondents were predominantly frequent smear-takers (with 60.3% reporting that they take smears at least once per week) and

worked in an urban environment. Almost half (49.3%) of participants reported that they work in a practice with a higher-than-average Māori population and almost one third (32.8%) reported that they work in a practice serving a higher-than-average Pasifika population.

Knowledge of HPV

The average score for the "Knowledge of HPV" was 56.5%, with a range of 20–100% for the 69 respondents who completed this section (see Graph 1). Each question was answered correctly or incorrectly, scores were summated and each participant was given an average score out of 100%.

Please see Table 2 for the summary of results of the questionnaire section around knowledge of HPV, cervical cancer and HPV screening. Please see Appendix 2 for further details of the respondent answers.

Knowledge of the two main HPV types causing cervical cancer was very high, with 92.8% answering correctly. While only 49.3% correctly answered the question around HPV frequency in sexually active people, there was a trend to overestimate the frequency, with a further 27.5% answering that they believed 90% of sexually active people are exposed to HPV.

With regards to awareness of the relative reliability of HPV screening and cervical cytology, 60.9% of respondents knew that HPV screening misses approximately 5% of high-grade changes or cervical cancer, whereas only 18.8% knew that cervical cytology misses approximately 20–30%. However, with both screening modalities, approximately one third of respondents answered "don't know/not sure". Additionally, only 20.3% knew that HPV testing is better at detecting glandular abnormalities, with 50.7% believing cervical cytology to be superior and a further 24.6%

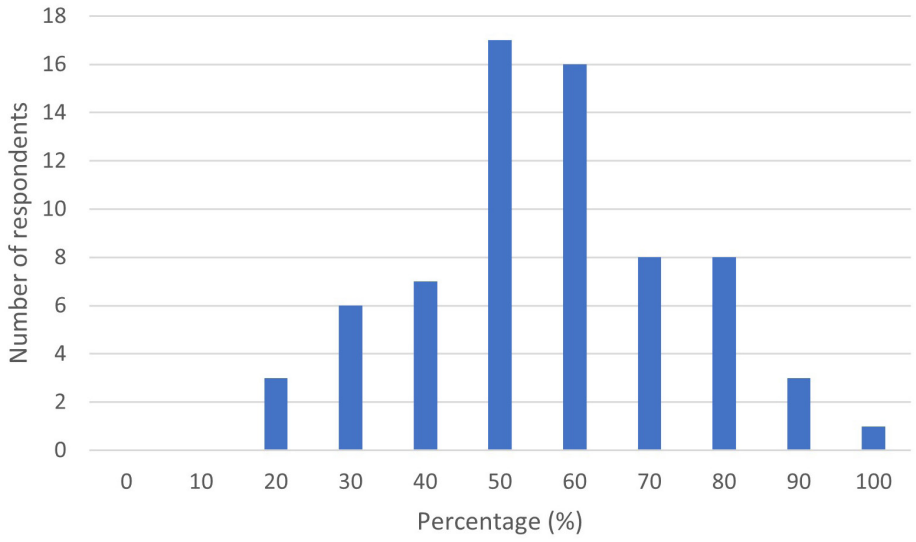
Table 1: Demographic characteristic of survey respondents (n=73).

	Options	**Percentage (%) of respondents (n)**
Age (years)	18–24	0.0% (0)
	25–34	11.0% (8)
	35–44	24.7% (18)
	45–54	28.8% (21)
	55–64	30.1% (22)
	>65	5.5% (4)
Gender	Male	12.3% (9)
	Female	87.7% (64)
	Gender neutral	0.0% (0)
	Prefer not to answer	0.0% (0)
	Other	0.0% (0)
Ethnicity	NZ European	72.6% (53)
	Māori	12.3% (9)
	Chinese	12.3% (9)
	Other	11.0% (8)
	Prefer not to answer	1.4% (1)

Table 1 (continued): Demographic characteristic of survey respondents (n=73).

Role	Practice nurse	52.1% (38)
	General practitioner	31.5% (23)
	Nurse practitioner	6.9% (5)
	Other	9.6% (7)
Smear taking frequency	Every day	4.1% (3)
	A few times per week	48.0% (35)
	Once per week	8.2% (6)
	A few times per month	16.4% (12)
	Once a month	4.1% (3)
	Less than once per month	19.2% (14)
Practice population	Urban (large city)	52.1% (38)
	Urban (town)	34.2% (25)
	Rural	13.7% (10)
Participant reported practice Māori population >16.5%	Yes	49.3% (36)
	No	42.5% (31)
	Don't know/not sure	8.2% (6)
Participant reported practice Pasifika population >8.1%	Yes	32.9% (24)
	No	49.3% (36)
	Don't know/not sure	17.8% (13)

Graph 1: Graph displaying average score for participants who answered "Knowledge of HPV" section (n=69).



answering "don't know/not sure".

There was very good knowledge around the comparability of clinician-collected and patient self-collected samples (with 79.7% answering correctly) and management of red flag symptoms (with 89.9% answering correctly).

However, knowledge of the proposed NCSP guidelines around management of recall and positive results was low, with correct answers ranging between 46.4–58.0%.

Anticipated issues implementing the HPV home self-testing programme

Please see Graph 2 for full details. The overall challenges to patient home HPV self-testing were felt to be largely "not at all" to "mildly challenging". However, over 50% of respondents felt that ensuring that the patient physically performs the HPV test was felt to be "moderately" to "extremely challenging". The second most difficult anticipated issue was following up on the test if it was not performed. Participants felt that getting the result to the responsible clinician was the least challenging aspect of the new screening programme, preceded by informing the patient of the result and any follow up actions required.

Participants felt that the responsibility of communicating the need for cervical screening recall should largely fall to the practice (74.6%), followed by the NCSP at 55.2% (see Table 3 for further details).

Educational needs

Participants identified ongoing needs for further education, with 73.3% requesting further education regarding the clinical management of results in the new HPV screening programme, 61.7% requesting further details on the reliability

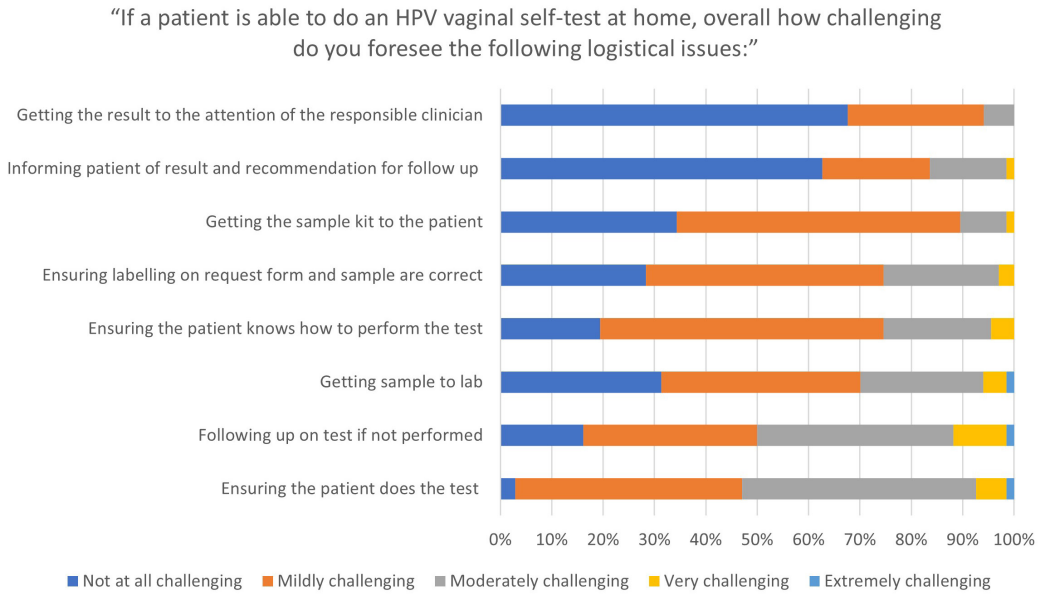
Table 2: Results of respondent answers for questionnaire section on "Knowledge of HPV, cervical cancer and HPV screening" (n=69).

Question	Correct answer	Proportion answered correctly % (N) (69 total respondents)
Approximately what proportion of sexually active people are exposed to human papillomavirus (HPV)?	80%	49.3% (34)
Which two HPV types cause around 70% of cervical cancers?	16 and 18	92.8% (64)
Approximately what proportion of high-grade changes and cervical cancers are missed by cervical cytology?	20–30%	18.8% (13)
Approximately what proportion of high-grade changes and cervical cancers are missed by HPV testing?	5%	60.9% (42)
Which is more reliable: a self-collected HPV test or a clinician-collected HPV test?	They are similar in reliability	79.7% (55)
Which is better at detecting glandular cervical abnormalities?	HPV testing	20.3% (14)
According to the proposed NCSP HPV screening guideline, if someone has a negative HPV test and a normal cervical screening history, when should they be recalled for their next cervical screen?	5 years	52.2% (36)

Table 2 (continued): Results of respondent answers for questionnaire section on "Knowledge of HPV, cervical cancer and HPV screening" (n=69).

According to the proposed NCSP HPV screening guideline, if someone tests positive for high-risk HPV "other" types, what will be the next recommended step for investigation?	Cervical cytology	60.0% (40)
According to the proposed NCSP HPV screening guideline, if someone tests positive for HPV types 16/18, what will be the next recommended stop for investigation?	Colposcopy	46.4% (32)
Which statement is correct? In people due for a cervical screen who report intermenstrual or post-coital bleeding, the most appropriate management plan should be	A face-to-face appointment for clinical review and examination	89.9% (62)

Graph 2: Respondents' anticipated issues with implementation of HPV home self-testing and comparison between cervical smears, ranked in order of difficulty (least to most) (n=67).



of HPV screening and 55.0% wanting further details on the practical aspects of the HPV testing. Please see Table 4.

Free-text comments about the proposed NCSP HPV testing cervical screening programme

Respondents expressed a need for information regarding patient frequently asked questions that clinicians may be asked, and one respondent queried what public education will be carried out. One respondent commented that screening should be free.

There were positive comments left via free text by 11.0% of respondents about the HPV self-testing screening option.

Discussion

The findings of this study indicate knowledge deficits regarding HPV testing for cervical cancer screening and a desire for the provision of further education. Overall, respondents felt that no major barriers to the implementation of HPV self-testing would occur.

Table 3: Respondents' opinions on the responsibility for communicating the need for cervical screening recall. Note that more than one response could be chosen (n=67).

Question: "In your opinion, who do you think should communicate the recall to people due for cervical screening? (please choose all that apply)"	Percentage (%) of respondents (total number of votes in brackets) (n=67)
The National Cervical Screening Programme	55.2% (37)
The primary health organisation	10.5% (7)
The general practice	74.6% (50)
A community health worker (e.g., kaiāwhina)	13.4% (9)
Other: answers provided included "midwife", "clinician ordering test", "for high risk and Māori patients, a clinician with a therapeutic relationship"	6.0% (4)

Table 4: Educational support identified (listed highest to lowest). Note respondents could choose multiple options (n=60).

Area	Percentage % chosen (n=60)
Clinical management of results (e.g., who to refer for colposcopy, when to recall patients, etc.)	73.3% (44)
Reliability of HPV screening	61.7% (37)
Practical aspects of HPV testing (e.g., how to perform test, what kind of swab to use, etc.)	55.0% (33)
Role of different HPV types in cervical cancer development	45.0% (27)
Natural history of the HPV virus	41.7% (25)
Role of HPV vaccine (including impact on HPV screening)	38.3% (23)

We believe that the demographic of respondents of this study are largely reflective of the primary healthcare workforce across Aotearoa New Zealand,[18,19] with the exception that the respondents over-represent the workforce working in higher-than-average Māori and Pasifika populations. Given that the current cervical screening programme is currently under-serving both populations, this over-representation may help to reduce inequities by mitigating anticipated challenges that Māori and Pasifika screening-eligible people may face in the new screening programme.

HPV knowledge

Overall, while there were displayed several areas of strong HPV and cervical screening knowledge, there remain significant knowledge deficits regarding key components of the programme. This is despite Aotearoa New Zealand using HPV testing within the screening programme since 2009,[20] as well as the provision of educational material prior to the survey commencing. While this survey gathered information from smear-takers, it is likely that knowledge deficits will be found among screening-eligible people and the general public.

Previous research also indicates knowledge deficits around HPV.[12,14] Our study showed improved knowledge within Aotearoa New Zealand around HPV infection rates: a 2016 survey showed that 24.7% of participants thought that most sexually active people will not get HPV at some point in their lives,[12] whereas the participants in this survey overestimated the frequency of HPV infections. This is especially important as stigma around HPV infection has long been present,[21–24] which impacts not only on vaccination rates but also among negative feelings and perceptions when encountering positive results. Therefore, it may be preferable that clinicians overestimate this frequency as this may help normalise and de-stigmatise HPV infections.

Overall knowledge around the benefits of HPV testing as compared to cervical smears was varying. Respondents were aware that HPV testing is minimally affected by whether a healthcare professional or the patient takes the test. However, the reliability of cervical smears for detecting high grade changes, cervical cancer and glandular abnormalities was notably overestimated. One of the key benefits of HPV testing is its ability to detect more glandular abnormalities, something that has been relatively unaffected by the current cervical cytology screening programme.[25]

Knowledge of the management of HPV screening intervals and management of positive results was generally poor. Half of respondents knew that the new recommended screening interval will be 5 years (with a negative HPV result), but one third believed that it would still be 3 years. These results indicate the importance of clear information and education around the introduction of the new NCSP programme.

It is reassuring that there is high awareness that an HPV test cannot be used as a proxy for a clinical review and examination for patients presenting with concerning "red flag" symptoms of pathology. While it still concerning that 10% of participants did not know this, Australian research indicated up to 29% of cervical-screening practitioners are still unaware of the correct management of symptomatic screen-eligible people, despite the change to HPV testing 5 years prior.[16]

Challenges

The overall challenges to HPV self-testing at home were felt to be largely "not at all" to "mildly challenging", which indicates that smear-takers in Aotearoa New Zealand do not anticipate significant challenges with this national roll-out option. The exceptions are the issue of following up on the test if it was not performed and ensuring that patients perform the HPV self-test, which was felt to be at least "moderately" to "extremely challenging". Robust systems and guidance need to be put into place to help both primary healthcare and screening-eligible people to access home self-screening. This is particularly important, as previous research within Aotearoa New Zealand has shown this option to have significantly increased uptake among the under- and never-screened population, compared to self-testing at the clinic.[8,9] It is important that Aotearoa New Zealand learns from other countries' experience in implementing HPV testing. For example, Australia has struggled with the successful implementation of self-testing, with issues cited to be inadequate consultation and engagement of their indigenous population.[26]

Previous research has indicated that Aotearoa New Zealand has been slow to adopt centralised healthcare pathways due to a mixture of preference and a long-entrenched healthcare system.[27] However, while smear-takers in Aotearoa New Zealand seem to generally support the ongoing model of local-based, decentralised care primarily (by indicating they felt that practices should be primarily responsible for cervical screening recall), they may be open to a national centralised lead. This is important, as the formation of the new national health body Te Whatu Ora – Health New Zealand may offer an opportunity for cervical screening (as well as other screening programmes) to be more centralised. It is important for Te Whatu Ora – Health New Zealand to understand the trend towards preference for the continuation of locally based care, in order to establish a system that does not alienate primary healthcare, as has been seen in some other countries.[27]

Further education

A large proportion of respondents would like further education about HPV, with an emphasis on the clinical management of results and the reliability of HPV testing in the context of cervical screening. This echoes education requests in other countries prior to the introduction of HPV screening[20] and also echoes the results of the "HPV Knowledge" section of our questionnaire. Reassuringly, Te Whatu Ora – Health New Zealand has already provided learning resources regarding the new NCSP guideline to meet this demand,[28] which are more extensive than the learning packages provided prior to the commencement of this study.

While we did not seek out overall feelings about the introduction of HPV screening, the free-text comments were predominantly positive about the introduction of HPV screening, with many welcoming its introduction as soon as possible, reflecting prior research.[11]

Strengths and limitations

The authors feel that the sample was reflective of the primary care smear-taking population, with a high completion rate of 57% that is comparable to previous published surveys on the topic.[11] However, completion bias may be present, with those who felt their knowledge to be weaker less likely to complete the survey.

Respondents were from primary care practices that had already agreed to participate in recruitment for the "Let's Test for HPV" study, and therefore some may have already completed their own learning on the topic. Thus, this study may have found a higher level of HPV knowledge than the general smear-taking population at the present time. However, the authors feel that a similar level of pre-reading in the general smear-taking population is likely to occur with the national roll-out of the HPV screening programme.

Conclusion

The findings of this study indicate existence of knowledge deficits about HPV testing, with a desire for provision of further education prior to the national roll-out of the new NCSP. Overall, respondents felt that no major barriers to the implementation of HPV home self-testing would occur. We have displayed a snapshot of knowledge and attitudes in primary care, which provides some guidance to the development of educational materials and policy for the new HPV screening programme.

COMPETING INTERESTS
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SI: conceptualisation, data curation, formal analysis, investigation, methodology, writing original draft and editing.
PS: conceptualisation, methodology, supervision, formal analysis, writing—original draft.
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JN: conceptualisation, methodology, writing—review and editing.
CI: conceptualisation, methodology, writing—review and editing.
STW, AT, LM, JM, BH, MG: methodology, validation, writing—review and editing.

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Appendix 1: Questionnaire provided to respondents

Section	Question number	Question	Available answers (for Q9–19, correct answer highlighted with * and bold font)
Demographics	1	What is your role?	GP/GP nurse/nurse practitioner/ other (please specify)
	2	What is your age?	18–24/25–34/35–44/45–54/55–64/ 65+/prefer not to answer
	3	What is your gender?	Female/male/gender neutral/prefer not to answer/other (please specify)
	4	Which ethnic group do you belong to? (Please select all that apply.)	NZ European/Māori/Cook Island Māori/Tongan/Niuean/Chinese/ Indian/prefer not to answer/other e.g., Dutch, Japanese, Tokelauan (please specify)
	5	What population does your practice predominantly serve?	Urban (large city)/urban (town)/ rural
	6	Is there a high proportion of Māori patients enrolled at your practice (>16.5% of patients)?	Yes/no/don't know
	7	Is there a high proportion of Pasifika patients enrolled at your practice (>8.1% of patients)?	Yes/no/don't know
	8	How frequently do you perform a cervical smear?	Every day/about once a week/a few times a week/a few times a month/ less than once a month
HPV cervical screening	9	Approximately what proportion of sexually active people are exposed to Human Papillomavirus (HPV)?	10%/35%/50%/**80%***/90%/don't know or not sure
	10	Which two HPV types cause around 70% of cervical cancers?	**16 and 18***/18 and 31/31 and 33/31 and 45/don't know or not sure
	11	Approximately what proportion of high-grade changes and cervical cancers are missed by cervical cytology?	5%/10–15%/**20–30%***/45–60%/ don't know or not sure
	12	Approximately what proportion of high-grade changes and cervical cancers are missed by HPV testing?	**5%***/10–15%/20–30%/45–60%/ don't know or not sure

Appendix 1 (continued): Questionnaire provided to respondents.

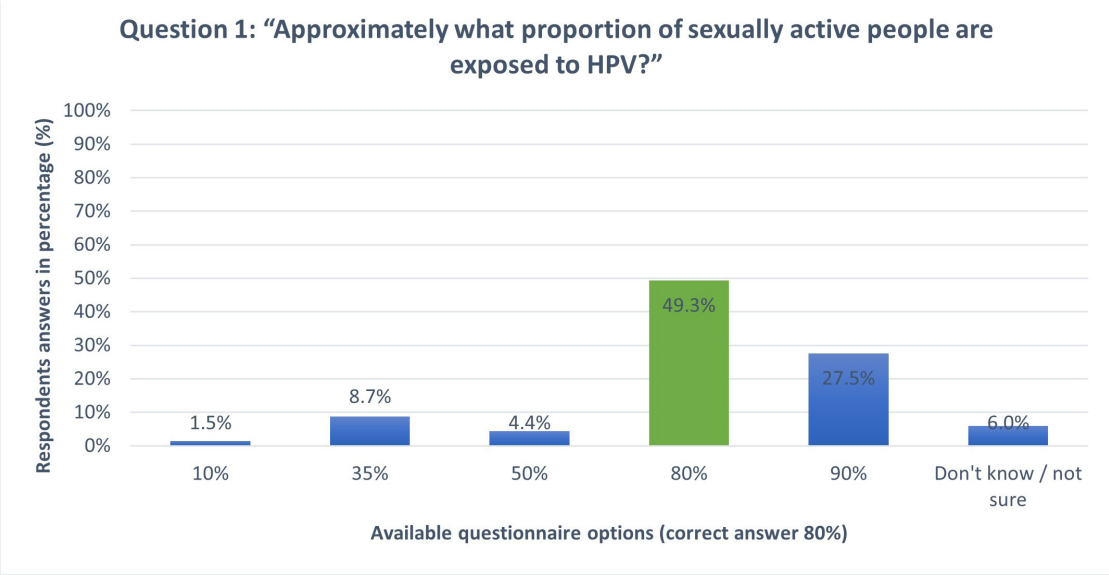
	13	Which is more reliable: a self-collected HPV test or a clinician-collected HPV test?	Self-collected HPV test/clinician-collected HPV test/**they are similar in reliability***/don't know or not sure
	14	Which is better at detecting glandular cervical abnormalities?	Cervical cytology/**HPV testing***/ they are the same/don't know or not sure
	15	According to the proposed NCSP HPV screening guideline, if someone has a negative HPV test and a normal cervical screening history, when should they be recalled for their next cervical screen?	2 years/3 years/**5 years***/7 years/ don't know or not sure
	16	According to the proposed NCSP HPV screening guideline, if someone tests positive for high-risk HPV "other" types, what will be the next recommended step for investigation?	Repeat HPV testing in 1 year/ **cervical cytology***/colposcopy/ don't know or not sure
	17	According to the proposed NCSP HPV screening guideline, if someone tests positive for HPV types 16/18, what will be the next recommended step for investigation?	Repeat HPV testing in 1 year/ cervical cytology/**colposcopy***/ don't know or not sure
	18	Which statement is correct? In people due for a cervical screen who report intermenstrual or post-coital bleeding, the most appropriate management plan should be:	To take an HPV test/to take self-STI swabs/A & B/**a face-to-face appointment for clinical review and examination***/don't know or not sure
Anticipated issues implementing the new NCSP HPV screening programme	19	If a patient is able to do an HPV vaginal self-test at home, overall, how challenging do you foresee the following logistical issues? (please choose one option per row) 1–5 challenge scale for each of the factors opposite: not at all challenging/mildly challenging/moderately challenging/very challenging/extremely challenging	• Getting the sample kit to patient • Ensuring the patient knows how to do the test • Ensuring the patient does the test • Ensuring labelling on request form and sample are correct • Getting the sample to lab • Getting the result to the attention of the responsible clinician • Informing patient of result and recommendation for follow-up • Following up on test if not performed • Other challenges not listed: please specify

Appendix 1 (continued): Questionnaire provided to respondents.

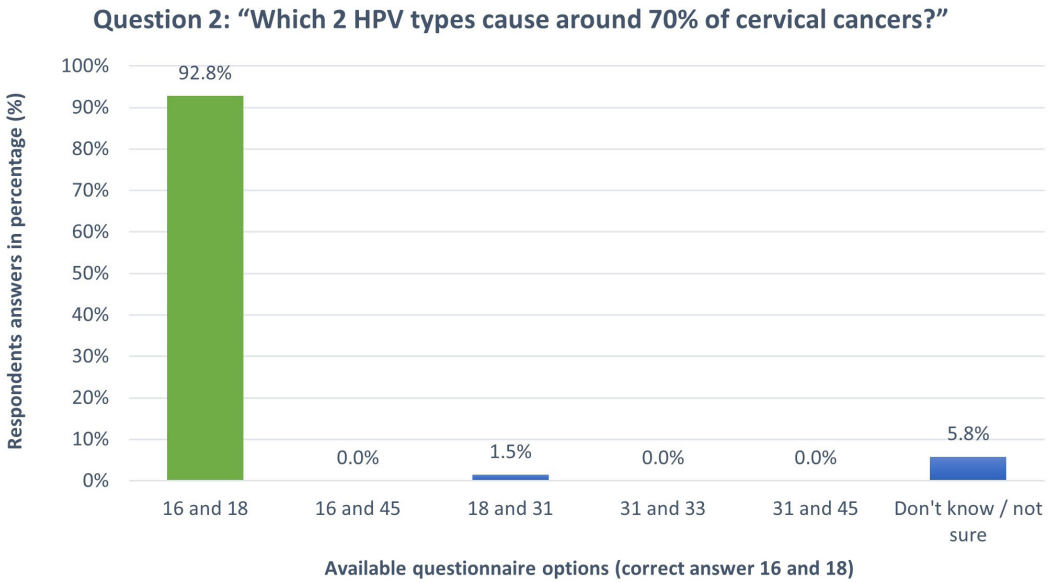
	20	In your opinion, who do you think should communicate the recall to people due for cervical screening? (Please choose all that apply)	• The NCSP • The PHO • The General Practice • A community health worker (e.g., kaiāwhina) • Other (please specify)
	21	Do you feel you would benefit from further education with regards to any of the following aspects of the proposed NCSP HPV testing cervical screening programme? (Please choose all applicable)	• Natural history of HPV virus • Role of different HPV types in cervical cancer • Role of HPV vaccine (including impact on HPV screening) • Reliability of HPV screening • Practical aspects of HPV testing (e.g., how to perform test, what kind of swab to use, etc.) • Clinical management of results (e.g., who to refer to colposcopy, when to recall patients, etc.) • Other queries: please state
	22	Do you have any other comments about the proposed NCSP HPV testing cervical screening programme?	Free-text answer box

Appendix 2: Knowledge of, and barriers to, HPV screening in selected general practices across New Zealand

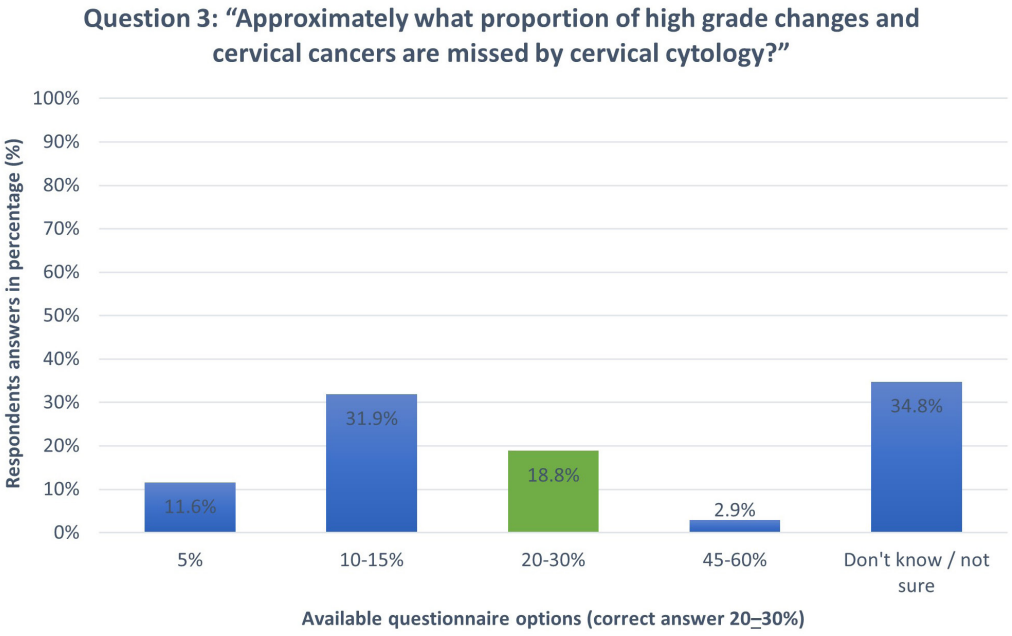
Appendix Graph 1: Results of question 1 "Approximately what proportion of sexually active people are exposed to HPV?". The available multichoice options are displayed on the x axis, with the correct answer highlighted green.



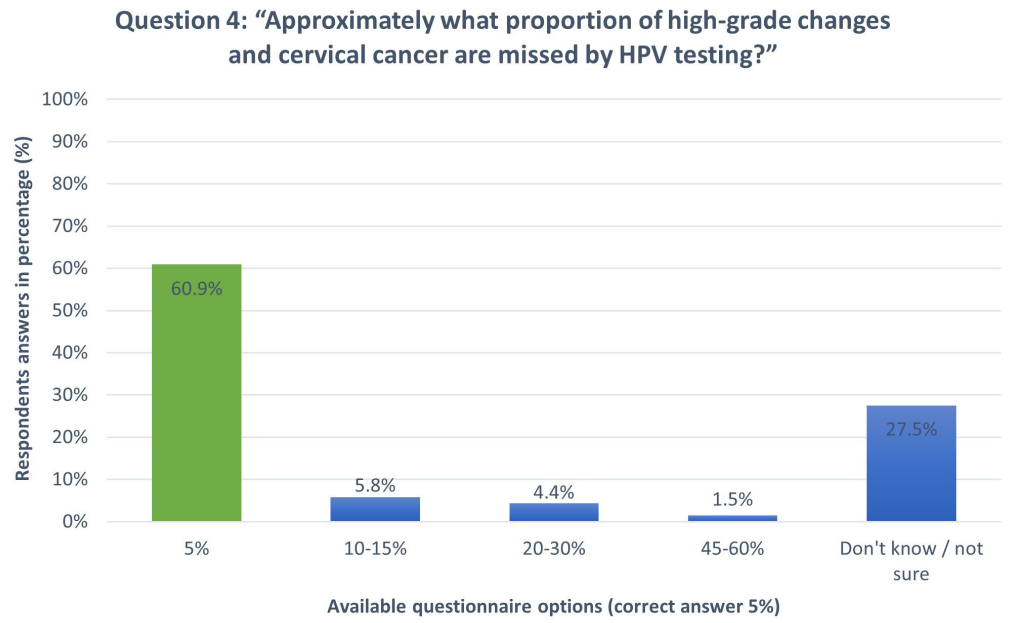
Appendix Graph 2: Results of question 2 "Which two HPV types cause around 70% of cervical cancers?". The available multichoice options are displayed on the x axis, with the correct answer highlighted green.



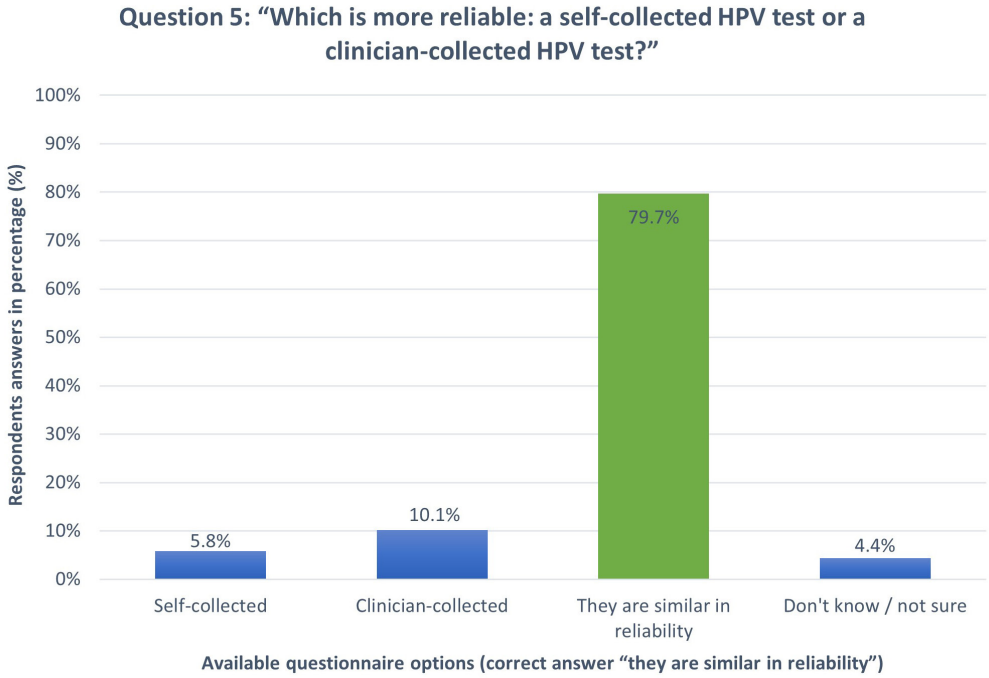
Appendix Graph 3: Results of question 3 "Approximately what proportion of high grade changes are missed by cervical cytology?". The available multichoice options are displayed on the x axis, with the correct answer highlighted green.



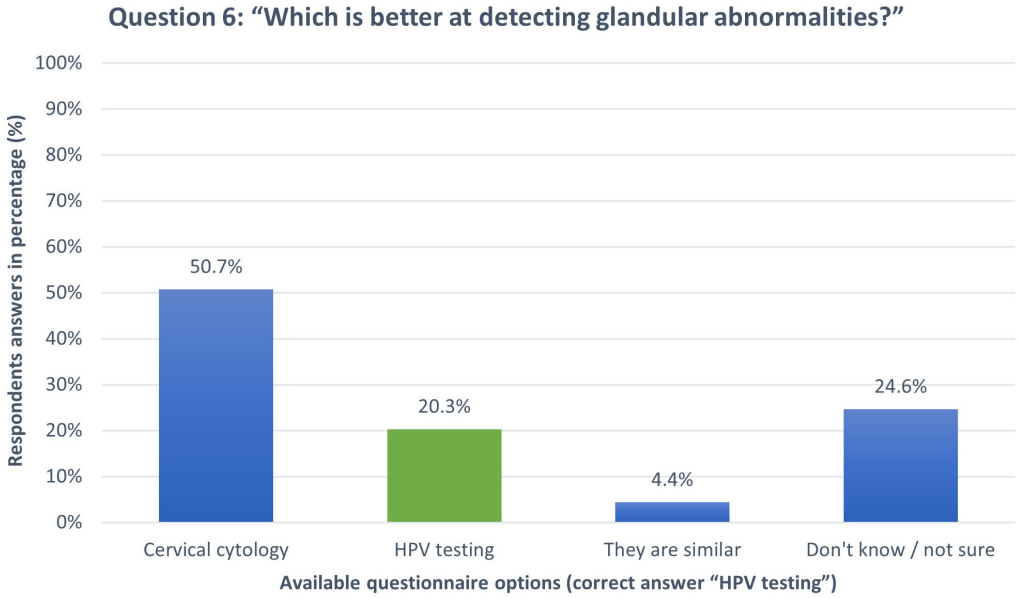
Appendix Graph 4: Results of question 4 "Approximately what proportion of high-grade changes are missed by HPV testing?". The available multichoice options are displayed on the x axis, with the correct answer highlighted green.



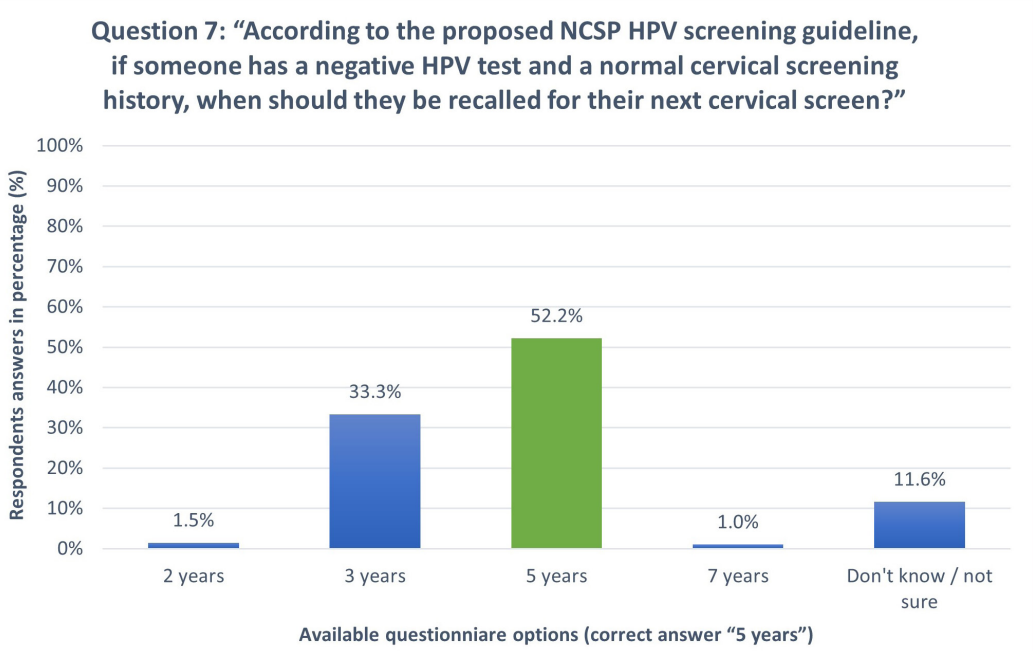
Appendix Graph 5: Results of question 5 "Which is more reliable: a self-collected HPV test or a clinician-collected HPV test?". The available multichoice options are displayed on the x axis, with the correct answer highlighted green.



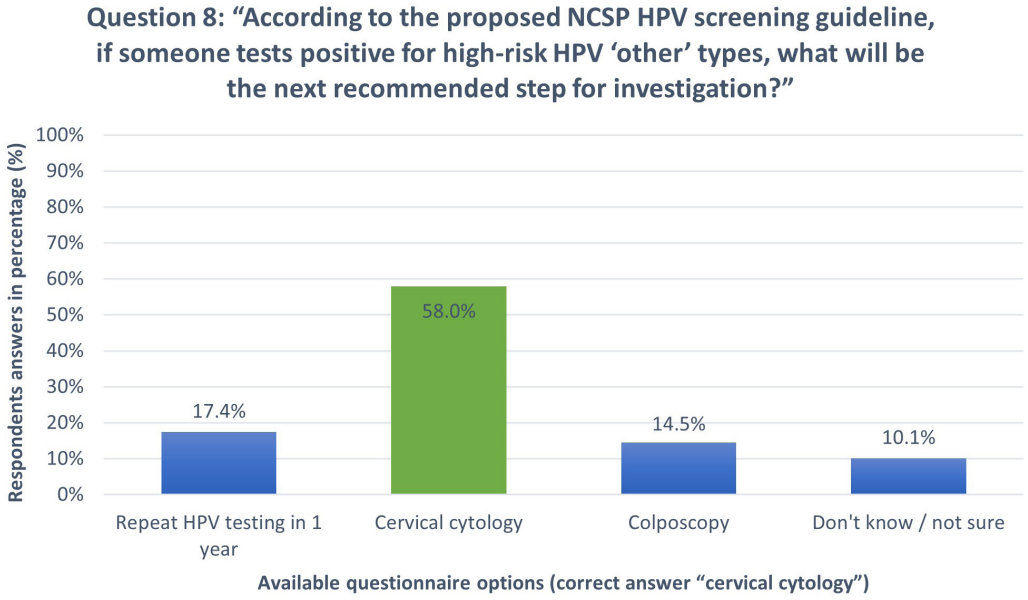
Appendix Graph 6: Results of question 6 "Which is better at detecting glandular abnormalities?". The available multichoice options are displayed on the x axis, with the correct answer highlighted green.



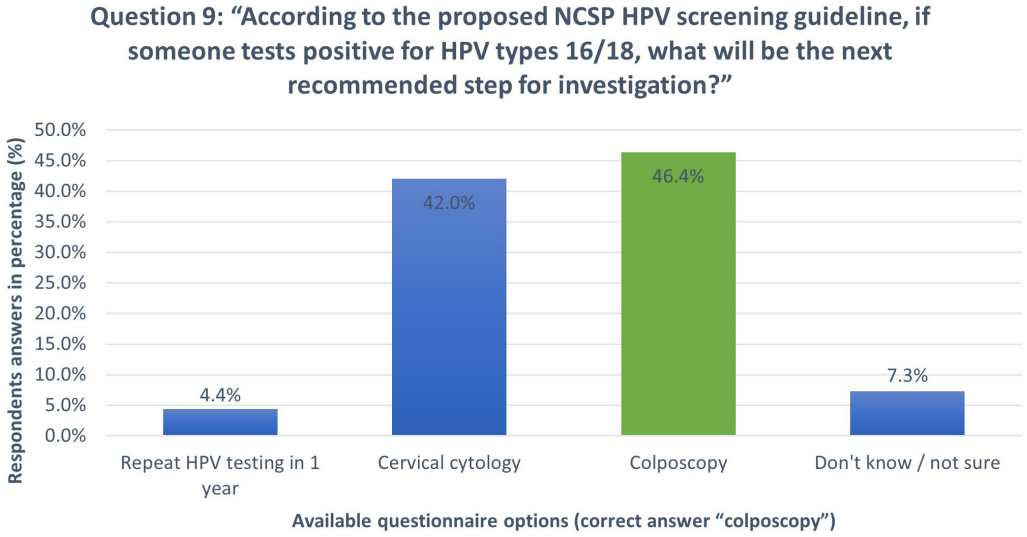
Appendix Graph 7: Results of question 7 "According to the proposed NCSP HPV screening guideline, if someone has a negative HPV test and a normal cervical screening history, when should they be recalled for their next cervical screen?". The available multichoice options are displayed on the x axis, with the correct answer highlighted green.



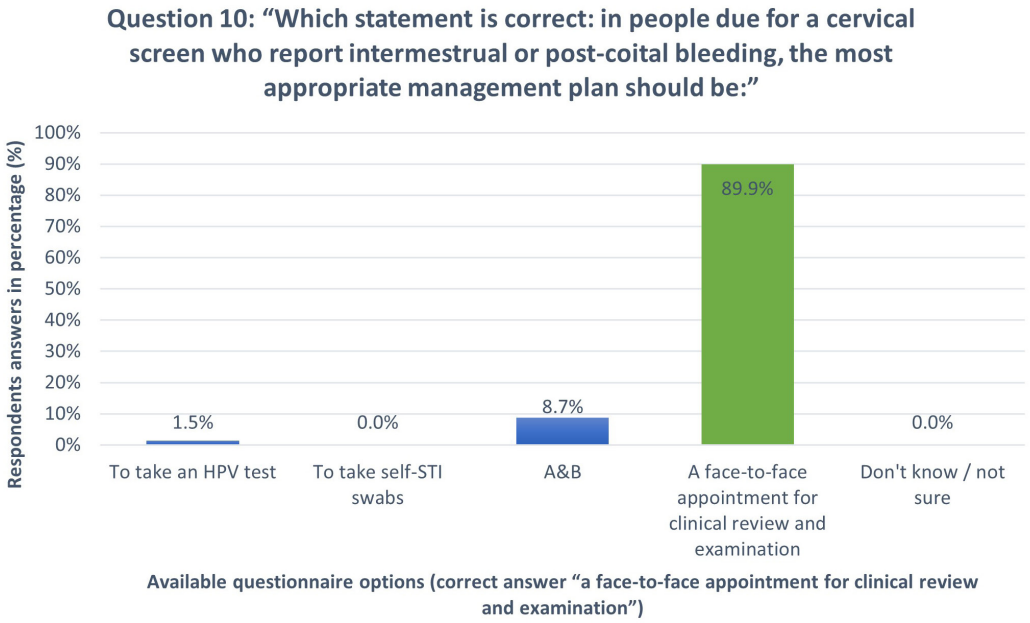
Appendix Graph 8: Results of question 8 "According to the proposed NCSP HPV screening guideline, if someone tests positive for high-risk HPV 'other' types, what will be the next recommended step for investigation?". The available multichoice options are displayed on the x axis, with the correct answer highlighted green.



Appendix Graph 9: Results of question 9 "According to the proposed NCSP HPV screening guideline, if someone tests positive for HPV types 16/18, what will be the next recommended step for investigation?". The available multichoice options are displayed on the x axis, with the correct answer highlighted green.



Appendix Graph 10: Results of question 10 "Which statement is correct: in people due for a cervical screen who report intermenstrual or post-coital bleeding, the most appropriate management plan should be:". The available multichoice options are displayed on the x axis, with the correct answer highlighted green.



Heart Rhythm New Zealand consensus statement on the practical management of cardiac implanted electronic devices in the peri-operative environment

Emma Guglietta, Sharron Denekamp, Susan Sinclair, Lucy Harris, Paula Bishop, Nivashni Naidoo, Timothy Holliday, Matthew Chacko, Ross Downey, Janice Swampillai, Andrew Martin, Matthew Webber

ABSTRACT

Electrosurgery is commonly used during a range of operations in order to maintain effective haemostasis. This can cause electromagnetic interference (EMI) with cardiac implanted electronic devices (CIEDs), which prevents normal device function. CIEDs include pacemakers (PPM), implantable cardiac defibrillators (ICD), cardiac resynchronisation therapy devices—both pacemakers and defibrillators (CRT-P/CRT-D)—and implantable loop recorders (ILRs). Damage to the generator, inhibition of pacing, activation of asynchronous pacing and ventricular fibrillation can all be induced by electrocautery. An active management plan for CIEDs during electrosurgery is critical to minimise these adverse effects of EMI.

PURPOSE: To facilitate the safe and effective peri-operative management of CIED patients during electrosurgery.

Heart Rhythm New Zealand (HRNZ) is an integral part of the Cardiac Society of Australia and New Zealand (CSANZ). It is composed of members of CSANZ who have expertise in the field of electrophysiology and cardiac rhythm devices. The consensus statement was generated using a combination of current international guidelines and publications, adapted to be relevant to the New Zealand medical system. The writing committee was comprised of stakeholders from the specialities who frequently manage cardiac implanted electronic devices (CIED) patients during electrosurgical procedures. Consultation within each specialty was sought, and feedback was discussed as a group and adopted where appropriate.

CIEDs can be prone to electromagnetic interference (EMI) during surgical/medical procedures using electrocautery. The factors determining the potential for EMI to affect normal device function are: the distance between source and site of CIED (less risk if >15cm from device), the intensity and duration of field or source, the frequency and waveform of signal and the path of current and its relation to the orientation of CIED leads. EMI usually only disrupts normal device function transiently, and when the interference ceases, the device typically returns to normal function.

Common adverse effects due to the CIED sensing EMI can include: inhibition of pacing—leading to haemodynamically significant bradycardia or asystole in the pacemaker (PPM) dependent patient, inappropriate tachyarrhythmia therapy with anti-tachycardia pacing and/or shocks in the implantable cardiac defibrillator (ICD) patient, inappropriate tracking of electrical noise causing pacing at upper rate and/or mode switching due to over-sensing of EMI on atrial lead, activation of asynchronous noise reversion mode and changes in pacing behaviour such as the activation of rate response algorithms. Rare adverse effects can include: thermal injury at the lead/myocardial interface, increased pacing thresholds, electrical reset of the device causing change in settings, and permanent damage to device (legacy devices are more prone to this).

Recommendations for peri-operative management of CIED patients have significantly altered in recent years, with advancements in device technology establishing a higher degree of tolerance to routine electrosurgical procedures. However, concurrently, newer electrosurgical technologies and CIED

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technologies are also occurring; this represents a challenge to the manufacturers of the CIEDs and CIED professionals.

Manufacturer-specific information should be used for magnet placement. Implantable defibrillators are generally implanted at the left prepectoral position, but some may be right prepectoral, abdominal implants or subcutaneously implanted in the left axilla. PPM generators are generally implanted left or right prepectoral, but some are implanted in the abdomen, particularly in children. Leadless devices are implanted directly in the heart.

General principles

Centres performing electrosurgery on patients with CIEDs are recommended to have an institutional protocol. Protocols may vary between centres depending on the availability of specialist device physiologists in each centre. The patient's CIED service should be contacted for specialist device physiologist advice. For elective procedures, advice should be requested well in advance of surgery.[1–4] The peri-operative management of CIEDs must be individualised to the patient, the type of CIED and the type of procedure being performed.[1–4] A single recommendation for all CIED patients is not appropriate.[1]

The decision to reprogram a device vs magnet use will depend on staff availability, urgency of surgery and surgical site. The most effective advice for the peri-operative care of a patient with a CIED will be obtained from the team that monitors that patient and device, combined with an understanding of the procedure to be performed and risk for EMI.[1–4]

All patients with PPM undergoing elective surgery should have had a device interrogation as part of routine care within the past 12 months. All patients with ICDs or any cardiac resynchronisation therapy (CRT) device (cardiac resynchronisation therapy defibrillator [CRT-D], cardiac resynchronisation therapy pacemaker [CRT-P]) undergoing elective surgery should have had a device interrogation as a part of routine care within the past 6 months; this may be in person or via remote monitoring.[1–4] Implantable loop recorders (ILRs) should be interrogated prior to surgery if the surgery is near the device, as EMI from electrosurgery may overwrite data. Interrogation can be done via remote monitoring or in person.[2]

Electrosurgery and CIEDs

Electrosurgery may be either monopolar or bipolar. Bipolar electrosurgery or the use of an ultrasonic scalpel is preferred to monopolar electrosurgery as these result in less EMI; however, these technologies are not appropriate for all electrosurgery operations.[2] Bipolar electrosurgery does not use a return pad and is unlikely to cause EMI unless applied directly to the device, but precautions need to be taken for some legacy devices.[5] Monopolar electrosurgery has the current flow through the patient's body to a patient return electrode, casting a wider electrical field. Device interference is unlikely if surgery is below the iliac crest and the return pad is on the thigh ipsilateral to the surgical site.[2] Newer capacitive return electrodes (mattress type) may disperse the current throughout the body depending on mattress placement regardless of the anatomical site of surgery, so devices are at higher risk of EMI, especially if the mattress is under the patient's chest.[6,7] PPM implanted in the abdomen will be more exposed to EMI during abdominal or pelvic surgery. Monopolar electrosurgery above the iliac crest and/or <15cm from the device has a higher risk of EMI.[1–4]

Recommendations for use of electrosurgery to avoid EMI interference with CIEDs:

- Follow electrosurgery unit manufacturer's guidelines for patient return electrode orientation.
- Use a harmonic (ultrasonic) scalpel or bipolar electrosurgery where possible.
- Place the patient return electrode on clean, dry, hair-free skin over a large, well-perfused muscle mass as close as possible to the surgical site, but >15cm from CIED.
- Ensure the heart and CIED are not between the site of surgery and the return electrode, e.g., patients undergoing head/neck surgery should have the grounding pad placed on the shoulder contralateral to the device (not the thigh), whereas those undergoing breast and axillary surgery should have the pad placed on the upper arm.[8–10]
- Capacitive full body return electrodes (mattress type) are designed to remove the risk of pad-site burns associated with the adhesive return electrodes. The return current is distributed over the whole area of the mattress, which may cause inhibition of pacing or ICD therapy even if the surgical site is below the iliac crest.[6,11]
- In PPM-dependent patients, the use of an adhesive return electrode pad is preferred to a mattress type electrode as there is potential for pacemaker inhibition due to

EMI regardless of surgery site, unless the device is appropriately programmed prior to the procedure.[2,6,11,12]
- Use monopolar electrosurgery in short bursts (<5 secs), intersected by pauses. Pure unblended cut is less likely to cause interference than the blended or coagulation settings of the electrosurgery unit. Use the lowest feasible energy.[1–4,10]
- Monitor patients with electrocardiogram (ECG) and pulse oximetry (and/or arterial line). Interference may saturate the ECG signal during electrosurgery, making it impossible to see inhibition of pacing.
- Ensure an external defibrillator capable of transcutaneous pacing is readily available for PPM-dependent patients or operations with high risk of EMI identified by the specialist device physiologist. Place transcutaneous pacing/defibrillator pads, including ECG, prior to draping if there are any concerns or barriers to placement during a case.
- If a specialist physiologist has recommended the use of a magnet, the magnet should only be applied for the duration of the electrosurgery.

Pre-operative device reprogramming and/or magnet use

All patients undergoing electrosurgery who have a CIED should be discussed with a specialist device physiologist prior and have a peri-operative CIED management plan established. This may include a recommendation for device reprogramming and/or magnet use.

Magnet use, placement and CIED response must be fully understood before use.[1–4,13,14] Magnet use may be recommended to inhibit ICD therapy or force asynchronous pacing. The use of a magnet and the response of the device to a magnet should be guided by a specialist device physiologist, as this varies depending on device type and manufacturer.[1,2,4,13,14] When a magnet has been recommended, the magnet response should be verified as expected prior to being required in PPM-dependent patients (Table 1 and 2).

If device reprogramming is recommended, it should be performed by a specialist device physiologist. Programming should be performed as close as possible to the time of surgery in case of delay or cancellation of surgery. ICDs should be reprogrammed to therapy off/or a magnet used to inhibit therapy only once the patient is in a monitored environment with ECG/pulse oximetry monitoring; defibrillator pads should be placed prior to programming the ICD off.[1–4] PPM that are programmed asynchronous (DOO/VOO/AOO) for the duration of surgery should also be monitored as above.[1,2] Rate response functions may increase heart rate during surgery in response to external stimulus or intra-operative events and may cause PPM-driven tachycardia. Minute ventilation sensors may emit a current to measure changes in thoracic impedance that can be detected by monitoring equipment and appear to be rapid pacing without capture. The rate response sensor may need to be programmed off prior to surgery if recommended by a specialist device physiologist.[1–4,15] Any changes to the CIED settings should be documented in the patient record (Figure 1).

When to consider CIED reprogramming for surgery rather than magnet application

- Where the device is not easily accessible to allow placement of the magnet during surgery, due to site of surgery or patient positioning.[1–4]
- Unipolar leads or where a CIED is programmed to unipolar sensing, due to a greater risk of oversensing EMI.[1–4]
- Biotronik PPM where asynchronous mode is likely to be required, i.e., pacing-dependent patient—magnet mode should be reprogrammed from “auto” to “async” or device programmed to asynchronous.[13]
- Pacing-dependent ICD patients as magnet use will not provide asynchronous pacing.[1–4]
- For ICD patients where correct magnet placement is difficult to assess (no tones) and monopolar electrosurgery is being used above the iliac crest or a capacitive return mattress is used.[8]
- If surgery is less than 15cm from the CIED generator for PPM-dependent patients and all ICD patients.
- Where a higher or lower base rate is desirable due to patient haemodynamics as requested by the medical team, surgeon or anaesthetist.
- Leadless PPM, which are implanted directly into the ventricle (Micra/Nanostim/Aveir) and subcutaneous ICDs (S-ICD Emblem/EV-ICD), need specific advice from a device physiologist as the advice, response to magnets and magnet placement may differ.[1–4]

Intra-operative CIED management

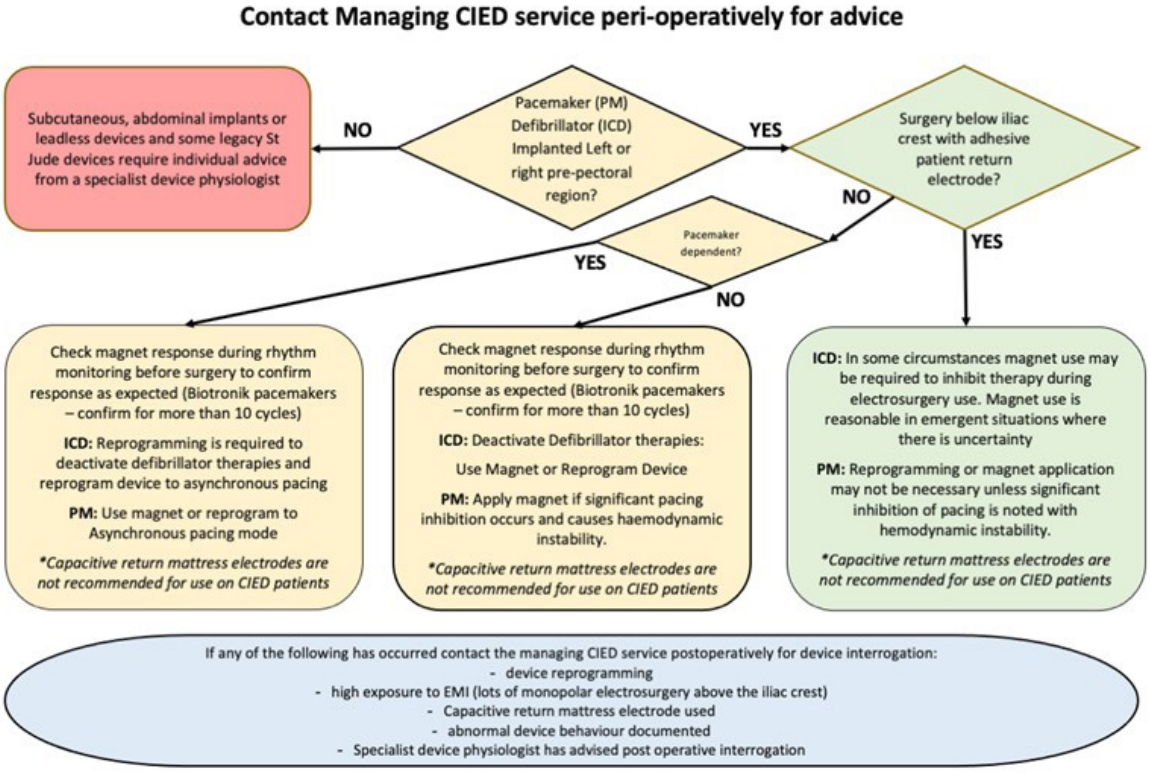
Patients should be monitored with ECG and pulse oximetry/or arterial line during the procedure, as the ECG tracing will be obscured during electrosurgery.[1–4] An external defibrillator with pacing capabilities should be readily available for all CIED patients, along with staff trained in its use.[1–4]

A magnet should be immediately available for all CIED patients who are undergoing a procedure that may involve EMI even if reprogrammed, along with staff familiar with the use of magnets[1–4] Caution should be exercised when using magnetic drapes to hold surgical equipment; placement of these on the thorax should be avoided. The use of bottom-isolated magnetic drapes may reduce the risk of interaction.[16]

Post-operative indications for CIED interrogation

- Patients with CIEDs reprogrammed prior to the procedure.[1–4] If ICD therapies are deactivated for surgery/procedure or a PPM is programmed to asynchronous mode, the team requesting reprogramming are responsible to ensure the device is returned to normal operation as soon as practicable and should have a clear plan for this.[3,4]
- Patients with CIEDs who underwent hemodynamically challenging surgeries such as cardiac surgery or significant vascular surgery (e.g., abdominal aortic aneurysmal repair), which likely have higher probability of significant EMI.[1–4]
- Patients with CIEDs who experienced significant intra-operative events including cardiac arrest requiring temporary pacing or cardiopulmonary resuscitation and those who required external electrical cardioversion.[1–4]
- Patients with CIEDs who underwent monopolar electrosurgery with a capacitive return mattress and there is a greater probability of EMI affecting device function, as determined by a specialist device physiologist.[2,6]
- Patients with CIEDs who underwent monopolar electrosurgery above the iliac crest and there is a greater probability of

Figure 1: Decision matrix for peri-operative cardiac device management.
For use when the device has not been programmed specifically for the operation/procedure.



EMI affecting device function, as determined by a specialist device physiologist.[1–4]
- Patients with signs of device dysfunction observed intra-operatively, e.g., heart rates below or above programmed or expected rates, pectoral or diaphragmatic twitching, erroneous pacing spikes (such as pacing spikes that vary considerably in size) and alarms, beeping or vibrating from device.[1–4]
- Post-magnet use where the specialist device physiologist has identified the CIED is nearing elective replacement. In this situation, magnet movement, EMI and battery status may cause unintended device programming due to tripping elective replacement. Changes in programming may not always be noticeable, e.g., increase in pacing rate, change in pacing mode, deactivation of rate response sensors for PPM, device alarms, beeping or vibration for ICDs due to battery status alert.[3]
- Where a specialist cardiac device physiologist has recommended post-operative interrogation.
- Where a specialist cardiac device physiologist has identified the CIED is a legacy Abbott/St Jude Medical device subject to safety alert (Affinity, Entity, Integrity, Identity, Verity, Frontier, Victory, Zephyr) see *Special considerations*.[5]

When emergency surgery is required

In situations where CIED patients present for urgent surgery, contact the patient's CIED centre or nearest tertiary hospital for advice. The availability of staff at local follow-up centres will vary during work hours and after hours. All tertiary cardiology centres in New Zealand have staff on call after hours.

Prior to making contact, it is helpful to the on-call team if the type of device/model can be identified—access hospital notes, question patient/attending support people and enquire if patient has a device ID card. Review the chest X-ray and 12-lead ECG.[1–4] If PPM spikes are present it should be presumed the patient is potentially PPM-dependent. Newer devices will have bipolar pacing spikes, which are very small (1mm) and may be difficult to see on the ECG. Unipolar pacing spikes are large spikes and obvious on the ECG; the presence of these may indicate older device/leads that may be more susceptible to interference.[1–4] A remote monitoring transmission can be considered as a substitute for in-person interrogation if no available specialist device physiology staff are on site.[1–3]

Defibrillator/pacing pads should be readily available in the event defibrillation or transcutaneous pacing is required. A defibrillator capable of transcutaneous pacing and a magnet with instructions for use (Table 1 and 2) should be readily available along with staff trained in its use.[1–4] In individual circumstances, pads may need to be placed prophylactically, which would be advised by a specialist device physiologist. If magnet use is likely to be required, identify the expected magnet response prior to surgery (Table 2).[1–4]

If surgery is above the iliac crest or a capacitive return electrode mattress is used, have a magnet available for PPM patients to provide asynchronous pacing should significant periods of inhibition occur during electrosurgery resulting in asystole or haemodynamically compromising bradycardia. Transient inhibition of pacing should be expected during the delivery of electrosurgery, but normal pacing is expected to return immediately upon termination of this. Asynchronous pacing will only occur while the magnet is *in situ*.[1–3,6] Please note the magnet response for Biotronik devices is only asynchronous for 10 beats unless the magnet response is specifically programmed to "async".[1–4]

For ICD patients there is the potential for inappropriate ICD shock therapy during electrosurgery due to sensing of EMI (Table 1). ICD tachyarrhythmia therapy can be temporarily disabled by placing a magnet over the device during electrosurgery. Therapies will resume on removal of magnet. When access to the device for magnet placement is not possible (e.g., due to patient position), programming by a specialist device physiologist may be required prior to surgery to disable tachyarrhythmia therapies. The correct positioning of a magnet is manufacturer specific; advice should be sought from a specialist device physiologist where possible (Table 1). In pacing-dependent ICD patients, electrosurgery should be in short bursts of <5 seconds to prevent long periods of inhibition—a magnet will only inhibit tachyarrhythmia therapy and will not provide asynchronous pacing.[1–4] In pacing-dependent ICD patients, the CIED may need to be re-programmed to provide asynchronous pacing if the operative field is above the iliac crest and EMI is likely to cause significant periods of inhibition, or if a capacitive return mattress is being used.[1,2]

Table 1: Magnet response—defibrillators.

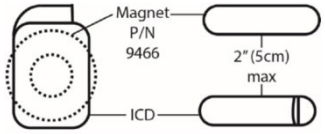
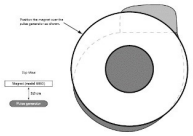
Summary of magnet application to ICDs—modified from Jacobs et al., Heart Rhythm Society/American Society of Anesthesiologists expert consensus statement on peri-operative management of patients with CIEDs and the European Heart Rhythm Association consensus on prevention and management of interference due to medical procedures in patients with CIEDs.[1,2,14,17]						
Company	**Magnet placement**	**Tachy/shock therapy**	**Tone emitted with magnet**	**Effect on Pacer component of ICD**	**Can ICD be pro-grammed to ignore magnet?**	**Notes**
Medtronic	Directly over device[18]  	Suspended—while magnet *in situ*	Yes Loud and continuous for 30 seconds if normal function Alternating tone indicates an alert warranting a device interrogation	None	No	
Boston Scientific	Directly over device—transvenous and 101 SQ-RX[19]  Emblem subcutaneous ICD. Off-centre over header or lower[19] 	Suspended*—while magnet *in situ* *unless programmed to change therapy	Yes R-wave synchronous tones (very faint, not loud); use stethoscope to hear if required NB: If patient has had an MRI the beeper function may be permanently disabled. Verify beeper function before surgery	None	Yes (but very rare)* *Can be programmed off or to trigger EGM in some legacy models	

Table 1 (continued): Magnet response—defibrillators.

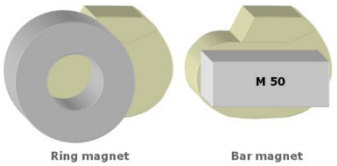
Biotronik	Directly over device Ring magnets should be offset slightly so that the opening of the magnet rests above the edge of the ICD housing 	Suspended—while magnet *in situ*, limit of 8 hours	None	None	No	Will revert to normal function after 8 hours unless magnet is removed and replaced
St Jude (Abbott)	Curve of donut over left or right side of device 	Suspended*—while magnet *in situ* *unless programmed to ignore	None May vibrate* *If vibrates, device interrogation is warranted	None	Yes (very rare)* *Can be programmed to ignore magnet	

Table 1 (continued): Magnet response—defibrillators.

Liva Nova (previously ELA/Sorin)	Magnet should be positioned off-centre, avoiding the header at the top of the device 	Suspended—while magnet *in situ*	None	Converts pacer rate to 96–85ppm depending on battery life. Pacing mode unchanged		No option to convert to asynchronous pacing mode

NB: Magnet removal will restore shock and anti-tachycardia therapies

Table 2: Magnet response—PPM.

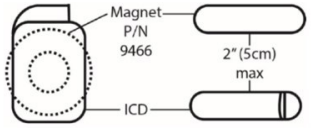
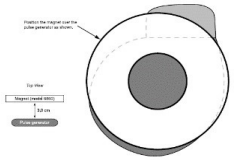
Summary of magnet application to PPM—modified from Jacobs et al., Heart Rhythm Society/American Society of Anesthesiologists expert consensus statement on peri-operative management of patients with CIEDs and the European Heart Rhythm Association consensus on prevention and management of interference due to medical procedures in patients with CIEDS.[1,2,14]					
Company	**Magnet placement**	**Default response**	**Tone emitted with magnet**	**Can PPM be programmed to ignore magnet?**	**Notes**
Medtronic	Directly over device* 	DOO/VOO/AOO—while magnet *in situ* 85ppm if device conditions are normal 65ppm if device is at RRT or device reset has occurred—a full device interrogation is warranted Normal function resumes 2 seconds after removal of magnet *Micra Leadless Pacemaker has no magnet response	No	Magnet operation does not occur if telemetry between device and programmer is established or if MRI Surescan is programmed on	AV delay 100ms in DOO Azure 100ppm for 5 beats then default response Adapta™/Versa™/Sensia™ TMT 100bpm with the amplitude reduced by 20% on the third pulse, then default response. For certain legacy models (Kappa, Enpulse, Adapta, Versa or Sensia), the magnet response is suspended for 1 hour following a device interrogation unless manual "clear data" command is chosen prior to ending the programmer session
Boston Scientific	Directly over device 	DOO/VOO/AOO—while magnet in situ 100ppm if device conditions are normal 90ppm if device is at 1 year or less battery life 85ppm RRT	No	Yes—can be programmed to store EGM Current devices restore magnet function after 1 stored EGM or 60 days elapse. Legacy devices require magnet function to be programmed back on	AV delay 100ms in DOO The third pulse during async magnet response is issued at 50% of the programmed pulse width—consider reassessing safety margin if loss of capture is observed

Table 2 (continued): Magnet response—PPM.

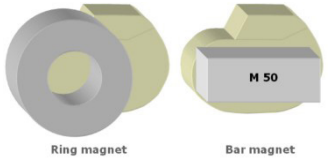
Biotronik	Directly over device  	Magnet response: auto* DOO/VOO/AOO 90ppm for 10 beats (80ppm @ ERI) then programmed mode and rate (PR -11% @ERI) Async* DOO/VOO/AOO 90ppm (80ppm @ ERI)—while magnet *in situ* Sync* programmed mode/rate—stores 10 second EGM (PR -11% @ ERI) rate response disabled	No	*Yes—3 modes available async/sync/auto	
St Jude (Abbott)	Curve of donut over left or right side of device* except leadless devices *Leadless PPM—a magnet applied over the apex of the heart 	DOO/VOO/AOO @100ppm—while magnet *in situ* Magnet rate gradually decreases over time 85ppm ERI *Aveir VOO 100ppm—while magnet *in situ* *Nanostim VOO 90ppm (65ppm @ ERI) —while magnet *in situ*	No	Yes—off, EGM store Vario (legacy devices)	Legacy devices that are subject to a safety alert make them more susceptible to transient anomalous device function during electrosurgery. This refers to a specific subset of legacy generation SJM PPM (SJM Affinity, Entity, Integrity, Identity, Verity, Frontier, Victory, Zephyr)[5] *Leadless PPM: The effectiveness of magnets varies. If one magnet does not cause magnet response, place a second magnet on top of the first or try a different magnet. Pressing firmly on the magnet to decrease the distance between the magnet and the pulse generator can also help

Table 2 (continued): Magnet response—PPM.

Liva Nova (previously ELA/Sorin)	Magnet should be positioned off-centre, avoiding the header at the top of the device 	DOO/VOO/AOO 96ppm—while magnet *in situ* Gradual decrease to 80ppm ERI	No	Yes—off	

NB: Magnet rate lower than default values indicates battery depletion. Some devices require more eccentric application of magnet in regard to generator casing to optimise magnetic field alignment.

Where the positioning of the patient limits access to the device for magnet placement, a specialist physiologist may be required prior to surgery to disable tachyarrhythmia therapies.

The post-operative device follow-up after surgery should be guided by a specialist device physiologist and should generally only be required for patients where CIED malfunction is suspected, significant exposure to EMI has occurred or if the device was reprogrammed prior to surgery.[1–4]

Special considerations

Cardioversion, defibrillation and transcutaneous pacing of adult CIED patients

High-voltage cardiac defibrillation can introduce a large amount of current to CIEDs. Adverse events during cardioversion, defibrillation and transcutaneous pacing are rare, though can include: elevated pacing thresholds/failure to capture, damage to the device and reversion to backup safety mode. Ideally, patients who have the potential requirement for defibrillation or transcutaneous pacing during a procedure will have pads placed in advance.

In pacing-dependent patients undergoing cardioversion, consider reprogramming the device to fixed outputs. This is to ensure 2x threshold safety margins, which may not always be the case when automatic threshold testing is enabled. The need to have a physiologist present during cardioversion is at the discretion of the specialist device physiologist.

In patients with an ICD or a permanent PPM, the placement of paddles/pads should not delay defibrillation.[20] A defibrillator capable of transcutaneous pacing should be utilised. The recommended positioning of the defibrillation pads should be in an anterior–posterior configuration (Figure 2) where possible, with the anterior pad placed at least 15cm from the generator.[1–4,21] For patients with large breasts, the anterior pad should be placed under the breast.[22] Alternative positioning with anterior–anterolateral (Figure 3) pad placement can be used if anterior–posterior placement is within the surgical field, or preferred for cardioversion of atrial fibrillation.[1–4,23] Alternative anterior–anterolateral pad placement may also be required in an emergency where it is not possible to attach a posterior pad easily.

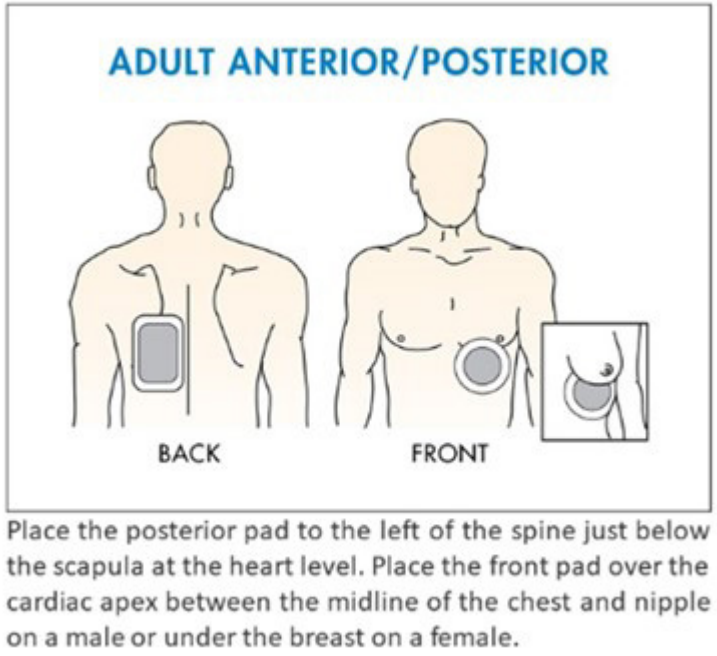
Following the procedure, the device should be interrogated and fully evaluated by a specialist device physiologist to ensure normal function.[1–4] When operating the defibrillator in automated external defibrillator (AED) mode, be aware that PPM pulses may prevent advisement of an appropriate shock, regardless of the patient's underlying rhythm.[20,24]

St Jude legacy devices

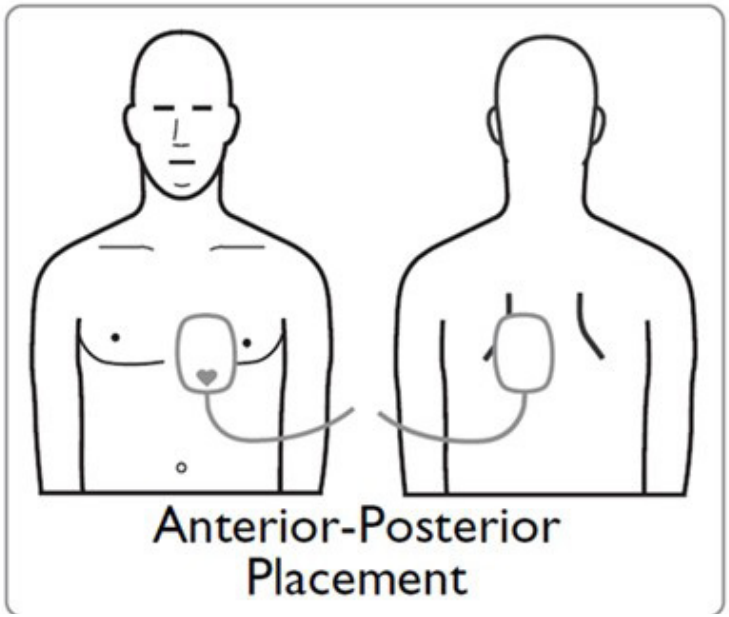
Abbott Medical (formerly St Jude Medical) legacy devices that are subject to a safety alert are more susceptible to transient anomalous device function during electrosurgery. This refers to a specific subset of legacy generation PPM, specifically: SJM Affinity, Entity, Integrity, Identity, Verity, Frontier, Victory and Zephyr. These devices may exhibit a temporary change in function that can persist for 30 seconds or longer, the most clinically significant observation being transient loss of capture due to reduction in pacing output voltage. This may occur regardless of program mode or magnet use.[5]

Figure 2: Defibrillator pad placement for cardioversion—adults anterior/posterior.

NB: Pads should always be placed >15cm away from CIED.



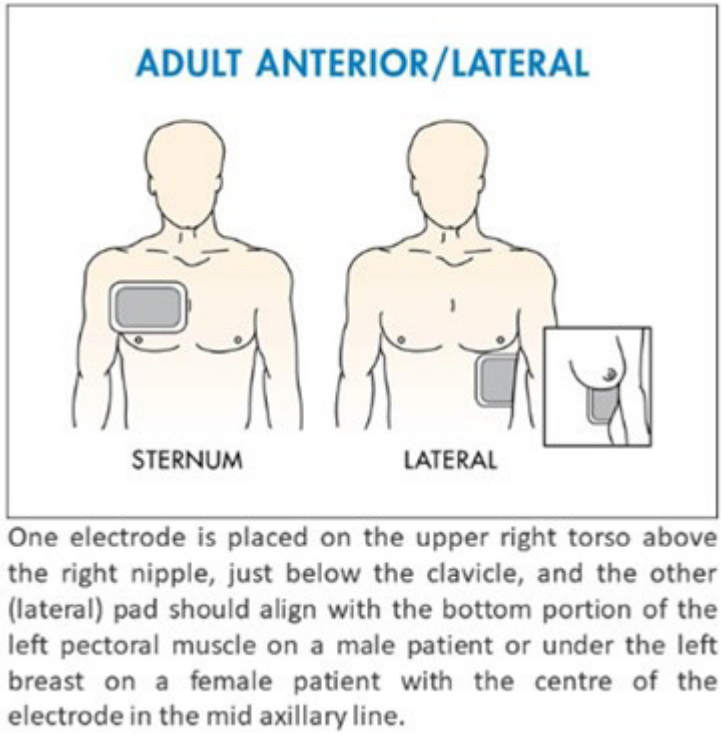
Reproduced with permission from Zoll Medical: Defibrillator Pad Placement, ZOLL Medical.[25]



Reproduced with permission from Philips HeartStart HS1/FRx: AED User Guide.[2]

Figure 3: Defibrillator pad placement for cardioversion—adults anterior/anterior lateral.
Some studies have indicated anterior–lateral electrode positioning is more effective for biphasic cardioversion of AF.[23]

NB: Pads should always be placed >15cm away from CIED.



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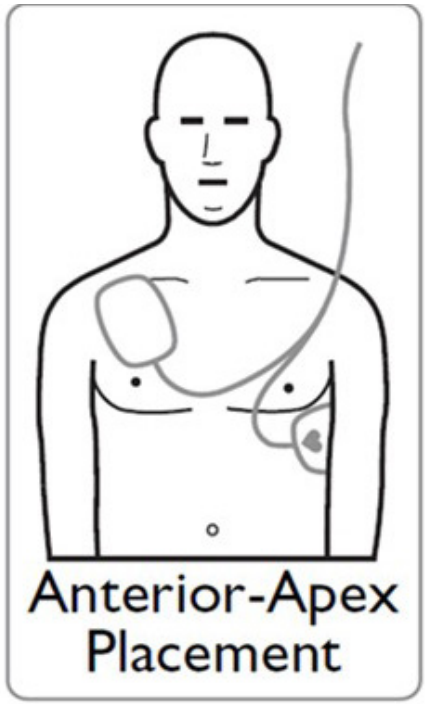

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COMPETING INTERESTS
The authors report no relationships that could be construed as a conflict of interest.

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2023 position statement on improving management for patients with heart failure in Aotearoa New Zealand

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ABSTRACT

Heart failure affects 1–3% of the population and remains a major public health problem, with high rates of hospitalisation and mortality. Health inequities in the incidence of heart failure have widened over the last 13 years in Aotearoa New Zealand. Urgent action is required to address the inequitable burden of heart failure among Māori and Pasifika. Regional and international heart failure guidelines now provide clear and consistent guidance on the contemporary approach to management for patients with heart failure. The purpose of this position statement is to ensure that all people in Aotearoa New Zealand have access to optimal healthcare delivery and pharmacotherapy for contemporary management of heart failure. Three main areas are addressed, including: 1) access to evidence-based pharmacotherapy for patients with heart failure, 2) the importance of early initiation and titration of pharmacotherapy, and 3) the workforce required to ensure timely delivery of heart failure therapies. Implementation of evidence-based healthcare will ensure all patients with heart failure in Aotearoa New Zealand have opportunity for substantial improvement in health.

Heart failure affects 1–3% of the population and more than 10% of those over the age of 70, and it remains a major public health problem.[1] While heart failure incidence rates appeared to be declining, recent Aotearoa New Zealand data have shown that the decline in incidence observed in the 2000s has now plateaued since ~2013.[2] This has been driven largely by an increase in incidence among younger people.

Equity considerations

Importantly, health inequities in the incidence of heart failure have widened in Aotearoa New Zealand over the last 13 years.[3] Previous data demonstrated that Māori were four times as likely to be hospitalised with heart failure and twice as likely to die from heart failure compared with non-Māori.[4] For Pasifika, hospitalisations due to heart failure were double that of non-Pasifika.[5] Recent national data provide important detail on the persisting health inequities relating to heart failure in Aotearoa New Zealand.[3] Firstly, incident hospitalisations for heart failure for Māori and Pasifika occur at a younger age, with two thirds of the cases occurring under 70 years, compared to one fifth for NZ Europeans. The disparity in incident hospitalisation rates was most marked for younger people, with Māori and Pasifika below the age of 50 having a six-fold higher risk of hospitalisation than NZ Europeans.[3] Furthermore, the decline in incident rate of hospitalisation for heart failure that has been observed for older NZ Europeans has not occurred for Māori and Pasifika.[3] Urgent action is required to address the inequitable burden of heart failure among Māori and Pasifika.

International guidelines for the management of patients with heart failure have been updated by the European Society of Cardiology in 2021[6] and by the American Heart Association/American College of Cardiology in 2022.[7] In 2022 a consensus statement[8] was published in Australia to provide updated guidance on the new recommendations for pharmacotherapy for patients with heart failure based on randomised trial evidence that had emerged since the 2018 Australian heart failure guidelines were published.[9] *2023 Focused Update of the 2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure* was released on 25 August 2023.[10] Collectively, these guidelines/consensus statement provide clear and consistent guidance on the contemporary approach to heart failure management.

The purpose of this position statement is to ensure that all people in Aotearoa New Zealand have access to optimal healthcare delivery and pharmacotherapy for contemporary management of heart failure. This will be addressed in the following sections:

1. Access to evidence-based pharmacotherapy for patients with heart failure
2. Importance of early initiation and titration of pharmacotherapy
3. The workforce required to ensure timely delivery of heart failure therapies

1. Access to evidence-based pharmacotherapy for patients with heart failure

Recommendations for pharmacotherapy for patients with heart failure can be considered according to the underlying left ventricular ejection fraction [LVEF] phenotype:

a) Heart failure with reduced ejection fraction (HFrEF)

Optimal therapy includes the following four classes of medications, all of which have Class 1-A recommendations in heart failure guidelines (i.e., recommended for use with data from multiple randomised controlled clinical trials) for use in patients with HFrEF:

- Renin-angiotensin system antagonist (ACE-inhibitor or angiotensin receptor antagonist
- [ARB] or the ARB and neprilysin inhibitor combination [ARNI])
- Beta-blocker
- Mineralocorticoid receptor antagonist (MRA)
- Sodium-glucose-cotransporter-2 (SGLT2) inhibitor

Specifics comments and recommendations relating to the above guideline-directed medical therapies (GDMT):

i. ARNI therapy (sacubitril/valsartan) is recommended to be available as first-line therapy for patients with HFrEF.[8,11] Current Aotearoa New Zealand special authority criteria for access to funded sacubitril/valsartan require the patient is receiving "*concomitant optimal standard chronic heart failure treatments*".

Recommendation: ARNI therapy (sacubitril/valsartan) is fully funded as first-line treatment for patients with HFrEF without special authority requirements.

ii. SGLT2 inhibitor therapy is recommended as first-line therapy for patients with HFrEF.[6–8,11]

Current special authority criteria for access to funded SGLT2 inhibitor therapy (empagliflozin) is limited to those who have diabetes with specific HbA_{1c} criteria. With the strength of evidence of benefit for patients with heart failure regardless of diabetes status, many patients with heart failure are being offered this therapy but with the need to self-fund. When access to GDMT is dependent on self-funding this can only perpetuate health inequities in Aotearoa New Zealand.

Recommendation: SGLT2 inhibitors are fully funded for patients with HFrEF without special authority requirements.

iii. MRA therapy in Aotearoa New Zealand is predominately with spironolactone. Spironolactone has a significant side-effect profile, including gynaecomastia in 10% of men, compared with the MRA eplerenone. Sole supply status for eplerenone in Aotearoa New Zealand expired on 30 June 2021 and generic versions of eplerenone are now available internationally.

Recommendation: Eplerenone is fully funded for patients with HFrEF without special authority requirements.

b) Heart failure with mildly reduced ejection fraction (HFmrEF) and preserved ejection fraction (HFpEF)

The categorisation of patients with heart failure based on the EF phenotype includes two categories where the LVEF is above 40%: HFmrEF LVEF 41–49% and HFpEF LVEF ≥50%.[6]

GDMT that have been successful in improving outcomes for patients with HFrEF (ACE-inhibitors/ARB/ARNI, beta-blockers and MRA) have not had the same efficacy when applied to patients with HFmrEF or HFpEF. The exception to this is the evidence of benefit with SGLT2 inhibitors. Major clinical trial evidence has recently emerged, with publication of the EMPEROR-Preserved trial (empagliflozin) in 2021 and the DELIVER trial (dapagliflozin) in 2022 (see Figure 1 and Table 1 for trial summaries).[12,13] The 2023

Figure 1: Summary of the four pivotal randomised controlled trials with SGLT2 inhibitors in patients with heart failure across the EF phenotypes.

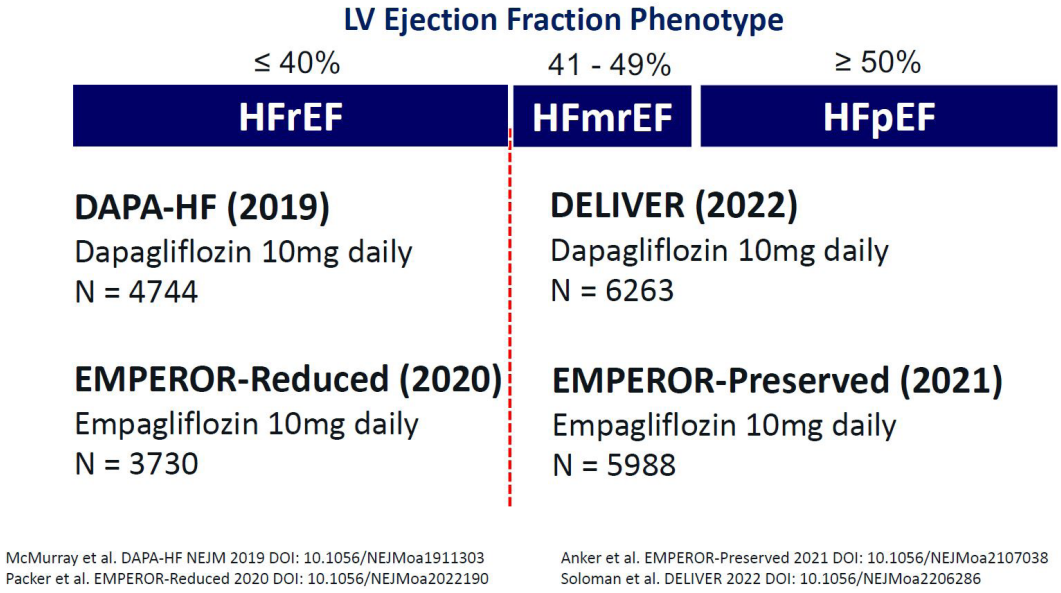

Table 1: Summary evidence tables for the key trials of SGLT2 inhibitors in patients with HFpEF.

	EMPEROR-Preserved trial[12]		**DELIVER trial[13]**	
Year published	2021		2022	
SGLT2 inhibitor	Empagliflozin 10mg daily		Dapagliflozin 10mg daily	
N	5,988		6,263	
NYHA functional class	II-IV		II-IV	
LVEF inclusion criteria	LVEF >40%		LVEF >40%	
Type II diabetes	49%		48%	
Primary end point	CV death or HF hospitalisation		Worsening HF or CV death	
	Placebo	**Empagliflozin**	**Placebo**	**Dapagliflozin**
Primary end-point events	511 (17.1%)	415 (13.8%)	610 (19.5%)	512 (16.4%)
HR (95% CI) Absolute risk reduction NNT	0.79 (0.69–0.90) 3.3% 31 over 26 months		0.82 (0.73–0.92) 3.1% 32 over 2.3 years	
Primary end-point composites				
Heart failure hospitalisations	541 (%)	407 (%)	455 (14.5%)	368 (11.8%)
HR (95% CI)	0.73 (95% CI 0.61–0.88)		0.79 (95% CI 0.69–0.91)	
CV death	244 (8.2%)	219 (7.3%)	261 (8.3%)	231 (7.4%)
HR (95% CI)	0.91 (95% CI 0.76–1.09)		0.88 (95% CI 0.74–1.05)	

SGLT2 inhibitor = sodium-glucose-cotransporter-2 inhibitor; NYHA = New York Heart Association function class; LVEF = left ventricle ejection fraction; CV = cardiovascular; HF = heart failure; HR = hazard ratio; CI = confidence interval; NNT = number needed to treat.

European Society of Cardiology Heart Failure Guidelines[10] now reflect this recent clinical trial evidence with a Class 1-A recommendation for SGLT2 inhibitor therapy for patients with HFmrEF and HFpEF.

Thus, the recommendations for SGLT2 inhibitor therapy applies to all patients with heart failure regardless of EF phenotype (with consistent level/strength of evidence across the EF phenotypes).

Recommendation: SGLT2 inhibitors are fully funded without special authority requirements for patients with heart failure with all EF phenotypes.

2. Importance of early initiation and titration of pharmacotherapy

Contemporary pharmacotherapy addresses multiple maladaptive pathways in the pathophysiology of heart failure and has independent and additive clinical benefits. The benefits of GDMT with the combined classes listed above has recently been quantified for patients with HFrEF.[14] To emphasise this benefit, in a 55-year person with HFrEF, the combined estimated benefit of the four classes of GDMT is to provide 8.3 additional years free of either cardiovascular death or first hospitalisation for heart failure compared with ACE-inhibitor or ARB and beta-blocker. These substantial benefits support the recommendation for combination therapy with ARNI, beta-blocker, MRA and SGLT2 inhibitor.

Despite these established benefits, translation of the evidence into practice remains challenging. Implementation interventions that can improve uptake of GDMT can be considered in three categories: healthcare (policy) interventions, institution/clinically led interventions and patient-level interventions (such as educational tools and electronic prompts).[15] Recommendations have been made in this current position statement regarding policy changes that can favourably impact on access to GDMT.

Recent evidence is now available on strategies that can enable early initiation and appropriate titration of disease-modifying medications for patients with heart failure. The STRONG-HF trial utilised early initiation of GDMT prior to hospital discharge following admission with heart failure.[16] Post-discharge early follow-up was planned with the primary aim of safe optimisation of GDMT. This intervention reduced the risk of death from any cause or heart failure readmission at 180 days compared with a usual care group (adjusted risk ratio 0.66 [95% confidence interval [CI] 0.50–0.86]).

With proven evidence-based interventions it is now appropriate to shift the emphasis to early initiation of combination GDMT (during hospitalisation and/or at diagnosis) and aim for rapid dose-titration to optimise clinical outcomes for patients with heart failure in Aotearoa New Zealand. This has been addressed with specific recommendations for pre-discharge and early post-discharge follow-up of patients hospitalised with heart failure in the 2023 European Society of Cardiology heart failure guidelines (level of evidence 1-B).[10]

Incorporating these guideline-based recommendations needs strategies that are appropriate to the Aotearoa New Zealand environment and that optimise healthcare delivery and outcomes. Such strategies must follow principles to ensure best-quality care, including, for example, involving patients and whānau (where appropriate), ensuring health literacy principles are followed (simple, clear language, checking patients' understanding and allowing time for questions) and using specific models of care for Māori and Pasifika that minimise barriers to healthcare.

Recommendation: Following hospitalisation for heart failure, patients with HFrEF should have early initiation of low-dose, combination GDMT. Appropriate models of healthcare are required to support immediate transition from hospital to the community and to facilitate subsequent rapid titration of GDMT to optimise therapy.

3. The workforce required to ensure optimal outcomes for patients with heart failure

Multidisciplinary heart failure management programmes have been shown to reduce heart failure hospitalisations and improve survival. Multidisciplinary management can ensure timely access to correct investigations and enable diagnoses, ensure implementation of GDMT and provide education and support for self-management. The 2009 Aotearoa New Zealand heart failure guidelines[17] recommended the following:

> *"A structured approach to chronic disease management is recommended for patients with heart failure, especially*

for those at high risk, such as those with recent hospitalisation (level of evidence 1: grade of recommendation A).”

Structured heart failure management programmes should be flexible and adapt to the needs of the patients and local healthcare environment. Importantly, such programmes in the Aotearoa New Zealand healthcare environment need to ensure patient- and whānau-focussed care can be delivered to appropriately support people affected by this long-term condition. People need to be empowered with self-management support programmes to be able to work in partnership with their healthcare team(s). Communication and health literacy principles need to be followed to ensure patients and their whānau can achieve this partnership.

There is a clear role for specialist-trained heart failure nurses for the success of any such programme. In addition, the 2009 heart failure guidelines highlighted that adequate funding to sustain such management programmes is required. Recommendations from the United Kingdom are that the minimum requirement of specialist heart failure nurses is two full-time equivalent [FTE] per 100,000 population for management of patients with HFrEF, increasing to four FTE per 100,000 population if all ejection fraction phenotypes are to be managed.[18] A recent survey of the heart failure nursing workforce in Aotearoa New Zealand (personal communication: in an email from H McGrinder following presentation at the CSANZ Regional Meeting 2023) has shown that there are only 0.79 FTE per 100,000 population, and only three District Health Board populations had ≥2 FTE per 100,000 population (although this combined population only represented 5% of the total Aotearoa New Zealand population). Increasing this workforce will help to reduce inequity based on domicile, which is especially important where ethnic disparities exist.

Finally, we need to recruit more Māori and Pasifika healthcare professionals into the cardiac workforce, not just for delivery of care but to provide leadership, cultural experience and diversity, which are vital to engaging under-served populations.

Recommendations:

1. **Heart failure nursing FTE is increased to a of minimum of 2 FTE per 100,000 population for the whole of Aotearoa New Zealand to optimise clinical outcomes for patients with heart failure.**
2. **Nurse practitioner internship pathways be made mandatory for regional cardiology services as part of workforce development.**

In summary, this position statement aims to provide clear guidance on key aspects of healthcare for patients with heart failure. Access to fully funded evidence-based pharmacotherapies, implementation strategies to deliver high-quality care and the workforce required to deliver this will reduce inequities and ensure that all patients in Aotearoa New Zealand have the opportunity for improved quality of life, reduced hospitalisations and improved survival. Action is urgently required to address these three important aspects of healthcare delivery.

COMPETING INTERESTS
None.

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An uncommon case of rhabdomyolysis in severe hypothyroidism

Sujatha Kamalaksha, Nicole McGrath, Chuen Siang Low, Sanjib Ghosh

Rhabdomyolysis is a triad of myalgia, myopathy and pigmenturia. Clinical presentation is usually triggered by dehydration, drugs and or intense exercise. Hypothyroidism-induced rhabdomyolysis is rarely described in literature.[1–3] It is often reported as a risk factor.[4,6]

Case report

A 77-year-old Caucasian woman was admitted to our hospital with gradual onset of progressive lower limb proximal weakness over that past year, which grew worse in last 2 weeks, associated with brain fog, constipation, cold sensitivity and unintentional weight loss of 4kg. She was an avid ocean swimmer in the past, now only able to paddle around the boat. Her mobility gradually deteriorated from having been independent to requiring support to mobilise. She was a teetotaller with no recent change of medications. Her past medical history included ischemic heart disease, hypothyroidism and cholecystitis, which was managed conservatively with antibiotics 1 year prior to this admission. Medications included bisoprolol, aspirin, losartan, levothyroxine as synthyroid and atorvastatin. She had been on statin for 8 years, and the dose was doubled 3 years ago for acute coronary syndrome. She was on 50mcg synthroid that could not be optimised due to side effects of feeling generally unwell. Although consistent euthyroid status was not achieved, in the past a synthroid dose of 150mcg correlated with brief normalisation of thyroid functions (Table 1).

On examination, she was normotensive, afebrile and jaundiced. There was 3/5 proximal muscle group weakness in the lower limbs, with normal power in other muscle groups. Examination of deep tendon reflexes revealed a positive Woltman sign. There were no fasciculations or sensory impairment. Review of other systems was normal.

Initial investigations (Table 2) revealed significantly elevated creatinine kinase (CK) (39,600U/L) and abnormal liver functions with alkaline phosphatase (ALP) and gamma glutaryl transferase (GGT) of 1,050U/L and 3,240U/L respectively. She had acute kidney injury with serum creatinine of 131umol/L. Thyroid stimulating hormone (TSH) was 59mlU/L with free T4 9.5pmol/L. Serum aldolase of 1,25U/L and positive urine haemoglobin pigments supported rhabdomyolysis. Myositis antibodies were negative. Magnetic resonance cholangiopancreatography (MRCP) and computed tomography (CT) revealed metastatic cholangiocarcinoma.

Initial treatment consisted of intravenous fluids and discontinuation of atorvastatin. Due to synthroid intolerability, she was commenced on eltroxin 50mcg daily. The dose was escalated quickly to 150mcg within a week as she was an inpatient. She was not considered for surgery or chemotherapy.

Table 1: Historical thyroid function tests.

	2017 (synthroid 150 mcg)	2018 (synthroid 50 mcg)	2019 (synthroid 50 mcg)	2020 (synthroid 50 mcg)	2021 (synthroid 50 mcg)
TSH (0.27–4.2mU/L)	2.5	28	35	34	59
Free T4 (12–22pmol/L)	17	13	12	13	9.5

TSH = thyroid stimulating hormone

Table 2: Results at the time of admission.

Urea (3.2–7.7mml/L)	8.1	**Bilirubin (<25 umol/L)**	34
Creatinine (45–90umol/L)	131	**GGT (<50U/L)**	3,240
CK (30–180U/L)	39,600	**ALP (40–130U/L)**	1,050
Serum aldolase (1–10U/L)	>125	**ALT (<45u/L)**	566
Urine myoglobin	Positive	**CRP (0–5mg/L)**	43
Myositis antibodies	Negative		

Table 3: Effect of eltroxin treatment.

	Day 1	**Day 5**	**Day 8**	**Day 22**	**Day 26**
Free T4 (12–22pmol/L)	9.5		13	28	
TSH (0.27–4.2mU/L)	59		51	2	
CK (30-180 U/L)		21,400	7,700		138

TSH = thyroid stimulating hormone
CK = creatinine kinase

There was clinical and biochemical improvement during her hospital stay and the patient was able to mobilise independently on day 11. There were no side effects from eltroxin. Serum TSH normalised on day 22 and serum CK normalised on day 26 of the treatment (Table 3).

Discussion

Hypothyroidism affects 2–5% of the general population; however, 30–50% patients are inadequately treated.[7] Rhabdomyolysis rarely occurs in patients with poorly controlled hypothyroidism and often in combination with provoking events like exercise, illness and or drugs.[8] Statin-induced rhabdomyolysis with hypothyroid state has been reported to occur within weeks of commencing the drug.[6,9] Our patient had been on statin for 8 years without an adverse event despite having hypothyroidism. Hence, it was thought unlikely related to the current presentation. Intolerance to synthroid in our patient could be due to gluten content, although she was unaware of gluten sensitivity in her regular diet.[10] Also, different levothyroxine preparations may exhibit differences in the bioequivalence.[7] As the concern was of intolerability rather than the bioavailability, the decision was made to equate the dose of eltroxin early. Clinical and biochemical recovery after commencing eltroxin, despite terminal malignancy, concluded hypothyroidism-induced rhabdomyolysis. Patient died within 3 months due to malignancy and hence a sustained effect of eltroxin at that dose cannot be commented on. Thyroid function tests should be checked for rhabdomyolysis presentations and changing the levothyroxine preparation should be considered, if necessary.

COMPETING INTERESTS
Nil.

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Improved antenatal HIV screening coverage with a switch from opt-in to opt-out testing in the northern region of New Zealand

Gary N McAuliffe, Rose Forster, Lesley Voss, Rupert Handy, Subha Rajanaidu, Jacek Kolodziej, Jeannie Oliphant, Matt R Blakiston

A universal offer of antenatal screening for HIV was introduced in New Zealand by the Ministry of Health in 2006. Since then, HIV infection has been diagnosed in 32 women through antenatal screening, and no cases of vertical (mother to child) transmission of HIV have been recorded.[1] Antenatal HIV screening, together with a low prevalence of infection among heterosexual individuals, an immigration policy that requires HIV screening for most long-term migrants and effective anti-retroviral therapy have likely contributed to this success. Despite the universal offer of antenatal HIV screening, the specifics of whether to offer HIV testing as an opt-in versus an opt-out test was left to regional health authorities. The northern region of New Zealand (Auckland and Northland regions) adopted an opt-in approach.[2] Differences in opt-in versus opt-out testing are described in Table 1.

An opt-in approach requires clinicians to be proactive in offering a test, and for the clinician and patient to correctly balance the pros and cons of accepting it, aggravating potential barriers to screening.[3] Opt-in testing also unduly focusses on HIV, which is only one of a bundle of blood tests performed at the first antenatal visit (the bundle also includes full blood count, blood group and antibodies, hepatitis B, rubella, syphilis and diabetes), instead of normalising HIV screening across healthcare. Recent research has found that heterosexual Māori individuals are more likely to be diagnosed with advanced HIV disease compared with Europeans, emphasising the need to normalise testing for equitable outcomes.[4] Since 2006, evidence has mounted that opt-out testing is the most effective approach to antenatal HIV testing, and this has been widely recommended and adopted internationally.[5–8] A 2017 systematic review described the opt-out strategy as lifting testing rates from a median of 59% to 88%.[9] Improvements in medical therapy for HIV mean that early diagnosis and treatment confers similar life expectancy to that of the general population,[10] additionally supporting a normalised approach to testing.

In 2022, preliminary data from the northern region indicated that <90% of women engaged in antenatal care were tested for HIV as part of their first antenatal bloods with the opt-in approach. With sub-optimal antenatal coverage, vertical

Table 1: Opt-in versus opt-out antenatal HIV testing.

Opt-in	Opt-out
Pregnant women receive pre-HIV test counselling and are offered a test. They must agree to having an HIV test, usually verbally.	Pregnant women are informed that HIV testing is normally included in the standard group of antenatal tests and that they may opt to decline any of the tests.
HIV must be requested specifically/in addition to the standard first antenatal blood test bundle on the laboratory request form.	HIV testing is performed as part of the standard first antenatal blood test bundle unless the decision to decline testing is documented on the laboratory request form

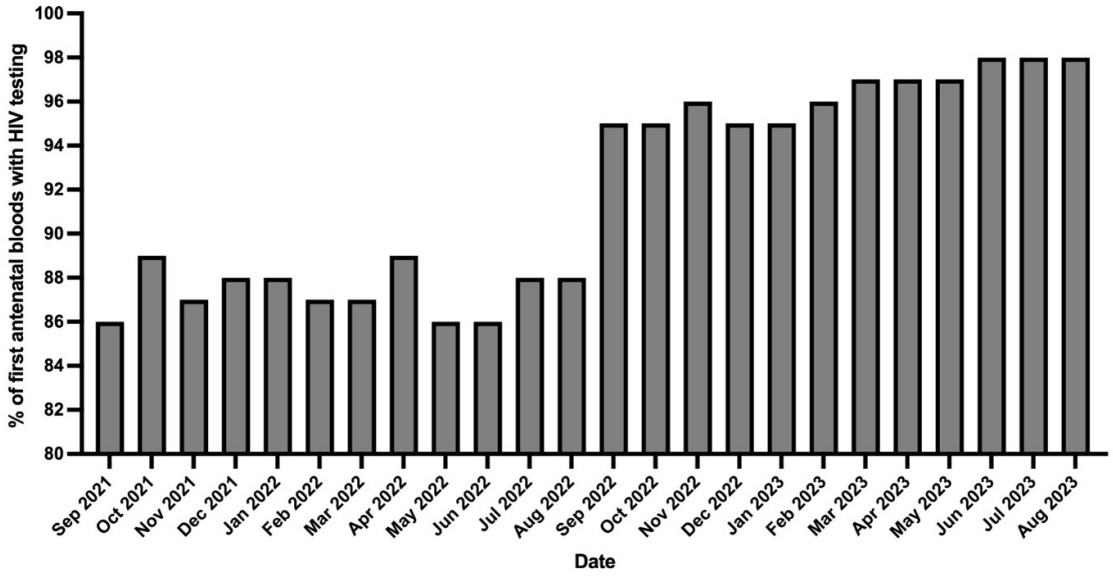
transmission of HIV is possible, and it also limits New Zealand's ability to meet its "95-95-95" targets of diagnosing, treating and virally suppressing people with HIV in order to eliminate local transmission of HIV by 2030.[10] Therefore, stakeholders in the region such as governance groups, non-governmental organisations, public health, sexual health, infectious diseases, obstetrics, midwifery and primary care were consulted with a proposal that all of the northern region laboratories would add HIV Ag/Ab testing into the existing bundle of first antenatal blood tests with an associated update to laboratory paper and electronic request forms.

Feedback from the consultation was positive. Notably, many individuals and organisations were unaware that the opt-in model was used in New Zealand. The proposal was adopted on 1 September 2022 at Te Tai Tokerau, Te Toka Tumai, Waitematā, Counties Manukau hospital laboratories and the community laboratories Northland Pathology and Labtests, which together provide services for all 1.9 million residents of the northern region of New Zealand.

Community laboratory (Labtests, Northland Pathology) testing data (which reflects >95% of first antenatal tests performed in the region) illustrates that with the pre-intervention opt-in testing policy, 16,907 (87%) of 19,374 first antenatal bloods were tested for HIV between September 2021–August 2022 (Figure 1). With the change to opt-out testing, 18,272 (96%) of 18,945 first antenatal bloods were tested for HIV in the period September 2022–August 2023 (Figure 1). An increase in coverage was observed over the course of the first year of opt-out, up to 98% (4,641 of 4,732) in the last 3 months of the opt-out period.

This consultation and intervention demonstrated that there are still gaps to be closed in New Zealand's antenatal screening for HIV. We have addressed one area, for women who already access antenatal screening, whereas a comprehensive program should ensure all women can access screening during pregnancy or at delivery.[11,12] During the consultation it was apparent that practices surrounding HIV screening in pregnancy are not transparent to the community sector and policy makers and they may not reflect current best-practice; therefore, we strongly recommend national oversight of this area, starting with an audit of current antenatal HIV testing policy and uptake in all localities (including ethnicity data), and an unequivocal move to national opt-out testing.

Figure 1: Proportion of bundled first antenatal bloods with HIV Ag/Ab testing performed in the northern region community, September 2021–August 2023.



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Nil.

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Physician associates would be a major loss for the Aotearoa New Zealand healthcare system

William Park

The proposal to regulate the physician associate (PA; formerly physician assistant) workforce is a step in the wrong direction from the Ministry of Health.[1]

Regulation of the profession appears to be an attempt to compensate for a shortage of healthcare professionals resulting from a lack of investment in the education and vocational training of existing workforces, especially doctors. Historically, PAs functioned as true "physician extenders" and performed the clerical and basic clinical tasks that detracted from a doctor's ability to practise medicine efficiently. However, over recent years, the profession has sought independence from doctors, lobbying in North America and the United Kingdom to be able to diagnose, treat and prescribe with little or no oversight from physicians. See how PAs have rebranded as "physician associates" to distance the profession from their initially intended auxiliary role as an assistant. PAs are effectively attempting to fill the niche of a doctor without a medical degree or vocational training.

The Ministry's proposal displays an intention to allow PAs to do the same in Aotearoa New Zealand: diagnose, treat and prescribe with little supervision and without adequate training, rather than fulfilling an "assistant" role. The New Zealand Physician Associate Society and PAs are lobbying strongly for this; look only to the recent article published in this Journal promoting the regulation of PAs, and the disappointing absence of opposing viewpoints in local literature.[2]

It is concerning that the Ministry is not proposing any method of ensuring PAs are appropriately qualified and trained. For a doctor to practise in Aotearoa New Zealand, they must have an equivalent vocational registration, have passed a recognised medical examination or have worked in a comparable health system in a comparable role. PAs do not meet any of these criteria. It would be dangerous to assume that someone is competent to practise medicine because they are registered and have worked as a PA overseas, since the PA degree is extremely heterogeneous, even between different states of the United States. Formal vocational training for PAs is nonexistent; continuing professional development, competencies and supervision requirements are vague and vary wildly between jurisdictions.[3]

In order to regulate PAs, this heterogeneity would need to be addressed. It is inadequate to consider an overseas PA qualification and registration enough to be able to safely practise medicine, especially in contrast to the strict standards that we (rightly) hold doctors to before granting them registration (which is often initially limited in scope and independence). Even putting aside the convincing anecdotal evidence from the medical community, there is quantitative evidence to suggest PAs would provide substandard care when compared with doctors. PAs appear to more frequently prescribe inappropriate opioids and antibiotics, as well as investigate and refer more often without evident improvement in patient-centred or economic outcomes.[4–7]

Additionally, there is no guarantee that PAs would work in "hard-to-serve" areas, or that the Ministry is even proposing a mechanism to ensure this. Even if this intention was realised, the lower level of care provided by PAs would unacceptably perpetuate health inequities, given that regions under-served by the health system tend to have a higher Māori population. Regulation would simply establish substandard workforces without adequate cultural competence in regions where workers *must* be culturally competent: a stark failure to meet Te Tiriti o Waitangi obligations. Importing an entirely overseas-trained workforce in no way addresses the specific cultural needs of Aotearoa New Zealand, and this will be especially detrimental for Māori.

The Ministry should focus on training its existing medical workforce rather than putting funding into a "New Zealand-based training programme" for PAs, which is an intended possible outcome

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of regulation.[1] Not only should the Ministry be increasing medical school numbers as proposed, but there should be guaranteed employment of all locally trained medical students, more NZREX examination spots and funding for more training positions for vocational trainees. The inadequate training opportunities for doctors would certainly be harmed when PAs inevitably move out of "hard-to-serve" communities and attempt to take on roles that were once reserved for trainees.

The medical community should advocate for both our profession and patient safety by opposing the regulation and eventual widespread adoption of PAs into the Aotearoa New Zealand health-care system. If we fail to do this **now**, we may be left on the back foot similarly to the United Kingdom, where PAs are being established while the medical profession is playing catch-up to voice their overwhelming concern.[8,9] It would be unwise to ignore our colleagues' warnings as the General Medical Council tries to shortsightedly integrate PAs into clinical practice and effectively grant them the same authority as doctors.

Aotearoa New Zealand is facing a shortage of physicians, not associates or assistants to the physician.

COMPETING INTERESTS
Nil.

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A Case of Epilepsy Treated by Luminal.

February, 1924

By G.N. MacDiarmid, M.D.

In October, 1922, Mr. J. McF. was brought to me by his wife, with a history of epilepsy. The attacks were almost invariably at night; occasionally they occurred while sitting up, and once while walking. The observations of Mrs. McF. were extremely detailed and intelligent. Commencing with the first attack in March, 1921, there had been no month without one, and the greatest number in any month was nine. On one occasion there were four in one night; the total number was 98. The attacks consisted of turning the head to the left with a jerking action while lying on the back; then a loud cry which woke all in the house; then twitching of hands (chiefly), body, and of face to a less degree; then laboured breathing; then a gradual relaxation. Attacks lasted for from five minutes to one hour. In the morning there was no memory of them. At times, irrespective of seizures, the patient was subject to violent manifestations of temper; once or twice he was violent towards his wife, bruising her against furniture.

The patient's age was 58; there was pyorrhœa; urine normal; systolic B.P. 120. Otherwise I could find nothing abnormal. He gave a history of acute rheumatism and malaria as a youth. He had a fall from a cycle about three weeks before onset of attacks, when he bruised his right arm and right hip. He had previously been a good walker, but during the period of seizures had not walked more than a mile and a-half. His memory was becoming poor. The number of attacks per month showed a tendency to increase. I learned from his wife that he had had frequent courses of bromides, pushed till he was in a dazed condition; also that a blood test had been carried out, presumably a *Wasserman*.

There had been five seizures in the first ten days of October, 1922, and on the night of the 11th October I started him on a course of luminal sodium (*Beyer*), directing him to take a one-grain capsule at bedtime. There was an immediate and absolute cessation of attacks for fifty-four days. During this time his memory improved; he showed no signs of violence or temper; he gained eight pounds in weight and took an interest in playing with his grandchildren. He enjoyed walks of from five to eight miles. This was in marked contrast to his former dull state, with the seizures increasing under bromide treatment.

On 5th December there was a recurrence of two attacks, and I at once increased the dose of luminal to gr. 1½. On four occasions—25th December and 7th, 26th, and 30th January—there were slight recurrences, but on each of these occasions the dose, for some reason, had been reduced to gr. 1. He had no further attacks while taking gr. 1½ till February, when there were two; on the second occasion consciousness was not lost. Luminal was then given in gr. 2 doses occasionally. On 26th April there were two, and again on 5th May, and irritability was complained of. I then gave gr. 1½ at nights and gr ½ in the mornings, and up till 15th June, when I last heard from him, there had been no more attacks. He was able to go backward and forward daily by train to a neighbouring town to carry on his work, that of a builder's foreman. The general health of the man is vastly improved. It remains to be seen whether the dose will have to be still further increased, but inasmuch as the present quality is small, that would not present any difficulty. No bad effects have been observed.

A comparison of the number of seizures per month before and after commencing luminal will make it obvious that , instead of increasing as under heavy doses of bromides, they are very considerably reduced.

The actual numbers are as follow:—1921: March, 1; April, 1; May, 1; June, 4; July, 3; August, 5; September, 5; October, 8; November, 6; December, 7. 1922: January, 5; February, 4; March, 7; April, 5; May, 9; June, 5; July, 5; August, 6; September, 6; October, (10 days), 5. Luminal commenced: October (21 days), *nil*; November, *nil*; December, 3. 1923: January, 3; February, 2; March, *nil*; April, 2; May (five days), 2; May (26 days), nil; June (15 days), nil.