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Unmet healthcare need and the significance of charity hospitals in Aotearoa New Zealand

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Summaries

High prevalence of scabies in Auckland pre-schools

Simon Thornley, Gerhard Sundborn, Daniel Engelman, Rachel Roskvist, Maryann Heather, Cielo Pasay, Roger Marshall, James McCarthy

Evidence is increasing that scabies is linked to important diseases of childhood such as acute rheumatic fever. The condition is very common in Pacific Island nations. The prevalence of the condition in New Zealand, however, has not been well understood. In preliminary findings of three early childcare centres in socio-economically deprived areas of Auckland, 56% of surveyed children had lesions which were consistent with scabies. This indicates that scabies infestation is much more common than was previously appreciated.

Surgical smoke: how an issue in healthcare fits a planetary health framework

Lucy Barber, Rosemary Lane, Linda Holmes, Ngaire Murray, James K Hamil

Healthcare has adverse effects on the environment and on people who work in the system. An exemplar is surgical smoke. We surveyed operating theatre workers and found that 89% would support a smoke-free policy whereby smoke evacuation devices were used for electrocautery. Using reflexive thematic analysis we developed themes within a planetary health framework. This framework and the methodology used might be applicable to other healthcare issues.

Psychiatric hospitalisation before and after commencing long-acting injectable antipsychotic medication: a mirror-image study

Marella Bedggood, Shirley Walton, Mayan Bedggood

Our study looked at a cohort of patients that had a diagnosis of a psychotic disorder (such as schizophrenia) or bipolar disorder and began treatment with a long-acting injectable antipsychotic medication. We compared the amount of time that these patients spent in psychiatric hospital before and after starting this form of treatment. We found that, on average, patients spent less time in hospital after they started treatment with the injectable medication. Long-acting medication could be a more effective treatment method for many patients, therefore reducing the amount of time that they spend hospitalised which is often an indicator of relapse of illness and is disruptive to their lives.

Cruise ship patient presentation, admission, and intervention rates to the emergency department

Alice Alsweiler, Alice Rogan, Emma Carlin, Brad Peckler

Though large numbers of patients can be aboard a cruise ship this does not have a significant impact on our emergency healthcare resources in Wellington. There is room for improvement for education and system development to divert non-urgent medical needs to other resources rather than the emergency department.

Paediatric forearm fractures manipulated in the emergency department: incidence and risk factors for re-manipulation under general anaesthesia

Shaye Seefried, Kim Chin-Goh, Vahe Sahakian, Nicholas Lightfoot, Matthew Boyle

Re-manipulation of paediatric forearm fractures under general anaesthetic may be required following inadequate closed reduction under conscious sedation. Manipulation under general anaesthetic carries significant inherent risks and is preferably avoided. We assessed one institution's experience with paediatric forearm fracture reduction and investigate the incidence of re-manipulation under general anaesthetic of fractures initially managed under conscious sedation without fluoroscopy (an imaging technique that uses X-rays to obtain real-time moving images of the interior of an object.) In this study we identified that there are higher rates of re-manipulation under general anaesthetic in children presenting to the emergency department of our National Children's Hospital with forearm fractures than seen in comparative international studies

2021 assessment of New Zealand district health boards' institutional healthy food and drink policies

Sarah Gerritsen, Bruce Kidd, Magda Rosin, Stephanie Shen, Sally Mackay, Lisa Te Morenga, Cliona Ni Mhurchu

Hospital nutrition policies align with the institutional values and expectations of staff and visitors, while increasing availability and access to food and drinks recommended in the national dietary guidelines. In 2016, a national healthy food and drinks policy (NHFDP) was created for district health boards (DHBs), but by 2018 only five of the 20 DHBs had adopted or intended to adopt the policy. For this study, all DHBs and two central health agencies (Ministry of Health and the Health Promotion Agency) provided their policies to assess adoption and comparison with the national policy. Nine of the 20 DHBs had adopted the NHFDP. Using a standard policy scoring tool, we found individual DHB policies were not as comprehensive as the NHFDP, but some contained stricter or additional clauses that could be considered for future iterations of the NHFDP. There remains significant regional inconsistency in the food and drinks available to staff and visitors in health institutions across Aotearoa. An improved mandatory NHFDP should be implemented.

Trauma teams in Aotearoa New Zealand—a national survey

Rohan Lynham, Matthew McGuinness, Christopher Harmston

A multidisciplinary trauma team is common in regional and tertiary trauma hospitals across New Zealand. They are composed of approximately 10 health professionals, medical, nursing and allied health. They are activated using physiological, mechanism of injury and injury pattern criteria. There is potential for trauma team composition and activation criteria to be standardised in New Zealand.

Unmet healthcare need and the significance of charity hospitals in Aotearoa New Zealand

Philip Bagshaw, Pauline Barnett, Susan Bagshaw

The story of the Aotearoa New Zealand health system is one of early optimism, some success and then disappointment at the failure of the public sector to respond to the needs of the community. Health and healthcare are very complicated, and we now understand the important links between health needs and other aspects of wellbeing.

The early story

In 1938, we led the world with the Social Security Act, which formed the basis of the first Labour government's welfare programme. This was expected to introduce a national health service, with universal access to healthcare. However, from its origins it inherited two deficiencies: (i) partially private primary healthcare; and (ii) a Western-style system that did not address the needs of tangata whenua and other marginalised groups.

In Aotearoa New Zealand, with increasing prosperity in the first half of the 20th century, heavy investment in health meant that, despite underserving some groups and embedding health inequities, we climbed high among international health rankings. The economy then stagnated and, with soaring oil prices and high inflation starting in the 1970s, the downward trend in health investment began. From the late 1980s, successive governments introduced neoliberal policies that established destructive, managerialist processes and austerity budgeting.[1]

The Health Reforms in the 1990s (Health and Disability Services Act, 1993), created a pseudo-market for health services, attempting to use competition to drive efficiencies, and to use reduced funding as an incentive to ration services. Over the decade, a range of explicit rationing efforts were tried without success.[2] For example, part charges in hospitals in 1991 were abandoned in the face of public ridicule. The efforts of the Core Services Committee in 1992 to create a list of which services would be provided were similarly discarded.[3] The use of clinical guidelines as a method of healthcare rationing also proved impractical, so more devious methods were tried. For example, the National Waiting Time Project in 1998 used softer, more sanitised language: rationing was called prioritisation; waiting lists were referred to as waiting times; but no mention was made of the large numbers of patients who did not qualify for treatment under the newly introduced points scoring systems.[4] In this way, it was said, the public were slowly adjusting to the notion that rationing of healthcare was inevitable.[5] However, the process of denying patients the treatment they needed was referred to in health management documents by the harsh metaphor of "steps you can take to alter the trajectory of demand".[6]

Under the neoliberal philosophy, austerity budgeting was applied to many aspects of healthcare.[7] Many of the most senior nurses at Christchurch Hospital were made redundant or were redeployed. This resulted in unsafe ward environments that led to a series of unnecessary patient deaths, culminating in the first major inquiry by the Health and Disability Commissioner, and what became widely known as the Stent Report of 1998.[8] This marked a minor win in a battle against the neoliberal reforms but did not seriously weaken the dominance of this philosophy within the Government.

It became ever more obvious to healthcare professionals that unmet need for both primary and secondary healthcare was growing; increasingly they had to inform patients that needed treatment that they would not qualify for inclusion on waiting lists. However, the health professionals' own representative bodies were unable to effectively highlight and counter these growing problems.[9]

Enter the charity hospitals

The growing frustration at the lack of progress with these problems led, in 2004, to the formation of the Canterbury Charity Hospital Trust (CCHT).[10]

The aims of the Trust were to provide a dedicated day hospital to meet as much unmet secondary elective healthcare need (USEHN) as possible; to be exclusively funded by public, charitable giving, and to be largely staffed by volunteers. It was followed by the opening of the Auckland Charity Hospital (ARCH) in 2009.[11] This was organised differently, using downtime in existing private hospitals. However, both have provided purely reactive services by trying to fill the ever-changing gaps, where public hospitals do not provide some necessary secondary elective services. Some gaps, such as inadequate dental and women's health services, have remained and have grown in size. Other gaps have come and gone over the years. For example, some district health boards (DHBs) prematurely restricted or stopped elective groin hernia surgery when early research initially indicated that it was safe to leave hernias until they became symptomatic.[12] However, with longer follow-up, research showed this policy increased the serious morbidity and mortality rates,[13] and so elective herniorrhaphy was reinstated by DHBs.

The CCHT has been able to react quickly to sudden changes in unmet needs, and it was able to set up counselling services within days of the Canterbury earthquakes and terror attacks.[14,15] It has been very well supported by the public, but also occasionally criticised as letting government off the hook. This criticism has been countered with the information that, without it, tens of thousands of patients would have gone without needed treatment, and that it is a sure reminder of the existence of USEHN.

Measuring unmet need

The lack of knowledge of the existence of USEHN by many people, and the absence of knowledge of its quantity and nature by everyone, led CCHT to assert the importance of regular independent measurement of USEHN by using population surveys. The resulting data would inform the public and the Government of the size and nature of unmet need, and also inform health planners of the effects of policy changes.[16] The NZ Health Survey has been measuring and reporting on unmet primary healthcare need for years, but it has never assessed USEHN.[17]

In 2015/16, CCHT brought together a national expert panel and, with financial support from other organisations, completed the first small population survey of USEHN in Auckland and Christchurch. This showed that around 9% of adults had an USEHN, for which they could not get treatment in the public healthcare system and could not afford private care.[18] It did not include those under 18 years old and also probably underestimated the unmet need for the most disadvantaged people, who are known to respond less frequently to such surveys. The private health sector did small internet-only surveys of USEHN in 2013 and 2016 with similar results.[19]

Having tested the methodology for measuring USEHN, CCHT's expert group convinced two Ministers of Health of the desirability of having survey questions on the topic regularly included in the NZ Health Survey. Both Ministers instructed the Ministry of Health (MoH) to include such questions, but on each occasion the MoH avoided the task. It appears that the MoH did not want USEHN regularly and independently measured, even though this has been done in many very large surveys in Europe, North America and elsewhere.[20] Our expert group went on to make two applications to the Health Research Council for support for a comprehensive national population survey of USEHN, using well established procedures, but both were turned down for funding.

Where to next?

Recent governments may have pursued somewhat less overt neoliberal health policies but nevertheless the USEHN has continued to grow: the wealth gap has also become very large.[21] Māori, Pasifika, and those in poverty still have deplorable disadvantages in health and wellbeing, with unacceptably high rates of some chronic diseases, and with poor health intervention rates, treatment outcomes, and life expectancy.[22] These appalling statistics are due partly to poor access to health services but also to disadvantageous socio-economic determinants of health (poor nutrition, inadequate housing, insecure employment, inadequate welfare benefits).[23]

What are the answers to these problems with health and wellbeing? Firstly, the charity hospital movement is growing; a third is being built in Invercargill,[24] others are being considered or planned elsewhere, and a national association has been formed. They, along with many other not-for-profit charities, are doing good work to help fill some of the health and welfare gaps,[25] but their efforts cannot keep pace with the levels of unmet need. Current health restructuring might eventually bring some benefits; we must be optimistic that Te Whatu Ora/Health NZ and Te Aka Whai

Ora/Māori Health Authority will work together to provide the leadership to reduce inequity.[26]

Second, if we believe in universal access to healthcare, with equity of outcome for all citizens, major policy shifts are needed. We must expunge the remaining remnants of neoliberal philosophy and policies, and reject more rationing of healthcare and welfare services. We need to acknowledge the results of massive international studies showing: (i) that widening income gaps are associated with larger health and social problems;[27] and (ii) that large financial dividends are achievable by moving from austerity to investment policies in health, education and welfare.[28,29]

Third, investment should be in human, physical and financial resources. We need to increase the numbers training as health professionals, and improve salaries and working conditions in order to retain trained and experienced staff.[30,31] Cultural differences need to be viewed as blessings and treasured, with stronger affirmative policies to train a more culturally representative health workforce.

Fourth, armed with better information about unmet health needs from regular national population surveys, a policy of proportionate universalism should be used to address inequities and lift standards of health and healthcare for all citizens.[32–34] This policy combines features of both targeting and universalism. Targeting ensures that extra resources go to the areas of greatest need, with the aim of achieving equal outcomes, while universalism directs resources for the welfare of all citizens, so that general standards are raised.

Significance of charity hospitals

Charity hospitals are important because they demonstrate every day the reality of unmet need and have worked to mitigate its impacts. The limited research available confirms this, but the reluctance of government to invest in research into unmet need is a clear failure of responsibility. Charity hospitals, with their professional and community commitment, are evidence of social capital of which we can be proud, but they are also symbols of the shame we all share in the inadequacy in our political decision-making.[35]

The longer we leave the current deplorable situation, the harder it will be to get us on a satisfactory track to improvement.

We need a better national story, with a sincere hope for a health and welfare system of which we can all be justly proud.

COMPETING INTERESTS
Nil.

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High prevalence of scabies in Auckland pre-schools

Simon Thornley, Gerhard Sundborn, Daniel Engelman, Rachel Roskvist, Maryann Heather, Cielo Pasay, Roger Marshall, James McCarthy

ABSTRACT

AIM: Scabies is a difficult disease to diagnose and its prevalence not well established. A strong association between scabies and more serious illnesses in children, for instance acute rheumatic fever, suggests greater understanding of scabies prevalence is warranted. Here, we present initial findings of a study of childcare centres, to estimate the prevalence of scabies in the Auckland community.

METHODS: Children in three childcare centres from socio-economically challenged areas were examined for scabies. Diagnoses were made according to the International Alliance for the Control of Scabies (IACS) criteria, whose "clinical" or "suspected" definition consists of examination findings of papules: either "typical" or "atypical" distribution, along with history features of itch and contact with likely other cases. A quantitative polymerase chain reaction (qPCR) test was also used.

RESULTS: A total of 67 children were examined, with over half (*n*=38 or 56.7%) showing signs of typical (14; 20.9%) or atypical (24; 35.8%) scabies lesions. History information was available for 50 children. Of these, nine (18%) met the criteria for "clinical" or "suspected" scabies. Of 27 qPCR tests performed nine (33%) tested positive.

CONCLUSION: The prevalence with scabies is high in early childcare centres in socio-economically challenged areas of Auckland.

Recent evidence indicates that scabies may play a more important role in the aetiology of various important diseases of childhood than has been appreciated.[1] One study links scabies infestation with bacterial skin infection, particularly cellulitis and abscess.[2] Scabies has also been implicated in the causation of kidney disease through post-streptococcal glomerulonephritis,[3] and mounting evidence suggests a link with acute rheumatic fever.[5]

The last formal assessment of the prevalence of scabies in New Zealand was published in the late 1970s.[6] This study showed a prevalence of scabies in high school children of about 18% in Pacific, 10% in Māori and 2% in NZ European children. A recent study in Samoa highlighted a high prevalence of scabies (14.4%) and the closely linked condition impetigo (57.1%). This island nation has close connections with many Pacific people living in Auckland.[7] Samoans comprise 50% of the Pacific population of New Zealand, the majority of whom reside in Auckland.

To further investigate the prevalence of scabies in New Zealand, we conducted a study in early childhood education centres and schools in the Auckland Region. Here, we present the results from the survey of children's skin in three early childhood education centres, situated in socio-economically challenged areas of Auckland.

Methods

We have started a study which initially planned to look for scabies in 23 childcare centres. The initial results from three in low socio-economic areas show a higher prevalence of infection than expected. We believe this is of public health concern. To protect privacy, the names of the centres are withheld.

Parents or guardians of children attending each sampled centre were invited and gave written informed consent for their child to participate. Parents were invited to fill in a written questionnaire relating to skin symptoms, signs and recent diagnoses and treatments of their child and other household members. Sociodemographic information including age, gender and ethnicity were also collected.

If parents selected more than one ethnicity, this was "prioritised" in the following order: Māori, Pacific, Chinese, South Asian, South-East Asian and NZ European and Other. This is consistent with standard practice for the handling of ethnicity data in the New Zealand health sector.[8]

Examination of the child's skin consisted of examining the child's arms, legs and abdomen for the presence of skin lesions. Two general practitioners conducted the assessment procedures after training and testing from an experienced paediatrician (DE), with expertise in the clinical diagnosis of scabies. Neither skin scrapings, der-

moscopy nor examination of the genitalia were carried out. Lesions were classified as either: i) typical for scabies; ii) atypical but possibly consistent with scabies; or iii) not consistent with scabies, according to international consensus definitions.[9] Examination findings were combined with history information of personal itch and history of close contact with an individual who has itch or typical scabies lesions. Children were classified according to the 2020 International Alliance for Scabies Control (IACS) criteria, as either "Clinical scabies", "Suspected scabies", or "No scabies" (including where other skin conditions were considered more likely than scabies).[9,10]

Examiners also assessed children for the presence of impetigo, defined during training as papules, pustules or ulcerative lesions with associated erythema, crusting or pus.

If any skin lesion was found and the child's parents consented, the skin was swabbed using a FLOQSwab® dipped in saline and placed in an Eppendorf Tube® and frozen. This sample was then sent to collaborators at the QIMR Berghofer Medical Research Institute (Queensland, Australia) for qPCR analysis using primers and probes designed to detect specific coding (*Cox 1*) and abundant non-coding regions (*SSR5* and *SSR6*) of the *Sarcoptes scabiei* var *hominis* genome.[11] The qPCR assay with three targets has undergone *in vitro* testing for specificity and sensitivity to the human scabies mite and tests negative to other common skin parasites. A preliminary study of the clinical use of the test has shown a high degree of clinical agreement with clinically confirmed scabies (5/7 tested positive), and tests negative when samples are taken from people with other dermatological conditions such as dermatitis, psoriasis and tinea (19 were negative for all three targets).[11] Further testing of the qPCR test against an existing gold standard, such as dermoscopy, would be desirable.

Parents of children who were assessed as having either clinical or suspected scabies or who had a positive qPCR test were offered 5% permethrin lotion or cream for the participant and their household.

Statistical analysis

Descriptive analysis of clinical and laboratory tests were undertaken, by demographic factor and centre. Chi-squared, Fisher and *t*-tests were used to check for associations between sociodemographic characteristics and scabies diagnoses. R software (version 4.1.0) was used for analysis.[12] The *srd* package was used to illustrate the relationships and overlap between categorical data.[13]

Ethics

Ethical approval was granted by the New Zealand Ministry of Health, Health and Disability Ethics Committee (20/STH/41).

Results

The sample for analysis is of children recruited between 11 March 2021 and 25 May 2021. This cohort is tabulated by IACS scabies category (Table 1 and Table 2). The mean age of children was 3.4 years (standard deviation: 1.1). Most parents identified as either Pacific (48.0%) or as Māori (32.0%).

A total of 67 children were examined, with 14 (20.9%) showing examination signs of typical scabies lesions. A further 24 (35.8%) had atypical lesions. The questionnaire was offered to all parents, 50 were completed (75% of children) which enabled classification by IACS criteria (clinical or suspected). Almost all missing responses (14/17; 82.4%) attended one childcare centre. Of the 50 children with history information, five (10%) met the IACS criteria for clinical scabies, and four (8%) were classified as suspected, giving a prevalence of 18% by these criteria.

A total of 27 qPCR tests were taken from the three centres in children with lesions which were considered either typical or atypical for scabies. Of the total, one third (nine) were positive, with two positives in children diagnosed with clinical scabies, two suspected and four did not meet the IACS criteria.[9] One child with a positive sample had typical scabies examination findings, but no history was available. Of the four who did not meet the criteria, two presented with "atypical" and two "typical" scabies lesions but had no itch or contact history. The positive qPCR results were spread through all childcare centres, with at least one positive in each. Of the three targets assayed, only *Cox 1* tested positive.

Of the 41/50 (82%) participants who had history and examination information but did not meet the IACS criteria for scabies, five (10%) had typical scabies lesions, and 14 (28%) atypical lesions but were not classified as scabies as they did not give a sufficient history of itch or exposure to contacts. Of the total children examined, three (4%; 3/67) had impetigo. A high proportion of children had a large number of lesions, suggesting that scabies had been present for some time without treatment.

A scaled rectangle diagram depicts the degree of overlap between different classifications (Figure 1). The outer rectangle represents the total population. The grey rectangle represents those with history information available, yellow are those

Table 1: Demographic characteristics of study cohort by IACS[9]* diagnosis category.

Variable	Level	Clinical (n=5)	Suspected (n=4)	No scabies (n=41)	Missing (n=17)	Total (n=67)	p-value
Age (years)	**mean (sd)**	**3.5 (1.3)**	**2.9 (1.2)**	**3.4 (1.2)**	**3.4 (0.8)**	**3.4 (1.1)**	**0.664**
Ethnic group	Pacific	3 (60.0)	3 (75.0)	18 (43.9)	0 (0.0)	24 (48.0)	0.666
	Māori	2 (40.0)	0 (0.0)	14 (34.1)	0 (0.0)	16 (32.0)	
	Indian	0 (0.0)	0 (0.0)	4 (9.8)	0 (0.0)	4 (8.0)	
	NZ European	0 (0.0)	1 (25.0)	2 (4.9)	0 (0.0)	3 (6.0)	
	South-East Asian	0 (0.0)	0 (0.0)	3 (7.3)	0 (0.0)	3 (6.0)	
	missing	0	0	0	17	17	
Childcare centre	A	2 (40.0)	2 (50.0)	9 (22.0)	2 (11.8)	15 (22.4)	
	B	1 (20.0)	0 (0.0)	11 (26.8)	1 (5.9)	13 (19.4)	
	C	2 (40.0)	2 (50.0)	21 (51.2)	14 (82.4)	39 (58.2)	0.183

Those with missing history information are included in the "missing" column.
*IACS: International Alliance for the Control of Scabies.

Table 2: Clinical characteristics of study cohort by IACS[9]* scabies diagnosis category.

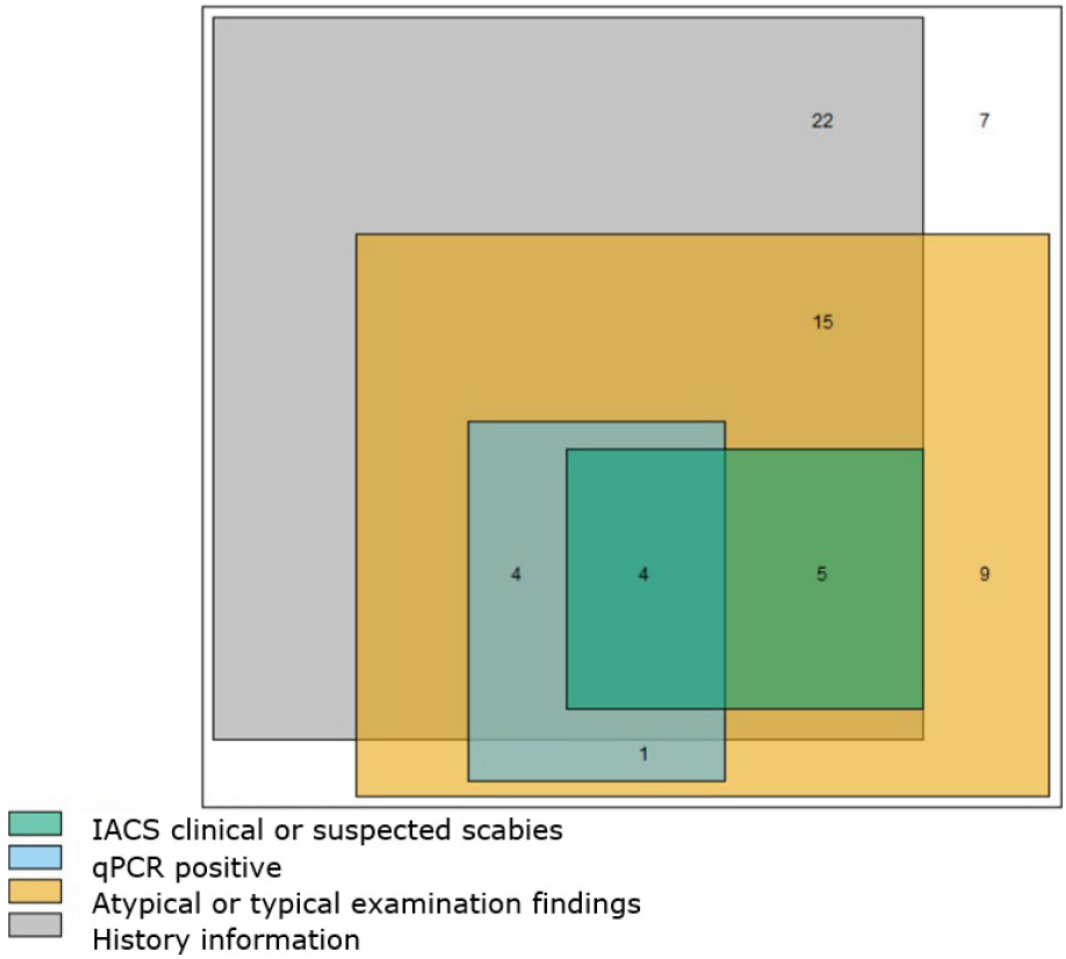
Variable	Level	Clinical (n=5)	Suspected (n=4)	No scabies (n=41)	Missing (n=17)	Total (n=67)	p-value
qPCR result	Positive	2 (50.0)	2 (66.7)	4 (33.3)	1 (12.5)	9 (33.3)	
	Negative	2 (50.0)	1 (33.3)	8 (66.7)	7 (87.5)	18 (66.6)	0.313
	missing	1	1	29	9	40	
Household contact with rash	Yes	4 (80.0)	2 (50.0)	2 (4.9)	0 (0.0)	8 (16.0)	-
	No	1 (20.0)	2 (50.0)	39 (95.1)	0 (0.0)	42 (84.0)	
Close contact with itch	Yes	3 (60.0)	3 (75.0)	1 (2.4)	0 (0.0)	7 (14.0)	-
	No	2 (40.0)	1 (25.0)	40 (97.6)	0 (0.0)	43 (86.0)	
Child itchy	Yes	4 (80.0)	2 (50.0)	7 (17.1)	0 (0.0)	13 (26.0)	-
	No	1 (20.0)	2 (50.0)	34 (82.9)	0 (0.0)	37 (74.0)	
	Missing history	0	0	0	17	17	
Rash	Typical lesions	5 (100.0)	1 (25.0)	5 (12.2)	3 (17.6)	14 (20.9)	0.002
	Atypical lesions	0 (0.0)	3 (75.0)	14 (34.1)	7 (41.2)	24 (35.8)	
Scabies lesion site	Arms	5 (100.0)	3 (75.0)	15 (36.6)	6 (35.3)	29 (43.3)	0.025

Table 2 (continued): Clinical characteristics of study cohort by IACS[9]* scabies diagnosis category.

Variable	Level	Clinical (n=5)	Suspected (n=4)	No scabies (n=41)	Missing (n=17)	Total (n=67)	p-value
	Legs	5 (100.0)	2 (50.0)	15 (36.6)	9 (52.9)	31 (46.3)	0.053
	Torso	1 (20.0)	3 (75.0)	4 (9.8)	3 (17.6)	11 (16.4)	0.010
Number of scabies lesions	1 to 2	0 (0.0)	1 (25.0)	3 (15.8)	1 (10.0)	5 (13.2)	
	3 to 10	1 (20.0)	2 (50.0)	9 (47.4)	7 (70.0)	19 (50.0)	
	11 to 49	2 (40.0)	0 (0.0)	6 (31.6)	1 (10.0)	9 (23.7)	
	More than 50	2 (40.0)	1 (25.0)	1 (5.3)	1 (10.0)	5 (13.2)	0.356
	missing	0	0	22	7	29	
Impetigo	Yes	1 (20.0)	0 (0.0)	0 (0.0)	2 (100.0)	3 (100.0)	
	No	4 (80.0)	4 (100.0)	41 (100.0)	15 (0.0)	64 (0.0)	1.000

Those with missing history information are included in the "missing" column. qPCR: quantitative polymerase chain reaction.
*IACS: International Alliance for the Control of Scabies.

Figure 1: Scaled rectangle diagram illustrating study by diagnosis category, availability of history, qPCR category and skin appearance. The numbers give the frequencies of the data combinations.



with “atypical” or “typical” examination findings, and the light green lower central rectangle represents the qPCR positive subjects. Children who had confirmed scabies by IACS criteria[9] are shown in dark green. The area and degree of overlap of the rectangles are proportional to the number in each group. qPCR positive tests were obtained in children with suspected scabies. The figure highlights that 50% (4/8; one who tested positive had missing history information and so could not have their IACS status determined) of the positive qPCR tests occurred in children who were otherwise classified as not having scabies by IACS criteria.

Discussion

The prevalence of children with scabies is high in several early childcare centres in socio-economically challenged areas of Auckland. The use of a qPCR test undergoing investigation as an adjunct to the diagnosis of scabies strengthens the evidence that some of the identified lesions are caused by scabies mites.

Although the sample size of this survey is limited and preliminary, and the study had some missing history information, the findings suggest the presence of scabies within these communities, with at least one positive qPCR test present in each childcare centre. When parents were phoned and the diagnosis conveyed, several had recently visited a family doctor and had a diagnosis of an alternative skin disease given, such as eczema or insect bites. Misdiagnosis of scabies may be common in New Zealand primary care, even where the prevalence of the condition is high, because it resembles eczema and insect bites, and can be complicated by impetigo, all of which are common in young children. “Normalisation” of scabies, as occurs in high prevalence communities in Australia,[14] may be a feature of diagnosis of the condition in Auckland.

The findings of a high prevalence of scabies in these childcare centres in children whose parents identify as either Pacific or Māori is consistent with the epidemiology of scabies in other areas of the Pacific. Samoa, for example, an island nation with close ties to Auckland, has recently undertaken a survey of scabies and skin disease and returned a prevalence of scabies of 14.4%, with a prevalence of impetigo of 57.1%.[7]

The study also highlights the uncertainty in ascertaining the diagnosis of scabies. Here, we have used several different methods, including clinical criteria, clinician training and qPCR to establish the diagnosis as rigorously as possible. Only 50% of children who tested positive to the qPCR test were diagnosed with scabies by IACS criteria. However, all had skin lesions considered either typical or atypical for scabies. This may be due to the inaccuracy of clinical history collected and possibly the normalisation of symptoms in high prevalence communities.

Given the finding of discrepant recent treatment, and under diagnosis that we believe is common, use of objective methods, such as qPCR, seems attractive particularly in the context of a child attending an institution such as a childcare centre, where establishing a positive diagnosis will affect the likelihood of the diagnosis of other children’s lesions and carries public health implications. Further work may further investigate the validity of the qPCR test against a gold standard such as dermatoscopy, which would facilitate the wider deployment of this test to assist in accurate diagnosis, without the need for expert assessment.

Given the accumulating evidence of association between scabies, bacterial skin infection and serious complications such as acute rheumatic fever and post-streptococcal glomerulonephritis,[1] the impetus to improve the control of scabies is growing.[16] Many different opportunities exist to reduce the prevalence of scabies. Our study suggests several, including improving clinical diagnosis, raising clinician awareness of the features of the disease, and using objective laboratory methods, such as qPCR. Further prioritisation of this disease, such as investing in public health follow-up of cases to ensure treatment success is another option, given the risk of spread to others in the community.

This paper reports the analysis of just three centres. In due course, the study will be extended, with more in-depth analysis. Due to low uptake by schools and childcare centres in relatively wealthy areas and delays in field work due to COVID-19; however, we may not be able to complete the study as originally planned.

In summary, we highlight the high prevalence of scabies in several early childcare education centres in Auckland, among the Pacific and Māori community. Improving the diagnosis and ensuring treatment success of this important and neglected disease is likely to reduce ethnic inequality in health status. The use of qPCR is an existing technology, which may improve the accuracy of diagnosis and reduce the prevalence of this condition.

COMPETING INTERESTS
Nil.

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Surgical smoke: how an issue in healthcare fits a planetary health framework

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ABSTRACT

AIM: The smoke generated from electrocautery machines may be harmful to health. Healthcare in general, and surgery in particular, has a large environmental footprint. The aims of this study were to discover what healthcare workers thought about the problem of electrocautery smoke, the idea of a surgical smoke-free policy, and to formulate ideas on how the matter could be approached in an environmentally and socially responsible way.

METHOD: Operating room personnel in a tertiary referral hospital were invited to complete a survey about electrocautery smoke: perceived risks, current exposure, and measures to minimise exposure. Quantitative data were analysed in a generalised linear model, and qualitative data by reflexive thematic analysis within a constructivist theoretical framework.

RESULTS: The survey response rate was 463/1234 (38%). Most supported a smoke-free policy (89%). Support for a policy was positively correlated with the perceived risk of electrocautery smoke ($p<0.001$. Support was lower amongst males ($p<0.05$). Themes from the qualitative analysis developed around nature, society and technology. A framework was developed consisting of earth and its ecosystems, human health, governance, economics, society, and the interconnected of these systems.

CONCLUSION: Although smoke-free policies form part of the solution to electrocautery smoke, they are not the whole solution. Healthcare issues, in this case the issue of electrocautery smoke, could be tackled within a planetary health healthcare framework, promoting a systems approach. Applicability of the framework requires confirmation by further research.

Electrocautery smoke consists of volatile compounds and organic material.[1] The nature of the smoke depends on the type of surgery performed, the type of tissue cauterised, and the instrument used.[1,2] Smoke from muscle contains ethylbenzene and styrene which are carcinogenic, and toluene, which is mutagenic.[3] Other carcinogens found in surgical smoke include hydrogen cyanide, butadiene and benzene.[1,2,4,5] Human papilloma virus has been detected in surgical smoke.[6] One study found that the amount of smoke produced in a plastic surgery operating room in a day was equivalent to 27 to 30 cigarettes.[7] For these reasons, surgical smoke may be considered an occupational health hazard.[8]

Exposure to surgical smoke has been linked to acute adverse health effects in healthcare workers including headaches, nausea, cough, and irritation of the eye, nose and throat.[9,10] Data on the long-term effects of surgical smoke are lacking;[1] however, almost 10 years ago, a UK research report concluded that "taking into account the published studies included in this review, there is sufficient published evidence to consider the use of surgical smoke evacuation devices and their effectiveness in reducing the levels of smoke exposure".[11]

How to manage surgical smoke remains controversial. One survey of 4533 operating theatre personnel found that only 14% always used a mobile smoke evacuation system in their theatre.[9] Some states in the USA have taken a legislative approach by enacting surgical "smoke-free" legislation.[12] In Aotearoa New Zealand, the Health and Safety at Work Act 2015 imposes a duty on a person who "has, or would reasonably be expected to have, the ability to influence and control the matter to which the risks relate: (a) to eliminate risks to health and safety, so far as is reasonably practicable; and (b) if it is not reasonably practicable to eliminate risks to health and safety, to minimise those risks so far as is reasonably practicable".[13] Currently, there is no specific requirement for the control of surgical smoke in New Zealand.[14]

In the lead up to the 2021 United Nations General Assembly, a group of medical journals released a joint statement in which they said that "the greatest threat to global public health is the continued failure of world leaders to keep the global temperature rise below 1.5°C and to restore nature".[15] The healthcare system is one of the world's largest polluters, contributing 4.4% of global carbon emissions.[16] This means that in any

healthcare issue, such as surgical smoke, environmental (planetary health[17]) as well as the human (occupational health) perspectives must be taken. Therefore, given the concerns in the literature, the variation in practice, and the larger environmental problems in healthcare, we were interested to learn how theatre workers view surgical smoke and the purported "solution" of a smoke-free policy.

The aims of this study were to discover what healthcare workers thought about the problem of surgical smoke and the idea of a smoke-free policy, and to formulate ideas on how the matter could be approached in an environmentally and socially responsible way. We hypothesised that the people who were exposed to surgical smoke in their jobs would have valuable insights into how to address the problem.

Methods

This study received approval from the Auckland DHB Research Office. The settings were the operating theatre suites of a children's hospital and an adjoining adult hospital. Smoke evacuation devices are available in the operating rooms, but their use is not mandatory. The survey was developed using the REDCap electronic data capture tools hosted by the Faculty of Medical and Health Sciences at The University of Auckland. REDCap (Research Electronic Data Capture) is a secure, web-based software platform designed to support data capture for research studies.[18]

Survey design

The survey consisted of 23 questions asking for demographic details, perceived risk of surgical smoke, current measures used to minimise surgical smoke within the operating theatre, estimated exposure to surgical smoke when not using a smoke evacuation device, barriers to using a smoke evacuator, and support or not for a surgical smoke-free policy. Free text fields gave respondents the opportunity to provide more information if desired. Questions were devised in a meeting held with all authors and adapted from similar questionnaires and published data on the negative effects of surgical smoke.[19,20] Please refer to Appendix 1 for a copy of the survey questions, including a broad definition of a smoke-free policy.

Participants

This was a cohort survey aiming to reach as many healthcare workers who might be exposed to surgical smoke as possible. Email lists of perioperative nurses, anaesthetic technicians, anaesthetists, and surgeons were obtained from the hospital administration. The exclusion criterion was anyone who did not work in the operating theatre. A sample size calculation was not performed.

Distribution

The survey was distributed by email to 1,234 recipients. We sent the first email invitation on 17 April 2021. Periodic reminder emails were sent to non-responders, and the final invitation was sent on 28 May 2021. Invitation emails contained the link to the REDCap survey. Using only official hospital email addresses and the REDCap system made multiple participation by participants unlikely. While the survey was not anonymous, confidentiality was maintained through the secure REDCap platform and the University based password protected file storage.

Quantitative analysis

For statistical analysis we used the statistical program, R.[21] Exposure to surgical smoke was analysed by converting estimated exposure (<20%, 20–40%, 40–60%, 60–80%, >80%) to an ordinal factor, then performing a cumulative link model in which rage, gender, professional role, and workplace were explanatory variables. Perceived risk of smoke was analysed in a linear model in which age, gender, role, and workplace were explanatory variables. Support for smoke-free policy was analysed using a generalised linear model in which age, gender, perceived risk of smoke, role, and workplace were explanatory variables. Log odds were exponentiated to odds ratios (OR) and reported with their 95% confidence intervals (CI). Missing data were handled by omission.

Qualitative analysis

Qualitative data from text responses in the survey were analysed using reflexive thematic analysis.[22–24] Braun and Clarke[24] have clearly described how to do reflexive thematic analysis making it accessible to those of us with less experience in qualitative research and aiding reproducibility for those performing similar studies in the future. The theoretical flexibility of reflexive thematic

analysis allowed us to choose our epistemological approach and to interpret data both inductively (data driven) and deductively (theory driven).

Theoretical framework

We chose a constructionist theoretical approach in order to view the issues surrounding surgical smoke as social constructs. We felt this was the best framework in which to achieve our aim of developing concepts on how to approach the surgical smoke problem. The constructivist epistemology takes a critical, as opposed to experiential, orientation to what participants had written in the survey. In coding and theme formation, we started inductively, forming codes from what the data "said", then deductively, formulating our final themes by using a pre-existing theoretical framework.

Researcher's reflexivity

The researchers are healthcare workers within Starship Children's Hospital (two nurses, two paediatric surgical registrars and one paediatric surgeon). As such, the researchers are located within the research setting, i.e., we work within the health system we are studying. We try to take an overtly environmental perspective on healthcare, and on life in general.

Data processing

The online version of Taguette[25] was used for coding. Researchers read and re-read the texts, tagged comments, and coded the tagged comments. These tagged and coded data extracts formed the data units of the study.

Data analysis

Coding and theme review were a recursive process involving review of the data, review of relevant literature, and deep reflection, in an iterative process. We first read the data set, reflected on the ideas, and presented these at a theatre management meeting. In Taguette, we highlighted data extracts and made codes for each. Next, we grouped codes together into initial themes then, after further reflection and review, refined and renamed themes. We then reflected on the social constructs that the themes evoked, looking to the literature and our own understandings and experiences. We finished by merging the themes we developed from the data with a previously reported Planetary Health Education Framework,[26] thus drawing on the wider literature as well as our data set.

Results

Response rate and demographics

From 1,234 invitations, we received 463 responses (38%) of which one was excluded because no fields were completed, leaving 462 for analysis.

The highest response rate was from anaesthetists (62%). Almost half of the surgical consultants responded (49%). Response rates by professional group are shown in Appendix 2, Table S1. Demographics of responders and their specialty areas are shown in Table 1.

The median perceived risk of surgical smoke on a 0–100 scale was 71. Surgeons and anaesthetists perceived less risk than nurses (estimate -23, 95%CI -29 to -17; p<0.001; and -16, 95%CI -23 to -10; p<0.001, respectively). Those identifying as male gender perceived less risk than females (estimate -5, 95%CI -10 to -0.4; p<0.05) as shown in Figure 1.

Estimated exposure and risk of surgical smoke

Almost half (48%) of the nurses reported exposure to surgical smoke in >60% or more cases in which diathermy was used without a smoke evacuation device; almost one quarter (23%) reported exposure in >80% of cases. Estimated exposure was lower amongst surgeons (OR 0.55; 95%CI 0.31 to 0.98; p<0.05) and anaesthetists (OR 0.16; 95%CI 0.08 to 0.32; p<0.001) compared to nurses (Table 2).

Support for a smoke-free policy

All professional groups supported the implementation of a smoke-free policy. Support was strongest amongst nurses (171/180; 95%), anaesthetic technicians (45/47; 96%), and anaesthetists (81/88; 92%). Most surgeons supported a smoke-free policy (108/139; 78%). In the generalised linear model, the most powerful predictor of support for a smoke-free policy was the perceived risk of surgical smoke (estimate 1.07, 95%CI 1.05 to 1.10; p<0.001). Support was lower amongst males compared to females (estimate 0.2, 95%CI 0.05 to 0.84; p<0.05). Although fewer surgeons supported a smoke-free policy than other professions, this was not statistically significant when the perceived risk of smoke was included in the model. Age, nursing level, and surgical specialty were not significant predictors of support for a smoke-free policy.

Table 1: Demographic characteristics and specialty areas of responders. Technician, anaesthetic technician. F, female; M, male; O, other/prefer not to say. ORL, otorhinolaryngology. O&G, obstetrics and gynaecology. MaxFac, maxillo-facial surgery.

	Nurse n=180	**Surgeon n=139**	**Anaesthetist n=88**	**Technician n=47**
Gender F:M:O (%F)	162:16:0	46:92:1	41:45:2	30:16:1
Age<35:35–54:>54 years	84:73:23	34:85:20	6:60:22	21:23:3
Specialty				
Cardiothoracic	15	8	11	10
ORL	18	13	0	0
General surgery	26	30	3	0
O&G	23	18	14	2
MaxFac/oral	2	1	0	0
Neurosurgery	12	5	6	0
Ophthalmology	5	10	0	0
Orthopaedic	27	20	4	0
Paediatric surgery	9	13	5	2
Plastic surgery	0	1	0	0
Transplant	0	6	0	0
Urology	7	10	1	0
Vascular	12	3	2	0
No main specialty	24	1	42	33

Table 2: Exposure to diathermy smoke in answer to the question, "in what percentage of cases do you think you are exposed to diathermy smoke without the use of a smoke evacuation device?").

	<20%	**20–40%**	**40–60%**	**60–80%**	**<80%**	**Total**
Nurse	37	25	27	42	40	171
Surgeon	55	22	19	22	19	137
Anaesthetist	24	26	22	8	5	85
Technician	12	6	14	8	6	46

Figure 1: Boxplot of the perceived risk of diathermy smoke. The question was asked, "how much of a health hazard is diathermy smoke in your opinion?" Participants answered on a 0–100 sliding scale, 100 representing the highest risk.

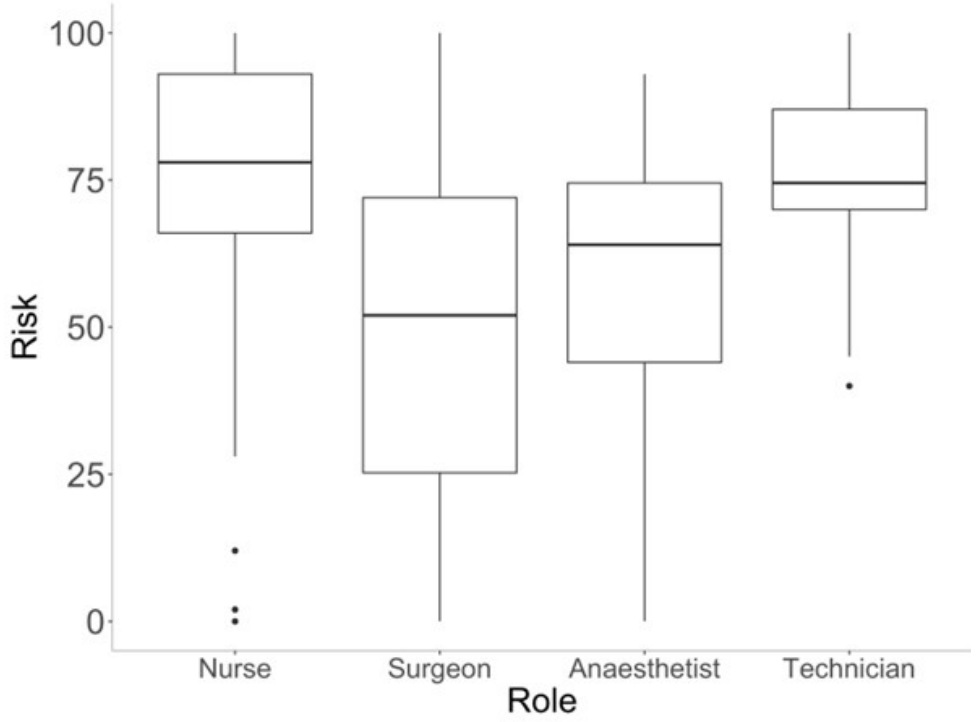


Table 3: Answers to the question, "What do you perceive are the negative effects of surgical smoke?"

	Nurse n=180	**Surgeon n=139**	**Anaesthetist n=88**	**Technician n=47**
Generally unpleasant	152 (84%)	111 (80%)	69 (78%)	38 (81%)
Headache	74 (41%)	12 (9%)	14 (16%)	10 (21%)
Nausea	48 (27%)	6 (4%)	7 (8%)	9 (19%)
Cough/other respiratory symptoms	128 (71%)	34 (24%)	35 (40%)	18 (38%)
Eye irritation	72 (40%)	19 (14%)	23 (26%)	13 (28%)
Potentially carcinogenic	137 (76%)	105 (76%)	66 (75%)	38 (81%)
Potentially teratogenic	88 (49%)	33 (24%)	20 (23%)	17 (36%)
No negative effects	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Table 4: Answers to the question, "What advantages do you see in a smoke-free policy?"

	Nurse n=180	Surgeon n=139	Anaesthetist n=88	Technician n=47
Better staff health	169 (94%)	117 (84%)	78 (89%)	45 (96%)
Improved staff morale	78 (43%)	47 (34%)	38 (43%)	21 (45%)
Improved patient safety	96 (53%)	39 (28%)	16 (18%)	22 (47%)
Can see better	75 (42%)	49 (35%)	17 (19%)	8 (17%)

Figure 2: Initial theme structure from the qualitative analysis showing 10 initial themes that are fitted into three broad categories.

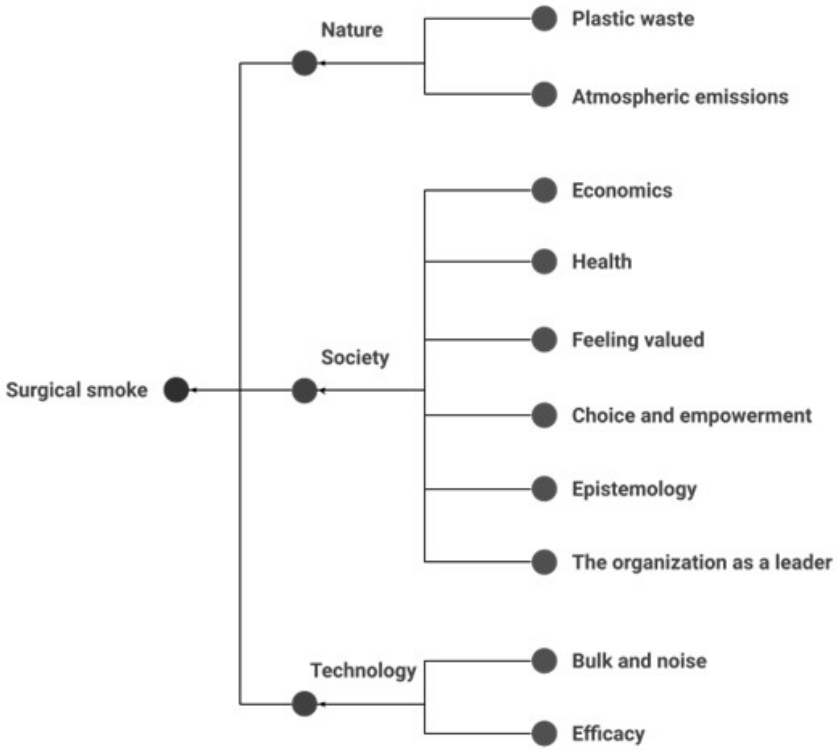
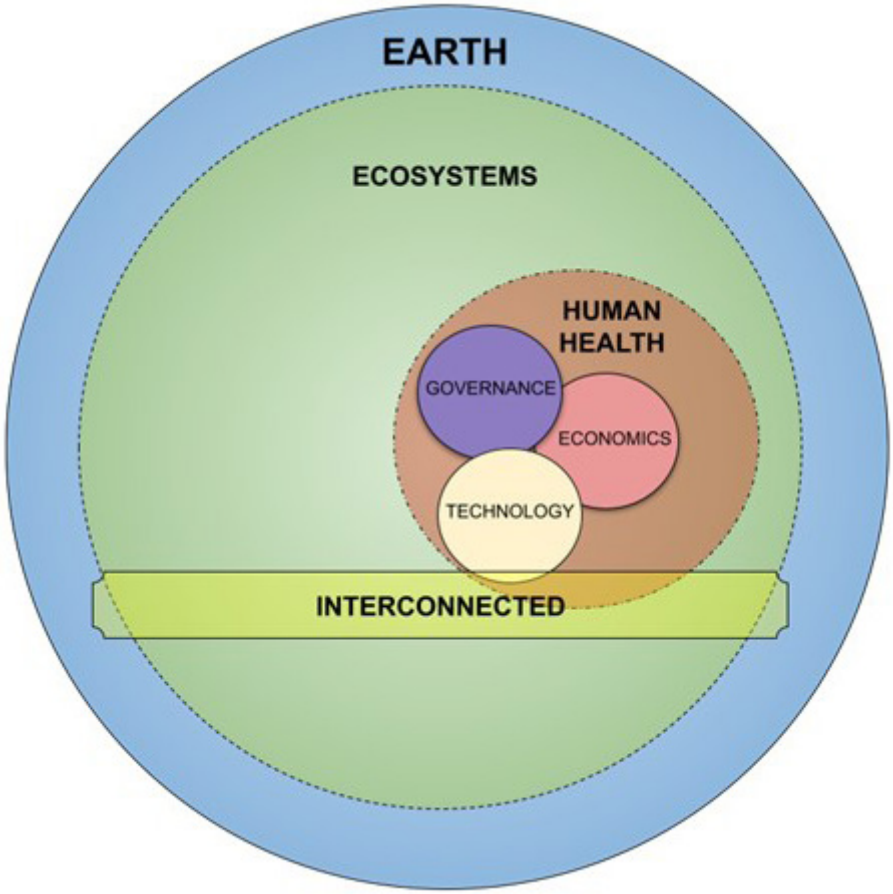


Figure 3: Proposed Planetary Health Healthcare Framework. Physical (blue) and living (green) are divided by a dotted line representing the interconnectedness between physical and life systems. Earth and its ecosystems span these two circles. Humanity is represented inside another dotted line representing the interconnection with earth as a whole. The humanity circle is eccentric to de-emphasise anthropocentrism. Health is viewed from a humanity perspective, being dependent on earth as a whole. Within the humanity circle, the three circles represent technology, economics, and governance, one feeding into the next.



Perceived risks and management of smoke

Most participants found surgical smoke unpleasant (82%). Over three quarters thought it was potentially carcinogenic (76.7%). One third thought it was potentially teratogenic (35.1%). Commonly cited disadvantages included cough, eye irritation, headache and nausea (Table 3). Participants saw better staff health as the main advantage of a surgical-smoke-free policy (92.9%) (Table 4).

Answers to the following questions are shown in Appendix 2, Tables S2–S6: "In what percentage of cases do you think you are exposed to diathermy smoke without the use of a smoke evacuation device?"; "When using diathermy, what smoke evacuation method/s do you usually use?"; "How should diathermy smoke be best managed?"; and "What reasons are there against the use of smoke evacuation diathermy?"

Thematic analysis

One hundred and sixty participants (35%) wrote comments in free-text fields of the survey. From these, we tagged 200 comments from which we developed 18 codes. In the first round of coding, we developed eight initial themes along with 14 sub-themes. After reviewing the initial themes, refinement and renaming, we developed three broad themes, nature, society (including the economics theme), and technology, with a total of ten sub-themes, as shown in Figure 2. Finally, we reflected on the themes through a constructionist lens, bringing published literature and our own understanding to bear on the study question of how the problem of surgical smoke could be approached in an environmentally and socially

responsible way. The nature theme was not as strongly supported in terms of number of comments from our dataset but was a strong overarching concept in planetary health literature.[26,27] Many of our participants commented on aspects of human health as reflected in the sub-themes, including health and feeling valued. This also fitted into a planetary health concept, in which earth and its ecosystems, including human health, takes a higher order than the constructs that society functions within (see Figure 3).

1. What are the implications for the planet?
2. What are the implications for society's constructs?
   - Technology—scientific evidence, engineering, devices, machines, information
   - Economics—financial cost, efficiencies, opportunity cost
   - Governance—movement-building and systems change, equity and justice
3. Consider the interconnection within nature—employ systems-thinking, integrated problem-solving and a collaborative approach.

For a detailed explanation of the themes and sub-themes, along with exemplar data extracts, please see Appendix 3, Supplementary Results.

We propose that all three sub-themes need addressing to bring about change. The healthcare system is situated within the constructs. Steps to address an issue in healthcare are as follows:

Discussion

This study analysed an issue of concern in medicine, surgical smoke, through the opinions of frontline workers. Using mixed methods, we have been able to show the many facets of the issue. There was majority support for a surgical smoke-free policy across all professions. Thematic analysis revealed nuances that were not apparent at first, which allowed the issue to be viewed from social, economic, and technical perspectives within a planetary health framework.

To construct an environmentally sustainable health system, MacNeill et al.[27] outlined three principles: reduce demand for healthcare, match supply of health services to demand, and optimise the environmental performance of healthcare delivery. The third principle suggests healthcare workers should look at health through a different lens, one of planetary health. Guzmán et al.[26] proposed a Planetary Health Education Framework consisting of five domains: interconnection within nature, the anthropocene and health, systems thinking and complexity, equity and justice, and movement building and systems change. Brundiers et al.[28] defined the competencies for sustainability in education as values-thinking, systems-thinking, future-thinking, interpersonal, strategic-thinking, integrated problem solving, and implementation. Our concern was for the health system, not the education system; however, the education frameworks provide a good template. In the present paper we propose a Planetary Health Healthcare Framework that we hope will stimulate systems thinking about healthcare issues.

How could our proposed framework guide the management of surgical smoke? One insight gained from the present study was the need not to simply pursue a "policy". A smoke-free policy, while widely supported by theatre workers in our institution, will be only one piece of the answer.

Environmental concerns of waste and emissions would come to the forefront in the framework. How can we reduce, reuse and recycle the devices? Can we find a supplier that complies with an environmental reporting standard?

Social issues take high priority. Is it fair that staff who do not have control over the use of smoke evacuation devices have to be exposed to smoke? Social justice must be addressed in order to tackle planetary health crisis, but if we cannot address social justice in our own healthcare workplaces, how can we address it globally?

The framework acknowledges technology and the tools we use. Do we need open a diathermy device for every operation? What are the alternatives? Following this piece of work, our paediatric operating rooms removed diathermy handpieces from the standard setup, only opening diathermy when required.

The framework also acknowledges economics. Changing the ways that we do things could bring efficiencies (although focusing on efficiency can paradoxically increase consumption).[29] Do our economists use environmental accounting practices?

This framework could be applied to other aspects of healthcare, targeting issues of justice and management of resources. It is a tool to get one thinking about the wider effects of our decision making within the healthcare setting with the hope of establishing a comprehensive, inte-

grated, and environmentally sound response to health challenges.

Limitations

The present study was limited by an overall response rate of just over one third. This may have been influenced by our wide invitation list that included some healthcare professionals who no longer worked in the operating theatre, which would be supported by the lower response rate from nurses and surgical trainees compared to anaesthetist and surgeons. Response might also have been influenced by people's level of concern about the issue, their engagement with the hospital system, or simply time constraints. Almost one half of consultant surgeons responded. It would be interesting to survey a sample of those who did not respond to determine any differences in demographics or attitudes. Although support for a smoke-free policy was impressive, the results of the survey cannot be considered a mandate given the limited response rate and voluntary response bias.

The qualitative component of the study was based on written responses in optional text field in the survey. Greater depth of understanding might be gained from interview studies. We took a constructionist paradigm in which the researchers themselves are seen as integral to the study, not impartial observers. This could be construed as bias by some or as a strength by others.[24]

The framework did not arise solely from our data but also from our thinking and reading. The framework takes earth and its ecosystems as an over-arching consideration, but few data extracts went into the environmental theme. The proposed framework represents a hypothesis which needs to be tested in future studies. Whether or not it would be useful for other healthcare issues remains to be determined.

Conclusions

Although smoke-free policies form part of the solution to surgical smoke, they are not the whole solution. Qualitative analysis allowed a more nuanced plan than simply mandating smoke evacuation devices. Further research could help clarify whether mixed methods analysis of survey data within a planetary health healthcare framework could lead to more ecologically and socially sound approaches to healthcare.

COMPETING INTERESTS
Nil.

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Appendices

Appendix 1: Copy of the survey.

Surgical smoke: how an issue in healthcare fits a planetary health framework

Let's get started. Please tell me your first name (optional).

Hi [first name]. We would like to know a little about you for demographic purposes. What is your age group?

* must provide value

- 24 or younger
- 25–34
- 35–44
- 45–54
- 55–64
- 65 or more

Please indicate your gender.

* must provide value

Female
Male
Other
Prefer not to say

Where in ADHB do you work most of the time?

* must provide value

- Grafton level 4
- Grafton level 8
- Grafton level 9
- Greenlane
- Starship

What is your main specialty area?

* must provide value

- Cardiothoracic
- ENT/ORL
- General surgery/sub-speciality
- Gynaecology/Obstetrics
- Maxillofacial surgery
- Neurosurgery
- Ophthalmology
- Oral and Maxillofacial surgery
- Orthopaedic surgery
- Paediatric surgery
- Plastics and Hand surgery
- Transplant surgery
- Urology
- Vascular surgery
- No main specialty–I work all over

What is your main role?

* must provide value

- Nurse
- Surgeon
- Anaesthetist
- Anaesthetic technician
- Other

Please tell me your role:

What nursing level are you?

* must provide value

- New Grad
- Level 2
- Level 3
- Level 4
- Senior Nurse
- Nurse Manager

What is your main nursing role?

* must provide value

- Scrub/circulating
- Recovery
- Coordinator/Charge Nurse
- Educator
- Manager

What is your surgical position?

* must provide value

- Consultant/SMO
- Fellow
- Registrar
- Other

When using diathermy, what smoke evacuation method/s do you usually use (tick as many as applicable)?

* must provide value

- Smoke evacuation diathermy device
- Standard hand-held suction
- Laparoscopic smoke evacuator
- None
- Not applicable

In what percentage of cases do you think you are exposed to diathermy smoke without the use of a smoke evacuation device?

* must provide value

- <20%
- 20–40%
- 40–60%
- 60–80%
- >80%
- Not applicable

Do you work at another hospital where there is

a diathermy smoke-free policy?
* must provide value

- Yes
- No

How much of a health hazard is diathermy smoke in your opinion?
* must provide value

No or very little health risk
Extremely high health risk

Change the slider above to set a response (0–100)

What do you perceive are the negative effects of surgical smoke (choose as many as you like)?
* must provide value

- Generally unpleasant
- Headache
- Nausea
- Cough/other respiratory symptoms
- Eye irritation
- Potentially carcinogenic
- Potentially teratogenic
- No negative effects

How should diathermy smoke be best managed?
* must provide value

- Encourage smoke evacuator diathermy use by surgeons
- Make smoke evacuator diathermy use mandatory
- The assistant should use hand-held suction to suck away smoke
- Don't worry about smoke

The following questions explore why you would support a smoke-free policy at ADHB and the benefits and barriers you might envisage. Simply stated, a smoke-free policy would make smoke evacuation diathermy devices standard in the operating room. The standard surgical setup would include smoke-free devices. The policy would allow exceptions for procedures where the use of a smoke-free device would not be possible or appropriate. The exact details of any policy would need to be worked out in consultation.

What advantages do you see in a smoke-free policy in ADHB? (Choose as many as you like.)
* must provide value

- Better staff health
- Improved staff morale
- Improved patient safety
- Can see better without all that smoke
- No advantages
- Any other advantages you can think of?

What reasons are there against the use of smoke evacuation diathermy? (Tick as many as you like.)
* must provide value

- Not readily available
- Clumsy device for fine work
- Noisy
- Too expensive
- Takes longer to set up
- Is not effective
- I would not want to be constrained to using a smoke-free device
- Bad for the environment (e.g., more plastic waste)
- No reasons against its use

Any other barriers to using smoke-evacuation diathermy?

Would you support a diathermy smoke-free policy at ADHB?

Simply stated, a smoke-free policy would make smoke evacuation diathermy devices standard in the operating room. The standard surgical setup would include smoke-free devices. The policy would allow exceptions for procedures where the use of a smoke-free device would not be possible or appropriate. The exact details of any policy would need to be worked out in consultation.

* must provide value

- Yes
- No

Thank you [first name]!

Feel free to tell us anything else you that you think is relevant.

Appendix 2: Supplementary tables.

Surgical smoke: how an issue in healthcare fits a planetary health framework

Table S1: Response rate by professional group.

Profession	Complete	Partial	None	Total
Anaesthesia	78 (62%)	2	46 (36%)	126
Anaesthetic Technician	45 (34%)	2	86 (64%)	133
Healthcare Assistant	0	0	10	10
Nursing	178 (35%)	7	320 (63%)	505
Ophthalmology	7 (19%)	1	28 (78%)	36
Surgical Consultant	79 (49%)	4	77 (48%)	160
Surgical Trainee	56 (21%)	2	206 (78%)	264

Table S2: Exposure to diathermy smoke (in response to the question, "In what percentage of cases do you think you are exposed to diathermy smoke without the use of a smoke evacuation device?").

	<20%	20–40%	40–60%	60–80%	<80%	Total
Nurse	37	25	27	42	40	171
Surgeon	55	22	19	22	19	137
Anaesthetist	24	26	22	8	5	85
Technician	12	6	14	8	6	46

Technician, anaesthetic technician. Not shown, work role "other" (n=8).

Table S3. Responses to the questions, "Do you work at another hospital where there is a diathermy smoke-free policy?", and "Would you support a diathermy smoke-free policy?"

	Nurse n=180	Surgeon n=139	Anaesthetist n=88	Technician n=47
SFP elsewhere*	10 (5.6%)	36 (26%)	23 (26%)	5 (11%)
Support SFP**	171 (95%)	108 (78%)	81 (92%)	45 (96%)

*Works at another hospital which has a surgical smoke-free policy (SFP).
**Would support a surgical smoke-free policy at our hospital.
Technician, anaesthetic technician. Not shown, work role "other" (n=8).

Table S4: Answers to the question, "When using diathermy, what smoke evacuation method/s do you usually use?"

	Nurse n=180	Surgeon n=139	Anaesthetist n=88	Technician n=47
Smoke evacuation diathermy device	140	95	29	16
Standard hand-held suction	92	71	24	15
Laparoscopic smoke evacuator	42	24	18	8
None	25	31	31	15

Technician, anaesthetic technician. Not shown, work role "other" (n=8).

Table S5: Answers to the question, "How should diathermy smoke be best managed?"

	Nurse n=180	Surgeon n=139	Anaesthetist n=88	Technician n=47
Encourage smoke evacuator diathermy use by surgeons	118	77	39	23
Make smoke evacuator diathermy use mandatory	155	69	65	45
The assistant should use hand-held suction to suck away smoke	56	51	15	8

Technician, anaesthetic technician. Not shown, work role "other" (n=8).

Table S6: Answers to the question, "What reasons are there against the use of smoke evacuation diathermy?"

	Nurse n=180	Surgeon n=139	Anaesthetist n=88	Technician n=47
Not readily available	29	42	32	18
Clumsy device for fine work	89	77	20	14
Noisy	76	52	18	14
Too expensive	38	33	24	13
Takes longer to set up	10	12	10	2
Is not effective	16	21	5	2
I would not want to be constrained to using a smoke-free device	10	17	4	2
Bad for the environment	59	43	34	20
No reasons against its use	8	5	6	2

The main reasons against the use of a smoke evacuator were technical issues, that it was clumsy (45.7% of participants), noisy (36.8%), or not readily available (27.4%); environmental concerns (35.7%); and economic concerns (24.4%).
Technician, anaesthetic technician. Not shown, work role "other" (n=8).

Appendix 3: Supplementary results.

Surgical smoke: how an issue in healthcare fits a planetary health framework

Theme development process

We used the reflexive thematic approach as described by Braun and Clarke.[1] Theme development was recursive, deeply reflective, one in which the researchers took an active role by bringing their own understanding and background to the process. Here, we seek to illuminate how we developed themes and give the number of data extracts that went into forming themes.[2] The dataset consisted of all free-text comments in the survey. Data extracts consisted of highlighted portions of text from the data set, each of which was tagged with one or more codes. Presented here are the codes, initial themes, and refined themes along with the number of data points (highlighted comment extracts) associated with each.

Codes

In Taguette, we read through the data set and highlighted extracts of text and tagging each with codenames that seemed to reflect the meaning of each comment.

1. Smell 15
2. Job 8
3. Valued 8
4. Well-being 32
5. Standard practice 6
6. Economics 12
7. Mirroring/example 8
8. Customer experience 6
9. Empowering 16
10. Change culture 4
11. Evidence 8
12. Technical 28
13. Bulky 21
14. Useless 11
15. Setup 4
16. Environmental 8
17. Noise 2
18. Right of refusal 3

Initial themes

We grouped the codes together into initial themes.

1. Diathermy smoke is unpleasant and bad for your health 53
   - Smell
   - Wellbeing
   - Customer experience
2. Want a working environment where people feel valued, cared for, and safe 16
   - Job
   - Valued
3. Choice and the power balance 29
   - Empowering
   - Change culture
   - Standard practice
   - Right of refusal
4. Need to look after the environment 8
5. Our hospital should be a leader, or at least up with the play internationally 8
6. Money and economics 12
7. Epistemological considerations 8
8. Design and technology 66
   - Technical
   - Bulky
   - Useless
   - Setup
   - Noise

Reviewed themes

Following initial theme making, we re-read the data set, reflected, and grouped them into three main themes, each with subthemes.

1. Nature 8
   - Plastic waste
   - Atmospheric emissions
2. Society 126
   - Diathermy smoke is unpleasant
   - Work environment
   - Epistemology
   - Choice
   - Hospital as a leader
   - Economics
3. Technology 66
   - Bulk and noise
   - Efficacy

Commentary and data extract examples of the reviewed themes

In making these themes, we were being mainly inductive while also trying to take a critical, not just realist, approach to how we interpretation of what people had told us. Here, we discuss each theme and subtheme with examples from the data to illustrate each.

Nature

Plastic waste

People were concerned about increasing the amount of plastic waste if smoke-evacuating diathermy was used routinely. Some people expressed concern about recycling and waste. For example, there was “no point introducing it if we are still

polluting in other ways". Another person stated that they would "not support the policy unless responsible disposal (recycling) is introduced concurrently".

Atmospheric emissions

The other environmental concern was about emissions. For example, smoke evacuation was seen as a way to "prevent air pollution" and to "reduce carbon emission".

In Planetary Boundary terms these issues could be categorised as "chemical pollution"[8] and perhaps "climate crisis".

Society

Economics

On the economic side, some people were concerned about the potential extra cost for the organisation, while others felt that any extra cost was not an excuse for the organisation not to use smoke evacuation devices ("…or is money more important?" asked one participant). Others pointed out that there is already wastage in the system because the "diathermy pencil comes out of the propack and it seems wasted if not used for a short procedure".

These comments suggest that people are concerned about costs, do not like seeing economic waste, but balance this with justification for extra cost where health and safety is at stake.

Health and feeling valued

Many comments concerned health and wellbeing as in the selected list of quotes here:

> *"surgical smoke is bad for us, and so an attempt to reduce the harm would be appreciated"*
>
> *"safety of staff overrides individual surgeon preference"*
>
> *"I feel quite frustrated when I have to sit in theatre and inhale the smoke because somebody has refused to use it" (a smoke evacuation device)*
>
> *"makes being present in theatre quite uncomfortable and hard to concentrate"*
>
> *"have had written complaints from anaesthetic colleagues not wishing to continue working in OR [operating rooms] cases with all that smoke"*
>
> *"definitely affects not only the people in the theatre but also the staff, patients and family down the corridors and in the general vicinity, as the smoke travels"*
>
> *"don't we care about our staff?"*

These comments show how exposure to smoke was not only seen as a health and safety issue but also a reflection on how others in the organisation, and the organisation as a whole, values its staff and patients.

Choice and empowerment

Several comments demonstrated how one team member would request a smoke evacuation device, but another had the power of refusal. Most people attributed the power to choose to surgeons. For example, nurses quoted "*surgeon preference*" as a common reason why smoke evacuation devices were not used, and avoidance of "*arguments with surgeons*". An advantage of a smoke-free policy would be that it *"empowers those who don't feel comfortable asking a surgeon to use a smoke evacuator*" according to one respondent. However, the power balance was not necessarily determined by profession, as one junior surgeon put it, "*at a more junior level we are often not given the choice and/or the normal diathermy equipment has already been opened so would be wasted"*. This indicates that power games played in society are more complex than just profession based. Anyone who feels they may be in a dominant position over another may indulge in power and control over co-operation and reasoning.

Some saw the organisation as having a role in managing power games, seeing the use of smoke evacuation devices as *"not a personal decision but an organisation wide decision"*. On a slightly humorous note, one participant explained, "gave a surgeon one to use … and he said 'oh I don't like to use those here, they make me use them in private' to which my answer was 'well ok then I'm going to make you use them here as well'!"

Epistemology

Views on what constituted "evidence" varied considerably. Some negated evidence, for example, *"I am yet to see any documented cases of cancer or ill health in surgeons or OR [operating room] staff induced by diathermy smoke"*; "*absence of any convincing data that diathermy smoke actually causes harm to personnel"* and "*lack of compelling evidence that diathermy plume actually does cause*

harm". The use of the terms convincing, compelling, and documented are interesting here, possibly suggesting the positivist epistemology taken by these participants.

Others took a different view, citing the "*threat of unknown risks"* and that 'this occupational exposure is bound to have long-term adverse effects which we are currently oblivious/complacent about'. To some, it was quite simply a matter that "*surgical smoke is bad for us, and so an attempt to reduce the harm would be appreciated"*. One participant quipped, "*I concede that smoke contains potential carcinogens and viable viral particles"*. Thus, some but not all participants seemed to take an epistemological stance conducive to their bias, whether citing that "*we will not all die of lung cancer"* as a reason not to change to a new device, or the "*virus particle transmission"* as a reason to remove something unpleasant and potentially dangerous.

The organisation as a leader

The role of the organisation was alluded to above. Identity with the hospital as a leader was a theme for some respondents, for example, "*we are the largest public hospital in Aotearoa, we should be setting the pathway for all other hospitals to follow"*, or *"other hospitals implemented this decades ago—unbelievable we have not!"* The leadership of other hospitals in implementing a smoke free policy was noted: *"surgeons starting asking for them as they only are allowed to use the smoke evac in private"*.

Tools and technology

Bulk and noise

The majority of the technical comments concerned the bulk of the device, for example, "*surgeons don't like the bulkiness"*, "*obstructs the view when operating on very tight spaces/cavities"*; *"is a bulky device"*.

A couple of people noted the noise made by the suction device: "*the device is quite noisy"*.

Efficacy

People noted problems with the efficacy of smoke evacuation devices when generating a large amount of smoke, for example, "*sometimes not enough to suck all the smoke emitted*". One respondent offered an additional solution for the high-smoke situation: "*bigger suction tubings are required and used by other departments"*.

Another problem people highlighted was lack of efficacy when an extension was added to the diathermy pencil, with one explaining that "*changing the length of diathermy tip impedes the effectivity of the smoke evac because of its proximity to the tip"*.

On the positive side, it was noted by a participant that the smoke evacuation device "*frees [the] surgical assist from [the] sucker"*.

Re-worked themes

In the final stage, we re-visualised the themes through our own view of the world, largely within a planetary health framework, but also our understanding of some of the key social constructs that society, including the health system, functions within. Societal structures were seen as nested within the larger concept of people's wellbeing (human health) which in turn was seen as nested within all ecosystems on earth and the physical environment. This nested structure is modeled after Planetary Boundaries[7] and the Doughnut Economics.[6] It gives perspective where a technological tool, such as a diathermy machine for example, is seen in the context of how it influences human health and the environment, and in its interactions with the complex system.

1. Earth and its ecosystems
   - Plastic waste
   - Atmospheric emissions
2. Human health
3. Society
   - Technology
   - Use and efficacy of tools
   - Governance
   - People and Health
   - People and Justice
   - People and Power
   - Economics

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Psychiatric hospitalisation before and after commencing long-acting injectable antipsychotic medication: a mirror-image study

Marella Bedggood, Shirley Walton, Mayan Bedggood

ABSTRACT

AIMS: Treatment adherence is an important predictor of outcomes in schizophrenia, related disorders and bipolar disorder, and may be improved by the use of long acting injectable (LAI) antipsychotic medication. Past research on the efficacy of LAIs is mixed with randomised controlled trials showing similar benefits to oral medication, and naturalistic studies showing advantages to LAIs.

METHOD: Psychiatric hospital bed-nights and admissions were compared before and after commencement of an LAI, using a retrospective cohort study with a mirror-image design. Total bed-nights and hospital admissions for each patient were compared for the same time period before and after commencing the LAI. Subgroup analyses were also conducted.

RESULTS: Mean bed-nights decreased from 47.1 pre-LAI to 14.3 post-LAI, and median bed-nights from 24.5 to 0.0. Mean hospital admissions decreased from 1.7 pre-LAI to 0.7 post-LAI, and median admissions from 1.0 to 0.0.

CONCLUSION: In our cohort, LAI treatment was associated with a significant reduction in bed-nights and total admissions to psychiatric hospitals. The findings of the current study are consistent with the results of previous naturalistic studies of LAI treatment for patients with psychotic disorders and bipolar disorder.

Treatment adherence is an important predictor of relapse and psychiatric hospitalisations in schizophrenia, related psychotic disorders, and bipolar disorder.[1–3] Administration of antipsychotic medication in long-acting injectable (LAI) slow release formulations (also called depot antipsychotics) allows doses to be administered in the form of an intramuscular injection every two to four weeks instead of daily oral dosing, ensuring consistent medication delivery and more accurate monitoring of treatment adherence.

Results of randomised controlled trials (RCTs) comparing LAIs with oral antipsychotics have not shown any benefits of depot formulations over oral.[4,5] However, although RCTs are often considered the gold standard for assessing treatment efficacy, it has been suggested that they may be less appropriate for questions of best practice relating to antipsychotic treatment.[6–8] This is because RCTs are likely to select competent, consenting patients where adherence can be reasonably expected, and often involve the artificial scenario of frequent monitoring and reminders, potentially resulting in different therapy adherence than real-world settings as the trial itself can influence patient outcomes via the Hawthorne effect.[6,9] Therefore, results from RCTs alone may not be representative of real world differences in outcomes relating to antipsychotic treatment.[10,11] More pragmatic study designs can be valuable for assessing real-world population outcomes and their use complements findings from RCTs by adding to the generalisability of available evidence.[8,10] With this in mind, Kirson and colleagues[12] conducted a systematic review and meta-analysis of studies assessing efficacy of LAIs versus oral medications for relapse and hospitalisation, comparing results from RCTs versus observational studies. They found no evidence of a difference in efficacy when only RCTs were analysed, but found that there were significant advantages to LAIs when both prospective and retrospective observational studies were analysed.

Mirror-image studies are observational studies that compare periods before and after a certain condition is met, with a patient acting as their own control. The mirror image design is a well-recognised and useful methodology for psychiatric research and has been used by several international authors to examine psychiatric outcomes.[9,11,13–16] As each patient is compared to their previous experience and not with an aver-

age, this can be useful for research in disorders where individual illness courses vary widely.[17] Compared to RCTs, mirror-image studies allow for a more naturalistic representation of real-world antipsychotic treatment outcomes, especially regarding research questions where medication adherence is thought to be so important. In a systematic review of 25 mirror-image studies of 5,940 adults with schizophrenia or schizoaffective disorder, the overall risk of hospitalisation, rates of hospitalisation and time spent in hospital were compared before and after initiation of LAI treatment.[6] Strong evidence was found that LAI treatment was superior to oral treatment in preventing hospitalisations (risk ratio [RR]=0.43), as well as decreasing the number of days patients spent in hospital. Tiihonen and colleagues[7] studied the antipsychotic treatment of 29,823 patients with a diagnosis of schizophrenia using an alternate method of within-individuals analysis. They found that the risk of hospitalisation with LAI treatment was 22% lower than when patients were treated with the oral form of the same medication (p<0.001).

In order to obtain information from an Aotearoa New Zealand context, the authors conducted a retrospective observational study with a mirror-image design examining outcomes before and after commencing LAI antipsychotic treatment in our local community service. The number of nights spent admitted to a psychiatric hospital, or "bed-nights", were used as an outcome measure. As well as being correlated with relapse rates,[18] hospitalisation is an important end point in itself, given that psychiatric in-patient unit beds are a scarce resource that must be utilised with consideration of both the individual patient needs as well as the needs of the community as a whole. This is certainly true in the Aotearoa New Zealand context, where the number of psychiatric in-patient beds (32 per 100,000 population) is roughly half the average per capita for Organisation for Economic Cooperation and Development (OECD) member countries.[19,20]

Method

The Health and Disability Ethics Committee reviewed the study protocol (Reference 21/CEN/61) and approved the unconsented use of previously collected data for the study purposes.

Study population

All patients under the care of a district health board (DHB) general adult community mental health team, who were prescribed a second-generation LAI medication as of 31 December 2019. Only those prescribed a second-generation LAI were included in the initial cohort as the service keeps a centralised record of these patients. It was expected that the majority of included patients would have a diagnosis of schizophrenia, but we were also interested in the outcomes for patients with other psychotic disorders and bipolar disorder, given that patients with bipolar disorder often experience psychotic symptoms and antipsychotic medication is effectively utilised in the management of bipolar disorder.[21]

Inclusion criteria

Patients with a psychotic or bipolar disorder, prescribed a second-generation LAI of any kind as of end 2019, under the follow up of the identified community mental health service at end 2019, treated with an LAI for at least six months prior to end 2019.

Exclusion criteria

Patients with a personality disorder or unipolar depression with or without psychotic features as their only diagnosis, patients not living in the region during the period under consideration and therefore with hospitalisation and bed-night data not accessible. Only those patients with evidence of contact with mental health services prior to the start of the pre-LAI mirror period were included, to ensure that both periods of comparison covered a part of the patient's life after the onset of their illness. In the case where a patient's first contact with mental health services was later, the time period of the mirror was adjusted to this date.

Outcome measures

The primary outcome was bed-nights pre- and post-LAI. Bed-nights were defined as nights spent admitted to any of the DHB's psychiatric in-patient units. Total number of psychiatric hospitalisations (admissions) pre- and post-LAI commencement were also assessed as a secondary outcome.

Data collection

Electronic medical records were reviewed to retrieve the following information: LAI commencement date, LAI type, age, gender, ethnicity (by self-report), whether patients were subject to compulsory treatment under the Mental Health (Compulsory Assessment and Treatment) Act 1992 (MHA) at the time of LAI commencement (MHA status) and whether they were in-patient

or out-patient at time of commencement (in-patient status). Two mirror periods of equal length were determined for each patient—the period of time from LAI initiation until the end of the study period or until the LAI was ceased, whichever came first (the post-LAI period), and a matching length period of time immediately prior to starting the LAI (pre-LAI period). A DHB data analyst staff member provided the associated bed-nights and admissions data for each mirror period.

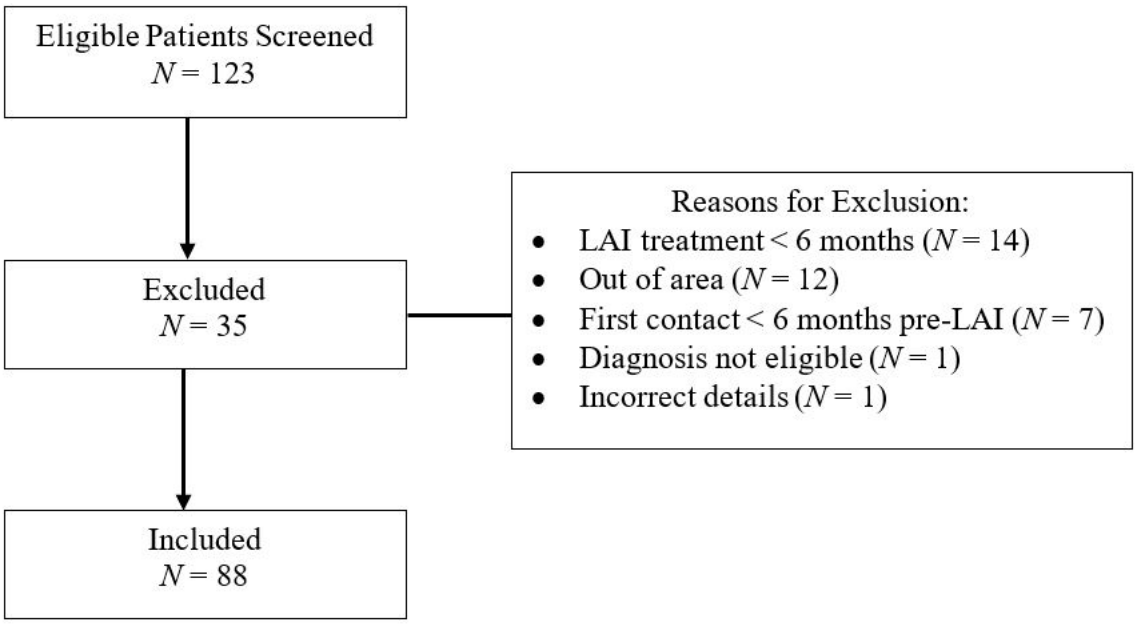
If a patient was prescribed more than one LAI but there was less than three months between the previous LAI and the current LAI, this was treated as one period of continuous treatment. When the date of LAI commencement fell during an admission, the remainder of bed-nights during that index admission were excluded, with the "mirror" starting from the date of discharge. For patients where their most recent episode of LAI treatment was not eligible for inclusion, if they had a prior period of LAI treatment then this was considered for inclusion instead whether they were prescribed a first- or second-generation LAI.

Statistical analyses were conducted using IBM SPSS Statistics (Version 28.0) and *p*-values of <0.05 were considered significant.

Results

After screening, 88 patients were included in the analysis (see Figure 1). Baseline patient characteristics are summarised in Table 1.

Figure 1: Patient screening.



Preliminary analysis

The assumption of normality was violated as indicated by significant Shapiro–Wilk tests for both the bed-nights (W=0.75; $p<0.001$) and admissions data (W=0.96; $p=0.006$); therefore, the Wilcoxon signed-rank test was used.

Primary analysis

Bed-nights pre- and post-LAI were compared using the Wilcoxon signed-rank test. Results indicated that there was a significant reduction in bed-nights post-LAI (*Mdn*=0.0; *M*=14.3; *SD*=33.0) compared to pre-LAI (*Mdn*=24.5; *M*=47.1; *SD*=64.9), z=-5.29; $p<0.001$, with a medium effect size of $r=0.40$ (see Figure 2).

Secondary analysis

Admissions pre- and post-LAI were compared using the Wilcoxon signed-rank test. Results indicated that there was a significant reduction in admissions post-LAI (*Mdn*=0.0; *M*=0.7; *SD*=1.5) compared to pre-LAI (*Mdn*=1.0; *M*=1.7; *SD*=1.4), z=-4.93; $p<0.001$, with a medium effect size of $r=0.37$ (see Figure 3).

In the pre-LAI period, only 17 out of 88 patients (19.3%) had no in-patient admissions at all, whereas this increased to 65 patients (73.9%) in the post-LAI period (see Figure 4).

Subgroup analyses

Subgroup analyses were conducted with descriptive statistics for each subgroup summarised in Table 2.

Table 1: Baseline characteristics.

Characteristics	Totals (%)
Age bands (years)	
18–29	10 (11.4)
30–39	20 (22.7)
40–49	21 (23.9)
50–59	20 (22.7)
60+	17 (19.3)
Gender	
Female	27 (30.7)
Male	61 (69.3)
Ethnicity	
Non-Māori	80 (90.9)
Māori	8 (9.1)
Diagnosis	
Schizophrenia	58 (65.9)
Schizoaffective disorder	15 (17.1)
Bipolar disorder	10 (11.4)
Psychotic disorder not otherwise specified	3 (3.4)
Substance-induced psychotic disorder	1 (1.1)
Delusional disorder	1 (1.1)
Type of LAI medication	
Olanzapine	31 (35.2)
Paliperidone	22 (25.0)
Risperidone	19 (21.6)
Flupenthixol	2 (2.3)
Mixed	14 (15.9)
Length of mirror period (days)	
Mean	1,085.0
Median	839.0
Minimum	184
Maximum	3,703

Figure 2: Average bed-nights pre- and post-LAI.

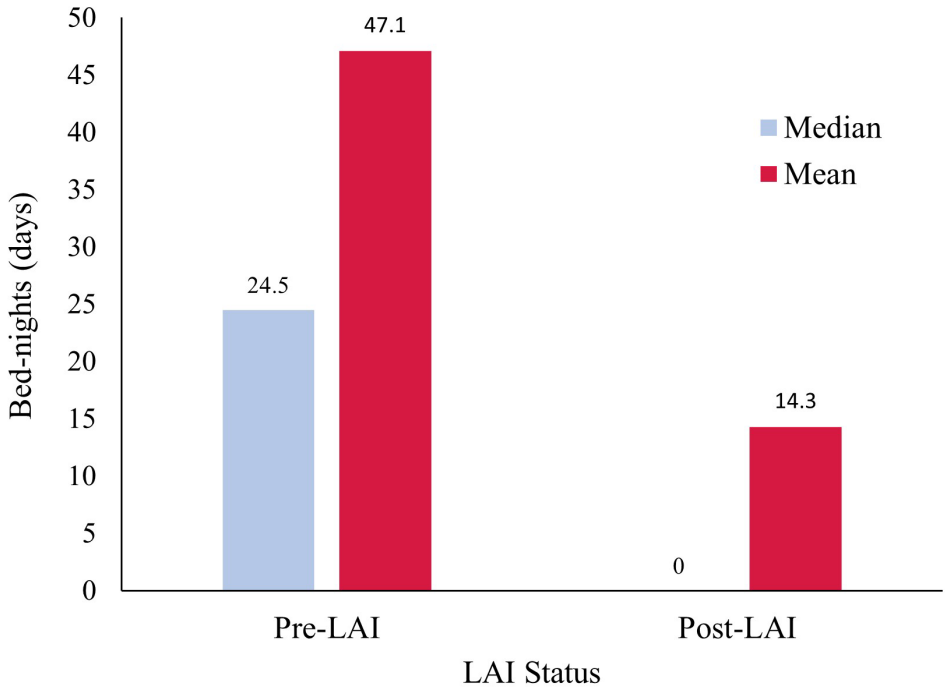


Figure 3: Average admissions pre- and post-LAI.

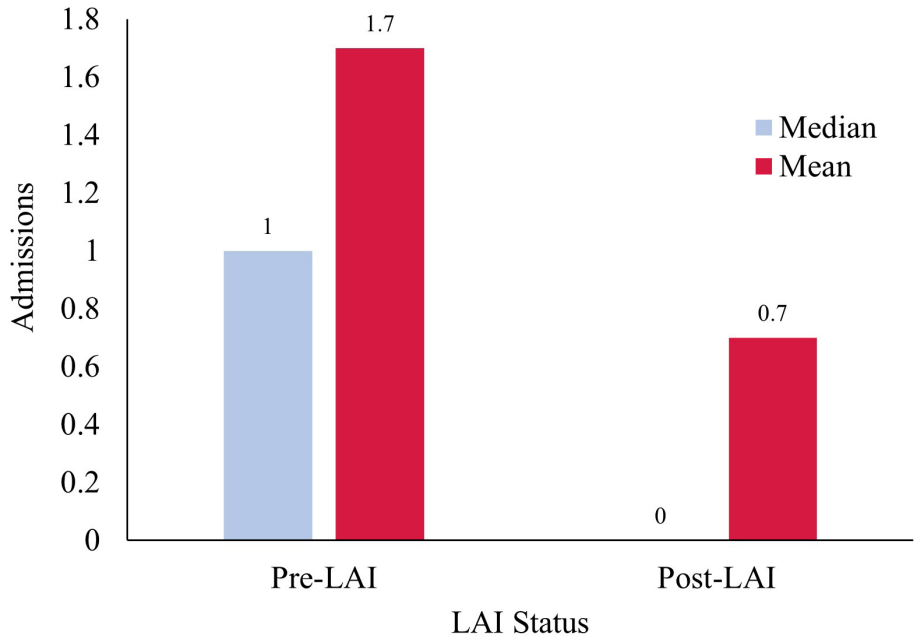


Figure 4: Change in proportion of patients with no admissions.

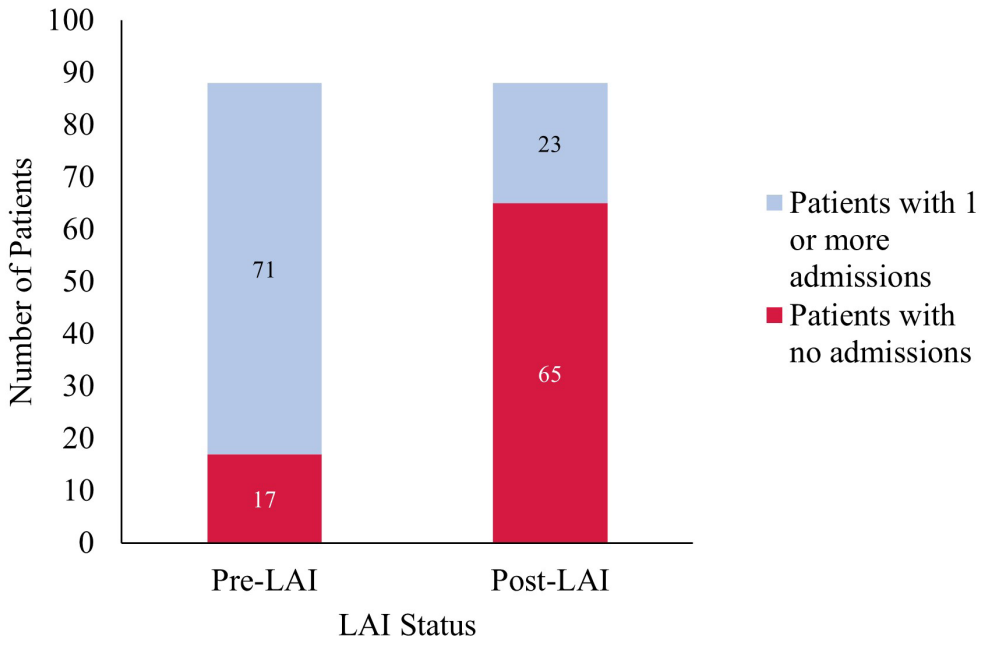


Table 2: Subgroup analyses for ethnicity, MHA status and in-patient status.

	Bed-nights				**Admissions**			
Sub-group	**Pre-LAI**		**Post-LAI**		**Pre-LAI**		**Post-LAI**	
	Mdn	**M**	**Mdn**	**M**	**Mdn**	**M**	**Mdn**	**M**
Ethnicity								
Non-Māori	22.5	48.5	0.0	14.7	1.0	1.8	0.0	0.7
Māori	32.5	33.0	0.0	11.1	1.5	1.4	0.0	0.8
MHA Status								
MHA	33.0	57.1	0.0	16.9	2.0	2.1	0.0	0.8
No MHA	0.0	15.1	0.0	6.3	0.0	0.6	0.0	0.5
In-patient status								
In-patient	33.0	56.5	0.0	17.7	2.0	2.2	0.0	0.9
Out-patient	0.0	27.9	0.0	7.4	0.0	0.8	0.0	0.4

Ethnicity

A Mann–Whitney U test indicated that there was no significant difference between Māori (*Mdn*=18.5; *M*=21.9) and non-Māori (*Mdn*=13.5; *M*=33.8) patients in terms of the change in bed-nights after commencing an LAI (p=0.81). Another Mann–Whitney U test also found no significant difference in change in admissions between Māori (*Mdn*=1.0; *M*=0.6) and non-Māori patients (*Mdn*=1.0; *M*=1.1), with p=0.56.

MHA status

A Mann–Whitney U test indicated a significant difference between change in bed-nights for the MHA (*Mdn*=22.5; *M*=40.0) and no MHA groups (*Mdn*=0.0; *M*=8.9), with $p<0.001$. A significant difference was also shown for change in admissions between the MHA (*Mdn*=1.0; *M*=1.3) and no MHA groups (*Mdn*=0.0; *M*=0.1), with $p<0.001$.

In-patient status

A Mann–Whitney U test was conducted to compare the change in bed-nights based on in-patient status and indicated a significant difference between the in-patient (*Mdn*=22.5; *M*=39.2) and out-patient groups (*Mdn*=0.0; *M*=20.5), with p=0.003. Lastly, a Mann–Whitney U test indicated a significant difference for change in admissions between the in-patient (*Mdn*=1.0; *M*=1.3) and out-patient groups (*Mdn*=0.0; *M*=0.4), with $p<0.001$.

Discussion

For this cohort, the median nights spent in hospital after starting an LAI dropped from 24.5 nights pre-LAI to zero nights post-LAI. Additionally, the proportion of patients with no admissions at all, which was only 19.3% in the pre-LAI period, more than tripled to 73.9% in the post-LAI period. This degree of change was statistically significant and would likely also be of clinical significance.

The current study provides information on outcomes of LAI use from an Aotearoa New Zealand context and includes data from Māori patients, which at time of writing has not previously been published. It is known that Māori have higher rates of mental illness,[22] are admitted to psychiatric in-patient units at a higher rate than non-Māori,[23] and are more likely to be admitted due to schizophrenia.[24] This is of relevance to the current study as patients prescribed LAIs commonly have a diagnosis of schizophrenia, and are often subject to involuntary treatment under the MHA.[25] Given there is every reason to expect Māori to be prescribed LAIs at least at the same rate as non-Māori, ensuring equitable outcomes is imperative and in accordance with Article 3 of Te Tiriti o Waitangi.[26]

In our cohort, we found similar benefits for Māori and non-Māori groups in terms of change in bed-nights or admissions. However, there was only data available from eight Māori patients. A power analysis indicated that the effect size would have needed to be approximately 0.9 in order for a difference to be detected between Māori and non-Māori with the existing sample sizes. Although our cohort included a similar proportion of Māori (9%) to that of the DHB catchment area (10%),[27] Māori comprise 16.5% of the population in Aotearoa New Zealand and so were under-represented in this study.[28] We also considered looking at Pasifika patients as a separate group; however, there were only two Pasifika patients in this cohort (similar to the catchment area population).[29]

A further subgroup analysis was conducted for the effect of MHA status at the time of LAI commencement. The reduction in both bed-nights and admissions was greater for those under the MHA at the time of LAI commencement, compared to those who accepted the LAI voluntarily while not subject to the MHA. This may be because the benefits of LAIs are more pronounced in those patients that are not being treated in a voluntary capacity and are, therefore, likely to be less willing to take oral medication.

Lastly, a similarly significant result was found for the subgroup analysis comparing differences based on in-patient status. The reduction in both bed-nights and admissions was greater for those who were in-patients at the time of LAI commencement, compared to those who were out-patients. This may be because patients commenced as an out-patient would generally be more well, possibly with greater insight into the need for treatment, and more likely to be accepting of treatment, whether it be oral medication or an injection.

We believe that a strength of the methodology of this study is that no conditions were placed on treatment prior to the LAI. While many previous studies have sought to compare treatment with oral versus injectable antipsychotics, including patients with evidence of treatment with oral antipsychotics prior to LAI use has the potential to introduce selection bias. This is because any attempt to include those consistently adhering to an oral medication regimen encounters the same issues as RCTs, with unrealistically organised and adherent populations being included that do not

represent the populations of interest. It could be argued that in order to be more generalisable, study inclusion should place no conditions on the treatment prior to starting the LAI. This approach was taken by Taylor and colleagues[13] in a mirror-image study of paliperidone LAI with a naturalistic cohort of patients with diagnoses including schizophrenia, other psychotic disorders, or bipolar disorder. They found that paliperidone LAI initiation was associated with a decrease in both number of hospitalisations as well as total days spent in hospital.

There are, however, some important limitations to the mirror-image methodology that apply to the current study.[6] In contrast to a more formal RCT, mirror-image studies cannot rule out potential biases such as the unknown influence of both patients and prescribers being aware of the type of treatment, or time related changes in hospital admissions such as due to population growth with increasing bed pressure, availability of alternatives to hospital care (such as respite facilities), or change in clinical practices over time.[14] It is possible that these factors could introduce a systematic bias wherein later periods of time would have a tendency towards having shorter admissions, which was not controlled for in this study. The study is thus limited by the absence of a contemporaneous comparator. However, it is worth noting that a 2018 Health and Disability Commissioner Annual Report indicated that the average length of in-patient admissions in the four years prior to the end of the study period had been stable.[30]

A further limitation of the study is that only one region was analysed, which could have resulted in admissions not being counted if patients were living out of area when an admission occurred, as well as limited the generalisability. This study design could be expanded to other community teams and therefore be more generalisability to Aotearoa New Zealand as a whole.

In conclusion, the current study contributes data from the Aotearoa New Zealand context regarding the real-world outcomes for patients started on LAI antipsychotics. In our cohort, patients spent significantly less time in a psychiatric hospital after starting LAI medication as measured by both bednights and total admissions. This effect was greater for those who were commenced on LAIs while under the MHA or as in-patients. The same benefits were found for Māori and non-Māori patients, but numbers of Māori were small in this cohort. We hope that future research could investigate larger populations in other catchment areas with a higher number of Māori and Pasifika patients, and that it could be further expanded to take into account issues such as reasons for hospitalisation and access to treatment to further develop understanding of any differences in outcomes.

COMPETING INTERESTS
The authors declare no conflicts.
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Cruise ship patient presentation, admission, and intervention rates to the emergency department

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ABSTRACT

AIMS: Patients presenting to emergency departments (EDs) from cruise ships are a unique cohort of patients with several management challenges. Little evidence details the effect this has on EDs in terms of resource use. Therefore, we aimed to review the frequency, characteristics, admission, and intervention rates of cruise ship patient presentations to ED.

METHODS: This retrospective study reviewed patient presentations to Wellington ED from cruise ships between 2016 and 2019. Data regarding presenting features, intervention and disposition were extracted via chart review.

RESULTS: There were 214 patient presentations included with a median age of 68 (IQR 43.0–76.0); 97/214(45.3%) were female. Regarding referral, cruise ship doctors referred 79/214 (36.9%) patients; 16/79 (24.1%) to in-patient specialties and 63/79 (79.7%) to emergency medicine (EM); and 135/214 (63%) self-referred to ED. Common presenting complaints were chest pain, abdominal pain and trauma. Advanced imaging was requested for 21.5% of patients and 9.9% required urgent intervention. Regarding disposition, 38% were admitted (22% to in-patient wards, 16% to ED observation unit [OU]) and 61% were discharged (30% by ED and 31% after specialty consultation).

CONCLUSION: Overall, the number of cruise ship patients presenting to the ED was low and unlikely to be a significant resource burden. Referrals by cruise ship doctors were appropriate. Education for cruise ship patients and port services regarding non-emergent care options would be valuable to reduce self-referral rates.

New Zealand welcomes 322,000 tourists and 93,000 crew members annually from cruise ships. Prior to the COVID-19 pandemic, cruise ship numbers were rising yearly and contributing nearly $600 million to the New Zealand economy annually.[1] Inevitably, some of these visitors require medical care for minor or major ailments. Modern cruise ships often have a medical team on board and varying access to investigations and treatment. The American College of Emergency Physicians make recommendations for cruise ship medical facilities,[2] which are supported by the Cruise Line International Association, but this still allows for significant variability of resources and standards between ships.

Providing medical care aboard a cruise ship is a unique clinical environment often complicated by geographical remoteness, resource limitation and rotating staff. Often passengers are elderly with a variety of co-morbidities, differing health beliefs and different brands and types of medications.[1,3–9] It is also challenging for cruise ship physicians to be familiar with local healthcare systems and how to access specialist consultation.

From the limited cruise ship healthcare data available; 11% of medical conditions treated are potentially life threatening,[3] and 3% required immediate hospital assessment or intervention.[4] Therefore, it is understandable that not all conditions can be safely managed on board. On average, 1.4–7% of passengers or crew require on-shore assessment.[3,4] Studies report a high prevalence of respiratory conditions among passengers and dermatological disorders in crew, [3–7] the former being particularly relevant given the current global COVID-19 pandemic, as cruise ships are a potential reservoir for transmittable infectious diseases.[10,11] Trauma and gastrointestinal complaints also made up a large proportion of consultations.[3–7]

The management of ship passengers and crew in emergency medicine (EM) also has challenges. There may be language barriers, limited access to medical records and different healthcare expectations.

A patient's need for timely return to the ship before departure can influence treatment decisions and interventions. Visa, immigration, and legal considerations may also contribute to decision making complexities. There can also be pressure on EM clinicians to provide letters declaring patients free from illness to continue cruising or for insurance purposes. Once discharged, there may be limited follow-up of their condition.

There is little data detailing the impact cruise ship patients and crew have on emergency departments (EDs) worldwide. Anecdotally, the perception of EM clinicians working in cities where ships frequent is that passengers become a resource burden, often of low acuity patients, contributing to ED overcrowding and access block. Therefore, we conducted a service evaluation to review the frequency and characteristics of cruise ship patient presentations to Wellington Regional Hospital ED during the Australasian "cruise season" (October to April). As secondary measures, the admission rates of cruise ship patients' vs general practitioner (GP) referrals were compared as well as the rates of specialty review, imaging studies, or urgent intervention required.

Methods

This was a retrospective descriptive study of patients presenting to Wellington Hospital ED from passenger cruise ships between 2016 and 2019. All patients who were identified as presenting to Wellington Hospital ED directly from a cruise ship were included, encompassing both passengers and crew members. Patients who arrived in another city via cruise ship who then embarked on land-based tour were excluded.

Study setting and service provision

Wellington Regional Hospital is a publicly funded major referral centre within the Capital & Coast District Health Board that serves a population of 318,040.[12] It has an annual ED census of 75,000 patients per year. Wellington City received 222,448 passengers from cruise ships during the year 2019, an increase of 37% from 2018.[1] There are no published data on the patients who are treated each year in Wellington Hospital from cruise ships. The general Wellington ED admission rate over four years was 35%. Median length of stay (LOS) was three hours 58 minutes (admitted patients five hours, one min; discharged patients two hours, 52 mins). GP referrals had a 41.1% admission rate (10,225/24,855).

Data collection

The electronic database information system (EDIS) in ED automatically extracts patient and clinical presentation related data to the hospital data service unit (DSU). A keyword search of the EDIS database was performed to identify any patients that were cruise ship crew or passengers. Keyword search included: "cruise", "boat", "ship", "passenger", "crew" and "tourist". This screened all clinical notes including triage, presentation, and discharge diagnosis.

The individual records were then reviewed by two study investigators (AA and JB) and included if it was confirmed the patient was a cruise ship passenger or crew member. A retrospective chart review was performed, and de-identified data were extracted using a standardised Microsoft Excel sheet. Data were collected for patient demographics, LOS in the department, triage category, presenting complaint, specialty referral, advanced imaging (computed tomography [CT] scan, formal ultrasound or magnetic resonance imaging [MRI]), or interventions (angiography, interventional radiology, surgery, intensive care unit [ICU] admission or transfer to other hospital), patient disposition, discharge diagnoses and outcomes. Information regarding whether patients were crew or passenger, and if they self-referred or were referred by the cruise ship doctor were also recorded. Study investigators were not blinded to the service evaluation intentions and the data collection form was not piloted or checked for interrater reliability, but this is unlikely to have significantly affected the results given the majority of nominal discrete clinical variables.

Statistical analysis

Data were coded and statistically analysed using SPSS software (SPSS Inc. Released 2019. Version 26.0, IBM Corp, Armonk, New York, USA). To describe the data, frequency, and proportions with 95% confidence intervals (CIs), and medians with interquartile ranges (IQRs) were calculated as appropriate. Admission rates and median ED LOS of cruise patients were compared to local ED data. Comparisons between crew and passengers and those admitted and discharged were performed statistically. The null hypotheses were that there would be no difference in admission rates, LOS or interventions between the crew and passenger patients. The null hypotheses regarding patients admitted vs discharged were that there would be no differences in demographics, acuity as measured by triage category and intervention rates. Chi-squared tests or Fisher's exact tests were used to compare proportions where appropriate and Mann–Whitney U testing was performed to compare continuous skewed data. Missing data were not included in statistical testing.

Ethical statement

This project was deemed out of scope for full HDEC review. Local authority approval was sought and approved by the CCDHB Quality

Improvement Project Teams and the senior leadership team at Wellington Regional Hospital ED.

Results

A total of 214 patients were identified as presenting to the ED from cruise ships during the study period. Accepting the limitations of cruise patient identification, this equates to 0.1% of ED presentations during the cruise season, assuming the census data is divided equally across the year. Baseline characteristics are detailed in Table 1. The median age of patients was 68 (IQR 43.0–76.0), 116 (54.2%) were >65 years old and 97 (45.3%) were female. Passengers accounted for 77.1% (165/214) of the sample and 22.9% (49/214) were crew members.

A summary of presenting complaints, triage category and diagnosis are detailed in Table 2. The frequency of complaints is in keeping with what would be expected for ED presentations with chest and abdominal pain among the most common. The majority presentations had an Australasian Triage Scale (ATS) category of 3 with category 4 being the next most frequent designation. Five patients had missing triage data. The most

Table 1: Demographics.

Characteristic		Frequency
Age	**Median (IQR)**	**68.0 (43.0–76.0)**
Age range n/non-missing data (%)	<18	4/214 (1.9)
	19–35	34/214 (15.9)
	36–50	25/214 (11.7)
	51–65	35/214 (16.4)
	66–80	86/214 (40.2)
	>80	30/214 (14.0)
Gender n/non-missing data (%)	Female	97/214 (45.3)
	Male	117/214 (54.7)
Person n/non-missing data (%)	Crew	49/214 (22.9)
	Passenger	165/214 (77.1)
Country of origin n/non-missing data (%)	New Zealand	8/214 (3.7)
	Australia	90/214 (42.1)
	Canada	7/214 (3.3)
	USA	40/214 (18.7)
	India	8/214 (3.7)
	Indonesia	7/214 (3.3)
	Philippines	16/214 (5.1)
	United Kingdom	12/214 (5.6)
	Other European country	8/214 (3.7)
	Other Asian country	11/214 (5.1)
	Other	7/214 (3.3)

Table 2: Presentation, triage category and ED diagnosis.

Feature		n/non-missing data (%)
Presenting complaint	Chest pain	14/214 (6.5)
	Lower limb trauma	5/214 (2.3)
	Back pain	6/214 (2.8)
	Cough	8/214 (3.7)
	Shortness of breath	12/214 (5.6)
	Abdominal pain	29/214 (13.6)
	Upper limb trauma	15/214 (7.0)
	Face or limb weakness	6/214 (2.8)
	Collapse/syncope	8/214 (3.7)
	Confusion/reduced consciousness	3/214 (1.4)
	Diarrhoea and vomiting	5/214 (2.3)
	Atraumatic lower limb pain/swelling	19/214 (8.9)
	Flank pain	8/214 (3.7)
	Haematuria	6/214 (2.8)
	Fever	11/214 (5.1)
	Fall	7/214 (3.3)
	GI bleed	6/214 (2.8)
	Mental health	3/214 (1.4)
	Headache	3/214 (1.4)
	Head Injury	3/214 (1.4)
	Cardiac arrest	1/214 (0.5)
	Other	36/214 (16.8)
Triage category	1	1/209 (0.5)
	2	26/209 (12.9)
	3	95/209 (45.5)
	4	73/209 (34.9)
	5	14/209 (6.7)

Table 2 (continued): Presentation, triage category and ED diagnosis.

Feature		n/non-missing data (%)
EM diagnosis	Non-specific abdominal pain	9/214 (4.2)
	Non-specific chest pain	4/214 (1.9)
	Fracture	22/214 (10.3)
	Sprain or strain	10/214 (4.7)
	Acute coronary syndrome	7/214 (3.3)
	Pneumonia, LRTI or influenza	24/214 (11.2)
	Gastroenteritis	8/214 (3.7)
	CVA/TIA	5/214 (2.3)
	Renal colic	10/214 (4.7)
	Acute surgical abdomen	12/214 (5.6)
	Low back pain/disc prolapse	6/214 (2.8)
	Other infection	28/215 (13.1)
	Arrhythmia	5/214 (2.3)
	DVT/PE	5/214 (2.3)
	Syncope	4/214 (1.9
	Other	55/214 (25.7)

*Acute surgical abdomen includes: diverticulitis, pancreatitis, cholecystitis, appendicitis.

Table 3: ED LOS, referrals and outcomes.

Feature		Frequency
ED LOS (hours)	Median (IQR)	3.8 (2.7–5.2)
Presentation n/non-missing data (%)	Referred to EM by ship doctor	63/214 (29.4) [95%CI 22.2–36.7]
	Referred to specialty by ship doctor	16/214 (7.4) [95%CI 3.8–11.1]
	Self-referred to ED	135/214 (63.1) [95%CI 52.4–73.7]
Specialty review n/non-missing data (%)	Specialty consultation	113/214 (52.8) [95%CI 43.1–62.5]
	General medicine	32/214 (15.0)
	General surgery	19/214 (8.9)
	Orthopaedics	21/214 (9.8)
	Cardiology	11/214 (5.1)
	Other medical specialty	10/214 (4.7)
	Urology	4/214 (1.9)
	ENT	3/214 (1.4)
	Psychiatry	3/214 (1.4)
	Ophthalmology	4/214 (1.9)
	ICU	1 (0.5)
	Other	3 (1.4)
Disposition n/non-missing data (%)	Discharged by EM	65/214 (30.4) [95%CI 23.8–38.8]
	Admitted to EM observation unit	35/214 (16.4) [95%CI 10.9–21.8]
	Died in ED	1/214 (0.5) [95%CI 0.0–1.4]
	Admitted after specialty review	47/113 (41.6) [95%CI 29.7–53.5]
	Discharged from ED after in-patient specialty review	66/214 (62.1) [95%CI 51.6–72.7]
	Died after admission to ward	1/82 (1.2) [95%CI 0.0–3.6]

Table 3 (continued): ED LOS, referrals and outcomes.

Feature		Frequency
Radiology required (CT/USS/MRI) n/non-missing data (%)	Yes	46/214 (21.5) [95%CI 15.3–27.7]
	No	168/214 (78.5) [95%CI 66.6–90.4]
Acute intervention or surgery required n/non-missing data (%)	Yes	21/213 (9.9) [95%CI 5.6–14.1]
	No	192/213 (90.1) [95%CI 77.4–100]

Table 4: Factors related to admission status.

Feature		Admitted	Discharged from ED	P value
Age	**Median (IQR)**	**72 (65.0–81.0)**	**63 (34.0–72.5)**	**<0.001**
Gender n/non-missing data (%)	Female	42/81 (51.9)	55/133 (41.4)	0.157
	Male	39/81 (48.1)	78/133 (58.6)	
ED length of stay (hours)	Median (IQR)	4.8 (3.7–6.4)	3.4 (2.3–4.3)	<0.001
Triage Category n/non-missing data (%)	1	1/79 (1.3)	0/130 (0)	<0.001
	2	18/79 (22.8)	8/130 (6.2)	
	3	47/79 (59.5)	48/130 (36.9)	
	4	12/79 (15.2)	61/130 (46.9)	
	5	1/79 (1.3)	13/130 (10.0)	
Referral n/non-missing data (%)	Referred to EM by ship doctor	30/63 (47.6)	33/63 (52.4)	<0.001
	Not referred by ship doctor	44/135 (32.5)	91/135 (67.4)	
	Referred to specialty by ship doctor	7/16 (43.8)	9/16 (56.3)	0.783
Radiology required (CT/USS/MRI) n/non-missing data (%)	Yes	33/81 (40.7)	13/133 (9.8)	<0.001
Acute intervention or surgery required n/non-missing data (%)	Yes	20/21 (95.2)	1/21 (4.8)	<0.001

common EM diagnoses were other infections (28/214, 13.1%), respiratory infection (24/214, 11.2%), fracture (22/214, 10.3%), and acute surgical abdomen (12/214, 5.6%).

Detailed in Table 3, the median LOS was 3.8 hours (IQR 2.7–5.2). Available data demonstrated that 79/214 (36.9%) patients were referred to hospital; 63/214 (29.4%) were referred to EM by a cruise ship doctor; and 16/214 (7.4%) were referred directly to an in-patient specialty. Patients self-presented in 135/214 (63%) of cases. A further 97/214 (45.3%) of patients were referred to specialties by EM, meaning that 113/214 (52.8%) were reviewed by a specialty team in ED. In 46/214 (21.5%) of cases advanced imaging (CT, formal ultrasound, or MRI) was required. Acute intervention (angiography, interventional radiology, surgery, ICU admission or transfer to another hospital) was required in 21/213 (9.9%) patients. Regarding disposition, 82/214 (38.3%) of patients were admitted; 35/214

Table 5: Comparison of crew vs passenger cohort.

Feature		**Crew**	**Passenger**	**P value**
Age	**Median (IQR)**	**32.0 (27–38)**	**72 (64–79)**	**<0.001***
Gender n/non-missing data (%)	Female	12/49 (24.5)	85/165 (51.5)	0.001*
	Male	37/49 (75.5)	80/165 (48.5)	
ED LOS (hours)	Median (IQR)	3.7 (2.8–4.7)	3.9 (2.7–5.5)	0.35
Triage category n/non-missing data (%)	1	0/48 (0)	1/61 (0.6)	<0.001*
	2	2/48 (4.2)	24/161 (14.9)	
	3	12/48 (25)	83/161 (51.6)	
	4	27/48 (56.3)	46/161 (28.5)	
	5	7/48 (14.6)	7/161 (4.3)	
Referral n/non-missing data (%)	Referred to EM by ship doctor	10/49 (20.4)	53/165 (32.1)	0.37
	Referred to in-patient specialty by ship doctor	2/49 (4.1)	14/165 (8.5)	0.53
	In-patient specialty review in ED	20/49 (40.8)	93/165 (56.4)	0.07
Radiology required (CT/USS/MRI) n/non-missing data (%)	Yes	6/49 (12.2)	40/165 (24.2)	0.08
Acute intervention or surgery required n/non-missing data (%)	Yes	0/49 (0)	21/165 (12.8)	0.01*
Admitted	Yes	5/49 (10.2)	76/165 (46.1)	<0.001*
n/non-missing data (%)				

(16.4%) to the ED observation unit, and 47/214 (22.0%) to a hospital ward. There were 131/214 (61.2%) discharges from ED; 65/214 (30.4%) patients were discharged after EM review, and 66/214 (31.0%) were discharged after in-patient specialty review. One patient died in ED and a further death occurred after admission to a hospital ward. The admission rate for the included patient presentations from cruise ships was marginally higher when compared to 35% in the general ED population, but lower than the 41% admission rate for GP referrals.

Table 4 displays a comparison of factors amongst patients who were admitted compared to those who were discharged. Patients were more likely to be admitted if they were older (median age 72 [IQR 65.0–81.0] vs 63 [IQR 34.0–72.5], p<0.001) or if they had a higher acuity ATS triage category (66/79 [83.5%] of patients admitted had an ATS triage category of 1–3 compared to 56/130 [43.1%] of discharged patients, p<0.001). Patients who self-referred were more likely to be discharged (91/135, 67.4% vs 33/63 52.4%; p<0.001).

There were differences in presentation features between passengers and crew members, shown in Table 5. The median age of crew members was 32.0 years (IQR 27–38) vs the median age of passengers of 72.0 years (IQR 64–79). Crew members were more frequently male (37/49 [75.5%] vs 80/165 [48.5%]). Crew members were triaged with lower acuity, were less likely to require radiology, urgent intervention or be admitted. LOS and referral rates were not significantly different between the groups.

Discussion

Over the four-year evaluation period, a relatively small number of patients from cruise ships were seen in our ED. A wide range of presenting complaints and diagnoses were made in keeping with general ED epidemiology. Infection, particularly respiratory, accounted for the largest proportion of patient presentations. Of presentations, almost two thirds were of high acuity according to the ATS, half required in-patient specialty review, one in five required specialist radiology, one in ten required urgent intervention and 38% were admitted to hospital. Passengers were more likely to be older, have higher acuity ATS scores and higher admission rates compared to crew. This admission rate is comparable to the general ED population (35%) and GP referrals (41%). Patients referred by cruise ship doctors were more likely to be admitted with a rate of 48% compared to self-referrals at 30%.

The identified pathology among cruise ship patients aligned with current studies, noting that respiratory illness, trauma, and gastrointestinal complaints are a large proportion of presentations.[3–7] Recent research demonstrates the impact and spread of respiratory illness on cruise ships.[10,11] Ships were highlighted as vectors for the spread of the novel coronavirus. As cruise ships recommence operation, respiratory viruses from cruise ships could become a significant burden on EDs and public health internationally; especially given factors such as age and co-morbidities of passengers and prevalence of opposite-season travel.[10] This highlights an area in which planning with ports and cruise ship companies would be prudent to ensure appropriate care of patients, and that local health systems are not overwhelmed.

In general, the admission rates of cruise ship patients are comparable to EM and GP rates, being slightly higher than general EM and slightly lower than GP admission rates. We postulate that the rate of admission may have been higher among cruise ship patients due to limited capability for follow up if there is any diagnostic uncertainty; or may relate to appropriate assessment by cruise doctors of patients requiring admission. Another contributing factor was likely the age distribution among passengers. Previous epidemiological studies show a high proportion of elderly among tourist presentations to hospitals; they are more likely to require admission for falls or exacerbations of chronic conditions;[9] longer LOS in ED and the hospital, as well as higher mortality rates. These past studies advocated for education and warning for tourists prior to travel, particularly those who are older and have existing medical conditions.[9]

Cruise ship doctors must decide which patients need emergency care or specialist review. Our results indicate relatively high levels of admission, intervention and in-patient specialty review of patients referred to EM, suggesting these medical decisions are just and appropriate. Notably, there were high rates of self-referral, mostly among crew members, and the number of self-referrals vastly outweighed the number referred in by the ship's doctor. The ATS category, rate of admission, and requirement for intervention was lower in this group. This potentially indicates an area for improvement—there may be limited knowledge amongst cruise ship crew and passengers about other available community urgent care

or primary care options. This may be improved by better communication with cruise companies directly, education at the port on arrival, or with patients at ED reception. However, it is acknowledged that the ATS triage category assigned, used as a surrogate marker for acuity in this evaluation, is not always a direct analogue of acuity or suitability for EM assessment. We were particularly surprised by the high rates of self-referral by crew members, given that they have access and likely a relationship with the cruise ship doctor. Reasons as to why crew self-refer cannot be answered based on our data, but may be due to not wanting to disclose information to someone who is also a crew member, or potentially wanting a second opinion. The decisions behind crew members health seeking behaviors to ED require further investigation; but again, is a key area where education could be beneficial.

Other studies have commented on the difficulty for cruise doctors of navigating foreign medical systems.[13] Deciding which patients can be safely managed in the community settings is important to improve processes and workflow, mitigate overcrowding and provide better outcomes for all patients.[14] ED overcrowding is one of the biggest challenges facing clinicians today. The Australasian College of Emergency Medicine (ACEM) believe that ED overcrowding is one of the most significant issues impacting patient safety in Australian and New Zealand EDs.[15] It is therefore critical that any factor that exacerbates this issue is identified and remedied.

The LOS for discharged cruise ship patients was longer than the general ED population (3.4 hours vs 2.9 hours). One of the factors influencing this may be the need for EM clinicians to make safe and timely decisions regarding discharge disposition. The patient's time pressure to return before the ship departs must be balanced against the ship's potential geographical isolation from advanced medical care for several days or longer. Thus, a longer period of observation may be required, with more diagnostics and interventions in order to confirm or deny presence of serious pathology before safe discharge. Early recognition that cruise ship populations have different needs to the general population of EDs and may require more investigations to ensure safe discharge may improve prioritisation and help LOS.

Limitations

The main limitations relate to the nature of data collection; some of these are detailed in the methods section. A notable limitation related to the identification of study patients. As the keyword search function was used to identify cruise ship patients, we may have missed those that presented when the selected key words were not present in their medical chart. It also would not account for spelling errors given the system is largely free text. Retrospective chart review has inherent limitations. Data collected were limited to what was contained in the electronic notes and, therefore, may not be a complete accurate record of each patient encounter. The patient selection process may also have some flaws. Keywords were used to conduct a local database search for appropriate patients to include in the study. If there were spelling mistakes in the electronic record, these patients would have been missed in the extraction of data. It is also possible that there were some cruise patients who did not have any of the keywords in their electronic records. Furthermore, often a paper or handwritten referral from a cruise ship's doctor may have been sent with the patient which was not electronically recorded. Hence, there may be missing data about referral status, which could underestimate the rate of referrals. There were also small amounts of missing data regarding triage data (n= 5); however, this is unlikely to have affected the results.

Organisational learning

The key learnings from this study are that in general cruise ship patients account for a small proportion of total ED patient load. Cruise ship doctors seem to have good judgement regarding suitable EM referrals given the high rates of admission, intervention, imaging, and specialty review. Working with cruise liner companies and ports to better educate passengers, crew and cruise ship medical teams of community health care options may reduce the volume of self-referrals. Respiratory illnesses and infections are the most common pathology seen and notably could be a significant burden to ED in the presence of a pandemic. Therefore, EDs and cruise ship medical teams should consider designing an escalation management plan to work in partnership should such an event arise.

Conclusion

Overall, the number of cruise ship patients presenting to the ED was relatively few compared to the annual ED census and therefore unlikely to significantly contribute to overcrowding in our

ED. It would be prudent to identify early that the needs of a tourist patient or cruise patient may be different to a general EM patient. Communication should be improved with cruise ships and port services regarding what non-emergent or primary care services are accessible, what resources or specialist reviews the patient is likely to be able to access via our public health system, and what is an appropriate referral to hospital services. Lastly, in light of the COVID-19 pandemic, it would be beneficial to have clear guidance between hospitals and cruise ships and port services about transferring patients with transmissible illnesses.

In future we may see the continuation of growth of the tourism industry, meaning the burden of cruise ship patients and tourists may continue to increase. In this study we have initiated analysis of the impact of these patients on Wellington Hospital ED; this should be re-evaluated in the future to ensure we continue to meet our patients' changing needs and could encompass further tourist groups or other centres with high numbers of tourist patients.

COMPETING INTERESTS
Nil.

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Paediatric forearm fractures manipulated in the emergency department: incidence and risk factors for re-manipulation under general anaesthesia

Shaye Seefried, Kim Chin-Goh, Vahe Sahakian, Nicholas Lightfoot, Matthew Boyle

ABSTRACT

AIM: Re-manipulation of paediatric forearm fractures under general anaesthetic may be required following inadequate closed reduction under conscious sedation. Manipulation under general anaesthetic carries significant inherent risks and is preferably avoided. We assessed one institution's experience with paediatric forearm fracture reduction and investigate the incidence of re-manipulation under general anaesthetic of fractures initially managed under conscious sedation without fluoroscopy.

METHOD: All paediatric forearm fractures presenting to the children's emergency department of our national children's hospital between 1 January 2019 and 30 June 2019 were studied. Radius and ulna fractures were categorised according to fracture location (distal third, middle third, proximal third), any associated injury, and any plan to proceed to the operating room that was documented prior to manipulation in the emergency department. Univariate and multivariate statistical analysis was carried out to test for differences between discrete and continuous data and odds ratios were calculated.

RESULTS: Three-hundred and nine patients presented during the study period with 267 being eligible for analysis. Fifteen point seven percent (42/267) required fracture manipulation in the operating theatre following initial reduction in the children's emergency department. Independent risk factors associated with significantly higher rates of failed reduction under conscious sedation ($p<0.001–0004$) were patients who had a delay in presentation to hospital, were older, or had a non-distal fracture site.

CONCLUSION: There are higher rates of re-manipulation under general anaesthetic in children presenting to the emergency department of our national children's hospital with forearm fractures than seen in comparative international studies. Risk factors which predict an inadequate initial reduction and interventions to improve this are discussed.

Forearm fractures are among the most common injuries in children, accounting for 45% of all childhood fractures and 62% of upper limb fractures.[1] Treatment upon presentation to the emergency department (ED) routinely involves the use of procedural sedation, closed reduction, and casting. Subsequent re-manipulation under general anaesthetic (GA) is at times required when the initial reduction is inadequate. However, it is well understood that manipulation under GA carries significant anaesthetic, psychological, financial, and environmental risk, and the need for this intervention should therefore be minimised wherever possible.[2–5]

Previously, Lee et al. found that repeat fracture reduction and the need for subsequent operative treatment was required in 8.4% of paediatric forearm fractures initially managed without fluoroscopic guidance.[7] This same study showed that under fluoroscopic guidance re-manipulation rates fell to only 2%.[7] This equates to around a 76% reduction in trips to theatre with use of the C-arm.

Kuman et al. showed that in a general ED setting without fluoroscopic guidance repeat reductions were required in 30.8% of forearm fractures.[6] In comparison, only 7.2% of forearm fractures in the study who underwent closed reduction with mini C-arm fluoroscopic assistance required re-manipulation.[6] Similar to the results of Lee et al., this equates to around a 77% reduction in trips to the theatre with use of fluoroscopic guidance.

At our national children's hospital, all paediatric forearm fractures are reduced in the ED under conscious sedation without the use of fluoroscopy. The adequacy of the reduction is judged clinically and on post-procedure radiographs, which are reviewed by the treating paediatric orthopaedic surgeon. If there is inadequate reduction or

alignment on the post-procedural radiograph, the patient is starved and transferred to the operating room for further fracture management under general anaesthesia. There has been anecdotal concern about the rates of subsequent re-manipulation under general anaesthesia in the current working model.

The purpose of this study is to assess the efficacy of conscious sedation in the children's ED in appropriately managing paediatric forearm fractures. The primary outcome is the percentage of patients who required unscheduled transfer to the operating room for further care. Secondary outcomes were the indication for transfer to the operating room, the procedure performed, and the hospital length of stay.

Methods

Ethics approval from the local institutional ethics review committee was obtained.

Patients who presented to our national children's hospital in Auckland, New Zealand with isolated upper limb injuries and radiographic evidence of a fracture of the radius, ulna or both between 1 of January and 30 of June 2019 were retrospectively identified and were eligible for study inclusion. Patients were excluded if after initial X-ray review a plan was in place for transfer to the operating room for emergent or semi-emergent fracture management, if conscious sedation was unable to be safely provided in the children's ED, or if there were concurrent fractures of the supracondylar distal humerus, olecranon or the radial neck. Patients with Monteggia pattern fracture-dislocations were also excluded due to the high likelihood of requiring operative management.

The electronic data warehouse maintained by the healthAlliance was queried to identify patients presenting with forearm fracture within the study period. Study data were obtained from review of electronic charts, radiographs and procedural records. Fractures were classified by bone and by fracture location.

While defining non-acceptable reductions depends on the patient's skeletal maturity and fracture location, in this study for distal fractures <20 degrees angulation were deemed acceptable. For midshaft and proximal fractures, <15 degrees angulation for patients under age 10, and <10 degrees angulation for those over age 10, were deemed acceptable. A delay in presentation was indicated in instances where patients presented to other facilities initially and then came to our national children's hospital over 24 hours after injury. No delay was defined as when patients presented directly to our hospital on the day of injury or soon after (<24 hours).

Statistical analysis

Information was stored in a Microsoft Excel spreadsheet and statistical analyses were completed using SPSS Version 27. Testing for the normal distribution was through the Shapiro–Wilk test with a two-tailed p-value of <0.05 being indicative of non-normally distributed data. Patient, procedural and outcome data are reported as number (percentage) or median (interquartile range [IQR]) as appropriate for categorical and continuous data, respectively. Fisher's exact test or a Chi-squared test with an appropriate Yate's continuity correction or the Mann–Whitney U test were used to test for differences between discrete and continuous data, respectively. Odds ratios with 95% confidence intervals (CIs), comparing different fracture parameters to a reference group, were calculated. When appropriate, to detect a trend or an association between categorical data, the Cochran–Armitage test for a trend was used. Across all statistical tests, a two-tailed p-value of <0.05 defined statistical significance. Binary logistic regression was used to identify patient and fracture-related variables, which were associated with the need for fracture management in the operating room. A model was built using backward elimination with odds ratios (ORs) and associated 95% CIs being reported. Model performance was assessed through the R-squared and Hosmer–Lemeshow statistics.

Results

Between 1 of January and 30 of June 2019, 309 patients presented to the children's ED with forearm fractures. Whilst at our national children's hospital attempts are made to reduce all forearm fractures as long as it is safe to do so, in the ED, without fluoroscopy at the surgeon's discretion including 100% displaced or off-ended fractures, a total of 42 patients were excluded from further analysis. Thirteen patients were excluded, as fracture manipulation under GA was planned due to sedation being unavailable in the children's ED, and 29 patients were, due to additional fractures, excluded from the study. There were 14 patients with supracondylar fractures, 13 patients with Monteggia fractures/dislocations and two patients

with radial neck fractures. Of those who were excluded from further analysis, 32 (76.2%) went to the operating theatre for fracture management.

Of the 267 patients included for analysis, 15.7% (42/267) required fracture re-manipulation in the operating theatre following management in the children's ED. The baseline demographic features and details surrounding the fractures sustained are further summarised in Table 1. Those who required fracture management under GA were older (10.2 vs 8.0 years old; p=0.03), and were more likely to have experienced a delay in presentation for fracture management (p=0.001), and also spent a greater period of time in hospital (p<0.001).

There were no differences in the total number of fractures sustained, both for the radius (p=0.31), ulna (p=0.21) and both bones combined (p=0.16) with most fractures being non-segmental. Those who required fracture management under GA were less likely to have sustained a distal radius fracture (p=0.02) and more likely to have sustained a midshaft radius fracture (p=0.02). Overall, patients who sustained non-distal fractures (proximal or mid-shaft) of the radius and/or ulna were more likely to require fracture manipulation under GA (45.2% v 25.3%; p=0.01).

Univariate comparisons, expressed as ORs with 95% CIs are shown in Table 2. When compared with those with an isolated distal radius fracture, children with an isolated midshaft radius fracture were more likely to require treatment in the operating theatre (OR 13.9 (3.1–62.4); p<0.00). Those with non-distal fractures of either the radius or ulna were significantly more likely to require operative treatment than those with isolated distal fractures (OR 2.7 (1.3–5.3); p=0.006). Although, the crude odds ratios increased progressively with an increase in the number of fractures sustained, due to insufficient patient numbers there were no significant differences observed when compared to patients with one fracture (p=0.24).

Multivariate logistic regression was completed to determine the demographic and fracture-related predictors of patients requiring subsequent fracture management under general anaesthesia (summarised in Table 3). Using backwards elimination and after nine steps, the predictors identified were delay in presentation to hospital (OR 12.9; p=0.001), non-distal fracture site (OR 7.5; p=0.001) and increasing patient age (OR 1.3; meaning every year of age increases the chance of manipulation under GA by 13%; p=0.004). The Nagelkerke R-squared statistic was 0.228, and the Hosmer–Lemeshow test revealed no evidence of poor model fitting (p=0.93).

Discussion

Forearm fractures are a common presentation seen in paediatric EDs. When treated with a closed reduction under procedural sedation in the ED, it is accepted that at times a subsequent re-manipulation under GA may be required. In this study of children presenting to the ED of our national children's hospital with forearm fractures, we identified disappointingly high rates of re-manipulation. Following initial closed reduction under conscious sedation, unplanned re-manipulation under GA was undertaken in almost 16% of patients. Paediatric forearm fractures can be unstable, and in general, up to 7–13% of forearm fractures treated by closed reduction are subject to re-angulation and/or displacement requiring re-manipulation before definitive union.[1,8,9] Our rates of re-manipulation immediately following initial reduction exceed this.

The high proportion of patients requiring re-manipulation at our national children's hospital raises concerns based on the inherent anaesthetic, psychological, financial, and environmental risks associated with manipulation under GA.[3–6] While anaesthesia-related mortality is rare, perioperative morbidity associated with GA is not uncommon.[11] Minor complications including postoperative nausea and vomiting, sore throat and dental damage all have negative impacts on patient experiences. Serious cardiovascular and respiratory complications associated with general anaesthesia meanwhile can have long-term repercussions resulting in permanent disability.[10] Reduction under GA is also linked to a significantly longer time to manipulate, and greatly increased hospital length of stay.[3] Alongside these are the emotional and mental factors of having a procedure in the operating theatre, which have been shown to result in a significantly greater negative psychological impact on paediatric patients.[5] Additionally, the mean facility charge and cost incurred with each patient is also significantly higher with manipulation under GA compared to procedural sedation.[4] At our institution, the average total time spent in theatre for a forearm manipulation under GA is almost 46 minutes. With operating theatre and anaesthesia time at our institution being billed at $50.60 NZD per minute, and operating theatre staff at $190.90 NZD per 15 minutes, this equates to an average cost of $2,885.12 per case. By halving the rates of manipulation under GA, our hospital would have a saving of $60,587.52 in theatre expenses alone over the six-month study period.

McQuinn and Jaarsma[12] have shown that in pae-

Table 1: Demographics.

	Entire cohort	Control	GA manipulation	p-value
Patients (%)	267 (100)	225 (84)	42 (16)	
Male (%)	151 (57)	126 (56.0)	25 (60)	0.74
Age (years)	8.3 (6.2–11.2)	8.0 (6.1–10.9)	10.2 (6.5–12.6)	0.03
Length of stay (hours)	5.3 (4.4–6.7)	5.1 (4.2–6.1)	8.5 (5.8–23.6)	<0.001
Delay in presentation (%)	10 (4)	4 (2)	6 (14)	0.001
Primary presentation to outside hospital (%)	10 (4)	4 (2)	6 (14)	0.001
Radius fracture (%) Bilateral Left Right	 3 (1) 125 (49) 127 (50)	 2 (1) 106 (50) 106 (50)	 1 (2) 19 (46) 21 (51)	 0.69
Radius fracture site (%) Distal Midshaft Proximal	 189 (74) 55 (22) 12 (5)	 165 (77) 40 (19) 9 (4)	 24 (59) 15 (37) 3 (7)	 0.02 0.02 0.42
Ulna fracture (%) Bilateral Left Right	 1 (1) 70 (45) 86 (55)	 0 (0) 55 (43) 74 (57)	 1 (4) 15 (54) 12 (43)	 0.05
Ulna fracture site (%) Distal Midshaft Proximal	 97 (62) 54 (34) 8 (5)	 82 (64) 42 (33) 6 (5)	 15 (54) 12 (43) 2 (7)	 0.39 0.38 0.63
Radius and ulna fracture (%) Unilateral Bilateral	 145 (54) 1 (0)	 118 (52) 0 (0.0)	 27 (64) 1 (2)	 0.18 0.16
Non distal fracture site of either bone (%)	76 (29)	57 (25)	19 (45)	0.01
Two-tailed p-value of <0.05 used to define significance				
Values for radius and ulna fracture sites may sum to more than 100% due to patients with more than one fracture site				

Table 2: Odds Ratios.

Parameter	Failed Manipulation / Total (%)	Odds Ratio (95% CI)	p-value
Distal radius only	8/97 (8)	Comparison group	
Midshaft radius only	5/9 (56)	13.9 (3.1–62.4)	<0.001
Proximal radius only a	0/3 (0)	1.5 (0.1–31.6)	0.80
Distal ulna only a	0/5 (0)	0.96 (0.05–18.8)	0.97
Midshaft ulna only	1/4 (25)	3.7 (0.34–39.9)	0.28
Proximal ulna only a	0/3 (0)	1.5 (0.07–31.6)	0.80
Radius fractures only	13/109 (12)	Comparison group	
Ulna fractures only	1/12 (8)	0.67 (0.08–5.6)	0.71
Radius and ulna fractures	15/102 (15)	1.3 (0.57–2.8)	0.55
One radius fracture	13/107 (12)	Comparison group	
Two radius fractures a	0/2 (0)	1.4 (0.06–30.8)	0.83
One ulna fracture	1/12 (8)	0.65 (0.08–5.5)	0.70
Distal fractures only	21/189 (11)	Comparison group	
Non-distal fractures	19/76 (25)	2.7 (1.3–5.3)	0.006
One fracture site	21/189 (12)	Comparison group	

Table 3: Regression.

Parameter	Odds Ratio (OR)	p-value
Delay in presentation to hospital	12.9 (3.0–54.7)	0.001
Non-distal fracture	7.5 (2.4–23.8)	0.001
Age	1.13 (1.01–1.26)	0.04
Two-tailed p-value of <0.05 used to define statistical significance: Nagelkerke R-squared = 0.228 Hosmer–Lemeshow test p=0.93		

diatric forearm fractures, initial displacement and accuracy of the reduction are the primary risk factors for re-displacement.[12] A retrospective analysis of risk factors for re-displacement of diaphyseal fractures of the forearm after closed reduction by Yang10 similarly concluded that along with complete fracture, poorer reduction quality is a major risk factor in re-displacement.[13] Clearly, ways of directly visualising the reduction at the time of initial manipulation would be advantageous to the treating physician. Fluoroscopic guidance in closed reduction under procedural sedation has been suggested as one possible improvement to decrease the risk of required re-manipulation under GA.[6] Numerous studies have shown significant improvement in fracture alignment when assisted by fluoroscopy. Lee et al.[7] reported that fluoroscopy use for ED reduction of paediatric forearm fractures reduced average angulation following closed reduction from 8°–6°.[7] This same study found that this improvement in reduction quality translated into a decrease in repeat fracture displacement; only 2% of fractures reduced with fluoroscopic guidance needed subsequent surgical treatment compared to over 8% of fractures reduced without.[7] An additional benefit in the use of fluoroscopic imaging systems in place of conventional X-ray is a reduction in radiation exposure to both patient and treating physician.[2,7] Several studies have also suggested simple paediatric forearm fractures that are reduced and cast under fluoroscopy receive no clinical benefit from post-reduction radiographs, saving on both costs and the dose-dependent effects of cumulative radiation exposure.[14–15]

In addition to fluoroscopic guidance, a variety of other interventions exist which may improve outcomes in closed reduction of forearm fractures. Ultrasound-guided closed reduction of forearm fractures has also been shown to have similar success rates.[16] However, the time taken to evaluate the reduction is longer, is a user-dependent skill, and cannot be used once a cast is applied. Given the short action of common medications used in procedural sedation, fast and readily reproducible image guidance such as fluoroscopy may be advantageous over ultrasound.

Differences in the quality of plaster cast application and padding have also been suggested to alter the risk of re-displacement.[17] Bhatia and Housden[17] found that solely through improvement in plaster application skills, the rate of re-displacement of paediatric forearm fractures was reduced by 50%. This is relevant to our teaching hospital, where rotating trainee paediatric orthopaedic surgeons result in a heterogeneity of clinical experience. With the aid of our experienced resident team of plaster nurses, all new doctors on rotation to our hospital are now formally trained in standardised forearm fracture reduction and casting.

Positioning during immobilisation has likewise been shown to influence the re-displacement of unstable forearm fractures in plaster. Immobilisation with the elbow extended may aid in maintaining reduction compared to casting with the elbow flexed and has been recommended by some authors.[18] However, numerous patient impracticalities with being cast in this position, such as not being able to use a sling, preclude its utility.

This study identified several risk factors that predict the likelihood of unsuccessful reduction under procedural sedation. These were a non-distal fracture, an older child, and a delay in presentation to hospital. These independent risk factors provide the treating surgeon with a greater evidence base to draw from when discussing informed consent with a child's parents and when deciding which cases should go straight to theatre for manipulation under general anaesthesia in order to avoid unnecessary sedation and manipulation in the ED.

Our study does have some limitations. Firstly, a subset of patients presenting with forearm fractures lacked subsequent documentation from the ED concerning sedation/reduction. While this group represents a small proportion of our overall data set, complete records may have influenced our re-manipulation rates. Secondly, the study period incorporates a set rotation of trainee surgeons whose skill level may have differed from the rotation previous or subsequent and may have altered the success rate of initial manipulation. Thirdly, with casting quality related to reduction success as previously described, the inability to retrospectively grade casting quality for all individual closed reductions in this study is a limitation.

In conclusion, we found disappointingly high rates of re-manipulation of paediatric forearm fractures at our national children's hospital when initially reduced in the ED, without fluoroscopy. A simple method of improving this and avoiding unnecessary GA might be the introduction of fluoroscopy to the ED to evaluate and alter the reduction in real-time, especially in patients with suspected non-distal fractures (proximal or mid-shaft) of the radius and/or ulna.

COMPETING INTERESTS
Nil.

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2021 Assessment of New Zealand district health boards' institutional healthy food and drink policies: the HealthY Policy Evaluation (HYPE) study

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ABSTRACT

AIM: To assess adoption of the voluntary National Healthy Food and Drink Policy (NHFDP) and the alignment of individual institutional healthy food and drink policies with the NHFDP.

METHOD: All 20 district health boards (DHBs) and two national government agencies participated. Policies of those organisations that had not fully adopted the NHFDP were assessed across three domains: nutrition standards; promotion of a healthy food and beverages environment; and policy communication, implementation and evaluation. Three weighted domain scores out of 10, and a total score out of 30 were calculated.

RESULTS: Nine of the 22 organisations reported adopting the NHFDP in full. Of the remaining 13, six referred to the NHFDP when developing their institutional policy and three were working toward full adoption of the NHFDP. Mean scores (*SD*) were 8.7 (1.0), 6.1 (2.6) and 3.8 (2.2) for the three domains, and 18.6 (4.8) in total. Most individual institutional policies were not as comprehensive as the NHFDP. However, some contained stricter/additional clauses that would be useful to incorporate into the NHFDP.

CONCLUSION: Since a similar policy analysis in 2018, most DHBs have adopted the NHFDP and/or strengthened their own nutrition policies. Regional inconsistency remains and a uniform mandatory NHFDP should be implemented that incorporates improvements identified in individual institutional policies.

Nutrition policies in institutions provide a key opportunity to create healthier food environments that may improve population health and reduce inequities associated with poor nutrition.[1] An institutional nutrition policy can create more accessible and affordable healthy food and drinks, thereby positively influencing the dietary intake and preferences of staff and visitors, and ultimately decreasing nutrition-related chronic diseases.[2] Population health is the core business of health-related institutions such as hospitals, and so a healthy food and drink policy aligns with the institutional values and expectations of staff and visitors while facilitating a stronger connection between national dietary guidelines and the food environment.[1,3] Healthy food and drink policies may also benefit the wider food system if they promote local, sustainable food procurement and food choices that are good for the planet.[1] Furthermore, because health-related institutions are large employers, they may be able to influence the types of foods produced for the general community by creating greater demand for and greater supply of healthier products.[3]

In 2015, The National DHB Food and Drink Environments Network—a group of nutrition, dietetic, food service, and/or public health representatives from all DHBs, along with the Ministry of Health—was established to develop a consistent National Healthy Food and Drink Policy (NHFDP) for voluntary use across all New Zealand district health boards (DHBs) and potentially other public sector settings.[4] DHBs are organisations responsible for providing or funding the provision of health services in their district. In developing the NHFDP, The Network received support and advice from the National Heart Foundation, Activity & Nutrition Aotearoa, the Ministry of Health, the Ministry for Primary Industries, the New Zealand Beverage Guidance Panel, and a University of Auckland population nutrition academic (author CNM). The NHFDP was published in 2016 with the intention that DHBs would use it to benchmark their own policies for alignment, and if adopting the policy, they would implement it over a two-year period.[4]

The NHFDP outlines a set of overarching principles based on the New Zealand Eating and Activity Guidelines for Adults and presents a cus-

tomised colour-coded food and drink classification system.[5] "Green" category foods and drinks are part of a healthy diet. "Amber" category foods and drinks are not considered part of an everyday diet but may have some nutritional value. "Red" category foods and drinks are of poor nutritional value and high in saturated fat, added sugar and/or added salt and energy. The policy encompasses food provided onsite for staff and visitors in cafés, staff cafeterias, catered meetings/functions, fundraisers and vending machines. It also includes food offered offsite if the DHB purchases it. It does not cover patient food or food brought on to the premises by staff or visitors for their own consumption.

DHBs were encouraged to adopt the NHFDP, but individual institutions could continue with their existing policy. An initial review in 2018 found that only five DHBs had adopted or intended to adopt the policy.[6] The second edition of the NHFDP was published in September 2019, and includes minor changes to the criteria used to categorise food and drink items in order to make the NHFDP more practical to adopt and implement, although the principles remain the same.[7]

A recent review of government-led nutrition policies in Australian institutions found that nutrient criteria and guidelines for catering, fundraising and advertising were commonly included in these policies.[8] However, an absence of tools and timelines for monitoring and evaluation, and differences in nutrient criteria, were potentially a barrier to the policies' implementation and intended impact. The review involved policies from state and territory governments, which included hospitals.[8] Another review of policies in the United States showed that the policy standards were generally evidence-based, but there were significant barriers and challenges to implementation that should be recognised so regular policy reviews and updates were required.[1]

In 2020, the Healthier Lives *He Oranga Hauora* National Science Challenge funded an evaluation of the implementation and impact of the NHFDP, called the HealthY Policy Evaluation (HYPE). As part of the HYPE study, this analysis assesses adoption of the NHFDP by DHBs and central government health institutions, and where the NHFDP was not adopted in full, the alignment between individual institutional healthy food and drink policies and the NHFDP was assessed using a policy content analysis assessment tool adapted for use in the HYPE study.

Method

An approach to quantitatively evaluate food policies was developed by the University of Connecticut (UConn) Rudd Center for Food Policy & Obesity.[9] Over time, the Rudd Center's tools have been adapted to reflect revised regulations and standards in the school and early education sectors.[10–13] In New Zealand, versions of the tools have been used to monitor adoption, comprehensiveness and strength of wording of healthy food and drink policies in schools and early learning services.[14] In 2018, the International Network for Food and Obesity/Non-communicable Diseases Research, Monitoring and Action Support (INFORMAS) at The University of Auckland developed the first New Zealand DHB food policy assessment tool using the same format and scoring system as the UConn Rudd Center tools.[6]

The INFORMAS tool assessed healthy food and drink policies across three domains: nutrition standards for a healthy food and beverages environment; promotion of a healthy food and beverages environment; and communication, implementation and evaluation of the policy. Indicators within this earlier tool were adapted for the current HYPE (HealthY Policy Evaluation) study to create the HYPE Policy Assessment Tool. The HYPE Policy Assessment Tool includes 13 indicators on nutritional standards, eight indicators on promotion of a healthy food and drinks environment and five indicators on communication, implementation and evaluation of the policy (detailed in Table 1). Indicators for elements not included in the NHFDP were excluded.

Each indicator was assigned a "yes" or "no" response regarding inclusion in the institutional policy (forming a measure of the comprehensiveness of topics contained in the policy). A "yes" response was allocated one point, and summed to produce a weighted score out of 10 for each of the three domains. Domain scores were summed to give a total score out of 30 (equal weighting for each domain). The NHFDP was treated as the "gold standard" top score of 30, although some individual institutional policies had clauses exceeding the requirements of the NHFDP, and these were noted in the content analysis. Scores for the "strength of wording" for the indicators (that is, the use of wording that encourages clear interpretation of the policy e.g., "must" and "always" instead of "could" or "when appropriate" (which were part of the INFORMAS and earlier UConn Rudd Centre tools), were not calculated in this study as the

Table 1: Domains and indicators in the HYPE Policy Assessment Tool.

Domain 1: Nutrition Standards for a healthy food and beverages environment	
1	Specifies that nutrition standards should comply with the Ministry of Health Eating and Activity Guidelines for New Zealand Adults.
2	Addresses nutrition standards for all foods and beverages provided or sold by any retailer, caterer, vending machine, snack box or volunteer service on the organisation's premises.
3	Outlines nutrition standards for all foods and beverages offered on site, or on behalf of the organisation off site, such as catering, fundraiser, meetings, conferences and similar events.
4	Addresses the provision of healthy foods and drinks that accommodate different cultural, religious and special dietary requirement needs.
5	Addresses the use of environmentally sustainable and socially responsible practices in purchasing and using food and drinks.
6	Addresses the provision of a variety of healthy foods from the four food groups in the Ministry of Health dietary guidelines.
7	Addresses the provision of mostly whole or less processed foods with minimal saturated fat, salt (sodium) and added sugar.
8	Addresses limiting the portion or serving size recommendations for foods and beverages provided.
9	Includes specific nutrient criteria for sugar content of provided foods and beverages.
10	Includes specific nutrient criteria for sodium content of provided foods and beverages.
11	Addresses limiting the provision and sale of deep-fried foods.
12	Addresses limiting the provision and sale of confectionery.
13	Recommends the provision and sale of water and unflavoured milk as predominant cold drink options.
Domain 2: Promotion of a healthy food and beverages environment	
1	Addresses the provision of facilities that allow employees to store, prepare, re-heat and consume their own meals.
2	Addresses the provision of accessible (free) drinking water on worksite premises.
3	Addresses the promotion of, and provision of facilities for, breastfeeding on worksite premises.
4	Specifies restricting partnerships, fundraisers and promotions involving products and brands inconsistent with a healthy food and beverage environment.
5	Addresses encouragement of healthy food and drink fundraising and catering ideas, including non-food related fundraising ideas.
6	Recommends making heathy food and beverage options the most prominently displayed by retailers.
7	Specifies ensuring the healthy food and drink options are promoted and readily available in sufficient quantities.
8	Specifies competitive pricing of healthy versus less healthy food and drink options.
Domain 3: Communication, implementation and evaluation	
1	Addresses accessibility of the worksite nutrition policy or guidelines (i.e. how the policy is shared and seen by the public/staff/visitors, e.g., available on the website).
2	Specifies staff or committee member(s) responsible for implementation and evaluation of the policy.
3	Specifies a plan for implementation of the policy, e.g., incorporation in food provider contracts, training food service staff.
4	Specifies a plan for evaluation of the policy.
5	Specifies a plan or timeframe for revision of the policy.

NHFDP is not mandatory, making this evaluation component redundant.

Ethical approval to conduct the HYPE study was granted by the Auckland Health Research Ethics Committee (AHREC ref #AH2519), and locality approval was sought from each participating organisation with the assistance of The National DHB Food and Drink Environments Network members.

In early 2021, all 20 New Zealand DHBs and the two central government agencies that had committed to adopting the national policy (Ministry of Health and Health Promotion Agency) were invited via email to provide the latest version of their food and drink policy for the HYPE study. Appropriate organisational contacts were identified via The National DHB Food and Drink Environments Network members. All policies were received within three months. Policies were analysed by Masters of Public Policy students at The University of Auckland as part of their course assessment for POLICY744 (Policy in Practice). Students analysed four policies each and then met in teams of 4–5 to discuss differences in scoring across policies and create a group report which included final scores and recommendations for each of the policies assessed. A policy analysis template (in Microsoft Excel) was provided for recording policy scores for each team, and the complete analysis repeated by one of the authors (BK). Scores across the assessors were checked for consistency, with differences predominately occurring for indicators in Domain 3. Where scores were inconsistent, the final score was discussed and decided by consensus with a second author (SG). Mean total scores (with standard deviation) were produced for each domain and a total score from the sum of domain scores (i.e., three equally-weighted domains). Results for individual organisations have been anonymised in this publication pending provision of that feedback to the DHBs. All analyses were undertaken in Microsoft Excel (see Appendices for full details of scoring).

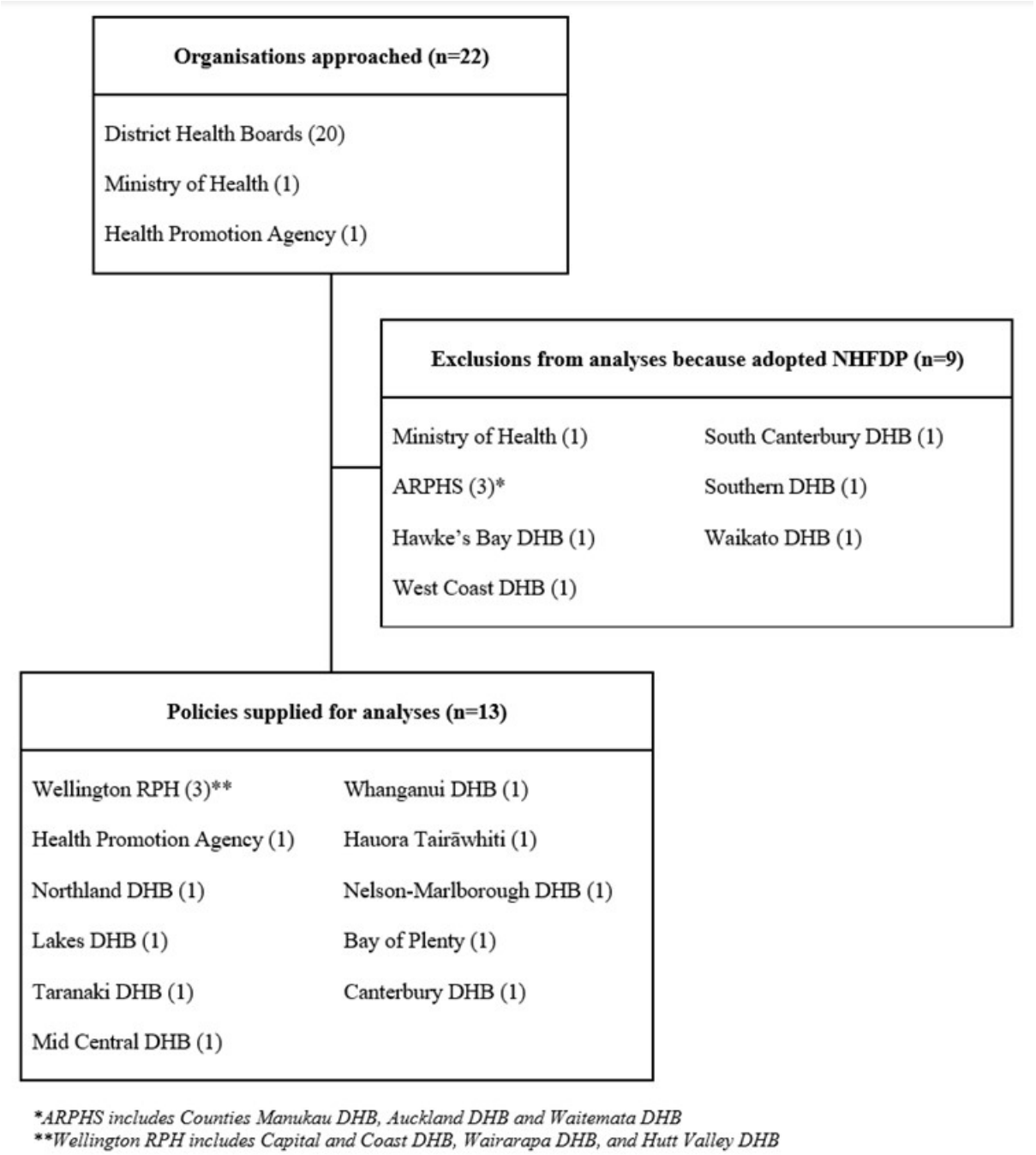
Results

All 22 organisations approached (the 20 DHBs, Ministry of Health, and Health Promotion Agency) responded to our request for information on their policy. There are two regional public health services in New Zealand, and within both, three DHBs follow the same policy. Nine organisations (including the Ministry of Health) reported that they had adopted the NHFDP in full and ,therefore, were not included in the content analysis as the NHFDP was considered the gold standard comparator (Figure 1). Of these nine, two DHBs (South Canterbury and Southern) reported that their institutional policies "go further" than the NHFDP, in that no artificially sweetened beverages or carbonated drinks (including water) were permitted onsite, although written guidance to support this were not provided (and so could not be included in the content analysis). Eleven unique policies were supplied for analysis relating to 13 organisations (Figure 1). Six of the 13 organisations included in the analysis reported they referred to the NHFDP when developing and implementing their policy, and three DHBs were "working toward full adoption of the NHFDP" (Whanganui, MidCentral and Taranaki).

The scores for the 11 policies are presented in Table 2, ordered by total score. Policy A scored highest on comprehensiveness by incorporating both verbatim wording from the NHFDP and customised additional wording, including the incorporation of culturally responsive clauses recognising institutional obligations under Te Tiriti o Waitangi (not captured in the assessment scores). Policy K was generic healthy food guidelines, containing points for organisations to consider when developing a nutrition policy, rather than describing what the organisation themselves would do to promote and provide healthy food and drinks.

The scores for the first domain Nutrition standards for a healthy food and beverages environment ranged from 6.9 to 10 and the mean score was 8.7/10. Most institutional DHB policies scored highly on this domain, indicating that they included almost all the same nutrition standard areas as the NHFDP. The NHFDP requires at least 55% of all food and drinks provided onsite to be in the "green" category (low in saturated fat, added sugar and added salt, and mostly whole and less processed), 45% or less of food and drinks in the "amber" category, and no "red" food and drinks be available. Most of the individual institutional policies specified the same criteria, except Policy I from a DHB and Policy K, neither of which specified the proportion of foods provided onsite that should be in each traffic light category.[5] Some DHB policies required more than 55% of foods to be in the "green" category: Policy G required 85% of foods to be "green" and 15% "amber"; Policies C and D required 70% of all food to be "green" and the remaining 30% "amber". Three DHBs specified that water and milk were the only drinks to be provided onsite (policies B, C, H) so 100% of drinks would

Figure 1: Organisations included and excluded in the HealthY Policy Evaluation (HYPE) Policy Analysis.



**ARPHS includes Counties Manukau DHB, Auckland DHB and Waitemata DHB*
***Wellington RPH includes Capital and Coast DHB, Wairarapa DHB, and Hutt Valley DHB*

meet the "green" drink criteria in the NHFDP. Additionally, policies E, G and H did not allow sugar-free versions of soft drinks (any carbonated drinks). However, policy G allowed small-sized (less than 250ml) flavoured milk and no added sugar juices, and policy E allowed fruit and vegetable juices with no added sugar.

Policy E was the only one with specific requirements for vending machines, although this did not go as far as the NHFDP, which says DHBs should move over time to ensure more than 50% of vending machine contents are in the "green" category. Another indicator area where some DHB policies were weak was non-inclusion of specific nutrient criteria for foods or drinks such as limits on the sugar (policies E, F, I) or sodium contents of foods (policies B, I, J, K), as in the NHFDP.

Five of the policies addressed the use of environmentally sustainable and socially responsible practices for purchasing and supply of food and drinks (B, C, F, H, I). Policy C and I focused on reducing food waste by asking people to confirm attendance before an event when catering and eliminating edible food waste, prioritising local food suppliers and producers, and reducing single-use plastic packaging. Reducing consumption of meat and processed meat was specified in Policy C and H, with Policy H providing specific targets for the availability of vegetarian and vegan options, and implementing meat-free Mondays, and fish Fridays.

The scores for the second domain, promotion of a healthy food and beverages environment, ranged from 1.3 to 10, and the mean score was 6.1/10. Five policies (A, C, D, E and J) specified the need for competitive pricing of healthy foods compared to less healthy options. Policies F, G, H, J, and K scored lower on the promotion indicator as the policies did not instruct retailers to ensure healthy food options were prominent and readily available. Policy J also omitted to specify the need to provide facilities for employees for food preparation and breastfeeding. Three policies (G, H, K) did not recommend that drinking water should be accessible onsite. Policies C, E, and K did not include wording about restrictions on partnerships, fundraisers, and promotions involving products and brands inconsistent with a healthy food and beverage environment.

The third domain, communication, implementation and evaluation of the policy, produced the lowest scores, ranging from zero to eight, and with

Table 2: HYPE Policy Assessment Tool scores for individual DHB Food and Drink Policies (where The National Healthy Food and Drink Policy had not been adopted in 2021).

Policy ID	Domain 1	Domain 2	Domain 3	Total*
A **	9.2	10.0	8.0	27.2
B	9.2	8.8	6.0	24.0
C	10.0	7.5	6.0	23.5
D **	9.2	8.8	4.0	22.0
E	7.7	7.5	4.0	19.2
F **	9.2	6.3	2.0	17.5
G	8.5	3.8	4.0	16.2
H	10.0	3.8	2.0	15.8
I	8.5	6.3	0.0	14.7
J	6.9	3.8	4.0	14.7
K	6.9	1.3	2.0	10.2
Mean score (SD)	8.7 (1.0)	6.1 (2.6)	3.8 (2.2)	18.6 (4.8)

Notes: Domain 1 Nutrition standards,
Domain 2 Promotion of a healthy food and beverages environment,
Domain 3 Communication, implementation and evaluation.
* Total possible score is 30, each of the three domains is scored out of 10.
** Plans to replace policy with the NHFDP. SD=standard deviation.

a mean score of 3.8/10. Policies A, B, C, and H were the only ones to explicitly state that contracts for food provision should contain a healthy food and drink contract clause. Eight of the 11 policies specified a staff member responsible for ensuring that contracted food providers aligned their food provision with the adopted policy. Less than half of the 11 policies specified how the policy would be evaluated, or when the policy would be reviewed.

The four highest-scoring policies in 2021 scored between 20 and 27 (out of 30), while three policies scored between 10 and 15 (out of 30). Table 3 summarises areas where policies were strongest (at least 90% = ≥10 of the 11 policies met the criteria) and weakest (less than 50% = ≤5 of the 11 policies met the criteria).

Discussion

In 2021, more than half of New Zealand's 20 DHBs had either already adopted (n=9) or intended to adopt (n=3) the NHFDP, whilst some that had not adopted the NHFDP as their institutional policy contained guidelines that went beyond the NHFDP. This shows an increase in the adoption of the NHFDP over time, as five years ago only five DHBs had adopted the NHFDP.[6] Most individual institutional policies were not as comprehensive as the NHFDP. The 2018 study of DHB food policies also found that individual DHB policies were not as comprehensive as the NHFDP across all three domains.[6] However, in 2021, some DHB policies contained stricter or additional clauses (not noted in 2018) which could be considered for inclusion in future iterations of the NHFDP.

The content analysis of 11 institutional policies from 13 organisations that had not yet adopted the NHFDP found considerable variation in the comprehensiveness of their nutrition standard areas relative to the NHFDP. Previous research has found that retailers and suppliers working across multiple institutions have difficulty imple-

Table 3: Strongest [a] and weakest [b] performing indicators in individual DHB Food and Drink Policies (DHBs where the National Healthy Food and Drink Policy had not been adopted in 2021).

Strongest		Weakest
Compliance with the Eating and Activity Guidelines		Environmentally sustainable and socially responsible practices
Nutrition standards applied to all foods and beverages provided or sold onsite and off-site [c]		Competitive pricing of healthy ("green") versus less healthy ("amber") food and drinks
Accommodating different cultural, religious and special dietary requirements		Accessibility of the DHB nutrition policy (guidelines) [d]
Providing mostly whole or less processed foods with minimal saturated fat, salt (sodium) and added sugar		A clear plan for implementation of the nutrition policy [e]
Limiting the provision and sale of deep-fried foods and confectionery		A plan and a timeline for evaluation or review of the policy
Provision and sale of water and unflavoured milk as predominant cold drink options		

Notes: [a]: (Strongest) at least 90% scored = ≥10 out of the 11 policies met the criteria.
[b]: (Weakest) less than 50% scored = ≤5 out of the 11 policies met the criteria.
[c]: Relates to all foods and beverages provided or sold by any retailer, caterer, vending machine, snack box or volunteer service on the organisation's premises AND all foods and beverages offered onsite, or on behalf of the organisation offsite, such as catering, fundraiser, meetings, conferences and similar events.
[d]: Accessibility is defined as how the policy is shared and seen by the public/staff/visitors, such as on the website.
[e]: Examples include incorporation in food provider contracts.

menting different healthy food and drink policies when there is inconsistency in the standards and expectations, and particularly when there are limits on specific nutrients, such as sodium, that need to be remembered.[15–17] Differences in institutional healthy food policies can create and/or exacerbate regional population health and nutrition inequities, and make it difficult and confusing for food suppliers and retailers that work across several DHBs.

Indicators from the third domain, communication, implementation and evaluation, were frequently missing from the individual institution policies. The NHFDP is, itself, not strong in this area, simply stating: "monitoring and evaluating the policy will be part of each organisation's Implementation Plan and will be aligned to the agreed expectations of The Network and the Ministry of Health." Consequently, it is probable that this aspect is weak across the sector, including within those organisations that have adopted the NHFDP.[7] Yet, existing literature about communication and monitoring of healthy food and drink policies show that it is critical to create accountability and enable feedback to senior leadership, and assists with justifying any necessary changes to the food environment.[1,18–21] Future iterations of the NHFDP should add more about how the policy will be made available, monitored and evaluated, and who is in charge of implementation.

Some clauses found in some individual DHB policies arguably improve on standards in the existing version of the NHFDP, showing such improvements may be feasible for inclusion in future iterations of the NHFDP:

- The importance and obligation of the organisation to provide a healthy food and beverage environment under Te Tiriti o Waitangi;
- Specification of a higher proportion of "green" items overall (NHFDP specifies a minimum of 55%, but some institutional policies have set thresholds at 70% and 85%);
- Definition of all processed meats as "red" items, i.e., not permitted;
- Definition of all carbonated drinks (including water) defined "red", a standard currently adopted by six DHBs;
- Use of specific sustainable and socially responsible practices for purchasing and supplying food and drinks, e.g., meat-free Mondays, fish Fridays, no single-use plastics (straws, cutlery, takeaway containers), and choosing seasonal and local food producers;
- Elimination of edible food waste and processing inedible food waste in an environmentally responsible way.

Additionally, the effectiveness of NHFDP would be strengthened if it were made mandatory, whereby compliance with the policy becomes a standard and required part of organisational operations rather than voluntary recommendations as currently.[1] Mandatory regulations are well documented in the public health literature to be more effective than voluntary codes and guidelines.[22,23] Australian and Canadian studies have found the inclusion of the policy in procurement contracts between the organisation and retailers, caterers and other food suppliers meant there was "no real room for arguments" and ensured compliance.[24–26] The original UConn Rudd Center policy assessment tools include the indicator: "specifies a course of action when the healthy food policy is breached", which would be relevant to include in future policy analyses if the NHFDP was made mandatory, but was not included in the current tool as voluntary policies cannot be enforced.[1,13] Also, the tool included the indicator: "addresses how to deal with suggestions, concerns and complaints regarding the healthiness of food environment on the DHB premises", but this was not included in the current assessment because this criteria was not included in the NHFDP.

The present study found an increase since 2018 in the adoption of the NHFDP, and found improvements in the content of other individual institutional policies regarding the food and drinks environments for staff and visitors in Aotearoa New Zealand's hospitals. However, there is inconsistency between policies, and this potentially confuses and frustrates retailers/suppliers who work across multiple institutions. Such inconsistencies also limit the opportunity to provide equitable access for all to nutritious foods and beverages, which would improve long-term population health outcomes while simultaneously benefitting the wider food system. Evaluation of the nutrient profile of foods currently available in New Zealand DHBs to assess the degree of implementation and impact of healthy food and beverage policies is currently underway. This will be critical for identifying how the differing policies found in the present study impact on the actual food available to staff and visitors in hospital settings throughout Aotearoa.

COMPETING INTERESTS
Four authors (Cliona Ni Mhurchu, Magda Rosin, Stephanie Shen and Bruce Kidd) are members of The National DHB Food and Drink Environments Network. The Network had no role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript. All other authors declare they have no conflict of interests.

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Trauma teams in Aotearoa New Zealand—a national survey

Rohan Lynham, Matthew McGuinness, Christopher Harmston

ABSTRACT

AIMS: Improved survival of trauma patients has been shown when a multidisciplinary trauma team is available. The aim of this study is to investigate the composition of trauma teams, trauma call criteria and the role of anaesthetists in trauma care across New Zealand.

METHODS: A survey was distributed using the modified Dillman's technique. Data was collected and aggregated using an online platform. The survey consisted of two streams of questions depending on trauma team availability. Trauma nurse specialists were the first contact point and if not available, direct contact with the hospital was made for completion of the survey.

RESULTS: Seventy-five percent of hospitals had a trauma team and trauma call system and correlated to size of the hospital. The number of trauma team members ranged from six to 17, with a median of 10. Trauma call activation criteria encompassed physiological criteria, injury pattern and injury mechanism criteria. Physiological criterial of GCS, heart rate, blood pressure and respiratory rate were universally used. Sixty-two percent of trauma teams had involvement of anaesthetists.

CONCLUSIONS: Trauma teams in New Zealand are common in regional and tertiary trauma hospitals. There is a wide variation in member numbers and criteria to trigger a trauma call. Anaesthetist involvement was in over half of trauma teams with regional variation noted. There is potential for trauma team composition and activation criteria to be standardised in New Zealand.

Injury is a leading cause of mortality, hospitalised morbidity and disability in New Zealand.[1] There are over 2,000 hospital admissions with major trauma in New Zealand per year, with a national incidence of 51 cases per 100,000.[2] The burden of trauma falls disproportionally on rural communities, with a doubling in rates of injury from large urban to rural areas.[3] Within New Zealand, there are three tiers of trauma provision, tertiary trauma centres, regional trauma hospitals and smaller rural hospitals, which would often be bypassed in the incidence of major trauma.[2]

Since the recognition by Cowley that a multidisciplinary team lead to better trauma outcomes, trauma systems have been a rapidly developing and expanding field.[4] Across New Zealand, there are four major trauma networks which come under the governance of the National Trauma Network.[3] Many hospitals now have multidisciplinary trauma teams and a trauma call system in place, now with trauma call data being reported by the National Trauma Registry.[3] The goal of trauma teams is to ensure the early mobilisation and involvement of experienced medical staff, thereby leading to improved patient outcome.[5] Evidence suggests that patients with moderate–severe injuries (injury severity score, ISS >12) have a significantly better outcome when trauma teams are involved, rather than when being treated on a service-by-service basis.[6] Other benefits include improvement in triage time, reduced mean resuscitation time, and overall trend towards lower mortality and morbidity rates in patients with severe head injury.[5,7,8] In New Zealand specifically, trauma team activation has been shown to make time to CT scan on average twice as fast.[3] A trauma team approach allows for coordinated distribution of several tasks to be completed simultaneously.[9]

The composition of this team, however, is less well defined.[5] A large variation has been noted in a number of previous studies. Egberink et a.l found the number of trauma team members varied from 3 to 16 professionals when a nationwide survey of Dutch Emergency Departments was conducted.[10] This study refers to a trauma team as a multidisciplinary team that attends for the initial management of a trauma patient in the emergency department (ED), and is not referring to the presence of an in-patient admitting trauma service. The composition of trauma teams across New Zealand is not well known.

This study aims to investigate the availability and composition of trauma teams in current practice in New Zealand across all levels of trauma care. Trauma call criteria and the role of anaesthetists in trauma care will also be investigated.

Methods

Study population

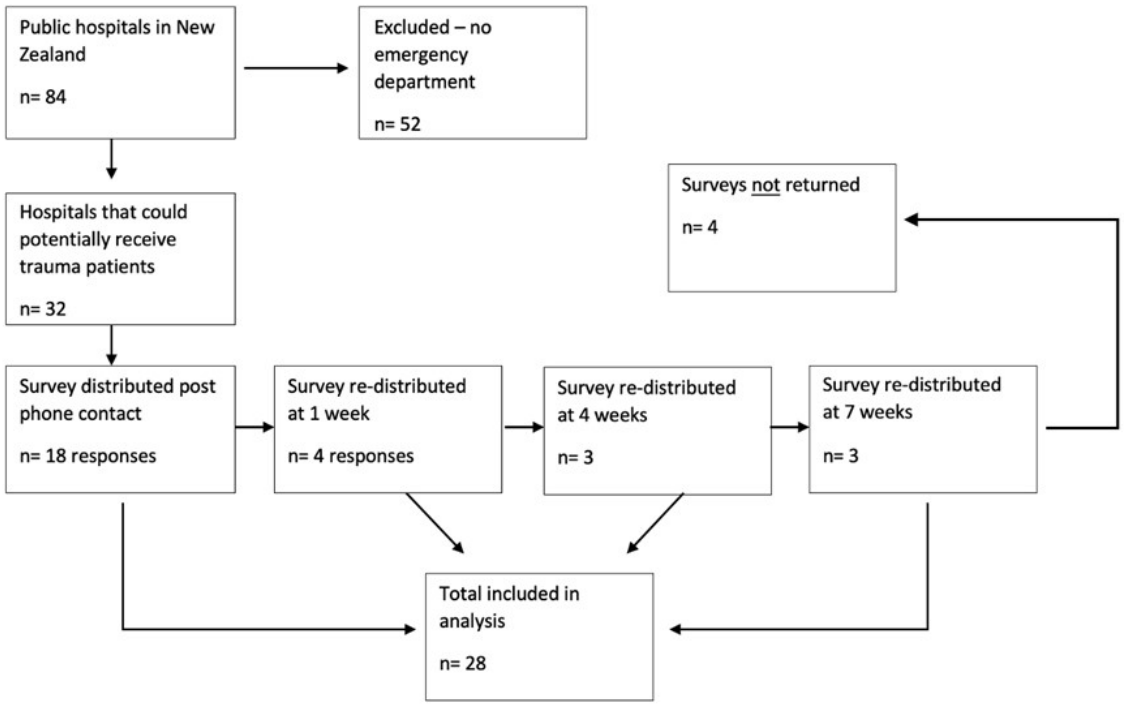
A structured online questionnaire was distributed to all New Zealand hospitals that have the potential to manage major trauma patients. The survey responses were collected between 11 November–15 December 2021. The Ministry of Health list of public hospitals in New Zealand was used to identify eligible hospitals.[11] A total of 84 hospitals were listed. Hospitals that did not have an ED (e.g., aged care, urgent care and psychiatric facilities) were excluded. Remaining were a total of 32 hospitals which could potentially receive and provide treatment for major trauma patients (see Figure 1).

Survey design

The survey questionnaire was based on a literature review and tailored to the New Zealand context. The questionnaire developed and evaluated for content and readability by the Northland District Health Board trauma service, consisting of a trauma surgeon, registrars from both surgery and anaesthesia, as well as the trauma nurse specialist.

The survey consisted of two streams of questions: those who identified as having a trauma team and those who did not (Figure 2). If the respondents' facility utilised a trauma team, the survey consisted of 22 questions using multiple choice, checkbox, free text and file attachment formats. These questions included trauma team members, activation criteria and activation methods. Those without a trauma team completed 11 questions consisting of multiple choice, checkbox and free text. Included were reasons why no trauma team is available, the perceived benefits to patients and the health service of trauma teams. Both groups were asked about the current role of anaesthetists in their facility and the perceived benefits or disadvantages of anaesthetist involvement in trauma. The specialty of the attending clinician was recorded corresponding to the department within the hospital they were representing. For example, an anaesthetist who was working in the ICU was recorded as "ICU", and a rural medicine specialist working in a senior medical role in the emergency department was recorded as "ED consultant". It was outlined that responses would represent the normal in-hours team that would attend and further questions about changes that occurred after hours were included so to explore this aspect.

Figure 1: Flowchart of survey distribution and return.



Survey distribution

The survey distribution consisted of modified Dillman's technique without financial incentive. Follow up emails were sent weekly for the first two weeks then again at week five and seven.[12] Phone contact was made with the trauma nurse specialists of each hospital, and if not available, the most appropriate person to distribute the survey to was determined on this initial phone contact. The surveys were initially distributed to trauma nurse specialists, or to the appropriate individual as determined on a case-by-case basis. Specific instructions were included to direct the initial recipient to seek assistance, or to forward the survey onto the most appropriate clinician if they felt unable to accurately answer the survey questions. Researcher details were also provided if any clarification was required by the individual respondents. Only one response was recorded from each hospital, as multiple responses from one hospital would not be able to be analysed if conflicting information was provided. Although, rural classified hospitals may not be required to manage major trauma as they would often be bypassed, it was thought these hospitals would be included to assess whether any of these smaller institutions were using a trauma team approach.

Phone contact was utilised for initial introduction to the concept of the study and then also at week five for follow-up if not completed at this stage. The survey was distributed using the Survey Monkey™ online platform.

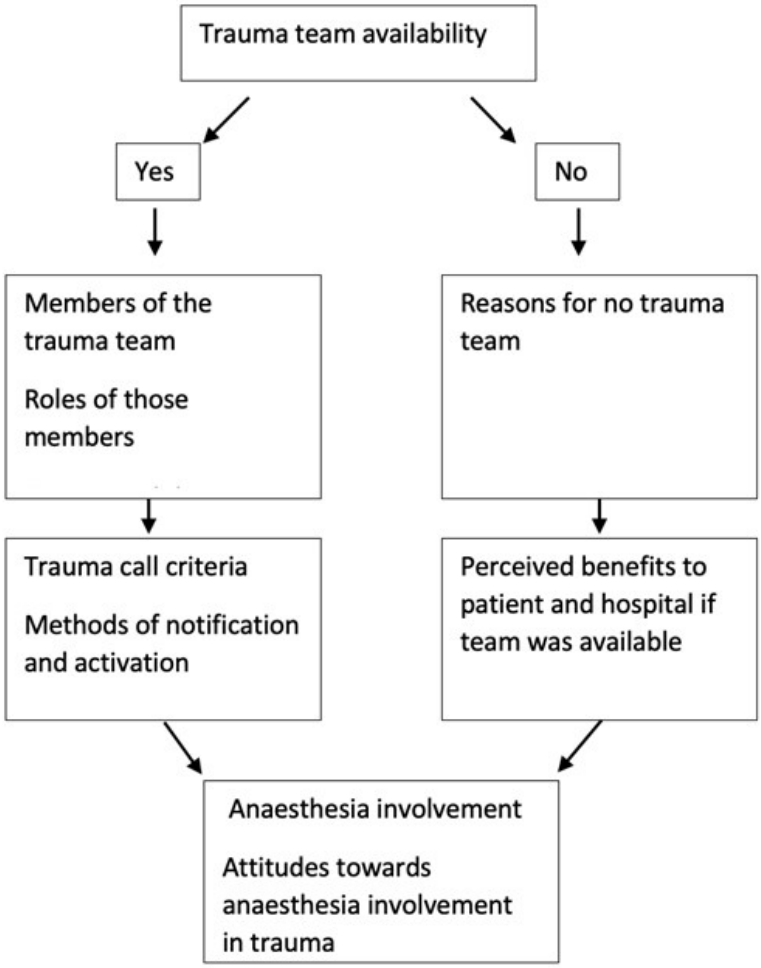
Data collection and statistical analysis

Data was aggregated using the Survey Monkey™ platform. Categorical data were described as number and percentage. Normally distributed data were described as mean and standard deviation (SD). Non-normally distributed data were described as median and Quartile 1 and Quartile 3 (Q1–Q3).

Ethics

Out of scope HDEC approval was granted 7 April 2022. Participation from respondents was completely voluntary without incentivisation.

Figure 2: Survey pathways.



Results

Participating hospitals and respondents

Twenty-eight of the 32 (88%) hospitals returned a completed survey (see Table 1). There was a large variation in the size of the hospitals ranging from 14 to 1,165 beds. Respondents included 53% (15/28) trauma nurse specialists, 32% (9/28) doctors (not trauma-specific), 10% (3/28) trauma-specific doctors, and 3% (1/28) nurses (not trauma-specific). Across the domains assessed, there was no significant differences between the regional and tertiary trauma hospitals and, therefore, there has not been separation of this data.

Ninety percent (19/21) of hospitals with trauma team availability participated in local trauma quality assurance such as trauma committee meetings and review. Only 9.5% (2/21) of responding hospitals had trauma-specific fellowships available; two in general surgery and one in orthopaedics.

Trauma team availability

Seventy-five percent (21/28) of hospitals indicated a trauma team was available and a trauma call system was in place. All regional and tertiary trauma hospitals had a trauma team and no rural hospitals with 52 beds had a trauma team; therefore, all trauma team data are referring to regional and tertiary trauma hospitals. The number of trauma team activations varied, with 33% having <50 activations per annum, 20% having 50–100 activations, 10% having 100–200 activations, 33% with >200 activations, and 4% being unsure of the total number. All responding hospitals that had a trauma team provided this service continuously, independent of time of day or the day of the week. All hospitals had trauma call activation by either pre-hospital notification information and/or at triage. Thirty-eight percent (8/21) also had provisions for activation later once assessed in the ED.

Notification to the trauma team most commonly occurred via a specific trauma pager (14%) while other contact methods included regular pager system (10%), loudspeaker announcement (5%), mobile phone contact (10%), with the remainder (61%) employing a combination of pager and mobile phone contact.

Trauma team composition

The number of trauma team members ranged from 6–17, with a median of 10 (8.5–11.5). This includes a median number of 5 (4–6) medical members of the team and median of 5 (2.5–6) nursing/allied health members. These figures were similar when comparing tertiary hospitals to regionals trauma hospitals with the medians being 11 (9.5–11.5) and 10 (8–11.5). Table 2 outlines the specialities and seniority levels of members. Seventy-six percent (16/21) of hospitals had their trauma team change after hours with the majority comprising of more junior staff (75%; 12/16).

Role allocation within the trauma team

The consultant/fellow ED doctor was allocated as the team leader in 96% (20/21) of cases, with the other team leader being an emergency registrar under direct supervision of a consultant. The role of airway doctor was shared between the specialties of anaesthesia (57%), ICU (38%) and ED (4%). Assessment of breathing and circulation status was done mostly by an emergency registrar (8/21) or general surgical registrar (6/21). Procedures (such as chest drain insertion) was completed by a general surgical doctor in (7/21), an ED doctor in (6/21), and an ICU doctor in (3/21). These allocations were flexible in 96% of hospitals depending on patient and/or staffing requirements.

Trauma call criteria

Trauma call activation criteria in all respondents encompassed a combination of physiological criteria, injury pattern and injury mechanism. Across all hospitals GCS, heart rate, blood pressure and respiratory rate were universally used as activation criteria although specific cut-offs varied. Thirty-eight percent (8/21) used mandatory activation based on pre-hospital notification if classified as a status 1 or 2 patient. One third (7/21) had a two-tiered response with different teams attending with the majority using a single response to all trauma calls. Seventy-six percent (16/21) mandated a trauma call if the patient met any physiological and injury pattern criteria with discretionary call available based on mechanism of injury criteria. Nineteen percent had separate criteria for obstetrics, and 21% had paediatric criteria, excluding specific paediatric or adult only hospitals. Forty-eight percent had trauma call activation criteria if multiple casualties were expected; however, there was variation from two to six patients and 24% did not specify a number. It was not elucidated if responding hospitals had separate mass casualty procedures.

Reasons for lack of trauma team

In the hospitals that did not have a trauma team 86% (6/7) identified staff availability as the major reason why a trauma team is not present. Other identified reasons included, too close to

Table 1: Participating New Zealand hospitals.

Hospital name	Number of beds	Trauma team available	Survey respondent	Level of trauma service
Auckland City Hospital	1,165	Yes	Trauma-Specific Doctor	Tertiary
Middlemore Hospital	905	Yes	Trauma Nurse specialist	Tertiary
Christchurch Hospital	808	Yes	Trauma Nurse specialist	Tertiary
Waikato Hospital	673	Yes	Trauma Nurse specialist	Tertiary
North Shore Hospital	663	Yes	Trauma Nurse specialist	Tertiary (considered in conjunction with Auckland City and Middlemore)
Wellington Hospital	484	Yes	Trauma Nurse specialist	Tertiary
Hawke's Bay Hospital	364	Yes	Trauma Nurse specialist	Regional
Dunedin Hospital	361	Yes	Trauma Nurse specialist	Tertiary
Tauranga Hospital	360	Yes	Doctor (Not trauma specific)	Regional
Palmerston North Hospital	354	Yes	Trauma Nurse specialist	Regional
Hutt Valley Hospital	322	Yes	Trauma Nurse specialist	Regional
Whangārei Hospital	246	Yes	Trauma Nurse specialist	Regional
Rotorua Hospital	233	Yes	Trauma Nurse specialist	Regional
Starship Hospital	219	Yes	Trauma Nurse specialist	Tertiary
Taranaki Base Hospital	194	Yes	Trauma Specific Doctor	Regional
Nelson Hospital	191	Yes	Trauma Nurse specialist	Regional
Southland Hospital	168	Yes	Trauma Specific Doctor	Regional
Timaru Hospital	132	Yes	Trauma Nurse specialist	Regional
Wairau Hospital	100	Yes	Trauma Nurse specialist	Regional
Whakatane Hospital	96	Yes	Doctor (Not trauma-specific)	Regional
Wairarapa Hospital	89	Yes	Nurse (Not trauma-specific)	Regional
Thames Hospital	52	No	Doctor (Not trauma-specific)	Rural
Taupō Hospital	36	No	Doctor (Not trauma-specific)	Rural
Kaitaia Hospital	32	No	Doctor (Not trauma-specific)	Rural
Bay of Islands Hospital	20	No	Doctor (Not trauma-specific)	Rural
Dargaville Hospital	19	No	Doctor (Not trauma-specific)	Rural
Lakes District Hospital	15	No	Doctor (Not trauma-specific)	Rural
Hawera Hospital	14	No	Doctor (Not trauma-specific)	Rural

Table 2: Specialties involved in composition of trauma teams.

Specialty	Position level (number on team)	Number of hospitals including these members % (n/21)
Emergency medicine	Consultant/Fellow (1)	95 (20)
	Registrar (1)	57 (12)
	Registrar (	14 (3)
	House officer (1)	52 (11)
	Nurse (1)	9 (2)
	Nurse (2)	48 (10)
	Nurse ()	38 (8)
General surgery	Consultant/Fellow (1)	28 (6)
	Registrar (1)	86 (18)
	House officer (1)	38 (8)
Intensive care medicine	Consultant/Fellow (1)	24 (5)
	Registrar (1)	48 (10)
	Nurse (1)	14 (3)
Anaesthesia	Consultant/Fellow (1)	38 (8)
	Registrar (1)	33 (7)
	Technician (1)	24 (5)
Radiology	Consultant (1)	5 (1)
	Radiographer (1)	52 (11)
	Radiographer (2)	19 (4)
Trauma-specific or duty manager	Nurse (1)	71 (15)
Non-medical/nursing staff	Healthcare assistants (1)	33 (7)
	Healthcare assistants (2)	9 (2)

Table 3: Trauma call activation criteria.

Activation criteria		Number of respondents % (n/21)
Physiological criteria	GCS	100 (21)
	Heart rate	100 (21)
	Systolic blood pressure	100 (21)
	Respiratory rate	100 (21)
	Airway intervention	24 (5)
	Oxygen saturations <90%	9.5 (2)
Injury pattern	Penetrating injury to the head, neck or torso	95 (20)
	Major burns >20% in adults (>10% in paeds), or airway burns	86 (18)
	Known or suspected spinal cord injury (paraplegia or quadriplegia)	71 (15)
	Major crush injury	66 (14)
	Suspected complex pelvic injury	57 (12)
	Two or more proximal long bone fractures	57 (12)
	Flail chest	52 (11)
	Airway obstruction	48 (10)
	Traumatic limb amputation	43 (9)
	Trauma to a limb with arterial injury	9.5 (2)
	Crushed, mangled, amputated or pulseless limb	9.5 (2)
Injury mechanism	Fall >3 metres	90 (19)
	Pedestrian versus car or train	71 (15)
	Cyclist or motorcyclist versus car	66 (14)
	Ejection from a vehicle	48 (10)
	Entrapment >30 minutes	38 (8)
	Fatality in the vehicle	38 (8)
	High voltage electrical injury	9.5 (2)
Special criteria	Pregnancy	62 (13)
	Multiple casualties	48 (10)
	Paediatric patient	29 (6)
	Trauma transfer from other facility	19 (4)
	Anticoagulated patient	19 (4)
	Elderly patient	43 (9)

major trauma centre (2/7) and too few trauma patients (2/7). Just over half (57%) recognised that the formation of a trauma team at their facility may positively impact patient outcomes, and 57% also identified potential benefits for the centre at which they work if there were not the barriers as mentioned earlier with workforce issues.

Anaesthesia department involvement in trauma teams

Of the 21 responding hospitals with a trauma team system 62% (13/21) had involvement of a member of the anaesthesia department in the form of consultant, registrar or both responding to a trauma call. Large tertiary hospitals in the upper North Island did not include anaesthesia, but the smaller hospitals and South Island trauma hospitals incorporate an anaesthesia member into their teams. Furthermore, 50% (14/28) of respondents felt anaesthesia was best to manage airway in major trauma, and 79% (22/28) felt anaesthetists possess skills beneficial in the management of major trauma. Eighty-two percent (23/28) of respondents agreed that anaesthetists would probably or definitely add value to initial care of major trauma patients. Those that did not include anaesthesia in their trauma teams all indicated they would be involved if specific intervention was required.

Discussion

This study has shown that the use of trauma teams is common in New Zealand hospitals, with all regional and tertiary trauma centres having a trauma team response process, suggesting the majority of patients suffering major trauma are received by a trauma team. There was a wide variation in team composition, trauma call activation criteria and anaesthetic involvement.

An organised trauma team present at the time of arrival of a major trauma patient to the ED is known to have a positive impact on patient care.[9] The number of members within this trauma team varied significantly across the country, similarly to the international experience.[10] The median number of members being 10 is in line with a national study from the Netherlands.[10] Trends in the research however suggest the ideal number is less than this, citing a number of five to eight as the ideal number for adequate skill mix without compromising team leader oversight.[13] Across New Zealand, only 23% (5/21) of trauma teams fell within the recommended team size, with the majority of teams being larger. This has implication across New Zealand, as without a well-organised team there is the potential for team fragmentation, resulting in unnecessary procedures and the team leader losing oversight of the trauma resuscitation.[13]

The rate of trauma team utilisation is higher than many other countries where the rates vary from 21% to 98%.[10,14–20] This may reflect the well-developed trauma systems in place within New Zealand.[21] Future research may be able to provide comparisons with countries that have lower trauma team utilisation and major trauma outcomes to determine potential benefit to this high rate.

Smaller rural hospitals (52 beds) were unable to utilise a multidisciplinary approach to trauma care due to restrictions related to staff availability. These hospitals would generally be staffed by rural medicine specialists, and it is unlikely there would be any other medical specialties available to form a multidisciplinary trauma team. A formal trauma team response would also generally be unnecessary, as they are preferentially bypassed by major trauma patients if clinical condition allows. It is, however, reassuring of substantial clinician recognition of the benefits of such an approach to both the patient and institution.

Although there were large variations in team member numbers across New Zealand, there were a number of clear trends in roles allocated during trauma resuscitation. Geographical trends showed tertiary hospitals in the more northern regions utilising ICU more so than anaesthesia. The reasons for this are likely due to local availability of specialities to attend trauma calls. However, these roles were flexible. This may be good to overcome shortfalls however if team members are required to work outside their predetermined roles there is the potential for this to lead to non-optimal outcomes.[22] There is not clear evidence that the inclusion of intensive care or anaesthesia members in the team is beneficial over another however this may be an area of future study particularly regarding effectiveness of airway management and transit time to theatre or ICU. It may be also important to recognise the significant cross over between these specialties that still exists within New Zealand, which may limit the ability to conduct this investigation.

All hospitals that indicated a trauma team present had coverage 24 hours per day, seven days a week. However, the composition after hours changed in 76%, with the main change being a more junior team. Subsequently a more junior team with less experience dealing with

major trauma may be unsure of their roles and responsibilities. This, however, is similar to the international experience with Australian studies demonstrating a rate of 74%.[15]

Hospitals with trauma teams utilised a criterion which incorporated aspects of physiological parameters and injury patterns for mandatory trauma call activation and discretionary calls based on injury mechanism. Table 3 outlines the specific criteria that was used by the responding hospitals. When comparing the criteria across New Zealand, there were many minor differences which has the potential to cause confusion. Specific examples include some criteria stating reduced GCS as a physiological parameter for a trauma call while others required specific GCS <14, <13, <12 or <9. Some even had specific time frames that this drop in GCS was required to be longer than five minutes. Similar trends were noted in the heart rate and respiratory rate requirements, with numbers for tachycardia and bradycardia to trigger a trauma call different across sites. There was, however, some standardisation across one of the trauma networks. There may be an argument that greater standardisation across trauma networks may improve familiarity with trauma call requirements. This may be particularly pertinent to those that rotate between hospitals, namely training registrars and there is evidence that standardisation within healthcare and specifically trauma systems can improve patient outcomes.[23,24] Although trauma team members may be required to be tailored to availability at certain hospitals, trauma call criteria is an area where there is potential for standardisation of practice.

Within the international literature, there is a trend towards utilisation of a two-tiered trauma call system. The reasons for this include avoiding a "cry wolf" situation where teams become fatigued from frequent calls and responses.[25] With a single-tiered system, there appears to be an increased risk of under triage, which Thoresen et al. determined translated to a significant increase in mortality within a Norwegian trauma system.[26] A 2–3x over-call rate is thought to be an acceptable level to prevent under call yet not cause significant team fatigue.[27] Trends across New Zealand demonstrate that 66% (14/21) trauma call response is a single-tiered response, meaning the same team attends for all trauma call. A two-tiered system could be explored and implemented within New Zealand with the potential benefits to decrease over-call rates, as well as reducing under triage, improving healthcare resource utilisation with potential for cost benefits.[15,26] Further research into the rates of over-call and under-call of trauma calls in the New Zealand context would be beneficial. During the composition of this study a national best practice critical bleeding bundle of care was being rolled out nationally, including a code crimson protocol.[28] The introduction of "code crimson", which is a rapid transfer protocol for the critically bleeding patient has the potential to increase the number of tiered trauma call responses, depending on the current team that attends at the particular hospital.

Across the literature the involvement of anaesthesia appears to have regional variation, a variation which is seen across New Zealand.[10,15] Although the Australian and New Zealand College of Anaesthetists stops short of making recommendations about the attendance of anaesthetists in trauma teams, attendance as part of a trauma team is a requirement of training.[29] The Royal College of Anaesthetists, United Kingdom, however, mandates that an anaesthetist should be present as part of the team receiving major trauma patients.[30] This is something for consideration within the New Zealand context. As mentioned previously, it is not suggested that the inclusion of anaesthetists will directly improve patient outcomes but, importantly, that those who are involved in the management of trauma should have adequate exposure to volume of practice to maintain skills and knowledge. This could be by direct involvement in trauma team management of patients or other training methods.

This study is limited by survey respondent selection issues and respondent accuracy which was unable to be confirmed. However, the overall response rate was high and the majority of respondents were experts in trauma.

Conclusions

Trauma teams in New Zealand are common with the majority of major trauma patients treated by a trauma team. Hospitals that routinely receive major trauma patients have trauma teams and non-trauma hospitals do not. There is a wide variation in the number of members included in trauma teams as well as the trauma call criteria utilised. Anaesthesia departments are involved in over half of trauma teams, with regional variation noted. There is potential for trauma team composition and activation criteria to be standardised in New Zealand.

COMPETING INTERESTS
Nil.

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Appendices

Appendix 1:

The injury severity score (ISS) is a trauma severity score which is used to predict morbidity and mortality.[31] It is an anatomically based severity system derived from the Abbreviated Injury Scale that divides the body into six regions and assigns a score from 0–75 for each region.

Injury Location	Description
Head and neck	Includes injury to the brain or cervical spine, skull or cervical spine fractures and asphyxia/suffocation.
Face	Includes those involving mouth, ears, nose, and facial bones.
Chest	Includes all lesions to internal organs, drowning and inhalation injury. Chest injuries also include those to the diaphragm, rib cage, and thoracic spine.
Abdomen and pelvic contents	Includes all lesions to internal organs. Lumbar spine lesions are included in the abdominal or pelvic region.
Extremities and pelvic girdle	Includes sprains, fractures, dislocations, and amputations.
External and other	Include lacerations, contusions, abrasions, and burns, independent of their location on the body surface. Also includes electrical injury, frostbite, hypothermia, and whole body (explosion-type) injury.

Severity	Score
No injury	0
Minor	1
Moderate	2
Serious	3
Severe	4
Critical	5
Un-survivable	6

Once a severity score is calculated for each region the three most severe injuries are designated A, B, and C and entered into the equation below.
$ISS = A^2 + B^2 + C^2$
ISS score therefore ranges from 0–75 with 75 being un-survivable. If a patient has a score of 6 in any body system, they are automatically assigned an ISS of 75.

The 2021 Global Health Security (GHS) Index: Aotearoa New Zealand's improving capacity to manage biological threats must now be consolidated

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

ABSTRACT

The 2021 Global Health Security (GHS) Index Report was published on 8 December 2021. With an average country score of 38.9 out of a possible 100 points, global scores are essentially unchanged from 2019. Despite experience with the COVID-19 pandemic, no country is adequately prepared for future biological threats. No country scored above 75.9 and the scores of the bottom 11 States have all fallen since 2019. Aotearoa New Zealand, however, has substantially improved its country score, rising to 13th in the world at 62.5/100. This gain is partly driven by consolidation of capabilities developed and deployed in response to COVID-19. This is promising progress, but a lot more can be done to ensure legacy benefits from the pandemic response, notably through the proposed restructuring of the health system (Pae Ora (Healthy Futures) Bill). In this viewpoint article, we discuss this recent further development of the GHS Index, highlight the global results for 2021, delve into New Zealand's progress, and discuss what more is needed.

The Global Health Security Index

The Global Health Security (GHS) Index was first published in 2019 by the Nuclear Threat Initiative (NTI), Johns Hopkins Centre for Health Security, and the Economist Intelligence Unit.[1] It is a comprehensive, criteria-based assessment of health security capabilities across 195 States Parties to the International Health Regulations. The metric encompasses six categories relevant to health security and biological threats: Prevent, Detect, Respond, Health, Norms, and Risk (see Figure 1).

Evaluation work to generate the Index relies on publicly available information documenting preparedness as well as sustainable capabilities. The method used prioritises published information, functional systems, testing of systems and appropriate financing. In October 2019, the average global score was 40.2 out of 100.[1] No country was adequately prepared to face a biological threat. We have previously described the GHS Index in this *Journal*.[3]

On 8 December 2021, the NTI published a revised version of the GHS Index, with scoring updated based on evidence collected from August 2020 to June 2021.[2] The 2021 version of the GHS Index had been expanded considering lessons from the COVID-19 pandemic and the new version spans 37 indicators, 96 sub-indicators and 171 individual questions.

Criticisms of the GHS Index

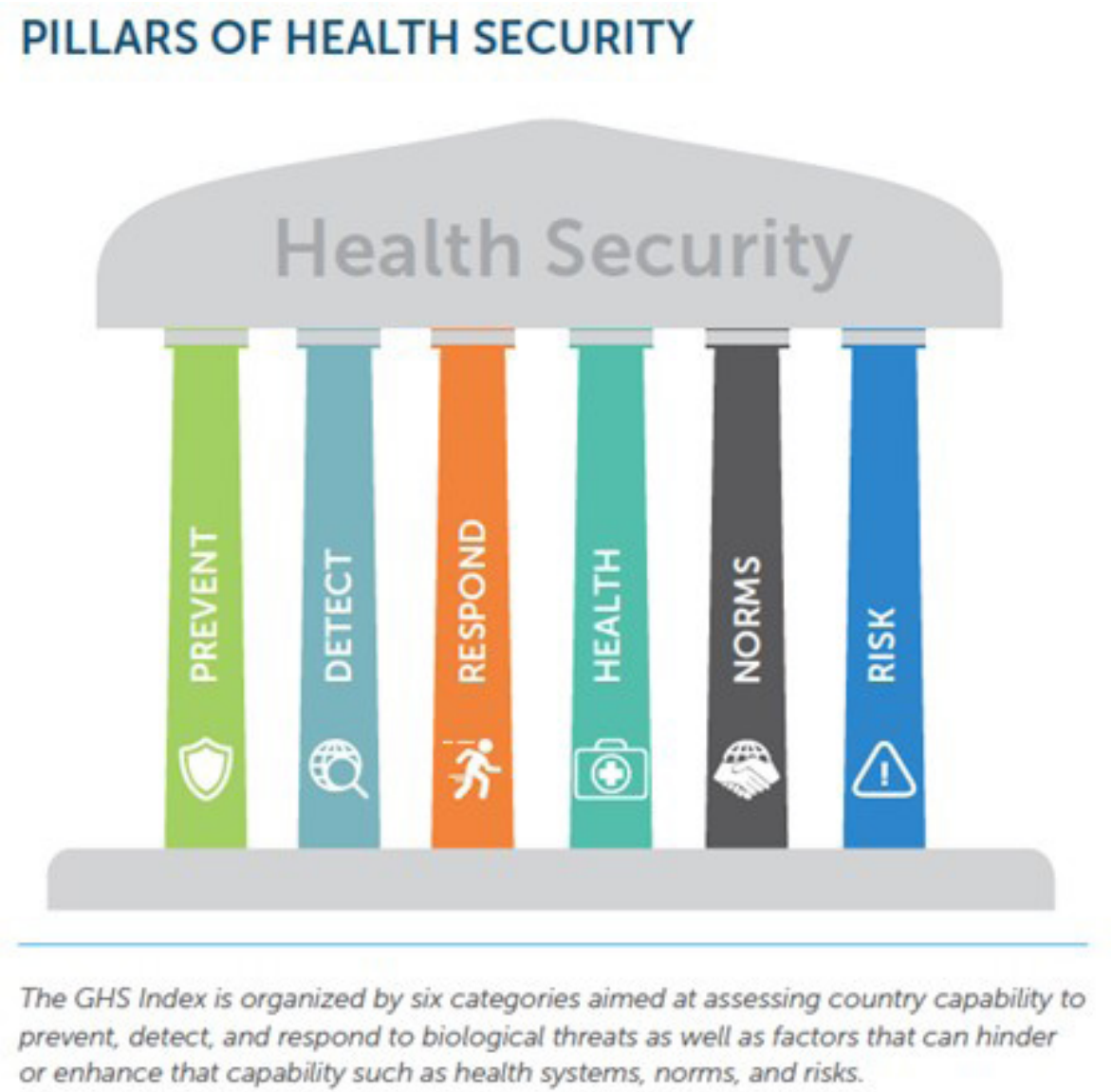
The GHS Index has received criticism, some of which seems justified given research that has found poor correlation between GHS Index scores and a range of COVID-19 pandemic outcomes.[4,5] However, other studies have found the expected associations between higher scores and COVID-19 outcomes in Africa,[6] or in the first eight weeks after a country's first case.[7] Razavi et al. questioned whether the items included skew towards the interests of high-income countries and whether the weighting of various items is appropriate.[8] Baum et al. presented ten factors that contributed to the Index's failure to predict country COVID-19 responses, including overlooking political, economic, and social contexts and the role of civil society.[9] Rose et al. found that political and governance features not included in the Index had consistent correlations with COVID-19 outcome measures, and recommended inclusion in future iterations.[10] Benton et al. criticised the national

focus of the Index, which perversely rewards hoarding of medicines and vaccines rather than equitable distribution of such resources.[11] Kaiser et al. concluded that the level of abstraction in global indices removed them from practical issues of policy on the ground.[12] However, all of the above criticisms were based on the earlier 2019 iteration of the GHS Index.

Importantly, the GHS Index cannot predict whether and how a country will make use of the capacities it has available during a public health emergency. Indeed, the GHS Index should probably not be used to compare dissimilar countries, which may have particular local or regional threats, or challenges and constraints. Identifying gaps and tracking change in score over time for each individual country is probably the more useful way of using the Index. Indeed, in the 2021 GHS Index report, the authors clarify that:

> *"Although countries are ranked using those scores, the GHS Index is a benchmarking tool that is scored on an absolute scale, meaning that gaps in any capacities could cripple countries in their response to health emergencies. As in cooking, a single missing ingredient can greatly change the outcome." (p.19)*

Figure 1: The six categories assessed by the Global Health Security Index.



Source: Nuclear Threat Initiative 2021 (Creative Commons).[2]

Validation of the GHS Index

In the face of criticisms specific to the context of COVID-19, our own assessment of the validity of the GHS Index found moderate validity in predicting key macro-indicators relevant to health security. Our peer-reviewed validation analysis of the 2019 version of the GHS Index[13] determined that:

- The GHS Index has face validity.
- The Index correlates strongly with other measures of health security.
- The Index correlates moderately with mortality from communicable diseases (see Figure 2).
- Countries that received health security aid have higher GHS Index scores than other countries matched by GDP and WHO region.
- GHS Index scores are typically higher for countries with experience of the SARS pandemic (2002–2004).

More recently we have found an emerging correlation between 2019 GHS Index scores and the proportion of the population vaccinated against COVID-19 (see Figure 3). We conclude that the GHS Index is a somewhat valid measure of health security, perhaps best used by countries to identify gaps for further analysis and investment. Furthermore, this is exactly what the authors of the original GHS Index report intended and stated in their value proposition of the GHS Index.[14]

GHS Index and lessons from the COVID-19 pandemic

The 2021 report details how the US "squandered" its world-leading capacities for pandemic response.[2] A key barrier was the lack of confidence in government, for which the US had the lowest possible score in the 2019 GHS Index. This factor has been associated with high numbers of COVID-19 cases and deaths in jurisdictions worldwide. Other gaps that had been identified prior to the pandemic included weaknesses in the US health system, limited access to care without cost barriers, and relatively few healthcare personnel and hospital beds per capita. Also, deficiencies in local capacities and capabilities could undermine national readiness.

When developing the 2021 iteration of the GHS Index, researchers took into account information and thinking about what had mattered most during the response to COVID-19. The result was the inclusion of additional socio-demographic, political, and governance variables; a revised Index with 171 rather than 140 items.

The revised GHS Index 2021

In the 2021 GHS Index, 31 questions have been added to address laboratory strength and quality, supply chains, medical stockpiles, isolation and contact tracing capability, national-level policies and plans, and government effectiveness. The researchers recalculated new "2019" scores using the revised Index and information that was available in 2019. This meant that progress from 2019 to 2021 was able to be assessed. It's important to note that the GHS Index does not give full scores for temporary measures, so COVID-19 responses need to be associated with enduring systems and capacity targeting threats other than COVID-19 to score full marks.

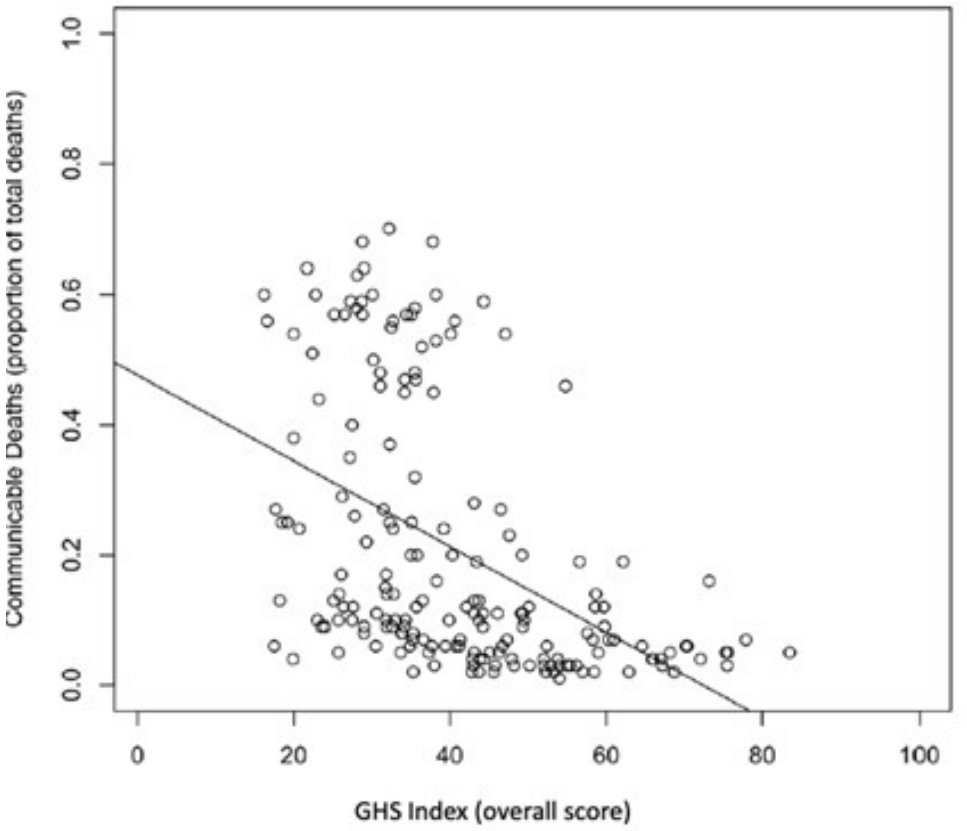
GHS Index 2021 findings

The average country score for 2021 was 38.9 out of a possible 100 points, essentially unchanged from 2019. No country scored above 75.9 and the scores of the bottom 11 nations have all fallen since 2019.[2] Despite evidence of growing capacities, there remain major gaps in the capability to leverage these capacities to prevent, detect and respond to emerging biological threats. The US, for example, failed to turn their substantial capacities into a coordinated response to COVID-19. Improvements in response to the COVID-19 pandemic are frequently only temporary, and should be consolidated into robust systems with enduring finance to raise GHS Index scores. Key findings are summarised below.

Findings for 2021 across the six GHS Index categories[2]

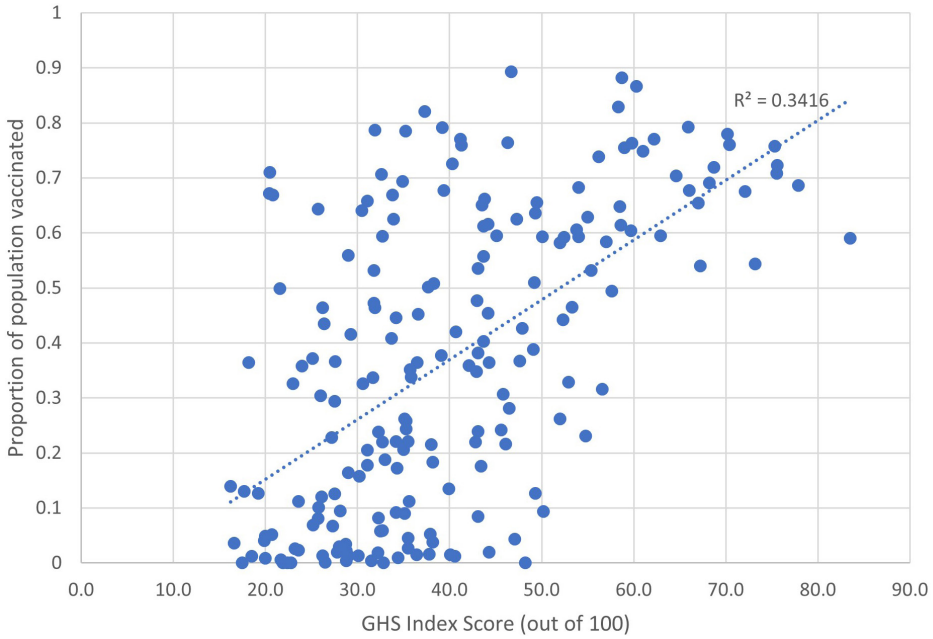
- *Prevention*: This was the lowest scoring category in the GHS Index, in particular most countries direct little attention to zoonotic diseases.
- *Detection and Reporting*: Scores in 2021 reveal major global weaknesses in laboratory systems, laboratory supply chains, real-time surveillance, and reporting.
- *Rapid Response*: Only 69 countries have a national public health emergency response plan in place addressing multiple communicable diseases. COVID-19 has

Figure 2: Communicable disease deaths (proportion of all deaths) and 2019 GHS Index score ($F(3,172)=22.75$, $p<0.0001$).[13]



Source: Authors' published analysis (2020).[13]

Figure 3: Overall GHS Index score 2019[1] and share of total population fully vaccinated against COVID-19 (as at 18 November 2021)[15] (Pearson's r=0.58, p< 0.0001).



Source: Authors' analysis for this viewpoint article.

triggered some gains in non-pharmaceutical interventions planning.
- *Health System*: There has been little progress in health systems since 2019, with the 2021 Index finding that 91% of countries do not have a plan, programme, or guidelines in place for dispensing medical countermeasures.
- *Commitments to Improving National Capacity, Financing, and Global Norms*: Just four of 195 countries have identified funding in national budgets, which is dedicated to addressing gaps identified in their World Health Organization (WHO) Joint External Evaluation (JEE).
- *Risk Environment*: Awareness of risk environment factors, such as orderly transfer of power, social unrest, international tensions, and trust in medical and health advice from the government, is critical because of their large impact on countries' response to a public health threat.

Additional important findings

- Most countries, including high-income nations, have not made dedicated financial investments in strengthening epidemic or pandemic preparedness.
- Most countries saw little or no improvement in maintaining a robust, capable, and accessible health system for outbreak detection and response.
- Political and security risks have increased in nearly all countries, and those with the fewest resources have the highest risk and greatest preparedness gaps.
- Countries are continuing to neglect the preparedness needs of vulnerable populations, exacerbating the impact of health security emergencies.
- Countries are not prepared to prevent globally catastrophic biological events that could cause damage on a larger scale than COVID-19.

GHS Index 2021 recommendations

The 2021 GHS Index report recommends action by countries, international organisations, the private sector and philanthropic organisations.[2] These recommendations are summarised below:

- *Countries*: Should ensure there are national budgets for building and maintaining health security capacities. The GHS Index and JEE evaluations can support development of National Action Plans for Public Health Security (NAPHS). There should be comprehensive after-action COVID-19 pandemic reports.
- *The United Nations (UN), WHO and World Bank*: Should use the GHS Index to identify major weaknesses and where urgent support is needed.
- *Private Sector*: Should use the GHS Index to partner with government to address gaps as well as increase sustainable development and health security R&D portfolios.

New Zealand and the Pacific

In the 2021 GHS Index, New Zealand scores 62.5/100, which is a rise of approximately 10% over 2019 scores, and New Zealand has risen to 13th globally (from 35th). This increase is driven in part by New Zealand's completion of its JEE, and in part by positive developments in health security as part of the COVID-19 response. We caution, however, about too much focus on rankings, and emphasise that the function of the GHS Index is not necessarily to compare countries that may have quite different political or economic parameters, but rather to guide individual countries in assessments and investments in their own capacities.

Where previously we had lamented New Zealand's relatively poor showing in the 2019 GHS Index[3] (including prior to the COVID-19 pandemic[16]), the 2021 report specifically highlights the country as "a case study in progress" (p.44). Stating that, "*Country leaders cited preparedness assessments, specifically the GHS Index, as providing the roadmap and impetus for their exemplary performance during the Covid-19 pandemic.*" This progress is promising, but the gains need to be consolidated, and persisting weaknesses addressed (see Table 1). The GHS assessment is supported by the observation that the elimination strategy adopted by New Zealand in response to an emerging pandemic (COVID-19) appears optimal, at least during the initial phase when vaccines and antivirals are not available.[17]

We had also previously published our concerns about the generally low GHS Index scores of New Zealand's Pacific neighbours.[3] No one expects that the GHS Index score of a country like Tuvalu will ever approach that of the US, but with scores in

Table 1: New Zealand's GHS Index scores and gaps (see the GHS Index online for a full list of indicators: https://www.ghsindex.org/country/new-zealand/).

GHS Index component	New Zealand score 2019* (global rank)	New Zealand score 2021	Comments
Overall score	54.0 (35th)	62.5 (13th)	New Zealand has improved its GHS Index score through the COVID-19 pandemic and greatly improved its global ranking from 2019 to 2021. But there is a long way to go to achieve health security.
Prevent	55.0 (27th)	45.0 (39th)	New Zealand scored poorly on measures to limit zoonotic disease spill-over, on biosecurity, and on dual use research and a culture of responsible science.
Detect	36.7 (107th)	75.3 (5th)	With the addition of items assessing scaling of novel pathogen testing, contact tracing, and laboratory facilities, New Zealand's score for disease detection has risen from 107th to 5th in the world. New Zealand's "epidemiology workforce" now has capacity equal to the best in the world. However, New Zealand is still only 94th on "surveillance data accessibility and transparency".
Respond	58.1 (21st)	50.3 (30th)	Exercising of response plans has risen from zero to 25/100, but there is much room for improvement. There is still inadequate linking of public health and security authorities. Border closures in response to the COVID-19 threat have halved New Zealand's score for travel and trade restrictions. However, this action may be uniquely rational for island nations, especially if it provides time until vaccines can be developed and distributed.
Health	45.2 (32nd)	48.9 (45th)	This component of the GHS Index is largely unchanged for New Zealand between 2019 and 2021.
Norms	59.4 (39th)	77.8 (3rd)	New Zealand is now doing better than almost every other State on compliance with reporting according to the international health regulations, for cross-border agreements, international commitments and national and international financing. More progress could be made by completing a National Action Plan for Health Security (NAPHS).
Risk	77.2 (23rd)	77.7 (17th)	Although scoring relatively highly for the risk environment overall (high is better), New Zealand suffers from risk due to urbanisation, types of land use, extreme weather events, and economic risk due to natural disaster. This places New Zealand at 177/195 for environmental risk that could contribute to health insecurity.

* This is the original score published in 2019. The scores for 2019 were recalculated once the GHS Index framework was modified in 2021.

2019 of around 20 out of 100, many Pacific nations were found to lack fundamental components of health security.

In the 2021 GHS Index, of 22 States scoring below 25/100, eight are island nations and six of these are in the Pacific. Nauru on 18.0 scored the least of the island nations and its score fell since 2019.

The relatively successful response of border closure has provided protection to some Pacific islands from the COVID-19 pandemic—and has given time for vaccination levels to rise. However, border closures cannot be indefinite, and cannot protect islands from a threat that originates within borders. Investment in key aspects of Pacific health security is therefore an ongoing requirement.

Focus on global catastrophic biological risks

The GHS Index report continues to have a focus on biological risks of unprecedented scale, that could have devastating outcomes for the world.[2] These global catastrophic biological risks (GCBRs) could be orders of magnitude worse than the COVID-19 pandemic. The probability of such events is almost certainly rising due to increasing urbanisation and human expansion, declining biodiversity and a changing climate, upticks in travel, trade, and terrorism, and the use of advanced biotechnologies in the absence of strong, normative guidance on responsible science.[18]

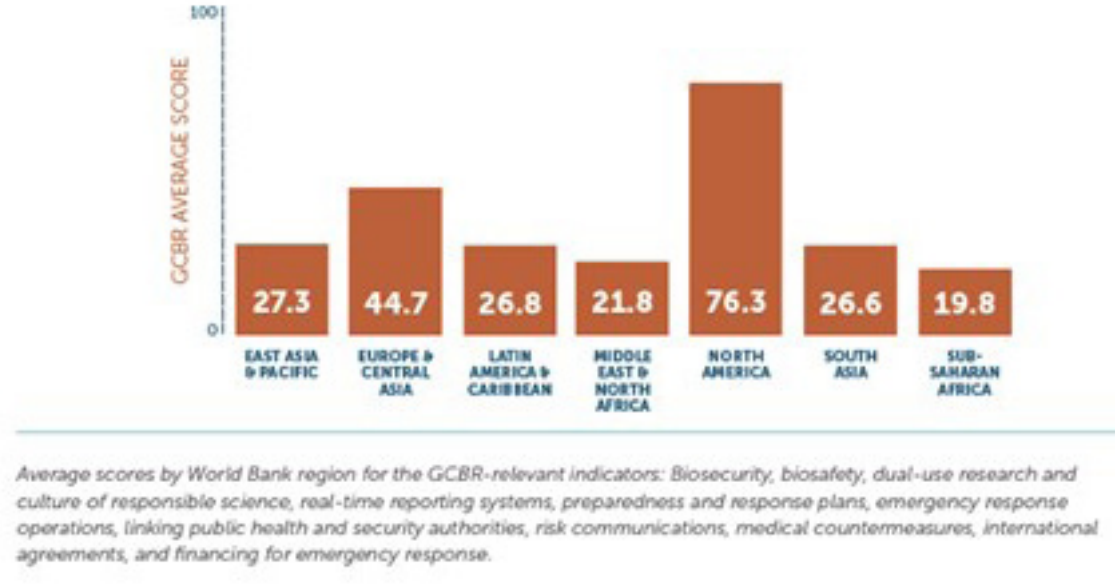
The authors of the GHS Index support the formation of an international body to promote early identification and reduction of GCBRs. The Index itself includes consideration of countries' readiness for GCBRs through 21 sub-indicators, on which the mean global score is only 29.6 out of 100 (see Figure 4). The New Zealand Government may wish to pay particular attention to GCBRs—given that the country is an island,[19,20] and because it scores highly as one of the most favourable ones to survive a pandemic with existential risk potential.[21,22]

Opportunities in New Zealand

New Zealand has the opportunity to focus its continuing large investment in its COVID-19 response on creating legacy benefits that will improve its health security.[23] Unfortunately, current indications are not promising that it will do this. The recently introduced Pae Ora (Healthy Futures) Bill that sets out a major new structure and arrangements for the health system contained very few specific measures to enhance health security.[24] In particular, it fails to specify the kind of independent public health agency needed to reduce the long-term erosion and fragmentation of public health capacity and capability.

Nevertheless, a large funding commitment to the proposed Public Health Agency within New Zealand's Ministry of Health would be a potentially

Figure 4: Global scores on 21 GHS Index items relevant to preparedness for global catastrophic biological risks (GCBRs), with New Zealand in the "East Asia and Pacific" grouping.



Source: Nuclear Threat Initiative 2021 (Creative Commons).[2]

useful step, with a part of this devoted to improving capacity where the GHS Index benchmarks New Zealand as poorly prepared. As a starting point, the items we identify in Table 1 could be addressed. One example is ongoing disease surveillance. Such surveillance for COVID-19 in New Zealand continues to be suboptimal when compared for example to the UK's Office for National Statistics Covid-19 infection survey, although the latter has also now been scaled back.[25] Similarly, New Zealand needs to keep funding its successful genomic sequencing capacity (as used with COVID-19[26]) and its detection of pathogens in wastewater (as also successfully used with COVID-19[27]). Wastewater surveillance for pathogens could even be extended to incoming international aircraft—as evaluated in an Australian setting.[28] It is programmes such as these, and for the prevention, detection and response to future infectious disease threats that are needed.

The new Māori Health Authority is a positive component of the current health reforms, and it could provide an equity lens to health security enhancements. In particular, it could review the experience of the COVID-19 pandemic from a Māori health and wellbeing perspective, and put this in context with how past pandemics have differentially impacted Māori.[29]

Conclusions

The 2021 iteration of the GHS Index provides an updated picture of global health security, with additional emphasis on aspects important through the COVID-19 pandemic. The key finding, again, is that the world remains grossly unprepared for emerging biological threats. That said, there are pockets of improvement, and New Zealand is specifically identified as a country that has bolstered its health security capacity during the pandemic. However, at 62.5/100 there is clearly much more that New Zealand can do to secure protection from future health disaster.

The report emphasises the distinction between capacity and capability. Capacity alone is not enough. Capacities must be exercised and integrated, and governance must be able to ensure they are leveraged when needed. This is capability. Without regular assessments of capacities and capabilities, governments cannot know their levels of preparedness.

A great opportunity exists to develop new capacities and make existing ones more durable, ensuring long-term gains in pandemic preparedness. The GHS Index helps identify important gaps, but, given the course of the COVID-19 pandemic, we may also need assessments that monitor the actual performance of health systems against emerging infectious diseases.

COMPETING INTERESTS
Nil.

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The unexpected benefits of sodium glucose co-transporter 2 (SGLT2) inhibitors

Chok G Chan, Ralph Stewart

ABSTRACT

The sodium glucose co-transporter 2 (SGLT2) inhibitor empagliflozin is currently funded in New Zealand for management of patients with type 2 diabetes who have an HbA1c >53mmol/mol and a high cardiovascular (CV) risk. Large clinical trials now provide strong evidence that SGLT2 inhibitors decrease the risk of cardiovascular death, heart failure, progressive kidney dysfunction, myocardial infarction, stroke and gout. Patients with or without diabetes who have a history of heart failure, including those with a preserved left ventricular ejection fraction and patients with chronic kidney impairment are likely to benefit most from treatment with an SGLT2 inhibitor. These findings make a strong case for extending funding of SGLT2 inhibitors to include patients with heart failure or kidney dysfunction without diabetes, so many more New Zealanders could benefit.

The sodium glucose co-transporter 2 (SGLT2) inhibitors were developed in the 1990s, over a century after an isolate from an apple tree bark was found to be glucosuric. The isolate, phlorizin, was found to inhibit active co-transport of sodium and glucose in the proximal kidney tubules and this was later modified to develop the first orally active SGLT2 inhibitor. The United States Food and Drug Administration approved canagliflozin for management of type 2 diabetes in 2013 after clinical trials confirmed that canagliflozin lowered blood glucose concentrations, reduced body weight, lowered blood pressure, and was safe.[1] Since early 2021 PHARMAC has funded empagliflozin in New Zealand with special authority criteria for patients with diabetes at increased cardiovascular (CV) risk. However, the criteria for using SGLT2 inhibitors now need to be revised because of accumulating evidence from large clinical trials which indicate the benefits of SGLT2 inhibitors go beyond glucose lowering. These include decreasing the risk of heart failure hospitalisation and CV death, improving quality of life in patients with heart failure, decreasing progression of chronic kidney impairment and preventing gout. Remarkably, many of these benefits are similar in patients with and without type 2 diabetes. The mechanisms responsible are currently only partly understood.

Clinical trials showing benefits of SGLT2 inhibitors in heart failure

The first large clinical trials to demonstrate improved clinical outcomes with SGLT2 inhibitors were in patients with type 2 diabetes and increased CV risk.[1–4] In these trials, SGLT2 inhibitors reduced progressive kidney dysfunction and the risk of myocardial infarction, stroke, heart failure hospitalisation and CV death. Because the benefit was greatest for heart failure hospitalisation and CV death, further trials were undertaken in patients with heart failure.

The "DAPA-HF"[5] and "EMPEROR-reduced"[6] trials investigated dapagliflozin and empagliflozin, respectively, in patients with heart failure and reduced left ventricular ejection fraction (<40%) who were also treated with other evidence-based treatments. In a meta-analysis of the two trials, which included 8,474 patients followed for 16 to 18 months, the SGLT2 inhibitors decreased CV death or hospitalisation for heart failure by 25% (p=0.0001) and all-cause mortality by 13% (p=0.018).[7] The "EMPEROR-preserved trial", randomised 5,988 patients with symptoms of heart failure and raised natriuretic peptide levels, but preserved left ventricular ejection fraction (>40%) to empagliflozin or placebo. During a median follow-up of 26 months, hospitalisation for heart failure or cardiovascular death was 21% lower on

empagliflozin (p=<0.001).[8] These trials provided the first clear evidence that medication treatment improved outcomes for patients with heart failure who have preserved, as well as reduced left ventricular ejection fraction. In patients hospitalised for acute heart failure, empagliflozin has also been shown to decrease heart failure exacerbations and improve quality of life during the next 90 days.[9] Favourable effects of SGLT2 inhibitors were evident early in all trials, and were similar for non-diabetic and diabetic patients.

Effects of SGLT2 inhibitors on the risk of cardiovascular death or hospitalisation for heart failure in clinical outcome trials are summarised in Table 1. The absolute benefits from treatment with a SGLT2 inhibitor were much higher for patients with heart failure, in part because heart failure patients have a much higher absolute risk. The risk reduction was similar for diabetic and non-diabetic patients with heart failure. The absolute decrease in CV death or heart failure hospitalisation, chosen for this comparison across trials, is modest, but these outcomes do not capture all the benefits of SGLT2 inhibitors. These include reducing the risk of myocardial infarction and stroke, slowing progression of kidney dysfunction, improving quality of life in patients hospitalised with acute heart failure and halving the risk of gout.[10]

Clinical trials showing benefits of SGLT2 inhibitors in kidney disease

Reduced progression of kidney dysfunction on SGLT2 inhibitors was observed in the early clinical trials which evaluated patients with type 2 diabetes.[1,3] Subsequent trials have shown that SGLT2 inhibitors have a similar benefit on kidney outcomes in patients who do not have diabetes. In the '*Dapagliflozin in patients with chronic kidney disease trial*',[11] 4,304 patients with an estimated glomerular filtration rate (eGFR) of 25–75ml/1.73m^2 and urinary albumin/creatinine 200–5000mg/g, were randomised to dapagliflozin 10mg per day or placebo. After a median follow-up of 2.4 years, doubling of serum creatinine, end stage kidney disease or kidney death were nearly halved on dapagliflozin (HR 0.56, 95%CI 0.45–0.68, p<0.001) and CV death was decreased. Results were similar for patients with and without diabetes. The EMPA-KIDNEY trial was recently stopped early because of clear evidence that empagliflozin decreased progression of chronic kidney disease, CV and kidney-related death. This trial evaluated empagliflozin in more than 6,600 adults with chronic kidney disease from a wide range of causes. Full results are expected in late 2022.[12]

Adverse effects

SGLT2 inhibitors were generally well tolerated in clinical trials. Side effects include a modest increase in urinary and genital infections from glucosuria in patients with diabetes. Although SGLT2 inhibitors do not directly cause hypoglycaemia, the dose of other glucose-lowering medications may need to be decreased. There is a small risk of euglycemic ketoacidosis with starvation, dehydration or intercurrent illness, particularly if the patient is insulin deficiency. To decrease this risk, it is currently recommended that SGLT2 inhibitors are withheld for three days prior to major surgery, or when the patient is unwell, missing meals or dehydrated. The benefits of SGLT2 inhibitors on kidney outcomes occur despite a physiological decrease in eGFR of up to 30% during the first few weeks after starting, which can be exaggerated by diuretic therapy. Usually this does not require cessation of the SGLT2 inhibitor

Comparison of SGLT2 inhibitors with other glucose-lowering medications

The accumulating evidence for benefit with SGLT2 inhibitors contrasts with the relative lack of evidence for improved CV outcomes for metformin, sulphonylureas and gliptins. Despite widespread clinical use, there is no clear evidence that metformin[13] sulphonylureas[14] or gliptins[15] lower CV mortality. In three large trials (16–18) with >23,000 diabetic patients at high CV risk, there was no decrease in CV mortality with more intensive, compared to standard, glucose control using combinations of these medications and insulin, and there was a possible increase in sudden death.[17] The glucagon-like receptor one agonists, which includes dulaglutide, are also funded in New Zealand for diabetic patients who have a high CV risk, reduce the risk of myocardial infarction and stroke; but reduction of CV death and hospitalisation for heart failure were less than for SGLT2 inhibitors.[19] Lowering glucose is important to prevent complications related to microvascular disease and other adverse consequences of hyperglycaemia. However, large clinical trials indicate the benefits and risks of different treatments are not simply related to glucose lowering. Treatment

decisions should, therefore, consider the impact of medications on major adverse CV and kidney events, and mortality.

The need to broaden indications for SGLT2 inhibitors in New Zealand

Changing evidence demands a rethink of clinical practice guidelines and funding criteria. SGLT2 inhibitors are currently funded for treatment of patients with type 2 diabetes who also have a high CV risk. However, international guidelines now recommend SGLT2 inhibitors for prevention and treatment of heart failure and progressive kidney impairment in patients both with and without diabetes.[20,21] This should also be the case in New Zealand.

In patients with type 2 diabetes, special authority requirements related to HbA1c levels and the need to first use other glucose medications should be reconsidered. It is important to consider HbA1c and CV risk, but the most important predictors of benefit are a history of heart failure or kidney dysfunction. It should be possible to start treatment early and in hospital, particularly in patients admitted with decompensated heart failure.

Ensuring access for Māori and Pacific peoples is important because they have a greater burden of ill health and premature death from diabetes, as well as kidney failure, heart failure, stroke, coronary artery disease, and gout.[22,23] It is possible that SGLT2 inhibitors are more beneficial for Māori and Pacific peoples, but more data are needed to confirm this. In secondary analyses from clinical trials, Asian and African American patients had a greater benefit from SLGT2 inhibitors compared to Caucasian patients.[7]

Conclusion

The SGLT2 inhibitors benefit patients with diabetes and increased CV risk, but the absolute benefits are greater for patients with heart failure or chronic kidney impairment, including for patients without diabetes. Funding for SGLT2 inhibitors should reflect this evidence, so these medications can be prescribed for the many more New Zealanders who could benefit.

Table 1: Relative and absolute reductions in cardiovascular death or heart failure hospitalisation in clinical outcome trials on a sodium glucose co-transporter 2 (SGLT2) inhibitor compared to placebo.

Clinical trials stratified by inclusion of patients with diabetes and/or heart failure	CV death or HF / 1,000 patient years		Reduction in CV death or HF hospitalisation / 1,000 patient years	Hazard Ratio (95%CI)
	SGLT2 inhibitor	Placebo		
1. Diabetes, No history of HF				
CANVAS	13.6	15.2	2	0.87 (0.72–1.06)
DECLARE TIMI 58	8.9	10.5	2	0.84 (0.72–0.99)
EMPA REG outcome	15.5	24.9	10	0.63 (0.51–0.78)
				0.79 (0.71–0.88)[+]
2. Diabetes + history of HF				
EMPEROR reduced	162	214	52	0.72 (0.60–0.87)
DAPA HF	132	168	36	0.75 (0.63–0.90)
EMPEROR preserved	75	91	16	0.79 (0.67–0.94)
				0.76 (0.68–0.84)[+]
3. No diabetes + history of HF				
EMPEROR preserved	53	67	14	0.78 (0.64–0.95)
DAPA-HF	87	117	30	0.73 (0.60–0.88)
EMPEROR reduced	130	158	28	0.78 (0.64–0.97)
				0.76 (0.68, 0.85)[+]

Outcomes are reported in clinical trials which compared SGLT2 inhibitors with placebo 1) in patients with type 2 diabetes at increased cardiovascular risk but with no history of heart failure, 2) patients with type 2 diabetes and a history of heart failure and, 3) patients with heart failure (HF) but no diabetes.
The composite outcome of cardiovascular death or heart failure hospitalisation are reported to allow comparison across trials. The risk reductions therefore do not include a reduction in myocardial infarction, stroke or progressive kidney dysfunction also observed with SGT2 inhibitors.
Risk reductions / 1,000 patient years were estimated from the events rates and median follow-up times for each trial and rounded to the nearest whole number.
[+] For each diagnostic group the Hazard ratio (HR) and 95% confidence intervals (95%CI) across trials were calculated using generic inverse variance analysis and a random effects model with Review Manager 5.4.[1–6,8]

COMPETING INTERESTS
Nil.

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Multisystem inflammatory syndrome following mild COVID-19 in an unvaccinated Tongan adult

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ABSTRACT

Multisystem inflammatory syndrome in adults (MIS-A), is a rare post-infectious complication of COVID-19. We describe an illustrative case of MIS-A in an otherwise well, SARS-CoV-2 unvaccinated 25-year-old Tongan man who presented to hospital 30 days after mild COVID-19 illness. We highlight the progression of his illness, including treatment in the Intensive Care Unit (ICU) for cardiogenic shock, and detail temporal evolution of clinical, laboratory and radiographic features of his illness. Clinicians should be alert for possible MIS-A in the weeks after a surge in COVID-19 cases.

Multisystem inflammatory syndrome in adults (MIS-A), is a rare post-infectious complication of COVID-19. Clinicians should be alert for possible MIS-A in the weeks after a surge in COVID-19 cases.

Case report

A 25-year-old, otherwise well, SARS-CoV-2 unvaccinated Tongan male presented to hospital in November 2021 with one day of fever, painful swollen toes, an itchy rash and diarrhoea. He had recently recovered from uncomplicated, confirmed COVID-19 (symptom onset 30 days prior) and had a resolving dry cough. On initial assessment, he was febrile (38.6°C), tachycardic (128bpm), tachypnoiec (26/min), normotensive (119/74mmHg) and had normal oxygen saturation (97% on air). He had an urticarial rash in his left axilla, diffuse erythema and swelling of the dorsal left foot and toes, and dactylitis of the left third finger. The examination was otherwise unremarkable. Initial investigations included a CRP of 98mg/L, neutrophilia of $9.5x10^9$/L, abnormal liver function tests, negative nasopharyngeal SARS-CoV-2 PCR and normal chest X-ray (see Table 2).

Over 48 hours his dactylitis and rash resolved; however, his fevers and inflammatory markers worsened. Further investigations were requested (Table 2) and empiric antibiotics initiated (Table 1). Infectious disease consultation identified conjunctival injection and cracked lips, concerning for possible MIS-A. Initial transthoracic echocardiogram (TTE) was normal. Rheumatology, cardiology and respiratory reviews supported probable MIS-A.

He started treatment with oral prednisone. This was associated with a temporary reduction in inflammatory response, before fever relapsed with tachycardia (130bpm), tachypnoea (30/min) and rising inflammatory and cardiac biomarkers (Tables 1 & 2). He was treated with intravenous immunoglobulin (IVIG), IV methylprednisone, IV ceftriaxone with IV clindamycin (for possible sepsis and toxic shock syndrome) and aspirin (due to reports of MIS-A-associated coronary artery aneurysm). Despite treatment he continued to deteriorate and on day 6 of illness developed cardiogenic shock with pulmonary oedema, requiring mechanical ventilation and inotropic support. A second TTE demonstrated acute severe biventricular dysfunction.

In association with continued glucocorticoid therapy, he recovered over the ensuing 10 days. Evaluation for alternative diagnoses was unrevealing (Table 2). Cardiac MRI on day 17 of illness showed normalised left ventricular function, with changes suggestive of acute myocarditis. CT coronary angiography did not demonstrate coronary artery aneurysm. He was discharged with a reducing dose of prednisone (10mg/week for 4 weeks) and remained well at follow-up two months later.

Discussion

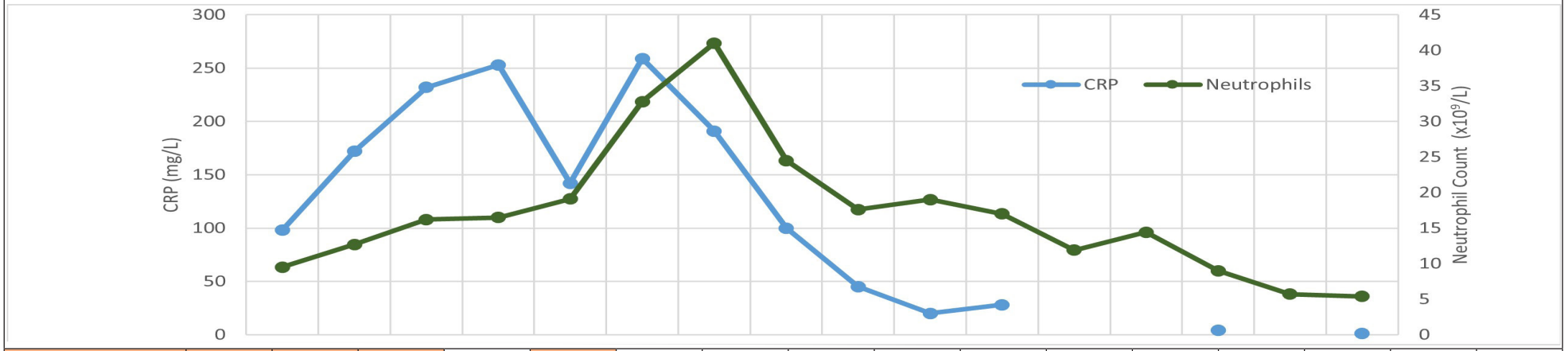
This illustrative case of MIS-A is the first described in New Zealand. MIS-A is a rare, post-infectious complication of COVID-19.[1,2] Diagnosing MIS-A can be challenging, as the preceding COVID-19 illness may be mild or asymptomatic, and symptoms at presentation are non-specific (including fever, rash and gastrointestinal symptoms).[3,4]

Investigations typically reveal markedly raised inflammatory markers and evidence of organ dysfunction. Cardiac involvement with reduced left ventricular ejection fraction is common, with evidence of myocarditis on cardiac MRI.[2,5,6] Coronary artery aneurysms have been described.[7] The CDC diagnostic criteria summarise these features and emphasise the importance of excluding other infectious and inflammatory diagnoses (Table 3).[8] Discussion with a multidisciplinary specialist group is recommended.

Treatment of MIS-A is extrapolated from paediatric experience of MIS-C (multisystem inflammatory syndrome of children), for which treatment with glucocorticoids and/or IVIG is recommended.[9] With aggressive treatment including ICU support, the prognosis of MIS-A appears reasonable, with a survival rate of 93%.[2]

Importantly, SARS-CoV-2 vaccination is likely to significantly reduce the risk of MIS-C.[10] Therefore, New Zealand might experience a lower burden of MIS-A and MIS-C than seen in pre-vaccine cohorts. Nevertheless, it is important that New Zealand clinicians are aware of these potentially life-threatening syndromes, as further cases are possible in the 2–5 weeks following a surge in community COVID-19 transmission (as has occurred in March 2022).[2,9]

Table 1: Summary of clinical and biochemical markers of systemic inflammatory response and treatment received by day of illness.



Day of illness	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Fever (max/d, degrees Celsius)	38.6	38.6	40.8	Nil	40.2	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Ferritin (ug/L)		957	974			6,554	18,416	5,978			1,643			1,758		
hs Troponin I (ng/L)			12		24	83	136			43	32					
Procalcitonin (ug/L)		0.31			2.6	1.5										
Prednisone PO (mg/day)				60								40	40	40	40	40
IVIG (g/d)					81											
Methylprednisone IV (mg/d)					500	500	500	500	500	500	500					
Aspirin PO (mg/d)					100	100	100	100	100	100	100	100	100	100	100	100
Enoxaparin SC (mg/d)		40	60	60	60	60	60	60	60	60	60	60	60	60	60	60

Table 1 (continued): Summary of clinical and biochemical markers of systemic inflammatory response and treatment received by day of illness.

Day of illness	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Ceftriaxone (g/d)		2	2	2	2	2	2	2	2	2	2					
Clindamycin (mg/d)					1,350	1,350	1,350	1,350	1,350	1,350	1,350					
Azithromycin (mg/d)						500	500	500	500	500	500					
Cilazapril (mg/d)												0.5				
Candesartan (mg/d)													4	4	4	8
Omeprazole (mg/d)				40	40	40	40	40	40	40	40	40	40	40	40	40
Inotropic support																
Mechanical ventilation																

Hospitalisation occurred late on day 1 of illness. Features are grouped by colour in shaded boxes: markers of systemic inflammatory response (orange), immune modulating therapy (blue), other medical therapies received (yellow) and organ support in intensive care (grey). Fever is defined as >38.0 degrees Celsius. Weight was 127kg. For investigations, numbers refer to result measured on that day of illness. For therapeutics, numbers in boxes refer to total 24-hour dose of medication received.

Table 2: Results of other relevant investigations.

Investigations for infections	
SARS-CoV-2 PCR (nasopharyngeal swab)	Negative
SARS-CoV-2 anti-spike antibody	>250 U/mL (<0.8U/mL)
SARS-CoV-2 anti-nucleocapsid antibody	Detected
Peripheral blood culture (x9)	No growth
Midstream urine	1 white cell x106/L, 1 red cell x106/L,1 epithelial cell x106/L, nitrite negative, culture negative
Pneumococcal urinary antigen	Negative
N. meningitidis DNA whole blood	Not detected
Streptococcal serology*	
Streptolysin 0 Ab	205kIU/L
Strep DNAse B Ab	>720kIU/L
C. difficile stool antigen (GDH) + toxin	Negative
Atypical pathogens PCR panel (tracheal aspirate)	
Mycoplasma pneumonia	Not detected
Chlamydophila pneumoniae	Not detected
Chlamydophila psittaci	Not detected
Legionella pneumophila	Not detected
Legionalla longbeachae	Not detected
Pneumocystis jiroveci	Not detected
Respiratory pathogens PCR panel (tracheal aspirate)	
Influenza A	Not detected
Influenza B	Not detected
Respiratory syncytial virus	Not detected
Rhinovirus/Enterovirus	Not detected
Parainfluenza virus 1–4	Not detected
Adenovirus types 1–8	Not detected
Human Metapneumovirus	Not detected
Bordetella pertussis	Not detected
Mycoplasma pneumoniae	Not detected
Epstein-Barr virus serology	IgG positive, IgM negative
EBV viral load	2.53 logIU/mL
Cytomegalovirus serology	IgG positive, IgM negative
CMV viral load	Not detected
Adenovirus DNA (plasma)	Not detected
Hepatitis A IgM	Negative

Table 2 (continued): Results of other relevant investigations.

Investigations for infections	
Hepatitis B surface antigen	Negative
Hepatitis B surface antibody	15IU/L
Hepatitis B core antibody	Negative
Hepatitis C antibody	Negative
HIV antibody/antigen screen	Negative
Serum treponemal screen	Non-reactive
Strongyloides IgG EIA ratio	0.61 (Negative)
Investigations for auto-immune conditions	
ANCA (p-ANCA and C-ANCA)	Negative
MPO antibodies	<3.2CU
PR-3 antibodies	<2.3CU
ANA titre	Not requested
ENA antibody screen	Negative
Rheumatoid factor	<10kIU/L
Anti CCP IgG	<4.6CU
C3	1.9g/L
C4	0.8g/L
IgG	15.2g/L
IgA	3.8g/L
IgM	1.3g/L
Parietal cell Ab titre	<80
Smooth muscle Ab titre	<80
Mitochondrial Ab titre	<80
Other investigations on admission (and most abnormal)	
Haemoglobin	131g/L (113 g/L)
Platelet count (highest)	261x109/L (476 x 109 /L)
Lymphocyte count (lowest)	1.6x109/L (0.5 x109/L)
APTT	56 seconds (61 seconds)
Prothrombin ratio	1.0 (1.3)
Fibrinogen (maximum)	7.6g/L (>9.0g/L)
LDH	339U/L (759U/L)

Table 2 (continued): Results of other relevant investigations.

Investigations for infections	
Albumin	30g/L (17g/L)
ALT	139 (303)
AST	67U/L (67U/L)
GGT	283U/L (283U/L)
ALP	282U/L (339U/L)
Bilirubin	20umol/L (45U/L)
NT-ProBNP	14pmol/L (1233 pmol/L)
HbA1c	50mmol/mol
TSH	0.6mU/L
Cholesterol (total)	4.0mmol/L
Triglycerides	1.5mmol/L
Summary of relevant radiology findings	
Chest X-ray (on admission)	Normal
Left foot X-ray (on admission)	Normal
High-resolution CT chest and CT pulmonary angiogram (day 4 of illness)	No pulmonary embolism Patchy diffuse, centrilobular and peribronchial ground glass opacification throughout lung fields. Trivial post-COVID-19 reparative fibrosis in right basolateral lobe
Cardiac MRI (day 17 of illness)	Normal LV size and function (LVEF 63%) Mild-moderate concentric LV hypertrophy Increased signal on “oedema” weighted black blood, T 1 mapping and late gadolinium contrast, most consistent with acute myocarditis
CT Coronary angiogram (after discharge)	No coronary aneurysms seen

*Streptococcal serology was positive, however without a clinical correlate: assessed to be of uncertain significance after Microbiology and Infectious Diseases specialist review.

Table 3: Centre for disease control: multisystem inflammatory syndrome in adults (MIS-A) case definition information for healthcare providers.[8]

A patient aged ≥21 years hospitalized for ≥24 hours, or with an illness resulting in death, who meets the following clinical and laboratory criteria. The patient should not have a more likely alternative diagnosis for the illness (e.g., bacterial sepsis, exacerbation of a chronic medical condition).	
Clinical criteria	Subjective fever or documented fever (≥38.0 C) for ≥24 hours prior to hospitalization or within the first THREE days of hospitalization* and at least THREE of the following clinical criteria occurring prior to hospitalization or within the first THREE days of hospitalization.* At least ONE must be a primary clinical criterion. Primary clinical criteria Severe cardiac illness *Includes myocarditis, pericarditis, coronary artery dilatation/aneurysm, or new-onset right or left ventricular dysfunction (LVEF<50%), 2nd/3rd degree A-V block, or ventricular tachycardia. (Note: cardiac arrest alone does not meet this criterion)* Rash AND non-purulent conjunctivitis Secondary clinical criteria New-onset neurologic signs and symptoms *Includes encephalopathy in a patient without prior cognitive impairment, seizures, meningeal signs, or peripheral neuropathy (including Guillain-Barré syndrome)* Shock or hypotension not attributable to medical therapy (e.g., sedation, renal replacement therapy) Abdominal pain, vomiting, or diarrhea Thrombocytopenia (platelet count <150,000/ microliter)
Laboratory evidence	The presence of laboratory evidence of inflammation AND SARS-CoV-2 infection. Elevated levels of at least TWO of the following: C-reactive protein, ferritin, IL-6, erythrocyte sedimentation rate, procalcitonin A positive SARS-CoV-2 test for current or recent infection by RT-PCR, serology, or antigen detection

NOTE: *These criteria must be met by the end of hospital day 3, where the date of hospital admission is hospital day 0.

COMPETING INTERESTS
Nil.

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Just because you can…does not mean you should: an examination of efficacy and potential harms from non-prescribed supplements taken by members of the Christchurch Health and Development Study at age 40

Geraldine FH McLeod, Anna Fenton, Bryony Manning, Andrea Insch, Joseph M Boden

The development and sale of non-prescribed dietary supplements is a growing industry. According to Euromonitor (2020)[1] the value of global retail sales of non-prescribed supplements increased by 105% between 2007 and 2021. New Zealand's market grew by 72% during the same period from NZ$194.8 million to NZ$335.5 million. Global demand for supplements such as vitamins C and D, minerals and herbal supplements increased as the COVID-19 pandemic has worsened despite, in most cases, no scientific evidence that their consumption can directly combat SARS CoV-2.[2]

While multivitamin supplementation is useful for pregnant people, vegans, older people, post-bariatric surgery[3,4] or during extremely stressful circumstances,[5] meeting nutrient intakes through diet rather than supplementation is preferable.[6] Non-clinical populations derive little benefit from using supplements and in extreme cases there is potential for interactions between products, toxicity due to chronic high dosages or financial hardship due cost.[7,8] Further, there is no specific legislation governing natural health products in New Zealand.[9] In this study, we examine self-reported use of non-prescribed supplements among birth cohort of individuals at age 40.

Methods

Participants

Participants were members of the Christchurch Health and Development Study (CHDS). The CHDS is a study of 1,265 children (630 females) born in Christchurch in 1977. This cohort has been studied regularly from birth to age 40 using a combination of interviews with parents and participants, standardised testing, teacher report and official record data.[10] The age 40 assessment of n=904 participants (472 female) represented 74.1% of the surviving cohort. All phases of the study were subject to ethical approval by the Regional Health and Disabilities Ethics Committee.

Measures

Biological sex

Biological sex of the participant was recorded at birth.

Non-prescribed medicines

At age 40, participants reported details of any non-prescribed medications or dietary supplements they were currently taking on a regular basis. Information gathered included the product name or type of product(s) and reason for use. Products were categorised according to Australian Food, Supplement and Nutrient Database (AUSNUT) 2011–2013.[11]

Prescribed medicines

At age 40, participants reported details of any prescribed medicines for physical or mental health problems used on a regular basis. Information gathered included the product name or type of product(s), reason for use, and dose of the product(s). This information was used to assess possible interactions between prescribed medicines and dietary supplements.

Analysis

Non-prescribed supplements were tabulated by sex of the participant. A Chi-squared test of independence and an independent samples t-test were used to assess if there were statistically significant differences between the proportion of males and females using supplements and the

number of supplements taken. Hand-searching of the New Zealand Formulary (NZF)[12] identified supplements that may cause interactions with prescribed medications. Efficacy and dose-checking used National Institutes of Health Dietary Supplement Fact Sheets.[3]

Results

At age 40, more than one third (36.4%; 329/904) of participants reported using a supplement. Nearly half (47.1%; 155/329) of them were also using prescription medication. More females took supplements than males (61.4%; (202/329) vs 38.6%; (130/329), χ^2 (1, N=904)=17.492, p<.01). The highest number of supplements taken was nine for females and seven for males. On average, females also took more supplements than males (female mean (SD) 1.04 (1.27); male mean (SD) 0.93 (1.14)); however, no statistically significant difference was found (t(590)=-1.12, p=0.26). Of the 626 products taken, the most commonly consumed were vitamins and minerals (60.7%; n=243); non-nutritive products (12.5%; n=78) (probiotics, coenzyme Q10, and bee products); oil supplements (9.6%; n=60); herbal botanical/homeopathic supplements (9.6%; n=60); nutritive products (fibre, protein, amino acids); (3.5%; n=22); remainder was unspecified.

Analysis showed 11.9% (39/329) of participants took products with insufficient evidence of therapeutic effects e.g., turmeric/curcumin for "IBS and joints"; evening primrose oil for "anti-inflammatory" reasons; spirulina for "gut health". In addition, 30.4% (100/329) of participants were taking supplements with no evidence of efficacy for the reason it was being consumed e.g., magnesium for "sleep"; fish oil for "allergies"; vitamin C for "immunity".

Ten of the 329 participants taking supplements were exposed to potential interactions. Six identified interactions were of moderate severity:[12] levothyroxine and magnesium (three participants); iron and zinc (two participants); levothyroxine and iron (one participant). In all cases, these combinations can cause reduced bioavailability of both products.[12] In addition potential interactions were identified for three participants: zopiclone and melatonin (risk of additive depressant effects on the central nervous system); warfarin and niacinamide (risk of increased prothrombin times) which have theoretical evidence of moderate severity); metformin and glucosamine (risk was increased blood glucose concentrations in patients with diabetes from case report with evidence of mild severity). Few participants reported the dosage of their non-prescribed products as collection of this information was not in the interview schedule. However, one participant reported taking 500mg of magnesium per day (tolerable upper level estimated is 350mg), while another participant was consuming 500mg vit C, above the Recommended Dietary Allowance (RDA) of 75mg.[3]

Discussion

In their analysis of trends in the vitamin and dietary supplements market, Pricewaterhouse-Coopers (PWC) predict that sales of supplements will continue to increase due to consumer awareness of purported benefits of nutraceutical products.[2] This study reports the supplementation practices of CHDS participants, showed that more than one third of participants took supplements. Participants potentially exposed themselves to interaction effects by combining prescribed and non-prescribed products; some were also taking excessive doses. Many of the non-prescribed products lacked efficacy for treating the stated health problem. The CHDS cohort was aged 40 years at the time of this study; as the population ages and it will be important to regularly reassess use of both prescribed and non-prescribed products as supplement use will likely increase.

Limitations include how reports may be subject to recall problems, or that participants may not report use of common products such as paracetamol because of how they interpreted the interview questions (e.g., "regular" use). It is also possible that products taken in non-oral forms may be under-reported. Multivitamins were unable to be assessed for efficacy or potential interactions as their specific formulations were not known. Finally, duration and dosage of supplementation was not assessed limiting assessment of harmful exposures. A strength of the study is that the participants have often been interviewed during adulthood, reporting on many sensitive and personal issues including medical conditions. Therefore, it is unlikely that reported prescribed and non-prescribed products will differ substantially from actual use.

In conclusion, clinicians should encourage patients to use diet to attain nutrition. Clinicians should also encourage information sharing of supplement consumption by their patients. A large proportion of patients used supplements and there is potential for interactions with prescription medication or for symptoms of excess consumption. Often, non-prescribed products are a waste of money offering no health benefit.

COMPETING INTERESTS
Nil.

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A quality improvement project to improve access to stroke clot retrieval from a regional stroke centre

Karim M Mahawish, Muir Wallace

Stroke clot retrieval (SCR) in patients with large vessel occlusion (LVO) is associated with significantly reduced disability at 90 days compared with intravenous thrombolysis alone.[1] The effectiveness of these reperfusion therapies is time critical. In Aotearoa New Zealand, SCR candidates require urgent transfer to one of three centres: Capital & Coast, Te Toka Tumai Auckland or Waitaha Canterbury.

Te Pae Hauora o Ruahine o Tararua, MidCentral serves a population of 186,190 and admits approximately 360 patients with stroke per annum. It provides a 24/7 thrombolysis service and SCR has been provided by Capital & Coast since 2019 via a regional telestroke network. At time of writing, MidCentral did not have perfusion imaging and so based on available evidence, the treatment window for SCR was limited to six hours from stroke onset. Inter-hospital transfer services for MidCentral were provided by the Capital & Coast retrieval team. An audit of patients referred for SCR undertaken in 2020 demonstrated a door-in-door-out (DIDO) time of approximately four hours. This delay limited the number of patients eligible for treatment.

A Search and Rescue Services (SRSL) helicopter is located on Palmerston North Hospital grounds, however, historically its role was limited to pre-hospital care. Use of the SRSL service could potentially reduce inter-hospital transfer times by at least half, and thus improve SCR accessibility. Here we describe a quality improvement collaboration with SRSL utilising the Taranaki model[2] for SCR: In summary, this involves pre-hospital alert, notification to the stroke team, standardised imaging protocol and rapid image transfer, and activation of the helicopter transfer team once LVO is confirmed prior to acceptance by the SCR neurologist.

The purpose of this report is to describe; the tailored application of the Taranaki model at MidCentral, the cohort of patients referred for SCR to date, and ongoing challenges and opportunities.

We considered a rapid improvement in inter-hospital transfer times to be necessary to achieve best patient outcomes. Factors considered most likely to help achieve this goal included: 1) having a narrow, well defined patient population, e.g., including patients with anterior circulation LVO who met SCR criteria and excluding patients with basilar artery occlusion who are at risk of airway compromise and therefore may require the skill set of specialist retrieval services;[3] 2) engaging with essential stakeholders; and 3) having a compelling business case.

By 2020, the changes brought in by the National Air Ambulance Sector Reforms required SRSL to have dedicated Critical Care Flight Paramedics. Further, SRSL were willing and able to provide an independent inter-hospital transfer service for time critical patients from hospitals.

Methods

Following a series of discussions and meetings with clinical and service managers, duty nurse managers, SRSL and members of the stroke team, pathways were developed and widely disseminated, and education and training provided. Direct contact numbers for SRSL are displayed prominently in pathways. In August 2020, SRSL started assisting MidCentral with SCR transfers.

For this report, we used a prospective hospital thrombectomy registry with information on demographics, national institutes of health score (NIHSS) at baseline and at 24 hours (scale from 0–42, higher numbers reflecting greater impairment), thrombolysis status and DIDO times. Other data included 90-day functional outcomes using the ordinal modified Rankin Scale, whereby 0–2 represents functional independence, 3–5 progressively increasing dependency, and 6–death. We analysed patients transferred prior (April 2019 to August 2020) and after implementation of the SRSL service (August 2020 to March 2022).

Continuous and categorical variables are presented as mean (SD) or median (IQR) and frequencies. Continuous data were tested using t-test (normally distributed) or Wilcoxon Rank-Sum Test for non-parametric data. Fisher's exact test was used for categorical data. The relatively small numbers precluded regression analysis. A p-value

of ≤0.05 was considered statistically significant. This project was exempt from ethics approval following institutional review. This manuscript was written in accordance with SQUIRE guidelines.[4] Data were analysed using STATA/BE 17.

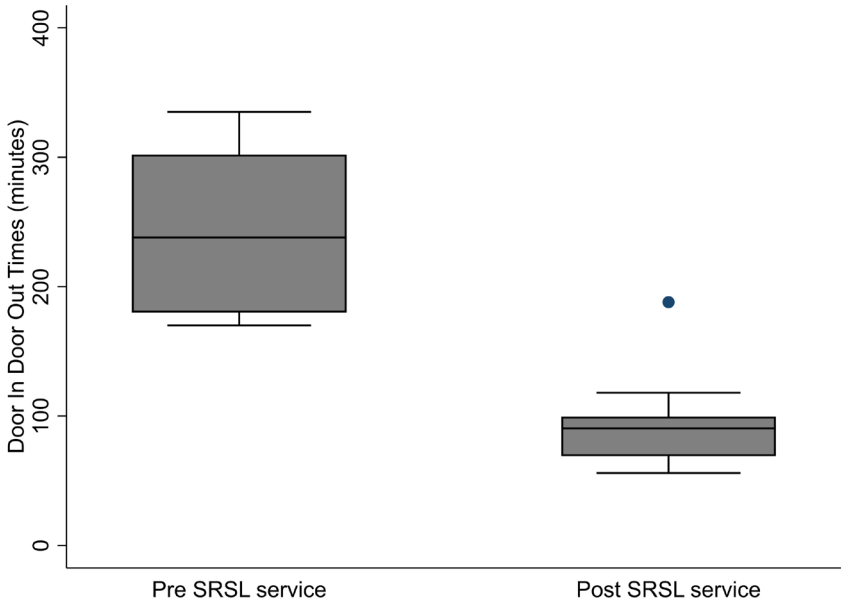
Results

Twenty-four patients (13 female), median age 68.5 years (IQR: 52.5 to 77.5), four NZ Māori and the remainder NZ European, were referred for SCR: Auckland n=3; Canterbury n=1 (during Auckland Level 4 lockdown), and the remainder to Capital & Coast. Seventy-nine percent of patients also received thrombolysis.

Pre SRSL service, eight patients had been transferred, and 16 patient post. With SRSL, DIDO times reduced from 242 to 90.5 minutes (IQR: 69 to 99.5), difference -151.5 minutes [95%CI -109 to -194, p<0.001], (see Figure 1). As an example, our first SCR patient under the SRSL service with an initial NIHSS of 22 had a DIDO time of 64 minutes. The following day post SCR, NIHSS was 2.

Door to groin puncture time reduced from 350 to 197 minutes, difference -153 minutes [95%CI -56 to -251, p<0.01]. The mean admission NIHSS was 14(6), reducing to 7(6) at 24 hours. At three months, 55% of patients were functionally independent and 17% had died. There were no significant differences in the NIHSS change at 24 hours, or proportion of patients at three months, with functional independence pre and post SRSL (p-values >0.05). Proportionally, more patients were sent for SCR following the intervention, though this did not reach statistical significance (OR 1.99 [95%CI 0.83 to 4.75], p=0.14).

Figure 1: Door-in-door-out times.



Discussion

Use of SRSL aeromedical inter-hospital transfer resulted in significant reductions (2.5 hours) in door-in-door-out times and a twofold increase in the numbers able to access stroke clot retrieval. At three months, over half of these patients were functionally independent.

There was no significant difference in outcomes between patients transferred pre and post SRSL. A recent observational study found no difference in outcomes following SCR in patients transferred from Taranaki by air, to patients from Counties Manukau/Waitematā transferred by road, despite a mean 77-minute delay in door to groin time.[5] This suggests that equitable outcomes are possible for regional New Zealand, and as in MidCentral, a national drive to reduce transfer times would increase the cohort of patients who could potentially benefit from SCR.

Strengths of this project are the cost-neutral, simple, intuitive approach. Our patient outcomes are comparable to results from other studies, suggesting appropriate patient selection and use of resources. Finally, we demonstrate generalisability of the Taranaki SCR model. This project has been well received by staff and has encouraged other specialties to consider SRSL for time critical transfers.

Ongoing challenges include the need for frequent reminders and education to the wider hospital staff. In particular, we note increased DIDO times outside normal working hours.

Limitations of this study are the low patient numbers and incomplete data on co-morbidities, which limits our ability to draw further inferences.

COMPETING INTERESTS
KM reports no conflict of interest.
MW is paid by SRSL in his role of Medical Director.

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Trends in the characteristics, service provision and outcomes of patients with stroke from 2013 to 2021 at a regional stroke centre

Karim M Mahawish

The care of stroke patients has revolutionised over the last decade, facilitated by national improvement programs and Ministry of Health targets. The 30-year period ending 2012 saw a 65% reduction in stroke fatality rates in Auckland, Aotearoa New Zealand—as of 2012, 28 day stroke mortality rates were 18.8%.[1] At the service level, admission to stroke units, routine assessment for dysphagia, interdisciplinary team work, higher ratios of nursing staff to patients and stroke unit accreditation are all associated with improved outcomes.[2–7] At the individual level, a number of trials have demonstrated improved outcomes with thrombolysis, thrombectomy and early aggressive antithrombotic therapy, among others.[2,8] The Ministry of Health in New Zealand stipulate a number of quality metrics ranging from the need for medical and nursing specialists, targets for thrombolysis rates (6% of all ischaemic strokes in 2012 rising to 12% in 2021), and a requirement for 80% of all patients to be admitted under an organised stroke service.

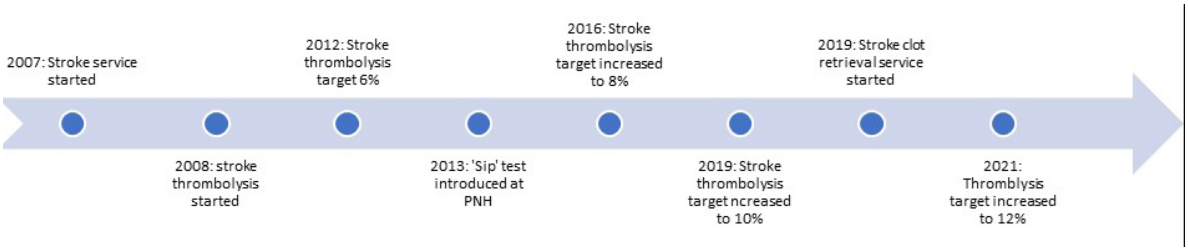
There is a paucity of data on more recent stroke outcomes in New Zealand. Here, we describe stroke admission trends at Palmerston North (PNH) Hospital from 2013 to 2021. Figure 1 illustrates the sequence of service improvements undertaken at PNH.

A number of stroke service delivery models evolved sequentially over the period. Between 2013–2018, neurologists would consult on stroke patients and provide advice, with care overseen by a number of general physicians; thrombolysed patients would remain under the care of a neurologist. From July 2018 to March 2019, patients were admitted under a stroke team led by a general physician with an interest in stroke. Finally, from April 2019 to December 2021, all stroke patients were admitted under the care of a stroke physician. PNH has a five bedded stroke unit.

Data on patient factors (e.g., demographics, ethnicity, inpatient deaths) and service level metrics (e.g., numbers admitted to the stroke service, thrombolysis rates) are routinely recorded for all stroke admissions at PNH and submitted quarterly to the Ministry of Health. These data were used to determine trends for stroke admissions and outcomes between 2013–2021 and look for associations with a focus on the medical management of stroke. There is no routinely collected data on nursing or allied health input in these reports.

Grouped variables are presented as means (±SD) for normally distributed or medians (IQR) for non-normally distributed data. Categorical variables are presented as absolute numbers and frequencies. We used Chi-squared or Fisher's exact to compare categorical data collected in 2013 and 2021, as appropriate. Since data were collected quarterly, we assessed associations using a logistic regression approach for grouped data. Only 1.6% of the data were missing (con-

Figure 1: Timeline of acute stroke service improvements at Palmerston North Hospital.



sidered missing at random); we used complete case analysis in this study. This project made use of routinely collected, deidentified patient-level data, and therefore was exempt from requiring ethical approval. All statistical analysis was performed using STATA BE/17.

Between April 2013 and December 2021, PNH had 2,448 stroke admissions of whom 324 (13%) identified as New Zealand Māori and 69 (3%) as Pacific Island ethnicity. Over the approximately nine-year period, hospital-based stroke incidence rates increased from 148/100,000 to 200/100,000 per year, a relative increase of 35% [95%CI 14%–59%]; p<0.001. 251 (10%) had a haemorrhagic stroke and a median of 12% (8–16) of all patients admitted with ischaemic stroke received thrombolysis.

Over the observed period, there were significant increases in the proportion of stroke patients admitted under the stroke service (22% [95%CI 15%–29%]; p<0.001, Figure 2) and proportion receiving thrombolysis (7% [95%CI 2%–12%]; p<0.05, Figure 3). There was a 13% [95%CI 7%–18%; p<0.001] reduction in in-hospital mortality, Figure 4. The proportion of patients aged over 65, and haemorrhagic strokes, remained stable over the period. Similarly, the proportion of patients of Māori or Pacific Island ethnicity remained stable. Summary data are displayed in Table 1.

A univariate analysis of predictors of in-hospital death (e.g., proportion admitted to a stroke unit, proportion thrombosed, etc.), identified only stroke clot retrieval (OR 0.78 [95%CI 0.68–0.89]; p<0.001) and inpatient care delivered by a stroke physician (OR 0.52 [95%CI 0.38–0.70]; p<0.001) were associated with significantly reduced mortality. There were no significant associations when these factors were used in a bivariate model. McFadden's pseudo R^2 was 0.013, suggesting that there are many other factors responsible for the reduced mortality.

Discussion

This study demonstrates significant increases in stroke admissions over the observed period, with more patients being looked after by an organised stroke service and receiving thrombolysis. A recent paper on stroke volumes in Aotearoa New Zealand projected a 40% increase between 2015 to 2028, with a 36% increase at PNH.[9] According to our data, this increase has occurred approximately four years early than anticipated. There was a significant reduction in mortality rates despite the proportion of stroke patients aged over 65 remaining stable. In the univariate model, factors associated with reduced mortality included stroke clot retrieval and inpatient care delivered by a stroke physician; however, these factors accounted for a small fraction of the overall mortality reduction. A recent meta-analysis assessing different models of organised inpatient stroke care found mobile stroke teams, defined as peripatetic teams looking after people with stroke across a range of wards, was not associated with a reduction in mortality or poor functional outcome.[10] There is an Aotearoa New Zealand strategy underway to improve access to endovascular clot retrieval.[11]

Table 1: Summary data of baseline characteristics and outcomes in 2013 and 2021.

Variable	2013 Patient cohort (%) n=235	2021 Patient cohort (%) n=355	*P* value
Ethnicity			
Māori	23 (9.8)	35 (9.9)	0.98
Pacific Island	7 (3.0)	9 (2.5)	0.8
Haemorrhagic strokes	35 (13.7)	35 (9.9)	0.06
Age >65	175 (75)	270 (76)	0.39
Stroke clot retrieval	0 (0)	11/320 (3.4)	<0.01
Thrombolysis	19/200 (9.5)	52/320 (16.3)	<0.05
In-hospital deaths	46 (18)	19 (5.4)	<0.001
Stroke service admissions	165 (65)	307 (87)	<0.001

Figure 2: Proportion of stroke patients admitted under the stroke service.

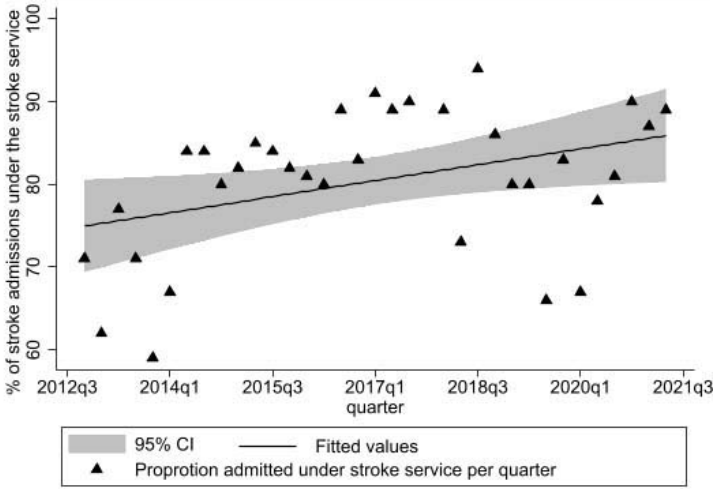


Figure 3: Proportion of all ischaemic strokes treated with thrombolysis.

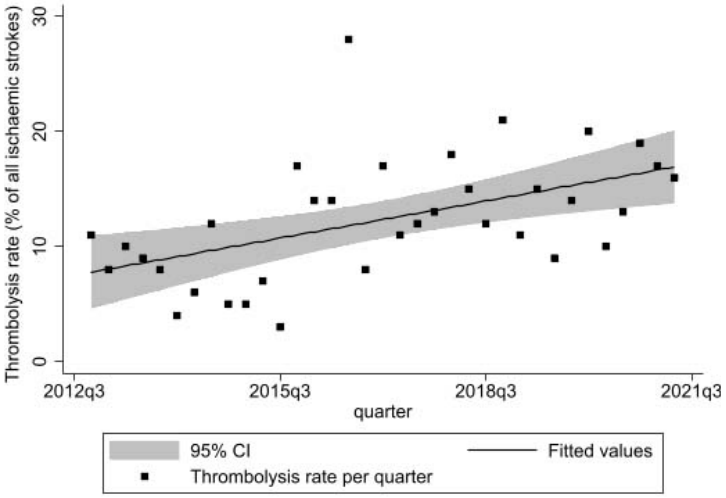
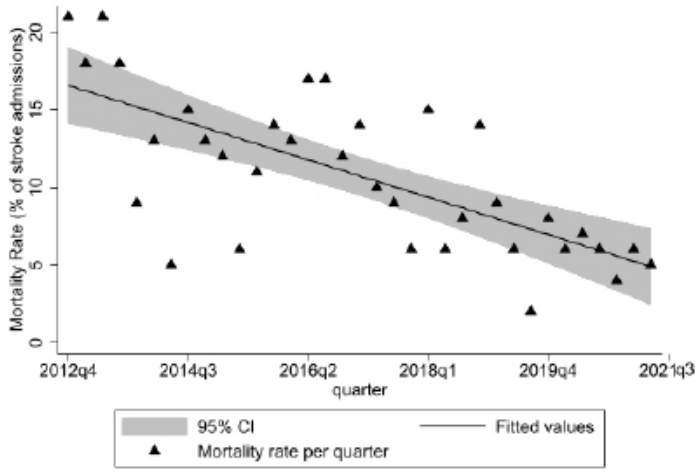


Figure 4: Time trend of in-hospital mortality rates between 2013 and 2021.



This trajectory of stroke volume will have significant implications on health and societal resources. More concerted action is needed on the addressing the causes of stroke and providing appropriate emergency care when it arises. Leadership, education and collaborative workings across services (i.e., public health services, primary care, emergency departments, radiology, and ambulance and aeromedical services) and effective interdisciplinary care in hospital are essential to meet this demand.

There are a number of limitations to this study. It is a single-centre observational study, and therefore findings may not be generalisable. A small number of stroke patients were discharged from the emergency department. There are likely to have been a number of unknown or unmeasured confounders (e.g., co-morbidities, baseline stroke severity, temporal service changes, timing of swallowing assessment, venous thromboembolism prophylaxis, timing of antiplatelets, multidisciplinary input etc.), which may bias our results. Finally, we do not have data on palliative discharges.

The strengths of this study are the measurement of hard endpoints and the use of reliable contemporaneously collected data which have been cross-checked. Further, we included all admitted patients and therefore minimised selection bias.

COMPETING INTERESTS
Nil.

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Pseudo-Myxoma of the Appendix

NZMJ, August 1922

I desire to report a case which was primarily papilliferous adenoma of the appendix, but which later showed myxomatous degeneration and cyst formation. The same condition occurring in the ovary is described in Eden and Lockyer's "Gynæcology," second edition as pseudo-myxomatous tumours whether of appendix or ovary rupture and pour out their secretion of pure pseudo-mucin into the general peritoneal cavity, giving rise to that rare disease pseudo-myxoma peritonei where the tenacious secretion increasing with semi-malignant characters may involve the whole abdomen.

This case was operated on before rupture of the pseudo-myxomatous cyst when it was about the size of a hen's egg.

Mrs. J., aged 44. She came in August, 1921, complaining of pain in the lower abdomen very severe the last week, but troublesome on and off for several years in less degree. There was also a history of pain in the back since the last child was born and a dragging pain in the vagina. She had a thorough nervous breakdown eight months ago which she attributes to these sufferings.

Previous history.—She has two children, the youngest sixteen. In May, 1921, I removed a suspicious ulcer from the forehead which the pathologist reported as rodent ulcer. The scar is now quite healthy.

On examination the abdomen appeared normal. Vaginally there was partial perineal laceration and small cystocele. The uterine body was partially retro-verted, and on straining prolapsed slightly. The pre-operative diagnosis of prolapsus uteri was made and operation advised as this would also give opportunity to explore the abdomen.

Operation 7th August, 1921.—Assisted by Dr. H. M. Monro I performed perineorrhaphy and opening the abdomen fixed the uterus by Kocher's method. Before closing the wound the abdomen was explored and the cæcal region exposed. Here at the caput a tumour was found about the size of an egg, but soft and cystic, irregular in shape, adherent everywhere to the peritonem of the ileo-cæcal angle. It was recognised only on looking for the appendix that this was a diseased appendix, for the anterior linea of the colon ran into a broad appendix stump which widened into this tumour. At this stage it was taken for an old inflamed appendix probably full of pus. It was freed by swab dissection with difficulty from its surroundings down to its base which was cut through and the stump invaginated in the ordinary way. There was now a wide raw area to cover over. The separation was not affected without the contents partly escaping from a small tear in the organ. The contents were most striking in appearance, resembling nothing so much as lemon jelly. It was sticky and dry. The abdomen was closed.

Progress.—The wound healed by first intention, and the patient made a quick recovery. It is now six months since operation, and there is no sign of recurrence. The condition of pseudo-myxoma peritonei is incurable by removal of the jelly masses together with their origin in ovary or appendix, because of the destroyed vitality of the peritoneum which results in gland cells being implanted and proliferating with continued production of pseudo-mucin. Yet it seems that if the diseased ovary or appendix is removed before rupture and implantation, as in this patient, there would be little fear of recurrence.

The fully developed disease pseudo-myxoma peritonei is very rare. It usually starts from the ovary. According to Eden and Lockyer only about twelve cases are recorded which started in the ovary and appendix. Of these only three were females, and in them, both ovary and appendix were diseased. The present case differs from those analysed by Eden and Lockyer in being that of a female, with the appendix alone involved, the ovaries being normal. Seelig* brings the knowledge of the disease up to date. When the pseudo-mucinous cyst of the ovary or appendix bursts there are four possible terminations:—

1. Absorption of exudate may occur.
2. The exudate may be limited and encapsulated in the right iliac fossa forming a tumour there.
3. Generalised spread of exudate which becomes incapsulated in small masses like polypi.
4. Generalised spread of exudate which does not become incapsulated, but implants itself and goes on secreting, producing ascites, cachexia and death, with all the semblance of widespread abdominal carcinoma.

Professor A. M. Drennan, Pathologist of the Otago Medical School, kindly provided a complete report of serial sections of the specimen set to him. I append his conclusions:—

"The specimen consists of a thin-walled sac with some mucus and white calcareous material adhering to the wall.

"At one side is a rounded stump which on longitudinal section appears to be the appendix, and it merges with the lumen of the sac. At the opposite side of the sac is another smaller rounded stump suggesting the tip of the appendix."

Of the most comprehensive section he reports:—

"This is the most interesting section. In one part is appendix with usual mucosa, but much diminished lymphoid tissue. Adjacent to and apparently continuous with this is a very hyperplastic mucosa lined with tall columnar cells and forming long compound papillary ingrowths amongst which is much mucus. The muscle coats of appendix are present for a certain distance and then are replaced by a fibrous wall (the wall of the sac); also immediately adjacent to the hyperplastic epithelium is a deposit of calcareous debris, and mucus, bounded by a definite fibrous wall.

"The condition is, I think, primarily a papilliferous adenomatous formation of the appendix epithelium which has resulted in rupture through the wall, with inflammatory reaction around forming the sac: the calcareous part is due to degenerated masses of epithelium. In parts the fibrous tissue has also become myxomatous."

*Seelig—"Surgery, Gynæcology and Obstetrics," January 20th 1920.

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