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The New Zealand oral and maxillofacial surgeon workforce in 2017–18: characteristics, practice and prospects

John B Bridgman, Graham Fulton, Simon M-Y Lou, W Murray Thomson, Alastair N Goss

We surveyed all of New Zealand's oral and maxillofacial surgeons (OMS) to update findings from a similar survey done in 2001. The findings highlight a number of problems—some long-standing, others emerging—in our OMS system. Because more surgeons are now working exclusively in private, there is greater stress on those who are working in the public hospital system, especially with more facial trauma and cancer cases to be treated. More resources need to be put into training surgeons who will take up hospital appointments and provide essential after-hours emergency services.

Ability of the Maze Navigation Test, Montreal Cognitive Assessment, and Trail Making Tests A & B to predict on-road driving performance in current drivers diagnosed with dementia

Etuini Ma'u, Gary Cheung

While drivers diagnosed with a dementia are twice as likely to be involved in a motor vehicle accident compared to cognitively intact older adults, the majority of drivers diagnosed with a mild dementia will still pass an on-road driving assessment. With specialist driving assessments being expensive and no longer publicly funded, this study aimed to evaluate the ability of three quick to administer cognitive tests to predict driving performance in individuals with dementia on a specialist on-road driving assessment. This study provides clinicians with a quickly administered maze navigation test (MNT) and an interpretation of the commonly used MoCA cognitive screening test that can help inform the need for a specialist driving assessment.

The prevalence of refractive error and visual impairment among New Zealand children in a community with significant socioeconomic disadvantage: is current preschool vision screening effective?

Rebecca Findlay, Joanna Black, Nicola Anstice, Alison Burge, Alison Leversha

The current preschool vision screening was effective in detecting amblyopia (lazy eye) but poor at detecting refractive error (need for glasses) in a study of mainly Māori and Pacific children living in socioeconomic disadvantage. The current vision screening programme is likely to be increasing inequities. More than half of children with refractive error passed the screening. Ten percent of children did not receive screening and a further 11% were identified for rescreening, which was not completed prior to starting school. Urgent attention is required to review the B4SC vision screening protocol to improve equity by ensuring that all children receive appropriate vision screening and eyecare.

The characteristics and outcomes of patients with colorectal cancer in New Zealand, analysed by Cancer Network

Tania Blackmore, Chunhuan Lao, Lynne Chepulis, Blaithin Page, Ross Lawrenson

Bowel cancer in New Zealand is common and we have relatively poor survival compared with other countries. We have shown that for younger patients the outcomes from bowel cancer in New Zealand are not affected by where you live—but there are regional variations for older patients with better outcomes for those living in the Northern and Southern Regional Cancer Networks. However, the greatest survival disparity continues to be found for Māori and Pacifica patients.

Ocular syphilis in Pacific peoples—are we making misdiagnoses secondary to yaws?

Hannah Gill, Helen V Danesh-Meyer, Joanne L Sims, Mitzi Nisbet, Rachael L Niederer

This paper was an audit assessing the demographic and clinical features of patients with ocular disease consistent with syphilis and positive treponemal serology in Auckland. It wanted to compare patients who lived in a Pacific nation before 1960 with all other patients, as they may have returned a positive treponemal serology due to prior yaws infection, rather than syphilis. The results demonstrated that the presentation of older, Pacific Peoples was different to others in the study, and that alternative causes for ocular inflammation should be considered as differentials.

Trends in prescription medicine use by older people in New Zealand 2010– 2015: a national population-based study

Andrew M Tomlin, David J Woods, James J Reid, Murray W Tilyard

This study has shown that in older people the use of most types of medicines is increasing and that people aged 85 years and older tend to use the most medicines. In particular, we found that use of strong painkillers and psychoactive medicines (those used for depression, other psychiatric disorders and sleep problems) were used frequently in older people and often in combination, which can lead to increased adverse events such as falls. Investigating the trends and patterns of medicines used in older people identifies opportunities to provide education on safe and appropriate medicines and reduce potential harm associated with medicines in this age group.

Is there a role for Rongoā Māori in public hospitals? The results of a hospital staff survey

Jonathan Koea, Glennis Mark

A significant number of staff at Waitemata District health Board had a knowledge of Rongoā Māori and just over a third of the total responders to a staff survey supported its availability within the hospital system. A larger feasibility study is now underway consulting with healers, hospital staff and patient participants to ascertain the culturally appropriate and medically robust practices necessary for researching Rongoā Māori/medicine collaboration within the health system.

Variation in volumes and characteristics of trauma patients admitted to a level one trauma centre during national level 4 lockdown for COVID-19 in New Zealand

Grant Christey, Janet Amey, Alaina Campbell, Alastair Smith

Despite the significant reduction in admissions during level 4 lockdown, hospitals should continue to provide full services until resource limitations are unavoidable. Immediate messaging is recommended to reduce rates of injury on the farm and at home, specifically falls prevention. Ongoing attention of road users to road safety is essential to reduce the incidence of preventable major injury. These immediate measures can potentially reduce unnecessary pressure on hospital beds and resources during the pandemic.

Towards elimination of tuberculosis in New Zealand

Ayesha J Verrall, Philip C Hill, Dougal Thorburn, Michael Maze, Lavinia Perumal, Kate Grimwade, Craig N Thornley, Josh Freeman, Mitzi Nisbet, Timothy K Blackmore

Tuberculosis is still an important disease in New Zealand. We could eliminate TB by improved screening and preventive treatment for people from overseas, and address the legacy of TB from colonial times that continues to impact Māori. Improved preventive, treatment and laboratory services are important to achieving this goal.

Why BMI should still be on the table

Lisa Daniels, Wayne S Cutfield, Rachael W Taylor, Barry J Taylor

Body mass index (BMI) is a calculation used to estimate body fatness and is used worldwide to define overweight and obesity. While its use during the before school check (a free health and development check for all New Zealand four-year-olds) has recently come into question it is currently the only appropriate field tool for assessing overweight and obesity. In this viewpoint article, we discuss the evidence in support of the measurement of BMI for population health monitoring as well as for screening a child's weight status.

Changes to management of a non-pandemic illness during the COVID-19 pandemic: case study of invasive management of acute coronary syndrome

Sean Coffey, Anouska Moynagh, Belinda Green, John Edmond, Gerard T Wilkins, Brendan Arnold, James Pemberton, Ben Wilkins, Michael JA Williams

Non-COVID-19 conditions will continue to be an issue during the COVID-19 pandemic. Usual treatment approaches need to be modified as the standard risk/benefit assessment is likely significantly changed during the pandemic. The main considerations relate to the risk of COVID-19 to patients and healthcare workers, population spread and potential resource constraints. With these considerations in mind, as a case study, we discuss in this paper how these changes affect management of patients with heart attacks in hospitals without on-site interventional cardiology (stenting) services.

The post-lockdown period should be used to acquire effective therapies for future resurgence in SARS-Cov-2 infections

Kurt L Krause, Richard Furneaux, Paul Benjes, Margaret Brimble, Tony Davidson, William Denny, Lawrence Harris, Simon Hinkley, Peter Tyler, James E Ussher, Vernon Ward

COVID-19 will be with us through the remainder of 2020 and almost certainly beyond. New Zealand needs a viable strategy to protect its populace until a vaccine is developed and in wide use. Until that time, it makes sense to protect the population by putting in place treatments that will be safe and effective, such as the use of convalescent sera and the use of direct-acting anti-virals. These treatments should be sourced externally or made locally, but steps in this direction must now begin as the lockdown ends. New Zealand has the scientists, the facilities and the will to make this happen, but the support of the government and the population will be needed if this plan is to succeed.

The case for New Zealand to have its own COVID-19 vaccine programme

James E Ussher, Graham Le Gros, Miguel E Quiñones-Mateu, Shivali A Gulab, Melissa Yiannoutsos

Top scientists are calling for a national COVID-19 vaccine programme to ensure New Zealand is best placed to access an effective vaccine at the earliest opportunity. While there are multiple vaccines being developed overseas, there is concern about the ability of manufacturers to scale up vaccine production to meet unprecedented global demand. A national COVID-19 vaccine programme is urged to build New Zealand-specific capability which can contribute to the worldwide vaccine development effort, secure early access to a COVID-19 vaccine to prevent SARS-CoV-2 infections in New Zealand and Pacific nations, and grow capability to respond to future pandemics.

COVID-19—the frontline (a GP perspective)

Kate Baddock

On the day 28 February 2020, the world changed for New Zealand, as it confirmed its first case of COVID-19. We, along with much of the world, were scrambling to understand this new virus—its transmission, its voracity and predilection for alveolar tissue, its mortality rate and most importantly, what this would mean for the New Zealand people and our health system.

March signalled a wholesale scramble for GPs and general practice. Could we protect ourselves and our patients adequately, and still provide the care that people needed—when they needed it? The first scramble was for personal protective equipment (PPE), particularly gloves and masks. Practices like ours immediately put in orders to our distributors for these, only to be told that they were not available, but would be on back order. Gowns and protective eyewear were also in short supply. Confusion reigned—did we need to wear PPE (or even just masks and gloves) when seeing people who didn't meet the criteria for swabbing? How would we protect our other patients and our staff?

Those first two weeks in March in general practice were incredibly stressful for doctors and nurses as the information coming from the Ministry was changing daily, and there was no conduit for concerns to get to the Ministry. Furthermore, the costs of trying to meet the COVID threat were straining the sustainability of general practice, which was already under threat from a decade of chronic underfunding of capitation. The dedicated Healthline was understaffed as nobody realised just how many people would be trying to find out information, so patients who could not get through on their telephone lines inundated general practice with their questions and concerns. PPE was now available but the supply lines were tenuous. COVID numbers were increasing and GPs were struggling to contain the risk to their premises, their staff and their patients.

At this stage the response to COVID was still not fully coordinated, and the RNZCGP encouraged the Ministry to set up a primary care subgroup which could convey concerns to the Ministry through the Technical Advisory Group (TAG). At the same time there was mounting pressure from GPs to set up community-based assessment centres (CBACs) as had been used in the SARS outbreak in 2003. At that time some general practices became designated as CBACs while others were "clean" practices. The increasing risk seen and felt by GPs was real and tangible, and there was a strong feeling that there needed to be better separation between those being seen and needing assessment and swabbing for COVID-19 according to the current criteria, and everyone else.

By mid-March the PHOs were coordinating the supply of PPE to practices but there was increasing concern about the supply of swabs for testing, and capacity in the laboratories around New Zealand to process the swabs.

Then the Ministry announced that the flu vaccines had arrived in New Zealand and would be available for all those who were eligible for funded vaccination. The problem was that there was no advance warning and so general practice was (again) scrambling to organise how we might deliver vaccination safely to our patients. In my practice alone we had 4,000 patients who met the criteria for funded vaccinations—it is no small logistical feat to arrange to have that number vaccinated in a timely manner. But then the vaccine supply dried up. An anxious and fearful patient population was literally demanding flu vaccines (both in person and 80% of phone calls) and there were none to be had. Through this time, the Ministry was saying that there was sufficient flu vaccine in New Zealand to meet demand. That may have been an accurate observation but it wasn't where it was needed. New Zealand by this stage was at Level 2 alert with limited public gatherings and small groups.

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Then on the Saturday, 21 March, a recommendation came through from the RNZCGP to all GPs recommending an immediate switch from face-to-face consultations to virtual consultations. This followed information that came out from Italy suggesting that community transmission of COVID-19 was occurring though GP clinic waiting rooms. The idea was that about 70% of consultations could be held virtually in order to protect patients from unwanted and unnecessary exposure to community-transmitted virus. By Monday afternoon, 23 March (48hrs later), general practice had been transformed. Patients were contacted and advised that consultations would be by telephone, email or videoconference where possible.

That same day, two patients with COVID-19 were suspected to have been infected by community transmission, and New Zealand went to Level 3. Within 48 hours of that announcement New Zealand was in Level 4 lockdown. What happened in general practice is that the flow of patients into GP clinics just stopped. A combination of fear and anxiety about catching the virus encouraged people to stay at home in their bubble, and the perception that their general practices would be overwhelmed by COVID patients, meant that they also did not ring with their various concerns. General practice as we traditionally know it ended on 25 March 2020.

General practice is a conglomeration of small- and medium-sized businesses who operate almost entirely on cashflow. This is particularly true for those practices that are not Very Low Cost Access (VLCA) and so have a greater reliance on co-payments from patients. The switch to virtual consulting required setup costs including webcams, microphones, extra telephone lines and headsets. But at the same time, there was still a need to see patients for assessment of various symptom complexes, eg, chest or abdominal pain. However, patients stayed away, and did not contact their practices. Neither did they turn up at the emergency departments of hospitals, or accident and medical centres. It was as if there was nobody needing care.

What that meant for GPs is that cashflow dried up "overnight". The number of consultations, whether virtual or in in person, plummeted by 50–80% within days. Suddenly general practices were in danger of becoming insolvent and not being able to meet their payroll requirements. The phones were still busy with staff (nurses and receptionists) fielding concerns regarding flu vaccines (that weren't available) but nobody was wanting consultations.

Leaders in general practice, NZMA chief among them, met with the Ministry and the DHBs CEO representative, and agreed a rescue package for general practice for the duration of the Level 4 lockdown. There was also an injection of funding to general practices to recognise the initial costs of meeting the threat of COVID-19. This money was made almost immediately available to practices via the PHOs and relieved the pressure of insolvency for many.

It is now three weeks into lockdown and general practice is tangibly different. The waiting rooms are virtually empty, with a trickle of patients being seen for assessment or treatment. The CBACs are now up and running all over the country and have almost entirely taken over the assessment and treatment of COVID patients, apart from the occasional designated practice. Flu clinics are operating generally smoothly—patients drive up in their cars according to their appointment times (every 10 minutes) and are vaccinated while sitting in their cars, and then drive home to their bubbles. Bubble-sharers are vaccinated together; where individuals are vaccinated for the first time, they are asked to remain in the carpark for 20 minutes and toot their horn if they experience any reaction (none so far in my practice and we have now done over a thousand). Doctors are sitting in their offices, or in their homes working remotely, having significantly fewer (mainly virtual) consultations than previously.

Where have the patients gone? GPs are concerned that they are presenting later than they should out of concern for their own risk, and consideration for the health system. This consideration is misplaced—these patients still need to be "seen"—and the Ministry in the last few days have been saying this publicly. These patients may well resurface after lockdown has ended but with higher acuity, needing more urgent attention and even admission.

In order for the hospitals to be prepared for the potential influx of patients with

COVID-19 elective surgery has all been put on hold and there have been no new first specialist appointments (FSAs) for the past four weeks. Those who had follow-up appointments and could be reviewed virtually have been, but the remainder have been deferred until after lockdown has ended and people can move more feely again. The real issue for general practice has been that many of those who had been referred for FSAs but had not yet been seen, have simply been returned to general practice. These are people with sufficient acuity and clinical need to be seen who have now just been declined, with a request to re-refer them if needed. This simply begs the question—either they needed to be seen or they didn't. If they did, why then subsequently decline them? They could have been deferred and reinstated when clinics re-opened. Those who have had their elective surgery deferred will simply be getting worse and need more community care in order to manage, while waiting for their surgery post-lockdown. This kind of activity simply further increases the pressures on general practice at a time when it is already reeling under multiple pressures.

The frontline in New Zealand is not(yet) the hospitals and hospital doctors (they have not been inundated with COVID patients); it is the GPs and general practice. GPs have been faced with the most profound threat in COVID-19 to which they reacted swiftly, efficiently and effectively. They were then asked to make the most profound change to their way of working in the history of general practice in New Zealand, and did it over the course of a weekend. But these changes have taken an enormous toll on GPs, and general practice will never be the same again. GPs are anxious about their financial futures as consultation numbers are still significantly fewer than before lockdown. Contracted doctors are having their contracts ended or suspended, even though there is an expectation that consultation numbers will go up after lockdown has ended. Nursing staff have no guarantee of continued employment, and those staff at higher risk of COVID have had to be stood down. Managing the risk of exposure to COVID and the threat that represents to themselves, to staff and to their patients, needs to be managed on a daily basis.

General practices and the people who work there are the unsung heroes of this pandemic and need to be recognised for how they have responded to this challenge. In the weeks and months to come they will need the support of the rest of the medical community, and the public at large, for the outstanding effort that has been required of them to meet the COVID threat.

At the time of publication the Government has only paid $22m of the $45m support package promised to General Practice and the sector has been advised that the balance would not now be paid.

Competing interests:
Nil.
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The New Zealand oral and maxillofacial surgeon workforce in 2017–18: characteristics, practice and prospects

John B Bridgman, Graham Fulton, Simon M-Y Lou, W Murray Thomson, Alastair N Goss

ABSTRACT

AIM: To describe and consider the findings of a workforce survey of New Zealand Oral and Maxillofacial Surgeons (OMS) which was conducted in 2017–18, and to compare those to findings from a similar survey undertaken in 2001.

METHODS: A questionnaire was used to obtain information on the qualifications, sociodemographic characteristics and and practising circumstances of all practising OMS in New Zealand. Data were analysed using SPSS (version 24). After the computation of descriptive statistics, cross-tabulations were used to identify differences in proportions (with those tested for statistical significance using Chi-squared tests), and analysis of variance was used to examine differences in means.

RESULTS: All 39 OMS took part. There were 17 medically qualified surgeons who also held a surgical fellowship, comprising just under half of the workforce. Overall, one in eight surgeons worked solely in the public sector, while just under one-quarter worked solely in private; the remainder worked in both sectors. Dentoalveolar procedures were by far the most common undertaken (with considerably more done by older surgeons than younger ones), followed by implants, the treatment of facial trauma, skin lesions and surgery for malignancy. Orthognathic surgery and dentoalveolar trauma procedures were the least commonly reported. Only two-thirds of surgeons participated in public on-call work. While 95% of surgeons were indeed satisfied with their work, the lowest rate was observed among those working solely in the public sector, where it was 80%; among those working exclusively in private, it was 100%. Between 2001 and 2017–18, the proportion of medically qualified surgeons rose from just over one-quarter to more than two-thirds. The proportion of surgeons working solely in private practice rose from one in seven to almost one-quarter. There were marked increases in the mean number of malignancies dealt with and implants provided.

CONCLUSION: The findings highlight a number of problems—some long-standing, others emerging—in New Zealand's OMS system. Fewer surgeons are participating in public sector provision and there is stress on those who remain. Workforce planners should be aware that more resources need to be put into training surgeons who will take up hospital appointments and provide essential after-hours emergency services.

The speciality of Oral and Maxillofacial Surgery (OMS) has undergone major changes in New Zealand and Australia over the last 30 years. Training in the 1960s and 1970s was individual and without standardisation, and this was the subject of criticism at the time from the medical surgical specialities. Most of the subsequent changes in OMS training in New Zealand and Australia were driven by the Australian and New Zealand Association of Oral and Maxillofacial Surgeons (ANZAOMS), a body comprising surgeons from both countries. In the 1980s, those organisations collaborated on the progressive development of a full training programme in Oral and Maxillofacial Surgery. The full story of this development has been recorded in a series of books and papers.[1–3] All steps were carefully charted in a series of studies.[4–14]

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Historically, speciality training in New Zealand had been based at the University of Otago, with trainees then seeking further experience and UK general dental college fellowships. Dental specialists were first recognised by the Dental Council of New Zealand (DCNZ) in 1990, with registration of both Oral Surgeons and Oral and Maxillofacial Surgeons (among a number of other specialties). By 1993, the University of Otago had recognised the need for intending trainees in OMS to complete both medical and dental degrees. OMS was recognised as a medical speciality by the Medical Council of New Zealand (MCNZ) in 1995. In 1998, the DCNZ recognised the RACDS special stream fellowship in Oral and Maxillofacial Surgery—FRACDS(OMS)—as a registrable qualification. By 2003, medical training was mandatory for OMS registration with the DCNZ. Each of the three centres involved in the current training programme (Auckland, Waikato and Christchurch) was accredited in 2016, with the current accreditation status covering the 2017–21 period.

A recent study examined the qualifications, training and practice patterns of oral and maxillofacial surgeons in Australia in 2011.[16] It found that there had been major growth in dental implant work, orthognathic surgery and management of pathology. The workforce had increased at the highest rate predicted earlier but was only just keeping up with population increases. Although New Zealand had been included in some of the Australian scope and workforce studies, the only previous extensive OMS workforce study was undertaken in 2001.[17] That particular study had the relatively low participation rate of 55%.

Almost two decades later, there is a need for more contemporary information on the characteristics, work patterns and job satisfaction of New Zealand OMS. Accordingly, the aim of the current study was to describe and consider the findings of a New Zealand OMS scope and workforce survey conducted in 2017–18.

Methods

A questionnaire was developed from the recent Australian survey[16] and modified for the New Zealand situation. It sought information on respondents' qualifications and sociodemographic and practising characteristics. It was completed by most attenders at the ANZAOMS (New Zealand Branch) meeting in Queenstown in August 2017, with those unable to do so completing it at the next meeting, in August 2018. A small number of unfinished questionnaires were completed later through phone calls, emails and personal visits.

The workforce aspect of the study was based on an analysis of current registered speciality oral and maxillofacial surgeons practising in New Zealand and compared to previous New Zealand data[3–5,7–9,13,14] and to New Zealand general dental data.[18]

Data were analysed using SPSS (version 24). After the computation of descriptive statistics, cross-tabulations were used to identify differences in proportions (with those tested for statistical significance using Chi-squared tests), and analysis of variance was used to examine differences in means. The alpha value was set at 0.05.

Results

All 39 OMS took part in the survey (Table 1). Approximately half of the surgeons were 50 or younger, and just over half were New Zealand Europeans. Over two-thirds were Otago BDS graduates. There were 17 medically qualified surgeons who also held a surgical fellowship (a combination of qualifications which is consistent with contemporary hospital consultant standards), comprising just under half of the workforce. Overall, one in eight surgeons worked solely in the public sector, while just under one-quarter worked solely in private; the remainder worked in both sectors. None of the medically qualified surgeons with fellowships worked exclusively in the public sector; most worked in both sectors.

While a little over half of surgeons' practice time was spent on private work (Table 2), that proportion was noticeably higher among New Zealand European surgeons, Otago graduates and older surgeons. Only a small minority of surgeons were less busy than they wanted to be. Although about one-tenth overall expected to be busier than they wanted to be over the next year, more than one-third of overseas graduates expected to be in that situation.

Table 1: Practice type, by surgeon characteristics (brackets contain row percentages unless otherwise specified).

	Practice type			
	Public only	Public/private	Private only	Both combined[a]
Age group				
36-50	3 (15.0)	14 (70.0)	3 (15.0)	20 (51.3)
51-71	2 (10.5)	11 (57.9)	6 (31.6)	19 (48.7)
Ethnicity				
NZ European	1 (4.3)	15 (65.2)	7 (30.4)	23 (59.0)
Other	4 (25.0)	10 (62.5)	2 (12.5)	16 (41.0)
Otago BDS graduate				
No	2 (18.2)	9 (81.8)	0 (0.0)	11 (28.2)
Yes	3 (10.7)	16 (57.1)	9 (32.1)	28 (71.8)
Medical degree and FRACDS				
No	5 (22.7)	11 (50.0)	6 (27.3)	22 (56.4)
Yes	0 (0.0)	14 (82.4)	3 (17.6)	17 (43.6)
All combined	5 (12.8)	25 (64.1)	9 (23.1)	39 (100.0)

[a]Column %.
[b]P=0.05.

Table 2: Aspects of practice, by surgeon characteristics (brackets contain row percentages unless otherwise specified).

		Practice busyness	
	Mean % private (sd)[a]	Less busy than want to be	Expect to be more busy than want to be during next year
Age group			
36–50	53.2 (34.8)	3 (15.0)	3 (15.0)
51–71	61.1 (36.2)	0 (0.0)	1 (5.3)
Ethnicity			
NZ European	68.3 (30.8)[b]	1 (4.3)	1 (4.3)
Other	40.0 (35.7)	2 (12.5)	3 (18.8)
Otago BDS graduate			
No	40.0 (26.2)	2 (18.2)	4 (36.4)[b]
Yes	63.2 (36.4)	1 (3.6)	0 (0.0)
Medical degree and FRACDS(OMS)			
No	54.6 (39.6)	2 (9.1)	3 (13.6)
Yes	60.6 (29.1)	1 (5.9)	1 (5.9)
Practice type			
Public only	0.0 (—)	1 (20.0)	1 (20.0)
Public and private	52.9 (23.5)	1 (4.0)	3 (12.0)
Private only	100.0 (—)	1 (11.1)	0 (0.0)
All combined	57.1 (35.2)	3 (7.7)	4 (10.3)

[a]Information missing for one respondent.
[b]P<0.05.

Table 3: Dentoalveolar surgery activity, by surgeon characteristics (brackets contain standard deviations unless otherwise specified).

	Mean percentage of dentoalveolar activity		
	Number of patients	Time spent	Contribution to gross income
Age group			
36–50	64 (24)	61 (27)	71 (26)
51–71	75 (20)	72 (22)	84 (14)
Ethnicity			
NZ European	73 (21)	69 (24)	81 (18)
Other	65 (25)	63 (27)	72 (27)
Otago BDS graduate			
No	63 (14)	62 (17)	73 (19)
Yes	72 (25)	68 (28)	79 (23)
Medical degree and FRACDS(OMS)			
No	72 (22)	70 (25)	80 (21)
Yes	66 (24)	61 (25)	74 (24)
Practice type			
Public only	56 (20)[b]	54 (29)[b]	58 (26)[b]
Public and private	64 (21)	60 (22)	76 (21)
Private only	91 (14)	91 (13)	95 (5)
All combined	70 (23)	66 (25)	70 (23)

[a]Column %.
[b]P<0.05.

Table 4: Mean number of procedures done annually (among those answering the question), by surgeon characteristics (brackets contain standard deviation).

		Trauma		Pathology		Other types of surgery					
	Dentoalveolar	Facial	Dentoalveolar	Jaw cysts	Malignancy	Orthognathic	Pre-prosthetic	Implants	TMJ	Bone grafts	Skin lesions
No. answering[a]	27	24	16	35	18	28	20	32	23	27	18
Age group											
36–50	589 (283)[b]	81 (61)	14 (14)	22 (17)	99 (246)	10 (8)	14 (16)	136 (126)	11 (7)	20 (25)	88 (233)
51–71	866 (296)	50 (44)	7 (3)	17 (13)	8 (9)	12 (9)	11 (8)	170 (216)	38 (72)	27 (27)	37 (51)
Ethnicity											
NZ European	786 (313)	60 (49)	9 (6)	18 (13)	90 (250)	10 (8)	15 (14)	187 (205)	32 (62)	27 (30)	82 (205)
Other	604 (299)	80 (65)	14 (17)	22 (18)	19 (16)	12 (9)	6 (4)	97 (87)	10 (8)	17 (17)	21 (12)
Otago BDS graduate											
No	633 (174)	76 (60)	17 (16)	22 (19)	14 (9)	11 (8)	7 (5)	139 (135)	13 (9)	20 (18)	49 (64)
Yes	717 (358)	65 (57)	8 (6)	18 (13)	81 (229)	11 (9)	15 (14)	159 (190)	31 (65)	24 (29)	71 (204)
Medical degree and FRACDS (OMS)											
No	767 (295)	60 (62)	7 (3)	20 (16)	12 (10)	12 (10)	12 (9)	105 (93)	33 (67)	23 (26)	38 (47)
Yes	598 (322)	77 (53)	13 (12)	19 (14)	133 (294)	11 (8)	14 (17)	208 (228)	13 (7)	23 (28)	92 (249)
Practice type											
Public only	433 (115)	200 (—)	—	23 (19)	19 (12)	20 (—)	20 (14)	58 (60)	20 (—)	8 (4)[b]	20 (0)
Public and private	691 (346)	66 (51)	11 (11)	21 (16)	71 (210)	11 (9)	10 (10)	117 (108)	22 (54)	17 (15)	90 (212)
Private only	825 (194)	12 (1)	9 (3)	12 (6)	6 (—)	7 (3)	20 (20)	276 (276)	45 (21)	56 (41)	12 (9)
All combined	692 (313)	69 (57)	10 (10)	20 (15)	59 (185)	11 (9)	13 (13)	153 (174)	24 (51)	23 (26)	65 (175)

[a]Includes those giving 0 as their response; some respondents did not answer these questions at all.
[b]P<0.05.

In respect of dentoalveolar surgery activity (Table 3), such patients comprised 70% of those seen, with that proportion being highest (at 91%) for those working exclusively in the private sector. There were similar differences in respect of the clinical time spent and in the contribution to gross income.

In respect of the numbers of procedures done (Table 4), there was considerable variation in the number of surgeons responding to the items on those, and so the presented means pertain only to those who responded. Dentoalveolar procedures were by far the most common undertaken (with considerably more done by older surgeons than younger ones), followed by implants, the treatment of facial trauma, skin lesions and surgery for malignancy. Orthognathic surgery and dentoalveolar trauma procedures were the least commonly reported. Medically qualified surgeons with fellowships did fewer dentoalveolar procedures but dealt with higher numbers of cases involving malignancy or implants.

Overall, three-quarters of referrals to surgeons were made by general dental practitioners (Appendix Table 2).

Where public on-call work was concerned (Table 5), only two-thirds of surgeons (but all of the non-Otago graduates and only half of the others) participated in public on-call work. That proportion was higher among those who were medically trained or worked solely in the public sector. None of those working solely in the private sector did so.

Table 5: Public on-call work, by surgeon characteristics (brackets contain row percentages unless otherwise specified).

	Does public on-call work[a]	**Frequency of public on-call work[b]**		
		Least	**Middle**	**Highest**
Age group				
36–50	16 (80.0)	5 (31.3)	6 (37.5)	5 (31.5)
51–71	10 (52.6)	4 (40.0)	4 (40.0)	2 (20.0)
Ethnicity				
NZ European	13 (56.5)	7 (53.8)	2 (15.4)	4 (30.8)[c]
Other	13 (81.3)	2 (15.4)	8 (61.5)	3 (23.1)
Otago BDS graduate				
No	11 (100.0)[c]	2 (18.2)	6 (54.5)	3 (27.3)
Yes	15 (53.6)	7 (46.7)	4 (26.7)	4 (26.7)
Medical degree and FRACDS(OMS)				
No	11 (50.0)	3 (25.0)	6 (50.0)	3 (25.0)
Yes	14 (82.4)	6 (42.9)	4 (28.6)	4 (28.6)
Practice type				
Public only	3 (100.0)[c]	1 (33.3)	0 (0.0)	2 (66.7)
Public and private	23 (92.0)	8 (34.8)	10 (43.5)	5 (21.7)
Private only	0 (0.0)			
All combined	26 (66.7)	9 (34.6)	10 (38.5)	7 (26.9)

[a]One respondent withdrew from the on-call roster after the survey was conducted. The data presented here have been adjusted to reflect that.
[b]Categorised as follows (for those doing public on-call work): 'Least' = 1 in 6, 7 or 8; 'Middle' = 1 in 3 or 4; 'Highest' = 1 in 1 or 2.
[c]P<0.05.

Table 6: Overwork, by surgeon characteristics (brackets contain row percentages unless otherwise specified).

	Feel overworked	Reasons for feeling overworked[a]	
		Not enough back-up in area	Not enough surgeons in specialty
Age group			
36–50	9 (45.0)	5 (83.3)	7 (100.0)
51–71	5 (27.8)	2 (66.7)	3 (75.0)
Ethnicity			
NZ European	8 (36.4)	4 (66.7)	6 (85.6)
Other	6 (37.5)	3 (100.0)	4 (100.0)
Otago BDS graduate			
No	2 (18.2)	0 (0.0)	1 (100.0)
Yes	12 (44.2)	7 (77.8)	9 (90.0)
Medical degree and FRACDS(OMS)			
No	6 (28.6)	3 (75.0)	3 (75.0)
Yes	8 (47.1)	4 (80.0)	7 (100.0)
Practice type			
Public only	3 (60.0)[b]	2 (100.0)	1 (100.0)
Public and private	11 (45.8)	5 (71.4)	9 (90.0)
Private only	0 (0.0)	—	—
All combined	14 (36.8)	7 (77.8)	10 (90.9)

[a]Only those feeling overworked are included in these two columns.
[b]P<0.05.

Among those doing public on-call work, the highest frequency of it was observed among New Zealand Europeans, those without a medical degree and fellowship, and surgeons working solely in the public sector.

While just over one-third of surgeons felt overworked (Table 6), well over half of those working solely in the public sector did so (and none of those working solely in the private sector). Insufficient back-up and not enough surgeons in the specialty were both heavily cited reasons for surgeons feeling overworked.

Some 17.9% of surgeons reported that there was insufficient surgery to maintain an adequate income (Appendix Table 1), and competence-related concerns about insufficient surgery were reported by 23.1%. All of those had higher rates among medically qualified surgeons with fellowships.

Where job satisfaction was concerned, while 95% of surgeons were indeed satisfied with their work, the lowest rate was observed among those working solely in the public sector, where it was 80%; among those working exclusively in private, it was 100%.

There were some noteworthy differences between the 2001 and 2017 surveys (Table 7). The proportion of medically qualified surgeons rose from just over one-quarter to more than two-thirds, and there was a similar increase in the proportion with a fellowship. The proportion who were male fell very slightly. The proportion of surgeons working solely in private practice rose from one in seven to almost one-quarter. There were marked increases in the mean number of malignancies dealt with and implants provided. There was a fall in the proportion feeling overworked, and an increase in the

Table 7: Overview of important differences and similarities between 2001 and 2017.

	2001	**2017**
Survey participation rate	55%	100%
Surgeon characteristics		
Medically qualified	27%	69%
FRACDS(OMS)	23%	59%
Male	100%	96%
Mean age (sd, range)	47 (10, 32–72)	52 (10, 36–71)
Practice characteristics		
Public only	14%	13%
Public and private	71%	64%
Private only	14%	23%
Mean % private	58	57
Mean number of procedures done annually		
Dentoalveolar	Not collected	692
Trauma	52	79
Jaw cysts	24	20
Malignancy	7	59
Orthognathic surgery	12	11
Pre-prosthetic surgery	15	13
Implants	56	153
TMJ	17	24
Bone grafts	21	23
Skin lesions	Not reported	65
Surgeon satisfaction		
Overall, satisfied with their work	100%	96%
Feel overworked – cause:	57%	37%
Because not enough back-up in area	67% of the 57%	78% of the 37%
Because not enough surgeons in area	33% of the 57%	91% of the 37%
Insufficient surgery to maintain		
Adequate income	10%	18%
Competence generally	5%	23%
Competence in area of specialist interest	2%	28%

proportion feeling that there was insufficient surgery.

The total number of hours worked, on average, increased from 57 in 2001 to 69 in 2017 (Table 8). There were increases in the mean number of hours spent in private practice and in the associated operating time. There were also increases in the public sector hours.

Table 8: Comparison of the mean number of hours spent on particular activities in a typical week in 2001 and 2017.

	2001	2017
Private practice		
Operating time	16	20
Consultations by appointment	11	14
Emergency consultations	1	1
Case discussion	2	2
Administration	6	6
Private practice total	37	45
Public hospital commitments		
Operating time	6	7
Outpatient time	4	7
Other teaching time	2	3
Case discussion	1	2
Other (incl. meetings, admin, etc)	2	2
Public hospital total	15	21
Travelling time	2	1
Other surgery-related activities	3	2
Total surgery-related activities	57	69

Discussion

This study investigated the characteristics, work patterns and job satisfaction of New Zealand's entire oral and maxillofacial surgeon workforce, updating the findings of a similar study conducted in 2001. It found that the OMS workforce (almost exclusively male) is well trained and operates with a wide scope of practice. It appears to have made a largely successful transition from single-degree, university-based training to the contemporary international standard of dual qualifications (in dentistry and medicine) alongside extensive hospital exposure and a surgical fellowship. Despite longer working hours (by 20%, on average) and concerns about a gradual drift away from public-sector involvement, satisfaction levels remain very high.

The OMS workforce is ageing, with the mean age having risen from 47 to 52 between 2001 and 2018. Surgeons are staying in the workforce for longer: while there was little difference in the age of the oldest respondent in the 2001 and 2017–18 survey (72 and 71 respectively), the proportion aged 60+ was 4.2% in 2001 but 20.5% in 2017–18. At the other end of the career trajectory, there were also differences, with 20.8% and 10.3% aged under 40 in 2001 and 2017–18, respectively. Thus, not only are surgeons having to stay in the workforce for longer, fewer are entering the specialty (although it is currently unclear whether this is because some are taking longer to train or newly-qualified surgeons are leaving the country to take up overseas appointments. Some 40% of the existing OMS workforce will have passed retirement age by the end of the next decade, and their current replacement rate is insufficient. The OMS workforce is notable for its lack of gender diversity, with only one female surgeon practising at the time of the 2017–18 survey, although a recent appointee in the

Bay of Plenty is female. That approximately 10% of Australia OMS are female indicates that work is needed in both countries to make the workforce better reflect the source population. There is a clear need for investigation of ways to make the training pathway less daunting for aspiring female surgeons.

Data from the 2018 Census allowed calculation of the national OMS:population ratio as 1:120,506. Most regions have acceptable ratios, although Northland has a population sufficient to sustain an OMS but does not have one. Other notable exceptions are the Bay of Plenty/Lakes region (with 1:313,380 at the time of the survey, but the situation has improved with the recent appointment of another surgeon) and the Tairawhiti/Hawkes Bay region (with 1:218,013). Those areas were also highlighted as problematic in a recent in-depth analysis of hospital dental services.[20]

This suggests an urgent need for the Ministry of Health and DHBs to closely examine the allocation and conformation of secondary and tertiary oral health services. Instead of training enough OMS to meet its population growth, New Zealand has been making up the shortfall through encouraging the immigration of overseas-trained surgeons. In the 2001 OMS workforce study, over 75% of respondents had been born in New Zealand; by 2017–18, this proportion had fallen to 59% (although some of those surgeons had been born overseas but went through the New Zealand training system). In order to maintain and develop an adequate OMS workforce, the country needs to have more than one surgeon complete the training pathway every year. Relying heavily on immigration is a risky strategy.

It is noteworthy that there have been significant changes in surgeons' case mix. The most notable change is an eight-fold increase in the mean annual number of malignancy cases dealt with, from seven in 2001 to 59 in 2017–18. Since 2001, OMS oncology units have started in some public hospitals, and an increasing amount of that work is done in the private sector. The increase in the number of cases most likely reflects two influences: (a) the broadening of the OMS skill base of OMS (with the higher percentage of medical degrees and surgical fellowships); and (b) a continuation of the steady but slow increase in cancer rates.[21] There has been a near-threefold increase in the annual number of dental implants placed by surgeons, from 56 in 2001 to 153 in 2018. This probably reflects the increasing acceptance of this treatment option in New Zealand, rather than a transfer of work from one sector to another.

The evolution of training and the associated regulations over time has meant that there are now four dentally qualified groups—oral surgeons, university-trained or 'non-fellowship' OMS, medically qualified fellowship-trained OMS, and non-medically qualified fellowship-trained OMS—working in the specialist field of surgery. Since a medical degree has been mandatory for OMS fellowship training since 2002, the latter group is gradually diminishing in size, as members retire from the workforce. After more than 30 years without it, the University of Otago re-opened the single-degree qualification in oral surgery, with the first of those graduates registering with the DCNZ in 2008. The number of oral surgeons has increased since then (to eight in 2019), and it is expected that their numbers will continue to increase relative to the number of OMS. Workforce planners will need to understand the likely effects of this development. While there is considerable overlap in the work undertaken by the abovementioned four groups in private practice—where dento-alveolar and implant surgery predominate—there are considerable differences in the scope of work undertaken in the public system, and particularly in participation in essential after-hours emergency service provision to public hospitals. Most (86%) of those medically qualified with a fellowship take part in such a service, whereas only 25% of the others do so. There has been a relative decline in the numbers of those working in public practice, whether full- or part-time. As is the case in many industrialised countries, the public-private remuneration disparity is likely to be a major contributing factor,[19] along with those in public practice working more hours for less pay than in private practice.[18] Because public hospitals are the bedrock of the surgical training system, continuation of the steady drift of the surgical workforce away from public practice—together with greater workload stress on those who remain—means that training is likely to suffer. Moreover, the lower satisfaction levels

(and higher rates of overwork) observed among public sector-based surgeons provide further evidence of the strains and stresses on the public system.

This workforce study highlights a number of problems—some long-standing, others emerging—in New Zealand's OMS system. Fewer surgeons are participating in public sector provision and there is stress on those who remain. More resources need to be put into training surgeons who will take up hospital appointments and provide essential after-hours emergency services. What might attract appropriately qualified future surgeons to undertake this is beyond the scope of this study, but those surgeons should be medically qualified, with a training pathway that has included a surgical fellowship.

Appendix

Appendix Table 1: Insufficient surgery, by surgeon characteristics (brackets contain row percentages).

	Is there insufficient surgery to maintain:		
	Adequate income?	**Competence generally?**	**Competence in area of specialist interest?**
Age group			
36–50	5 (25.0)	6 (30.0)	7 (35.0)
51–71	2 (10.5)	3 (15.8)	4 (21.1)
Ethnicity			
NZ European	3 (13.0)	6 (26.1)	6 (26.1)
Other	4 (25.0)	3 (18.8)	5 (31.3)
Otago BDS graduate			
No	3 (27.0)	3 (27.3)	5 (45.5)
Yes	4 (14.3)	6 (21.4)	6 (21.4)
Medical degree and FRACDS(OMS)			
No	3 (13.6)	4 (18.2)	4 (18.2)
Yes	4 (23.5)	5 (29.4)	7 (41.2)
Practice type			
Public only	1 (20.0)	1 (20.0)	1 (20.0)
Public and private	5 (20.0)	8 (32.0)	9 (36.0)
Private only	1 (11.1)	0 (0.0)	1 (11.1)
All combined	7 (17.9)	9 (23.1)	11 (28.2)

Appendix Table 2: Referral sources, by surgeon characteristics (brackets contain standard deviations unless otherwise specified).

	Mean percentage of patients referred by:		
	GDPs vs GPs	GDPs vs dental specialists	GPs vs medical specialists
Age group			
36–50	71 (24)	78 (11)	69 (26)
51–71	77 (11)	79 (15)	79 (14)
Ethnicity			
NZ European	74 (19)	79 (14)	77 (15)
Other	74 (19)	78 (11)	69 (29)
Otago BDS graduate			
No	71 (19)	82 (8)	74 (28)
Yes	75 (19)	77 (14)	74 (19)
Medical degree and FRACDS(OMS)			
No	71 (20)	80 (14)	77 (15)
Yes	77 (17)	77 (12)	69 (28)
Practice type			
Public only	48 (28)[a]	80 (10)	78 (11)
Public and private	75 (14)	78 (15)	72 (25)
Private only	86 (10)	80 (10)	74 (17)
All combined	74 (19)	78 (13)	74 (22)

[a]P<0.05.

Competing interests:
Nil.

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Ability of the Maze Navigation Test, Montreal Cognitive Assessment, and Trail Making Tests A & B to predict on-road driving performance in current drivers diagnosed with dementia

Etuini Ma'u, Gary Cheung

ABSTRACT

AIM: This study aimed to evaluate the ability of the Maze Navigation Test (MNT), Montreal Cognitive Assessment (MoCA) and Trail Making Tests A & B (TMT A & B) to predict on-road driving performance in current drivers diagnosed with dementia.

METHODS: Current drivers with a diagnosis of dementia in whom there were clinical concerns about their driving safety were invited to participate between December 2014 and February 2018. Participants completed the MNT, MoCA and TMT A & B, then underwent a blinded specialist Occupational Therapy & Rehabilitation Service (OTRS) off-road and on-road driving assessment.

RESULTS: Of the 34 participants, 19 (55.9%) retained their full license and 15 (44.1%) received driving restrictions (including cessation). Only completion time for the MNT (AUC .737, p=.019), the MoCA domain of attention (AUC .809, p=.003) and a combination of the MoCA domain of attention and visuospatial/executive (AUC .783, p=.006) predicted outcome. Derived optimal cut-scores were <443s for MNT completion time (sensitivity 73.3%, specificity 68.4%), <5/6 for MoCA-attention (sensitivity 73.3%, specificity 72.2%) and <8/11 for MoCA-visuospatial/executive+attention (sensitivity 80%, specificity 66.7%). Using these derived cut-scores, MNT completion time predicted poor performance during the on-road assessment in the domains of speed control (p=.039), planning/judgement (p=.004) and vehicle position (p=.028).

CONCLUSION: Results of this study indicate MNT completion time and the MoCA domains of attention and visuospatial/executive could be used to inform driving ability and further referral for a specialist driving assessment.

An estimated 4% of current drivers over the age of 75 years have a diagnosis of dementia.[1] Published motor vehicle crash statistics suggest drivers with dementia have at least twice the risk of crashes when compared with cognitively intact older adults.[2] While it is accepted that those with a moderate or severe dementia are unsafe to drive,[2,3] the majority of those with a very mild or mild dementia are still able to pass an on-road driving assessment.[4–6] This indicates that it is not the diagnosis *per se* that affects driving performance but the specific cognitive deficits that are present.

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Driving is a complex task integrating a number of neurocognitive functions, including executive function, visuospatial awareness, motor control and the ability to maintain attention.[7] The gold standard for assessment of driving ability is an occupational therapy (OT) on-road driving assessment, but they are often expensive and largely unfunded in the New Zealand public health sector since 2003.[8] Many older drivers find this cost prohibitive, so there is an onus on clinicians to minimise the need for this assessment by accurately screening their driving ability as the loss of a autonomy associated with driving cessation has significant ramifications for the individual and their family.[9] With research indicating the subjective and unreliable nature of self-report,[10] caregiver report[5,11] and clinician judgment,[5] there is a need for valid and reliable objective measures of neurocognitive functions to guide assessment of driving ability.

Neuropsychological assessments have known utility in the detection of early cognitive decline and could be an economical alternative to on-road driving assessment, but evidence for their correlation with driving ability has been mixed. Mild deficits on global measures of dementia severity such as the Montreal Cognitive Assessment (MoCA) and Mini mental state examination (MMSE) correlate poorly with on-road driving assessments.[12,13] However, a recent systematic review demonstrated good correlation between driving ability and tests of attention, visuospatial cognition and executive function.[14] The many tests purporting to assess these cognitive domains differ in their completion time and training requirements to administer them. They also vary in their abilities to predict driving competence and, to date, no single cognitive test has been demonstrated to be an accurate predictor of on-road driving ability.[13–15] While there is a growing body of evidence for combining neuropsychological tests in both computerised and manual form, and the use of driving simulations,[14,15] many of these test batteries require specialist equipment and/or a longer duration of time than is available in the standard clinic setting in New Zealand. The expectation on clinicians to balance individual autonomy against their medicolegal obligation,[16] often in the absence of definitive evidence of impaired driving ability, highlights the need for commonly used or quick to administer screening tests in a standard clinic setting so that clinicians feel more confident and informed when assessing fitness to drive.[17]

Trail Making Tests (TMT) A & B are commonly used neuropsychological assessments of attention, visuospatial cognition and executive function; and they can be quickly and easily administered in clinic settings.[18] However, results of their ability to predict driving competence have been mixed, with some studies,[19,20] but not others,[21,22] correlating with on-road driving assessments. The same cognitive domains are also required to successfully navigate a maze, with research suggesting results from maze tests in both computerised[23] and written[24] form predict on-road driving performance. The Maze Navigation Test (MNT) was developed as a modification of the Porteous Maze test; it requires goal-directed navigation and obstacle avoidance through a series of eight pencil/paper mazes. The MNT has been shown to provide a reasonable approximation of driving ability and an accurate predictor of driving ability in both US[24] and New Zealand samples.[25]

The primary aim of this study was to evaluate the ability of three quick to administer cognitive tests—the MNT, MoCA and TMT A & B—to predict on-road driving performance in current drivers diagnosed with dementia in a New Zealand population.

Methods

This study was approved by the New Zealand Ministry of Health's Health & Disability Ethics Committee (HDEC), approval number 14/NTA/54

Setting and participants

Participants were recruited from the Waikato District Health Board (WDHB) Memory Service and Mental Health Services for Older People between December 2014 and February 2018. The WDHB is one of 20 DHBs in New Zealand. It has a 65+ population of 65,000 and a catchment area that covers both urban and rural areas.

The inclusion criteria were deliberately broad to keep the study as real world as possible. As such, we included individual

who had a valid driver's license (a legal requirement for the Occupational Therapy & Rehabilitation Service, OTRS, driving assessment), have a formal diagnosis of dementia (of any severity) made by a specialist psychogeriatrician as part of a multidisciplinary team (MDT), and the team have concerns about their driving ability based on their assessment that included informant history and cognitive testing. The MDT team consists of a consultant psychogeriatrician, nurse, occupational therapist, psychologist and social worker. Cognitive testing performed as part of the assessment included the MoCA and Addenbrooke's Cognitive Examination (ACE-III). Cognitive testing scores were not interpreted in isolation but used to inform the overall picture as part of the MDT assessment of driving safety. Participants were excluded if they did not hold a valid driver's license or held a valid driver's license but had already ceased driving.

In keeping with standard practice, individuals in whom driving concerns were raised by the MDT had this discussed with them as part of the assessment summary. During this discussion they were advised of these concerns and the need to satisfactorily complete an OTRS driving assessment in order to continue driving. Patients were given the OTRS driving information leaflet as well as an information sheet on the study inviting them to participate. With the potential for impaired cognitive processing and decision-making capacity in the context of a dementia, two versions of the information sheets were provided—one for the participant and another for their next of kin. Conflict of interest was minimised as it was an MDT team consensus on whether there were driving concerns present, and these patients would have been referred for an OTRS assessment regardless of the study. The first author was notified by the MDT of those given an information sheet and subsequently contacted the potential participant (usually within the next week) to discuss study participation further.

Procedure

Participants were either seen in their own home or in clinic by the first author who is a specialist psychogeriatrician, where informed consent was sought prior to commencement of the assessment. The assessment process took 30–45 minutes.

Baseline demographic data were collected, including age, gender, ethnicity, marital status, education, years of driving, rurality and dementia subtype. Participants were then administered the following psychometric tests:

Maze Navigation Test (MNT).[24] The MNT takes 10–15 minutes to administer and requires navigation through a series of eight progressively more complex pencil/paper mazes. The MNT is scored on both completion time and number of errors.

Montreal Cognitive Assessment (MoCA), version 7.1.[26] The MoCA has been developed as a screening test designed to detect mild cognitive impairment. It is scored out of 30 and with higher scores indicating better performance, and it takes approximately 10 minutes to administer. It assesses multiple cognitive domains including attention, visuospatial ability, executive function, language, orientation and memory.

Trail Making Tests A & B (TMT-A & TMT-B).[18] The TMT-A is a test of visual attention, requires the participant to connect a sequence of consecutive numbers, and is a measure of cognitive processing speed. The TMT-B is a test of task switching, requires the participant to alternate between both numbers and letters, and is a measure of cognitive flexibility. Both TMT A & B are scored on time to completion with faster times indicating better performance.

Following the psychometric tests, participants were referred to OTRS for a Ministry of Health-approved specialised driving assessment. OTRS clinicians were aware the participants had a diagnosis of dementia but were blinded to participant performance on the three psychometric tests. Median time from completing the psychometric tests to the OTRS driving assessment was 21 days (range 7–56 days). The cost of the OTRS off-road and on-road driving assessment was covered by the study.

OTRS driving assessment

The OTRS assessment consists of both an off-road and on-road assessment.

Off-road assessment

The off-road assessment takes 40–60 minutes and is carried out with the DriveSafe DriveAware (DSDA) assessment.[27] DSDA is an iPad-based cognitive screening tool designed to measure a driver's awareness of both the driving environment and their own driving

abilities. The DriveSafe component is scored out of 84, with higher scores indicating better performance. DriveSafe assesses the level of awareness across a number of driving scenarios, where the participant is shown a series of pictures of intersections for four seconds then is required to correctly answer questions pertaining to what objects were present, object location and direction of movement. DriveSafe is scored on recall accuracy as well as speed of response.

The DriveAware component is scored out of 17, with higher scores indicating better performance. DriveAware is an assessment of a drivers' insight into their potential driving difficulties and consists of seven questions. Two of the questions are a self-assessment of how the participant perceives they performed on the DriveSafe questions, with the remaining questions asked directly at the conclusion of the DriveSafe testing.

Results of the DriveSafe DriveAware (DSDA) subtests are then used to categorise participants into three groups: (i) those who would likely fail an on-road assessment, (ii) those who would likely pass and (iii) an intermediate group of those in whom further on-road testing is indicated. Since there is a separate cost for the off-road and on-road components of the OTRS assessment, usual OTRS practice is that only the intermediate group would undergo the on-road assessment. However, for the purpose of this study, all participants completed both the off-road and on-road components.

On-road assessment

The on-road assessment takes 40–60 minutes to complete and was carried out, where possible, in the participant's own car and usual driving environment. A trained driving instructor sat in the front passenger seat and provided directions of where to drive and when to turn. An OTRS occupational therapist sat in the back seat and assessed the medical fitness to drive. The assessment was across a range of driving situations and could include both controlled and uncontrolled intersections, high and low speed zones, parking and general vehicle manoeuvring.

Domains assessed during the on-road assessment included a general observation of the participant's physical ability and appropriate use of the vehicle controls, scanning the environment including use of mirrors and blind-spot checking, speed control, vehicle position, reaction time, and general planning and judgment. An overall determination of driving ability was then made with three possible outcomes: unconditional driving, driving with restrictions or driving cessation.

Data analysis

Statistical analysis was carried out using the Statistical Package for Social Sciences version 20.0 (SPSS Inc., Chicago, Il, US). Means and standard deviations were obtained for continuous demographic variables and psychometric tests. The three possible outcomes of the on-road assessment were re-categorised to a binary outcome: (i) unconditional driving and (ii) driving with restrictions or driving cessation. We decided to re-categorise the outcomes because we wanted to determine a cut-off on a psychometric test indicating a driver is no longer able to drive unconditionally; and clinicians could use this cut-off to guide their clinical practice in terms of referring the driver for further OT driving assessment, which would determine whether driving with restrictions or driving cessation is recommended. All variables were assessed for their ability to predict the binary outcome of the on-road assessment. For categorical data, Chi-square tests were used. For continuous variables, outliers were assessed for by inspection of boxplots and for normal distribution by Shapiro-Wilk's test ($p>.05$). Square-root or inverse transformations were used on positively skewed data to achieve normality. Normally distributed continuous variables were assessed by Student's t-tests and one-way ANOVA. Continuous variables with a non-parametric distribution were assessed with Mann-Whitney U tests.

Area under the Receiver Operating Characteristic (ROC) curves and optimal cut-points were calculated to determine the ability of psychometric tests to discriminate between participants who had no conditions imposed on their driving and those who received restrictions (including driving cessation).

Results

Of the 34 participants, 19 (55.9%) retained their full license, nine (26.5%) received driving restrictions, and six (17.6%) were required to cease driving. Demographic

Table 1: Demographics.

		Driving with restrictions (N=9)	Driving cessation (N=6)	Driving restrictions* (N=15)	Unconditional driving (N=19)	p-value †
Age (years)	mean (SD) Range	75.8 (5.6) 68–87	74.8 (8.9) 61–87	75.4 (6.8) 61–87	71.6 (8.3) 52–84	0.161
Gender	Male Female	3 6	3 3	6 9	14 5	0.048
Ethnicity	Pakeha Māori Other	8 1 0	5 1 0	13 2	13 2 4	0.167
Marital status	Married Widowed Other	5 4 0	1 4 1	6 8 1	14 4 1	0.127
Education	Secondary Tertiary	7 2	6 0	13 2	13 6	0.213
Years driving	Mean (SD) Range	59.9 (3.1) 56–66	51.8 (14.1) 29–70	56.4 (9.9) 29–70	55.6 (9.1) 32–69	0.810

*Driving restrictions included people who had conditional passed (N=9) and failed (N=6) the on-road driving assessment † pass vs. driving restrictions.

details are shown in Table 1. Participants had a mean age of 73.3 years and reported driving for a mean of 55.9 years. Participants were more likely to be male (58.8%), married (58.8%), New Zealand European (76.5%), live rurally (58.8%) and have secondary school as their highest level of education (76.5%). Only gender showed a statistically significant difference when comparing whether participants received restrictions on their license, with females (64%) more likely than males (30%) to have this outcome (X^2 (1, N=34) = 3.927, p=.048).

Psychometric test results are detailed in Table 2. MNT completion time (t(32)=—2.488, p=.018) predicted driving assessment outcome. TMT- A (t(32)=.089, p=.209), TMT-B (t(32)=.405, p=.082) and total MoCA score (t(31)=.208, p=.184) did not predict driving outcome. The MoCA domains of attention (*U*=51.5, z=-3.093, p=.002) and a combination of visuospatial/executive + attention (*U*=58.5, z=-2.794, p=.005), but not the other domains, predicted outcome. DSDA algorithm did not predict driving assessment outcome and did not correlate with any of the administered cognitive tests.

Area under the ROC curve and diagnostic cut-offs are presented in Table 3. Only the MoCA domains of attention (AUC .81, 95% CI .66 to .96, p=.003), a combination of the MoCA domains of attention and visuospatial/executive (AUC 0.78, 95% CI .62 to .95, p=.006), and MNT completion time (AUC .74, 95% CI .57 to .91, p=.019) were shown to predict driving restrictions following the on-road assessment.

Table 4 presents the association between psychometric tests and the on-road assessment driving domains. Using the optimal cut-scores, MNT completion time predicted performance in the on-road assessment domains of driving judgement (X^2 (1, N=34)=10.088, p=.004), vehicle position (X^2 (1, N=34) = 6.585, p=.026), speed selection (X^2 (1, N=34)=4.250, p=.039), and driver reaction time (X^2 (1, N=34) = 5.885, p=.039). The MoCA, TMT-A and TMT-B showed no association.

Table 5 describes derived optimal cut-scores for the three tests with a statistically significant AUC. The MoCA domain of attention gave an optimal cut-off of <5 (out of 6) with a sensitivity of 73.3% (95% CI

Table 2: Predictive ability of psychometric tests for overall OTRS driving assessment outcome.

		Driving with restrictions (N=9)	Driving cessation (N=6)	Driving restrictions* (N=15)	Unconditional driving (N=19)	p-value †
MoCA[a] (out of 30)	Mean (SD) Range	17.8 (3.1) 12-21	16.7 (4.5) 10-23	17.3 (3.6) 10-23	19.2 (4.1) 12–27	0.184
MoCA subdomains						
Visuospatial/Exec[b] (Out of 5)	mean (SD)	3.2 (1.3)	2.3 (1.3)	2.8 (1.4)	3.3 (1.3)	0.401
Attentionc (Out of 6)	mean (SD)	3.4 (1.4)	3.5 (1.4)	3.5 (1.4)	4.5 (1.4)	0.002
Recall[d] (Out of 5)	mean (SD)	0.7 (1.0)	1.7 (1.9)	1.1 (1.5)	0.6 (1.1)	0.381
Orientation[e] (Out of 6)	mean (SD)	4.9 (1.3)	5.3 (0.5)	5.1 (1.0)	4.7 (1.3)	0.455
Combined Visuospatial/Exec +Attention[f] (Out of 11)	mean (SD)	6.7 (1.6)	5.8 (2.2)	6.3 (1.8)	8.3 (1.9)	0.005
TMT-A[g] (s)	mean (SD) Range	46.2 (11.4) 27–63	95.3 (62.3) 41–200	65.8 (45.5) 27–200	48.4 (18.4) 21–90	0.209
TMT-B[h] (s)	Mean (SD) Range	148.0 (39.3) 81–200	264.0 (57.5) 170–300	194.4 (74.3) 81–300	150.1 (80.8) 38–300	0.082
MNT Time[i] (s)	mean (SD) Range	524.1 (215.2) 283–957	673.3 (190.9) 474–954	583.8 (212.6) 283–957	410.7 (217.6) 145–891	0.018
MNT Errors[j]	mean (SD) Range	9.9 (7.0) 3–26	12.7 (8.5) 2–26	11 (7.5) 2–26	8.4 (5.0) 1–21	0.229
DSDA[k]	Pass (N=5) Intermediate (N=8) Fail (N=21)	1 3 5	1 0 5	2 3 10	3 5 11	

*Driving restrictions included people who had conditional passed (N=9) and failed (N=6) the on-road driving assessment † pass vs driving restrictions [a]Montreal Cognitive Assessment [b]visuospatial/executive [c]attention [d]Recall [e]Orientation [f]Visuospatial/Executive + Attention [g]TMT-A -Trail making test A completion time (seconds) [h]TMT-B - Trail making test B completion time (seconds) [i]MNT time – Maze Navigation test completion time (seconds) [j]MNT errors – Maze Navigation test (total number of errors) [k]DSDA – Drive Safe Drive Aware algorithm prediction.

[a]Montreal Cognitive Assessment total score (out of 30) [b]MoCA attention domain (scored out of 6) [c]MoCA visuospatial/executive + Attention domains (scored out of 11) [d]TMT-A -Trail making test A completion time (seconds) [e]TMT-B - Trail making test B completion time (seconds) [f]MNT time – Maze Navigation test completion time (seconds)) [g]MNT errors – Maze Navigation test (total number of errors).

Table 3: ROC Area Under Curve (AUC).

	AUC (95% CI)	p-value
MoCA[a]	.620 (.425–.816)	0.240
MoCA attention[b]	.809 (.655–.963)	0.003
MoCA attention + visuospatial/executive[c]	.783 (.619–.948)	0.006
TMT-A[d]	.619 (.427–.811)	0.238
TMT-B[e]	.689 (.509–.870)	0.061
MNT time[f]	.737 (.569–.905)	0.019

[a]Montreal Cognitive Assessment total score (out of 30) [b]MoCA attention domain (scored out of 6) [c]MoCA visuospatial/executive + Attention domains (scored out of 11) [d]TMT-A -Trail making test A completion time (seconds) [e]TMT-B – Trail making test B completion time (seconds) [f]MNT time – Maze Navigation test completion time (seconds).

Table 4: Association between Psychometric tests and on-road assessment domains (p-values).

	Vehicle speed	Vehicle position	Driver judgement	Driver reaction time
MoCA[a]	.398	.538	.363	.435
MoCA attention[b]	.318	.866	.875	.691
MoCA attention + visuospatial/executive[c]	.282	.840	.651	.438
TMT-A[d]	.055	.188	.093	.277
TMT-B[e]	.357	.129	.144	.066
MNT time[f]	.039	.026	.004	.039
MNT errors[g]	.095	.013	.021	.140

44.83–91.09) and specificity of 72.2% (95% CI 46.41–89.29). The combination of MoCA domains of attention + visuospatial/executive domains gave an optimal cut-off of <8 (out of 11), with a sensitivity of 80% (95% CI 51.37-94.69) and a specificity of 66.67% (95% CI 41.15–85.64). Optimal cut-scores for the MNT of <443 seconds gave a sensitivity of 73.3% (95% CI 44.83–91.09) and a specificity of 68.4% (95% CI 43.50–86.45).

Discussion

This study assessed the ability of cognitive screening tests to predict on-road driving performance in 34 current drivers diagnosed with dementia. Only six (17.5%) drivers with dementia in this study sample failed the on-road driving assessment, a further nine (26.5%) had restrictions imposed on their license due to concerns about their driving ability, with the remaining 19 (56%) retaining full driving privileges. Consistent with previous studies,[2] the diagnosis of dementia alone in this sample did not predict on-road driving performance. Dementia severity did not appear to be an accurate predictor either, with nine (47%) of the participants who passed without restriction having a MoCA score <20/30, including one participant with a MoCA score of 12/30. A possible explanation for the high proportion of participants retaining their driver license (with or without restriction) is that those who were unsafe had already self-restricted their driving activity and were not considered as a clinical concern by the MDT team.[28,29]

Despite the participants referred to this study deemed to be at risk of unsafe driving by their MDT team, the majority still unconditionally passed the on-road assessment. This finding is consistent with previous studies showing subjective clinician judgment to be a poor accurate predictor of driving ability.[5] The finding that females were more likely to receive driving restrictions may reflect

Table 5: Sensitivity, specificity, and likelihood ratios for psychometric tests with a statistically significant AUC.

Test	Cut-point	Sensitivity	95% CI	Specificity	95% CI	+LR*	95% CI	-LR†	95% CI
MoCA Attention[a]	<5	73.33	44.90–92.21	72.22	46.52–90.31	2.64	1.18–5.90	0.37	0.15–0.90
MoCA visuospatial/executive + attention[b]	<8	80.0	51.91–95.67	66.67	40.99–86.66	2.40	1.19–4.84	0.30	0.10–0.87
MNT time[c]	<443	73.33	44.90–92.21	68.42	43.45–87.42	2.32	1.12–4.81	0.38	0.16–0.95

*Positive likelihood ratio †negative likelihood ratio [a]MoCA attention domain (scored out of 6) [b]MoCA visuospatial/executive + Attention domains (scored out of 11) [c]MNT time – Maze Navigation test completion time (seconds).

unconscious assessor gender bias or could be related to type I error due to the small sample size, as the p-value was approaching .05.

Consistent with previous studies,[14] global tests of cognition such as the MoCA did not predict driving ability. In this study, The TMT B was not shown to be an accurate predictor of driving performance, which is at odds with some previous studies.[19,30] These findings, however, are consistent with studies reporting the poor predictive ability of the TMT on driving performance in those with a known cognitive impairment.[31,32] The predictive ability of the MoCA domains of attention, attention + visuospatial/executive and MNT completion time are in line with previous studies that show tests of attention, visuospatial ability and executive function correlate with on-road driving performance.[13,14] Based on the derived cut-scores in this study, those scoring <5/6 in the domain of attention or <8/11 in the domain of attention + visuospatial/executive for the MoCA, or with a completion time of >443s for the MNT, were over twice as likely to have concerns raised about their driving following an on-road assessment. Furthermore, a higher MNT completion time or number of MNT errors predicted poor performance on specific driving domains including speed, planning, vehicle position, and reaction time. The DSDA was not an accurate predictor of driving ability, with 11 (52%) of the 21 participants assessed as likely to fail unconditionally passing the on-road assessment and only three (60%) of the five predicted to pass did so without restrictions being recommended.

This study had a number of limitations. Firstly, the relatively small sample size may mean the study was not adequately powered to detect differences in some of the psychometric tests. There may have been a referral bias present, as participants were invariably referred to the study due to concerns about their driving ability and resulted in recruitment of participants with a higher level of driving impairment. Secondly, we did not include a healthy control group for comparison. A study of healthy older drivers by Rapoport et al[33] showed a modest association between TMT-A&B performance, but not total MoCA score, on perceived driving ability and avoidance of more difficult driving situations. Despite this, healthy older drivers have been shown to perform well in on-road driving assessments, with a recent systematic review and meta-analysis finding only 1.6% of healthy older drivers compared with 33.3% of individuals with a mild dementia failed an on-road driving assessment.[34] Thirdly, the OTRS assessors were blinded to the results of the psychometric tests completed prior to their assessment. While the OTRS on-road assessment used a trained driving instructor and standardised assessment rubric, this study was based in a single centre so the results may not be applicable across other regions in New Zealand where different on-road assessments may be used. The validity of driving restrictions as an outcome is unclear, as the restrictions imposed were to limit driving to a specified radius from home and the evidence suggests most driving accidents occur near a driver's home address.[35]

While the MoCA domains of attention and visuospatial/executive, as well as MNT completion time, all predicted driving performance, the MoCA is already a familiar and commonly used cognitive screening test in primary and secondary care settings, both in New Zealand and overseas. This study provides clinicians with an interpretation of a commonly used test that can help inform the need for a specialist driving assessment.

Given the cost of specialist driving assessments, further research would be informative to explore how the less expensive standard on road driver licensing tests compare with the specialist OTRS driving assessment. It would also be informative to determine the validity of driving restriction compared to outright driving cessation as an outcome in individuals with dementia.

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The prevalence of refractive error and visual impairment among New Zealand children in a community with significant socioeconomic disadvantage: is current preschool vision screening effective?

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ABSTRACT

AIM: To examine the prevalence of refractive error and visual impairment and evaluate the efficacy of B4 School Check (B4SC) vision screening, in a cohort of predominantly New Zealand Māori and Pacific children from a community with socioeconomic disadvantage.

METHOD: A cross-sectional investigation of children in the Welcome-to-School study. Participants received a comprehensive eye examination at six to seven years of age. Refractive error and amblyopia were identified and compared with B4SC vision screening results.

RESULTS: One-hundred and fourteen children were assessed: 21.9% Māori, 57.9% Pacific and 20.2% Other. Over 30% of children had significant refractive error. Eighty-nine percent received a B4SC; 26.3% of children who passed the B4SC had significant refractive error. Seven children (6.1%) had amblyopia risk factors: none passed the B4SC, four were referred, one was identified for rescreening and two were not screened.

CONCLUSION: Refractive errors were common in this cohort. For those screened, the B4SC was effective at identifying children with amblyopia risk factors but poor at detecting refractive errors potentially affecting academic performance. The efficacy of the programme was limited by the number of children screened, inequity of screening and the mismatch between the aims of the vision screening test and the overall rationale for the B4SC.

On a typical day, around 70% of classroom time is spent performing academic tasks which require visual input.[1] Uncorrected refractive errors account for up to 96% of visual impairment in school-aged children and are associated with the development of amblyopia and strabismus.[2] Amblyopia or 'lazy eye' is a reduction in best corrected visual acuity (VA) in the presence of an amblyopia risk factor and in the absence of ocular pathology.[3] Amblyopia risk factors include anisometropia (difference in refractive error between the two eyes), bilateral high refractive error, visual pathway obstruction and strabismus ('squint' or turned eye).[3] Amblyopia treatment is most effective before seven years of age, thus it is important to identify children with amblyopia risk factors at a young age.[4] Additionally, lesser amounts of uncorrected

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hyperopia and astigmatism (irregular curvature of the cornea or lens causing blurred vision) have been associated with reduced performance in tests of early literacy, reading ability and academic achievement.[5–7]

Studies of refractive error distribution have been conducted in many countries and the prevalence, particularly of myopia, varies considerably by geographic location.[8] Population-based studies of children in Australia have shown overall refractive error prevalence of 12–14%, with higher prevalence of hyperopia and astigmatism in young school-aged children, and increased myopia prevalence in older children.[8,9] Unfortunately, similar contemporary refractive error data do not exist for New Zealand children and it is not known whether ethnic differences exist, particularly for children of Māori and Pacific ethnicities. Distance VA screening is commonly used worldwide to detect reduced vision in children. It is effective in detecting myopia but poor at detecting significant hyperopia and astigmatism as children with these conditions often achieve sufficient distance VA to pass a screening.[10] Therefore, understanding the refractive error profile of New Zealand children is essential to ensure screening strategies identify children who will benefit from refractive correction.

Preschool children in New Zealand receive a universal, free, well child check, the *B4 School Check* (B4SC), at four years of age which aims to identify behavioural, developmental and other health concerns which could negatively impact on their ability to learn in the school environment.[11] The B4SC has excellent coverage, with 96.7% of eligible children and 94.5% of children living in high deprivation communities in the Auckland region completing the check in 2017.[12] As part of the B4SC, vision-hearing technicians measure distance VA using the Parr vision chart[13] with the specific aim of identifying children who may have amblyopia.[11] Recent studies of children assessed following referral from the B4SC vision screening show high numbers of false positive referrals and low positive predictive value;[14,15] however, there are currently no data for children who passed the B4SC or did not receive screening.

The aims of this study were, therefore, to determine the prevalence of refractive error and visual impairment in a cohort of six- to seven-year-old children in the multicultural community of Tāmaki, and to evaluate the efficacy of the B4SC vision screening programme in this community.

Methods

Participants

Welcome-to-School (WTS) was a multidisciplinary collaborative study of children from schools in the Manaiakalani Community of Learning in Tāmaki: the Auckland suburbs of Glen Innes, Point England and Panmure Bridge. Children were recruited into the WTS project on school entry at five years of age. Children received a comprehensive health, developmental, educational and social assessment and appropriate referrals and linkages made. These same children and whānau were contacted by the WTS research nurse approximately a year later at six to seven years of age. This project was discussed and informed consent for formal vision assessment obtained.

Data collection

Data were collated from a parental questionnaire, a health and developmental assessment, school entry educational assessment, oral health assessment and formal speech and language assessment. Demographic data included their address, NZDepIndex (an area based measure of socioeconomic deprivation)[16] and ethnicity, defined as per New Zealand statistics Level 1.[17] B4SC results were obtained from the Well Child Manager within Planning and Funding at Auckland District Health Board.

Vision assessment

Two authors (RF and JB) conducted comprehensive eye examinations of the participating children in their schools. Vision assessment comprised measurement of distance VA using the Electronic Amblyopia Treatment Study (e-ATS) protocol presented on an Electronic Visual Acuity (EVA) testing system (JAEB Centre for Health Research)[18] viewed at 3m; and near VA using the Sloan Letter Near LogMAR acuity chart (Good-Lite Company) viewed at 40cm. Binocular vision assessment included the cover test for detection and measurement of strabismus, near point of convergence using

Table 1: Definition of significant refractive error.[21]

Refractive error (either eye)	Refractive error (D)
Myopia*	≤-0.50
Hyperopia*	≥+2.00
Astigmatism	≥0.75

*Spherical equivalent.

the Royal Air Force (RAF) rule (Good-Lite Company),[19] ocular motility assessment and measurement of near stereoacuity using the Randot Preschool Stereotest at 40cm (2012, Stereo Optical Company Inc).[20]

Non-cycloplegic autorefraction was measured with the Spot Vision Screener VS100 (Welch Allyn Inc) and the Nidek ARK-30 Type R (Nidek Co Ltd). Following cycloplegia (a minimum of 40 minutes after instillation of one drop of cyclopentolate 1% and when pupils were no longer reactive), autorefraction was repeated and cycloplegic retinoscopy was performed.

Ocular health was evaluated by assessment of pupillary reactions, slit lamp evaluation of the anterior segment and binocular indirect ophthalmoscopy.

Definitions

Significant refractive error (refractive error requiring glasses; Table 1) and visual impairment (Table 3) were defined according to the Refractive Error Studies in Children group.[21] Amblyopia risk factors were defined as presence of refractive error thought to induce amblyopia, visual pathway obstruction or strabismus (Table 2).[3] Convergence insufficiency was defined as exophoria greater at near than distance and receded near point of convergence.[22]

Analysis

Each participant was assessed for significant refractive error, amblyopia risk factors and ocular pathology. The results were compared with their B4SC vision screening results. Data analysis was conducted using IBM SPSS Statistics (Version 25, IBM Corporation, US). Descriptive statistics were used to summarise the data. The chi-squared test was used to compare the prevalence of significant refractive error between different ethnic groups.

Ethics approval was attained from the Central Health and Disability Ethics Committee of the New Zealand Ministry of Health with an amendment to the protocol (15/CEN/224/AM04). The research followed the tenets of the Declaration of Helsinki and parental consent for a comprehensive vision assessment was obtained for all participants.

Table 2: Definition of amblyopia risk factors.[3]

	Refractive error (D)
Anisometropia	
Myopia*	≥2.50
Hyperopia*	≥1.50
Astigmatism	≥1.50
Bilateral refractive error	
Myopia*	≥2.50
Hyperopia*	≥3.50
Astigmatism	≥1.50
Visual pathway obstruction	
Strabismus	

*Spherical equivalent.

Table 3: Visual Impairment categories.[21]

	Visual Acuity (LogMAR)
No visual impairment either eye	0.2 (6/9.5) or better both eyes
Visual impairment one eye	0.2 (6/9.5) or better one eye only
Mild visual impairment	0.3 (6/12) to 0.5 (6/19) better eye
Moderate visual impairment	0.6 (6/24) to 0.9 (6/48) better eye
Severe visual impairment	Worse than 1.0 (6/60) better eye

Results

Study population

120 children were enrolled in WTS. Consent for vision assessment was obtained for 115 children: full consent for 113 children and consent for examination without cycloplegia for two children. Vision testing was completed for 114 children: one child left their school before vision assessment was completed.

Demographic characteristics

All children lived in a community with significant socioeconomic disadvantage; NZDepIndex quintile 5. The mean age at testing was 6.72 years (range 6.14–7.24 years). There were more boys than girls in the cohort and the majority were of New Zealand Māori or Pacific ethnicities (Table 4).

Refractive error

Thirty-six participants (31.6%) had significant refractive error, most commonly astigmatism (29 participants, 80.6% of refractive errors, all 'with-the-rule' with the steepest meridian vertically). Seven participants (6.1%) had amblyopia risk factors: two anisometropia, four bilateral astigmatism and one bilateral hyperopia. Two of these participants also had strabismus.

There was no difference in the prevalence of refractive errors between ethnic groups (Table 5; chi-squared, z=2.866, df=2, p=0.239).

Visual impairment

No participant had binocular distance visual impairment; all participants had unaided distance VA of 0.2 logMAR or better in at least one eye and 97.4% of participants had unaided distance VA of 0.2 logMAR or better in both eyes (Table 6). Causes of distance visual impairment were astigmatism (1, 0.9%), myopia (1, 0.9%) and anisometropia (1, 0.9%). Binocular near visual impairment was identified in 14 participants and a further 11 participants had monocular near visual impairment.

Binocular function

Three participants (2.6%) had binocular vision abnormalities. Two (1.8%) had strabismus for which they were under care: one was referred following the B4SC and the other did not receive a B4SC and was referred following the WTS assessment. A third participant had convergence insufficiency.

Table 4: Demographic characteristics.

	n (%)
Gender	
Female	51 (44.7)
Male	63 (55.3)
Ethnicity	
NZ Māori	25 (21.9)
Pacific (Tongan, Samoan, CI Maori, Other)	66 (57.9)
Other (NZ European, Asian, European)	23 (20.2)

Table 5: Prevalence of refractive error and amblyopia risk factors.

	NZ Māori n (%)	Pacific n (%)	Other n (%)	Total n (%)
Myopia ≤-0.50	0 (0)	4 (6.1)	0 (0)	4 (3.5)
Hyperopia ≥+2.00	3 (12.0)	4 (6.1)	0 (0)	7 (6.1)
Astigmatism ≥0.75	8 (32.0)	16 (24.2)	5 (21.7)	29 (25.4)
Any refractive error	**11 (44.0)**	**20 (30.3)**	**5 (21.7)**	**36 (31.6)**
Amblyopia risk factors	**2 (8.0)**	**5 (7.6)**	**0 (0)**	**7 (6.1)**

Note: Three participants had myopia and astigmatism and one participant had hyperopia and astigmatism.

Ocular health evaluation

No anterior or posterior segment pathology was detected.

Efficacy of the B4SC vision screening

A significant number of children (13, 11.4%) did not receive a B4SC vision screening; one (0.9%) declined screening while 12 (10.5%) were unable to be contacted or scheduled (Table 7). A similar number (12, 10.5%) were identified for rescreening (borderline or inconclusive result), which had not been completed. No child with amblyopia risk factors passed the B4SC vision screening; however, two did not receive screening and one was identified for rescreening but did not receive follow-up. These children, therefore, remained undiagnosed at the time of WTS data collection. Eight children (7.0%) were referred from B4SC vision screening; six of these had significant refractive error and four also had amblyopia risk factors.

Vision correction

Only five of the 36 participants with significant refractive error (13.9%) and four of the seven participants with amblyopia risk factors (57.1%) were wearing glasses at the time of our assessment. More than half of the participants with significant refractive error (21/36, 58.3%) passed their B4SC vision screening and none of these had glasses at the time of our assessment.

Discussion

Almost one-third of six- to seven-year-old children in Tāmaki had significant refractive errors likely to affect reading development and academic achievement,[5–7] most of which were previously undetected. Over 80% of refractive errors were astigmatism, a prevalence similar to that seen in studies of specific populations of school-aged children in the Americas but lower than countries in the Western Pacific region.[8] The prevalence of myopia (3.5%) and hyperopia (6.1%) were low, similar to that seen in six-year-old children in Australia[9] and much lower than myopia prevalence reported in East Asian countries.[8]

The prevalence of unaided distance visual impairment in this cohort was low. All participants had VA of 0.2 logMAR or better in at least one eye and only three

Table 6: Prevalence of unaided distance and near visual impairment.

	Unaided distance VA n (%)	Unaided near VA n (%)
No visual impairment either eye	110 (97.4)	88 (77.9)
Visual impairment one eye	3 (2.6)	11 (9.7)
Mild visual impairment	0 (0)	13 (11.4)
Moderate visual impairment	0 (0)	1 (0.9)
Severe visual impairment	0 (0)	0 (0)

Table 7: B4SC vision screening outcomes, significant refractive error and amblyopia risk factors.

B4SC outcome	Cohort n (%)	Significant refractive error n (%)	Amblyopia risk factors n (%)
Pass bilaterally	80 (70.2)	21 (58.3)	0 (0)
Rescreen	13 (11.4)	4 (11.1)	1 (14.3)
Referred	8 (7.0)	6 (16.7)	4 (57.1)
Declined	1 (0.9)	0 (0)	0 (0)
Not screened	12 (10.5)	5 (13.9)	2 (28.6)
Total	114 (100.0)	36 (31.6)	7 (6.1)

participants (2.6%) had monocular visual impairment, a level similar to that reported in six-year-old Australian children.[23] Children with higher levels of astigmatism (>1.50D) can frequently achieve unaided distance VA of 0.2 LogMAR or better,[10] which was the source of the disparity between refractive error prevalence and visual impairment in this cohort. Correction of astigmatism of 0.75D or more is, however, recommended in published guidelines, even in children without symptoms.[24]

Although most children in New Zealand receive a B4SC vision screening, inequities are evident and a significant number of children in this cohort failed to benefit from this health initiative. While the screening was effective in detecting amblyopia, it was ineffective in detecting refractive error in this population with predominantly astigmatism. Consequently, many children in this cohort started school with uncorrected refractive errors potentially impacting their academic performance.[5–7] Therefore, for these children, the current B4SC vision screening did not meet the overall aim of the B4SC to detect conditions that may adversely affect a child's ability to learn in the school environment. Additionally, 10.5% of children in this cohort were not screened and a further 11.4% were recommended for rescreening, which was not performed before school entry. Many of these children with uncompleted screenings had amblyopia risk factors and significant refractive error. In 2017, in the Auckland and Waitemata District Health Board catchment areas, 5.3% of children from high deprivation households did not receive a B4SC vision screening and 7.5% were recommended for rescreening whereas in the most advantaged areas 4.9% were not screened and 4.3% were recommended for rescreening.[12] Differing models are required to ensure all children receive screening and appropriate eyecare prior to school entry, irrespective of ethnicity and the community they live in.[25]

For this cohort living in socioeconomic deprivation, accessing eyecare services appears to have been problematic. Six children with significant refractive error were referred from the B4SC vision screening, but only four were wearing glasses. Moreover, nearly 60% of children with significant refractive error passed the screening and none of these children were wearing glasses at our assessment, suggesting no access to eyecare following screening. This is consistent with a UK study that found seven year old children from lower socioeconomic groups were less likely to have seen an eyecare specialist than those from more advantaged groups.[26] Previous studies have noted financial, logistical, social and perceptual issues prevent families from obtaining a vision assessment following a failed screening.[27] Additionally, there is increasing evidence that cultural factors including racism and lack of trust in healthcare systems influence access and utilisation by Māori and Pacific whānau.[28] Optometry services in New Zealand are not government funded, and while limited subsidies are available for prescription glasses, the process can be difficult to navigate. Cost should not be a barrier for good care for children and funding for eyecare services should be available for all children. Culturally appropriate coordination is necessary to ensure children who

are referred or identified for rescreening receive follow up and to assist whānau in accessing services.

The false positive referral rate from the B4SC vision screening in this cohort was low, with 75% of those referred having significant refractive error. This is contrary to previous retrospective reviews of B4SC vision screening referrals in New Zealand which found only 30–50% of children referred from vision screening had diagnosed vision conditions.[14,15] The reasons for this disparity are unclear: screening and referral processes appear to differ between district health boards and higher prevalence of the condition in the target population improves the positive predictive value of the test, which may explain the differences between the studies.

Three children in this cohort presented with binocular vision abnormalities. Children with co-existing significant refractive error had been identified and referred for treatment. VA screening, however, is unlikely to identify children with intermittent or alternating strabismus without significant refractive error. Convergence insufficiency is also unlikely to be detected by VA screening and is associated with symptoms such as discomfort, loss of concentration, slow reading and need to re-read when completing near tasks.[22]

Limitations of this study include the small sample size, which reduces the power to detect statistically important differences, particularly for comparing differences between ethnic groups. The children in this study received their B4SC vision screening at four to five years of age while formal vision assessment was conducted at six to seven years of age, so the magnitude of refractive error may have changed between the two assessments. Previous studies, however, suggest that astigmatism remains stable or reduces across this age range.[29] Although this was a prospective cohort study, there was no control group and it is unclear whether the effects are a result of socioeconomic status, ethnicity or other factors.

Further investigation is necessary to determine the refractive error profile across a broader cross-section of New Zealand children and to establish methods of vision screening most effective for this population. A previous study found autorefraction superior to VA screening for detection of astigmatism,[30] and the prevalence of near visual impairment was greater than distance visual impairment in this cohort, suggesting alternative screening strategies may be more appropriate to detect refractive error in the New Zealand population. The current Well Child Tamariki Ora review provides an opportunity to re-examine the rationale for the preschool vision screening and follow-up protocol. Additionally, research addressing attitudes and beliefs towards the B4SC vision screening and vision correction in children is required.

In conclusion, almost one third of children in this ethnically diverse cohort with known socioeconomic disadvantage had significant refractive error. The current B4SC vision screening was effective in detecting amblyopia but poor at detecting significant refractive error. As the goal of the B4SC is to detect and intervene on issues which could adversely impact educational outcomes, this research highlights a mismatch between the current vision screening protocol and the intent of the B4SC programme, particularly for socioeconomically disadvantaged Māori and Pacific children. This mismatch, in combination with the differential reach of the B4SC, is likely to be increasing inequities. This study suggests that urgent attention is required to review the B4SC vision screening protocol to ensure it is appropriate and equitable, so all children receive high-quality vision screening and eyecare to improve their health, educational and social outcomes.

Competing interests:
Nil.
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The characteristics and outcomes of patients with colorectal cancer in New Zealand, analysed by Cancer Network

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ABSTRACT

AIM: The incidence of colorectal cancer (CRC) in New Zealand is high by international standards. Approximately 1,200 people in New Zealand die from this disease per year. Outcomes in New Zealand following a CRC diagnosis are poor. We aimed to describe the characteristics and outcomes of patients diagnosed with CRC across the four regional cancer networks in New Zealand.

METHOD: Patient demographics, tumour characteristics and survival outcomes for all patients diagnosed with CRC between 2006 and 2015 were analysed retrospectively from the National Cancer Registry (NZCR) and National Mortality collection and were linked by National Health Index (NHI) number.

RESULTS: A total of 29,221 CRC cases were recorded during the 10-year study period, of which the majority were cancer of the colon (67.9%). In this sample, 42.0% were >75 years, 52.1% were male and 88.1% were New Zealand European. After adjustment for factors such as age, gender, ethnicity year of diagnosis, cancer extent, cancer grade, lymph node and cancer site, cancer-related and all-cause survival were not significantly different by cancer network for those aged <75 but for patients aged >75 years, those living in the Central and Midland Cancer Network had a higher risk of dying of CRC compared to those in the Northern Cancer Network (1.12, 95% CI: 1.03–1.22 and 1.10, 95% CI: 1.02–1.18 respectively). Overall, Māori and Pacific people had worse cancer-specific and all-cause survival than New Zealand European.

CONCLUSION: No regional variations were seen within New Zealand for the characteristics and survival outcomes of patients <75 diagnosed with CRC. The risk of dying from CRC increased for those >75, which is supportive of the international literature regarding outcomes for the elderly and CRC. We continue to show disparity in outcomes for Māori and Pacific patients diagnosed with CRC in New Zealand.

Colorectal cancer (CRC) is the second most common cancer in New Zealand.[1] Almost 3,500 new cases were registered in New Zealand in 2018, with around 1,200 deaths.[2] The incidence of CRC in New Zealand is high by international standards; the GLOBOCAN age-standardised estimated incidence rate shows Australia and New Zealand as having the highest rates of CRC in the world.[2] Outcomes in New Zealand are poor; five-year survival rates in New Zealand following a CRC diagnosis are lower than Australia.[3–5] Stage of disease at diagnosis, Māori ethnicity, deprivation level and rate of presentation to hospital emergency departments[5,6] are contributing factors associated with poorer outcomes.

Worldwide, a higher incidence of CRC occurs in those aged 70 years or more.[7–9] Increasing levels of comorbidity[7,10–13] together with higher risk of functional and cognitive impairment[12] contribute to poorer outcomes for elderly compared to younger patients. Higher rates of comorbidity and increasing frailty results in older patients being less likely to access treatment,[11,14–16]

have higher rates of emergency surgery and have significant risk of mortality at 90 days post-surgery.[17] An assessment of cancer survival in seven high-income countries from 1995–2014 demonstrated an increase in age standardised five-year net survival in New Zealand for both colon and rectal cancer in those aged <75, but a decrease for those aged >75 diagnosed with colon cancer.[18] Thus, New Zealand data are supportive of the international literature, where poor survival is noted with increasing age, particularly for those aged 80 and over[8,16,19] with little improvement over time despite advances in treatment options.

New Zealand is divided into four regional cancer networks: the Northern, Midland, Central and Southern Cancer Networks. Within these regional networks are several district health boards (DHBs) that provide for the health needs of the local population: the Northern Cancer Network covers the Northland, Auckland, Counties Manukau and Waitemata DHBs, the Midland Cancer Network covers Waikato, Lakes, Bay of Plenty and Tairawhiti, and the Central Cancer Network encompasses Taranaki, Whanganui, MidCentral, Hawke's Bay, Wairarapa, Hutt Valley and Capital and Coast DHBs. The Southern Cancer Network encompasses the whole of the South Island. This study aimed to quantify the outcomes of patients diagnosed with CRC in New Zealand using national databases across these four regional networks.

Method

This study retrospectively reviewed patients diagnosed with CRC (ICD-10-AM codes C18–C20) in New Zealand between 01 January 2006 and 31 December 2015. Eligible patients were identified from the New Zealand Cancer Registry (NZCR). Their mortality information was obtained from the Mortality Collection and linked by National Health Index (NHI) number.

The combined dataset consisted of: 1) patient demographics: date of birth, gender, ethnicity and district health board (DHB); 2) tumour characteristics: date of diagnosis, cancer site, cancer extent and number of positive lymph nodes; and 3) date of death and cause of death. Age at diagnosis was categorised into five groups: <55, 55–64, 65–74, 75–84 and 85+ years. Ethnicity was classified into New Zealand European, Māori, Pacific, Asian and others as recorded on the NZCR using prioritisation to manage multiple ethnicities. Patients were grouped into one of the four cancer networks based on their domicile: Central, Midland, Northern or Southern Cancer Network. The NZCR records cancer stage and uses both the Tumour Node Metastases (TNM) staging system[20] and the Surveillance Epidemiology and End Results (SEER) programme of cancer staging definitions.[21] Complete SEER staging was recorded for 81% of CRC patients.

Patient and tumour characteristics were compared between the four cancer networks and the differences were examined with Chi-square tests. Patients were considered to be censored on the date of death or the last updated date of Mortality Collection, which was 31 December 2015. Survival analyses were stratified by patients aged less than 75 years and patients aged 75 years or over. The Kaplan-Meier method was used to estimate the colorectal cancer-specific survival and all-cause survival by cancer network. A Cox proportional hazards model was used to estimate the hazard ratios of colorectal cancer-specific survival and all-cause survival by cancer network after adjustment for ethnicity, gender, year of diagnosis, cancer extent, cancer grade, lymph node and cancer site. All data analyses were performed in IBM SPSS statistics 25 (New York, US). The study was approved by the Health and Disability Ethics Committee (HDEC) –17/NTB/156.

Results

Patient and tumour characteristics by cancer network are shown in Table 1. In the 10-year period, 2006–2015, 29,221 people were diagnosed with CRC in New Zealand. Of these, 52.1% of patients were male. Overall, 88.1% were New Zealand European and only 5.4% were Māori. The Midland Cancer Network had the highest proportion of Māori patients (8.7% vs 2.7–6.0%), the Northern Cancer Network had the highest proportion of Asian (6.6% vs 1.0–2.0%) and Pacific patients (4.8% vs 0.3–1.7%), while the Southern Cancer Network was 95% New Zealand European. Patients in the Central and the Midland Cancer Network were younger and less likely to be diagnosed at age >75 years (33.3% and 34.0%, p<0.001)

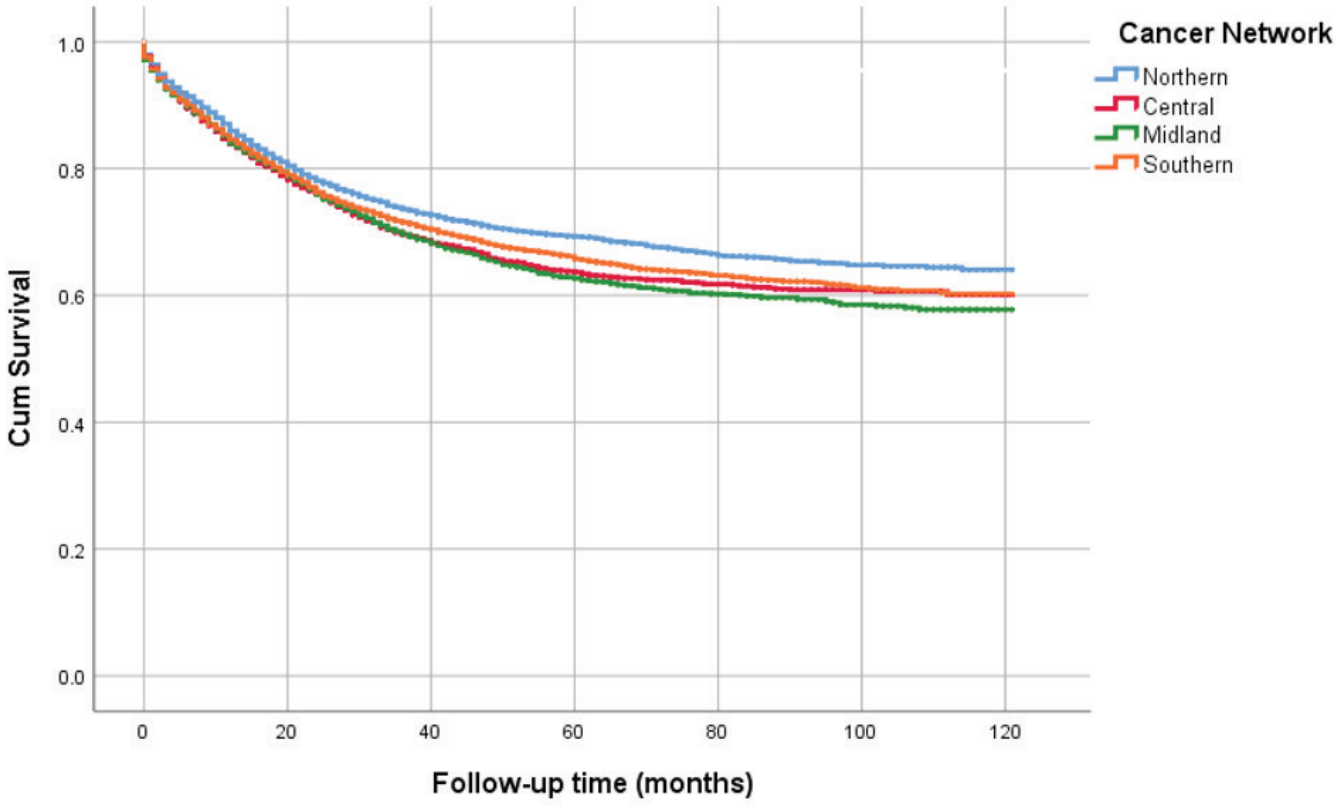
Table 1: Patient and tumour characteristics by Cancer Network.

Characteristics	Central		Midland		Northern		Southern		P-value	Unknown		Total	
Gender													
Female	2,778	48.6%	2,886	47.8%	4,112	46.8%	4,201	48.7%	0.065	25	43.1%	14,002	47.9%
Male	2,941	51.4%	3,156	52.2%	4,665	53.2%	4,424	51.3%		33	56.9%	15,219	52.1%
Ethnicity									<0.001				
Asian	116	2.0%	67	1.1%	575	6.6%	83	1.0%		3	5.2%	844	2.9%
European	5,078	88.8%	5,336	88.3%	7,093	80.8%	8,205	95.1%		39	67.2%	25,751	88.1%
Māori	344	6.0%	523	8.7%	493	5.6%	229	2.7%		1	1.7%	1,590	5.4%
Pacific	99	1.7%	31	0.5%	421	4.8%	29	0.3%		10	17.2%	451	1.5%
Others	82	1.4%	85	1.4%	195	2.2%	79	0.9%		5	8.6%	585	2.0%
Age group									<0.001				
<55	669	11.7%	644	10.7%	1,169	13.3%	838	9.7%		12	20.7%	3,332	11.4%
55–64	929	16.2%	947	15.7%	1,591	18.1%	1,460	16.9%		18	31.0%	4,945	16.9%
65–74	1,644	28.7%	1,795	29.7%	2,534	28.9%	2,735	31.7%		17	29.3%	8,725	29.9%
75–84	1,743	30.5%	1,946	32.2%	2,446	27.9%	2,576	29.9%		9	15.5%	8,720	29.8%
85+	734	12.8%	710	11.8%	1,037	11.8%	1,016	11.8%		2	3.4%	3,499	12.0%
Cancer site									<0.001				
C18	3,884	67.9%	4,191	69.4%	5,810	66.2%	5,919	68.6%		40	69.0%	19,844	67.9%
C19	336	5.9%	411	6.8%	699	8.0%	562	6.5%		2	3.4%	2,010	6.9%
C20	1,499	26.2%	1,440	23.8%	2,268	25.8%	2,144	24.9%		16	27.6%	7,367	25.2%
Extent									<0.001				
B	1,261	28.2%	1,544	30.7%	2,122	29.6%	1,997	28.2%		9	19.1%	6,933	29.1%
C	778	17.4%	801	15.9%	1,307	18.2%	1,281	18.1%		10	21.3%	4,177	17.5%
D	1,291	28.9%	1,476	29.3%	2,075	28.9%	1,996	28.2%		15	31.9%	6,853	28.8%
E	1,141	25.5%	1,216	24.1%	1,677	23.4%	1,816	25.6%		13	27.7%	5,863	24.6%
F	1,248		1,005		1,596		1,535			11		5,395	
Grade									<0.001				
1	238	5.0%	577	11.4%	1,317	19.0%	460	7.0%		9	20.9%	2,601	11.1%
2	3,610	75.7%	3,503	69.2%	4,550	65.6%	4,517	68.7%		27	62.8%	16,207	69.3%
3	861	18.1%	896	17.7%	852	12.3%	1,524	23.2%		6	14.0%	4,139	17.7%
4	59	1.2%	88	1.7%	215	3.1%	75	1.1%		1	2.3%	438	1.9%
Unknown	951		978		1,843		2,049			15		5,836	
Lymph nodes									0.115				
No positive nodes	1,964	55.9%	2,206	56.8%	3,212	57.4%	3,232	58.4%		20	52.6%	10,634	57.3%
Positive nodes	1,549	44.1%	1,678	43.2%	2,381	42.6%	2,303	41.6%		18	47.4%	7,929	42.7%
Unknown	2,206		2,158		3,184		3,090			20		10,658	
Total	**5,719**		**6,042**		**8,777**		**8,625**			**58**		**29,221**	

C18: Malignant neoplasm of colon,
C19: Malignant neoplasm of rectosigmoid junction
C20: Malignant neoplasm of rectum
Extent
B: Localised to organ of origin
C: Invasion of adjacent tissue or organ
D: Regional lymph nodes
E: Distant
F: Unknown

Figure 1: Colorectal cancer-specific survival by cancer network: (a) <75 years (p=0.000); (b) ≥75 years (p=0.005).

a)



b)

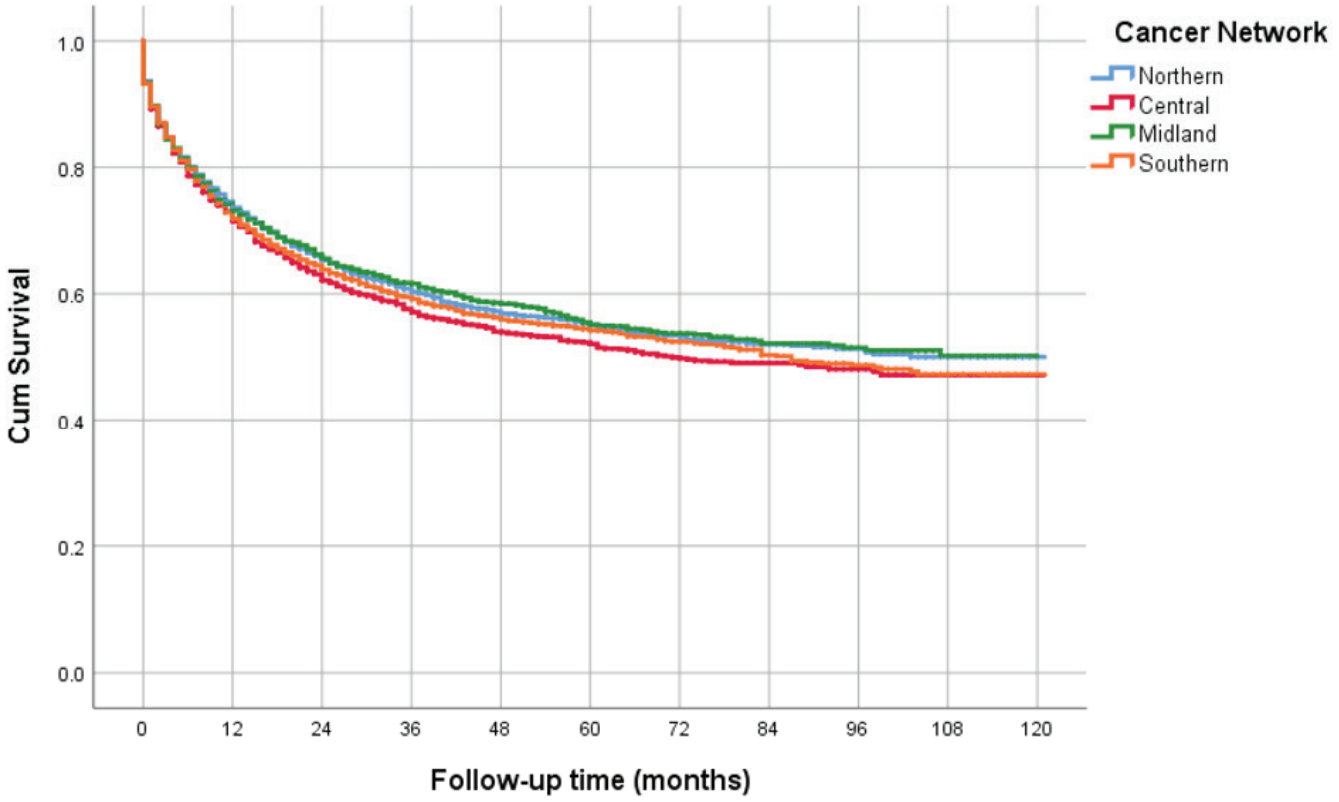


Figure 2: All-cause survival by cancer network: (a) <75 years (p=0.000); (b) ≥75 years (p=0.114).

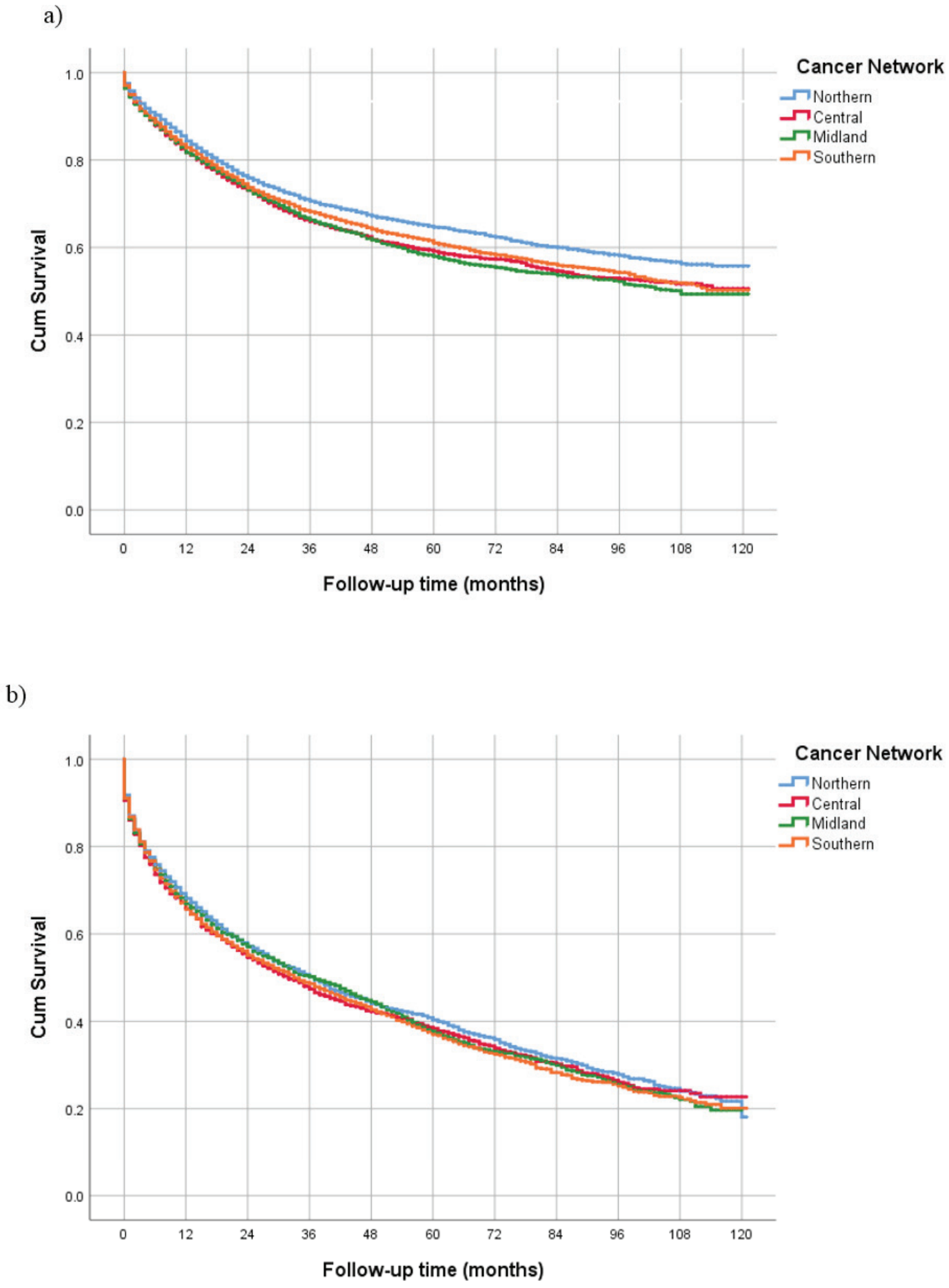


Table 2: Hazard ratios for cancer-specific mortality and all-cause mortality for patients aged <75.

	Cancer-specific mortality				All-cause mortality			
Factors	**p-value**	**Hazard ratio**	**95% CI**		**p-value**	**Hazard ratio**	**95% CI**	
			Lower	**Upper**			**Lower**	**Upper**
Age (continuous)	<0.001	1.02	1.01	1.02	<0.001	1.02	1.02	1.03
Ethnicity								
European	Ref				Ref			
Māori	<0.001	1.30	1.18	1.43	<0.001	1.41	1.30	1.54
Pacific	0.170	1.12	0.95	1.31	0.027	1.18	1.02	1.37
Asian	0.001	0.73	0.60	0.88	<0.001	0.69	0.58	0.83
Others	<0.001	0.35	0.25	0.49	<0.001	0.30	0.22	0.42
Gender								
Female	Ref				Ref			
Male	0.003	1.09	1.03	1.16	<0.001	1.13	1.07	1.19
Year (continuous)	<0.001	0.94	0.93	0.95	<0.001	0.95	0.94	0.96
Cancer Network								
Central	0.330	1.04	0.96	1.13	0.082	1.07	0.99	1.16
Midland	0.452	1.03	0.95	1.12	0.306	1.04	0.96	1.12
Northern	Ref				Ref			
Southern	0.052	0.93	0.86	1.00	0.147	0.95	0.89	1.02
Extent								
B	Ref				Ref			
C	<0.001	2.92	2.43	3.52	<0.001	1.75	1.53	2.00
D	<0.001	4.46	3.74	5.31	<0.001	2.42	2.11	2.77
E	<0.001	21.84	18.67	25.55	<0.001	10.83	9.67	12.12
Grade								
1	Ref				Ref			
2	0.011	1.17	1.04	1.33	0.028	1.13	1.01	1.26
3	<0.001	2.16	1.90	2.46	<0.001	1.96	1.75	2.20
4	0.008	1.57	1.12	2.21	0.002	1.60	1.18	2.16
Lymph node								
No positive nodes	Ref				Ref			
Positive nodes	<0.001	1.69	1.48	1.93	<0.001	1.45	1.29	1.63
Cancer site								
C18	Ref				Ref			
C19	0.043	0.90	0.81	1.00	0.043	0.91	0.83	1.00
C20	<0.001	0.71	0.66	0.77	<0.001	0.71	0.67	0.77

C18: Malignant neoplasm of colon,
C19: Malignant neoplasm of rectosigmoid junction
C20: Malignant neoplasm of rectum
Extent
B: Localised to organ of origin
C: Invasion of adjacent tissue or organ
D: Regional lymph nodes
E: Distant
F: Unknown

Table 3: Hazard ratios for cancer-specific mortality and all-cause mortality for patients aged ≥75 years.

	Cancer-specific mortality				All-cause mortality			
Factors	**p-value**	**Hazard ratio**	**95% CI**		**p-value**	**Hazard ratio**	**95% CI**	
			Lower	**Upper**			**Lower**	**Upper**
Age (continuous)	<0.001	1.04	1.04	1.05	<0.001	1.06	1.05	1.06
Ethnicity								
European	Ref				Ref			
Māori	0.564	1.06	0.88	1.27	<0.001	1.29	1.12	1.49
Pacific	0.026	1.35	1.04	1.75	0.020	1.32	1.04	1.66
Asian	0.030	0.76	0.60	0.97	0.011	0.77	0.63	0.94
Others	0.001	0.45	0.27	0.73	<0.001	0.36	0.23	0.55
Gender								
Female	Ref				Ref			
Male	0.572	1.02	0.96	1.08	<0.001	1.12	1.06	1.17
Year (continuous)	<0.001	0.96	0.95	0.97	<0.001	0.97	0.96	0.98
Cancer Network								
Central	0.006	1.12	1.03	1.22	0.016	1.09	1.02	1.17
Midland	0.098	1.07	0.99	1.17	0.008	1.10	1.02	1.18
Northern	Ref				Ref			
Southern	0.892	1.01	0.93	1.09	0.256	1.04	0.97	1.11
Extent								
B	Ref				Ref			
C	<0.001	2.46	2.10	2.88	<0.001	1.39	1.26	1.53
D	<0.001	3.81	3.19	4.55	<0.001	1.99	1.75	2.27
E	<0.001	13.18	11.32	15.36	<0.001	5.81	5.24	6.43
Grade								
1	Ref				Ref			
2	<0.001	1.33	1.15	1.54	0.002	1.17	1.06	1.30
3	<0.001	1.94	1.66	2.26	<0.001	1.56	1.39	1.75
4	<0.001	1.94	1.47	2.56	0.002	1.48	1.16	1.89
Lymph node								
No positive nodes	Ref				Ref			
Positive nodes	<0.001	1.42	1.22	1.65	0.030	1.14	1.01	1.29
Cancer site								
C18	Ref				Ref			
C19	0.136	0.91	0.80	1.03	0.046	0.90	0.81	1.00
C20	<0.001	0.80	0.73	0.86	<0.001	0.78	0.73	0.83

C18: Malignant neoplasm of colon,
C19: Malignant neoplasm of rectosigmoid junction
C20: Malignant neoplasm of rectum
Extent
B: Localised to organ of origin
C: Invasion of adjacent tissue or organ
D: Regional lymph nodes
E: Distant
F: Unknown

than patients in the Northern and Southern Cancer Network (39.7% and 41.7%, p<0.001). Patients in the Central Cancer Network were more likely to have rectal cancer (C20: 26.2% vs 23.8–25.8%, p<0.001) than the other cancer networks. Patients in the Northern Cancer Network had more grade 1 cancer (19.0% vs 5.0–11.4%), but more grade 4 cancer (3.1% vs 1.1–1.7%) than other regions (p<0.001). The proportion of patients reporting positive lymph nodes were similar across the four cancer networks.

The observed regional difference in survival was greater in patients under 75 years than in patients aged 75 years or older (Figures 1 and 2). Patients aged less than 75 years in the Northern Cancer Network had the best survival: five-year cancer-specific survival of 69.2% (67.7–70.6%) and five-year all-cause survival of 64.9% (63.4–66.3%); while their counterparts in the Midland Cancer Network had the worst survival: five-year cancer-specific survival of 62.9% (61.0–64.8%) and five-year all-cause survival of 58.3% (56.4–60.2%). For patients aged 75 years or older, the five-year all-cause survival between the four cancer networks was similar (p=0.114) (Figure 2B) while there were small differences in cancer-specific survival between regions (Figure 1B).

Cancer-specific survival and all-cause survival improved over time for both patients under 75 years and patients aged 75 years or older, after adjustment for other factors (Tables 2 and 3). The risk of dying of CRC and the risk of dying from other causes both increased with age. Men under 75 years were more likely to die of CRC compared to women, but men aged 75 years or older had a similar risk. For patients aged under 75 years, Māori had the highest hazard ratio of cancer-specific mortality (1.30, 95% CI: 1.18–1.43) and the highest hazard ratio of all-cause mortality (1.41, 95% CI: 1.30–1.54) compared to New Zealand European (Table 2). However, for patients age 75 years or older, Pacific patients had the highest hazard ratio of cancer-specific mortality (1.35, 95% CI: 1.04–1.75) and the highest hazard ratio of all-cause mortality (1.32, 95% CI: 1.04–1.66) compared to New Zealand European (Table 3). After adjustment in a multivariate analysis for other factors (age, ethnicity, gender, year of diagnosis, cancer extent, cancer grade, lymph node and cancer site), the differences in the cancer-specific mortality and all-cause mortality for patients aged less than 75 years between the four cancer networks disappeared. However, for patients aged 75 years or older, those resident in the Central and Midland Cancer Network had a higher risk of dying of CRC compared to patients in the Northern Cancer Network (1.12, 95% CI: 1.03–1.22 and 1.10, 95% CI: 1.02–1.18 respectively). For both cancer-specific mortality and all-cause mortality for patients under 75 years and patients aged 75 years or older, the risk was higher in patients with colon cancer, patients with more extensive cancer, patients with higher grade of cancer and patients with positive lymph nodes.

Discussion

New Zealand has high rates of CRC, and poorer outcomes compared to International Cancer Benchmarking Partnership (ICPB) and GLOBOCAN data.[2,18] After adjustment for patient and tumour factors, there was no significant difference in survival between regions for those aged <75, but for those aged >75 there were small regional differences.

Cancer-specific and all-cause mortality increased with age. Poor CRC survival with increasing age has been reported internationally,[8,16,19] and is attributed to higher levels of functional limitation[12] and multi-comorbidity in older patients.[7,10,11] Patients aged <75 and living in the Northern Cancer Network had the best five-year all cause and cancer-specific survival, and patients living in the Midland Cancer Network had the worst. However, after adjustment for patient and tumour-related factors these regional variations were no longer important. One important factor was that although Māori only account for 5.4% of cases, outcomes for Māori are poor, with an unadjusted HR for cancer-specific survival of 1.3 and all-cause survival of 1.41 in patients <75. The Midland region had the highest proportion of Māori and this may account for some of the disparity in outcomes. Another factor was tumour characteristics. The Midland region also had a greater proportion of colon cases. Cancer-specific outcomes for rectal cancer were 20% better than outcomes for colon cancer. Thus after adjustment for a number of patient and tumour factors, including

ethnicity and tumour location, we can see that the impact of the health services in each region seems to result in equitable outcomes, especially for those <75.

Māori and Pacific patients <75 had worse all-cause and cancer-specific survival than New Zealand European. Historically, Māori have a lower incidence of CRC compared to New Zealand European,[22–24] but this incidence has been rising.[5] Our data are consistent with poorer health outcomes often observed in Māori and Pacific cancer patients in New Zealand[6,25–28] and is in line with reported survival rates of indigenous and ethnic minority populations in other countries.[23,29–32] Of interest was the finding that in the over 75 year age group, while Pacific patients had poorer survival (OR 1.35) compared with New Zealand European, outcomes for Māori were similar (OR 1.06). Factors contributing to the ethnic disparities seen in New Zealand cancer care are well documented; Māori experience more inequalities/barriers when accessing health services than non-Māori,[27,28] experience a lower level of care from those services[26] and do not get the same access to treatment.[33] Māori and Pacific patients are also more likely to present with metastatic disease,[6,28,34,35] experience delays to diagnosis[6] and present to the emergency department compared to non-Māori /non-Pacific patients.[6] Disease biology and culture (eg, diet, help-seeking behaviour),[27] deprivation level,[6] and higher levels of comorbidity for Māori and Pacific patients[6,28,31,33,36] are also factors that contribute to these disparities.

Strengths/limitations

The New Zealand Cancer Registry (NZCR) is a large, population-based register of all cancer registrations in New Zealand. Accuracy of the demographic data in the NZCR is high.[37] Combining with data from the Mortality Collection increases the robustness of the dataset used. However, a limitation of this study was that we were unable to access surgical and other treatment data, which was missing from the dataset. It would be worthwhile to evaluate whether CRC outcomes also differ with regard to treatment in future studies.

Conclusions

No regional variations were seen within New Zealand for the characteristics and survival outcomes of patients <75 diagnosed with CRC. However, the risk of dying from CRC increased for those >75, which is supportive of the international literature regarding outcomes for elderly patients. We continue to show disparity in outcomes for Māori and Pacific patients diagnosed with CRC in New Zealand.

Competing interests:
Nil.

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Ocular syphilis in Pacific peoples—are we making misdiagnoses secondary to yaws?

Hannah Gill, Helen V Danesh-Meyer, Joanne L Sims, Mitzi Nisbet, Rachael L Niederer

ABSTRACT

AIMS: To determine the demographic and clinical features of patients with ocular disease consistent with syphilis and positive treponemal serology in Auckland, and to compare patients who lived in a Pacific nation before 1960 with all other patients with regard to these features, considering a possible history of yaws infection.

METHODS: Retrospective review of subjects seen in uveitis and neuroophthalmology clinics at Auckland District Health Board between January 2006 and June 2019.

RESULTS: Two thousand four hundred and ninety-three subjects were reviewed in uveitis clinics during the timeframe, of whom 45 were diagnosed with syphilitic uveitis (1.8%). Mean age was 56.2±14.8 years and 34 (75.5%) were male. Ethnicity was Caucasian in 16 (35.5%), Pacific peoples in 16 (35.5%), Māori in two (4.4%), Asian in six (13.3%) and other in five (11.1%). Pacific peoples were older at presentation (p=0.001) and 75.0% were aged >60 compared to 24.1% of non-Pacific peoples (p=0.002). Comparing Pacific people born prior to 1960 (aged >60) to the rest of the cohort, older Pacific subjects had lower RPR titres (median 3 vs 32 p=0.004), less optic nerve swelling (0% vs 28.0% eyes p=0.014) and less posterior uveitis (6.25% vs 32.0% eyes p = 0.033). No difference was observed in anterior and intermediate uveitis between the groups. No difference was observed in the resolution or recurrence of inflammation between the groups.

CONCLUSION: Syphilitic uveitis is common in New Zealand, occurring in 1 in 55 patients seen in consultant uveitis clinics. Clinicians should consider a history of yaws in Pacific peoples presenting with ocular inflammation and positive treponemal serology. In these cases alternative causes of ocular pathology should be included as differentials. In cases of diagnostic uncertainty, the risk of treatment versus the potentially severe sequelae of untreated syphilis need to be considered.

Acquired syphilis is a multi-systemic infectious disease which is known as the 'great imitator' because of its wide variety of clinical presentations and ability to mimic many other conditions.[1] The disease is caused by the spirochete *Treponema pallidum* spp. *pallidum* and spread via the muco-cutaneous route. Sexual transmission is most common, however it may also be transmitted to a fetus or neonate during pregnancy or childbirth.[1–3] Four stages of the disease are recognised and overlap can exist between the stages.[1,4] Syphilis is successfully treated with antibiotics; however, untreated can result in chronic complications or death.[1,3,5]

Ocular syphilis is relatively uncommon; however, syphilis may involve any structure of the eye. The time course and presentation of ocular involvement is equally variable. The most common ocular involvement is uveitis (intraocular inflammation), accounting for 1.3% of all uveitis.[6] Syphilis has also been reported to cause optic neuritis, chorioretinitis, retinal vasculitis, conjunctivitis, dacryoadenitis, dacrocystitis, episcleritis, scleritis and interstitial keratitis.[4,7] A high index of suspicion should be enforced in cases of unexplained ocular inflammation to avoid long-term sight-threatening complications.[4,7]

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Once ocular involvement is confirmed, it is regarded as neurosyphilis. The recommended treatment for neurosyphilis, and therefore ocular syphilis, is intravenous penicillin for 10–14 days.[8]

The rate of syphilis infection in New Zealand has been increasing since 2012, with 470 cases reported in 2017 compared to 225 in 2015.[1] The annual incidence continues to increase in parallel with rates observed internationally.[1] The increase in prevalence is partly explained as a result of syphilis being more prevalent in some groups of patients with HIV (human immunodeficiency virus), including men who have sex with me (MSM), with co-infection rates reported to be between 20–70%.[9] As of January 2017, syphilis was made anonymously notifiable in New Zealand, with an aim to identify at-risk groups and provide targeted public health interventions.[3,10] In 2019, the New Zealand Ministry of Health published the National Syphilis Action Plan with an aim to guide a coordinated and systematic response to interrupt ongoing transmission of infectious syphilis and prevent congenital syphilis.[10] While MSM with HIV co-infection have the highest risk of acquiring syphilis, the incidence of cases in heterosexual males and females has also been rising.[1,3] Rates of syphilis presentations have increased across all ethnicities in New Zealand, with New Zealand European reporting the highest rates of infection in the male sub-group, and Māori reporting the highest rates of infection for females. For both men and women, the highest risk age group is 20–39 years.[1]

A presumptive diagnosis of syphilis, based on the patient's epidemiological and clinical features, may be supported by serology consistent with a current treponemal infection.[1,5] Serology testing is most commonly performed on serum samples using rapid plasma reagin (RPR) testing, but occasionally may also be tested on CSF, using venereal disease research laboratory (VDRL) testing. These are non-specific treponemal tests and may normalise during tertiary and latent stages, therefore serological testing should also include specific treponemal antibody tests such as fluorescent treponemal antibody absorption (FTA-ABS) or *Treponema pallidum* particle agglutination (TP-PA).[5,11]

One complexity of syphilis result interpretation is the lack of diagnostic tests available to distinguish between syphilis and other non-venereal treponemal diseases, such as yaws.[5,11] Yaws is a chronic skin infection caused by spirochete *Treponema pallidum* spp. *pertenue*. It presents with tender skin ulcers that persist for three to six months, typically in children younger than 15. Yaws was highly prevalent in the South Pacific in the 1950s and early 1960s, until a mass treatment campaign utilising penicillin resulted in a dramatic decline and eventual eradication of the disease.[12–14] Despite treatment, previously infected subjects will still return a positive treponemal serology.[11] Due to New Zealand's large Pacific Island population, yaws needs to be considered as a differential on return of a positive syphilis serology in Pacific peoples born before 1960. There is no data currently published connecting yaws and ocular pathology.

The current study aimed to investigate the cohort of patients diagnosed with ocular syphilis in Auckland, New Zealand. It wanted to consider whether older Pacific patients presented differently to other subjects, due to potentially incorrect ascription of positive treponemal serology to syphilis rather than yaws.

Methods

This is a retrospective study reviewing the medical records of patients diagnosed with ocular inflammation and positive treponemal serology between January 2006 and June 2019 at a tertiary referral center in New Zealand.

Subject selection

A database of subjects seen in the uveitis or neuro-ophthalmology clinics at Auckland District Health Board between 1 January 2006 and 1 June 2019 was reviewed. Electronic coding was used to identify subjects from this database who has returned a positive RPR and or TP-PA in the setting of uveitis or optic neuropathy consistent with syphilis. Subjects were excluded by an experienced consultant ophthalmologist or infectious disease physician if they believed syphilis not to be the primary reason for uveitis or optic neuropathy. This study adheres to the tenets of Declaration of Helsinki. Ethics approval NTX/12/EXP/085.

Data collection

Clinical notes, imaging and laboratory testing was reviewed for all subjects and data recorded on a standardised de-identified pro forma. Ethnicity was defined using self-identified ethnicity recorded within the health record. Country of birth was not routinely available.

Vision was recorded in the clinical notes as Snellen acuity. Best corrected visual acuity results were converted to logarithm of the Minimum Angle of Resolution (logMAR) units for analysis with the following conversion used for vision of counting fingers or worse; counting fingers 2.0 logMAR; hand movements 2.3 logMAR; light perception 2.6 logMAR; no light perception 2.9 logMAR.[15] The outcome of permanent moderate vision loss (MVL; range 6/15–6/60) and severe vision loss (SVL ≤6/60) was defined according the to the Standardization of Uveitis Nomenclature (SUN) Working Group.[16] Anatomical classification of uveitis was defined according to SUN nomenclature.[16]All subjects with a diagnosis of uveitis or optic neuropathy who were considered to have syphilis were referred to an infectious disease physician for further investigation and treated with intravenous benzylpenicillin either in hospital or at home for 10–14 days' duration.

Statistical analysis

Data was entered into an Excel spreadsheet and analysed in STATA version 15. Categorical variables are reported as n (%) and continuous variables as mean ± standard deviation (sd) for normal distribution and median (interquartile range [IQR]) for skewed distribution. Groups were compared with chi square, t test or Mann-U-Whitney for subject variables, and a generalised estimating equations approach with eyes nested within subjects was used for eye data. All tests were two-tailed and a p value of <0.05 was considered significant.

Results

Forty-five subjects were included for analysis, with 66 affected eyes. Mean age at presentation was 56.2±14.8 years and 34 (75.5%) subjects were male. Ethnicity was Pacific peoples in 16 subjects (35.5%), Caucasian 16 subjects (35.5%), Asian six subjects (13.3%), Māori two subjects (4.4%) and other five subjects (11.1%). Pacific peoples with syphilis were significantly older compared to other ethnicities (65.7 vs 51.0 years p<0.001) with lower proportion of males (56.3% vs 82.6% p=0.021) (Table 1).

The presumed mode of transmission was documented in 29 subjects (64.0%) and included MSM in 10 subjects. The remaining 19 subjects had heterosexual relationships.

At presentation median RPR was 8 (IQR 2–64) with lower values in Pacific peoples although this did not reach statistical significance. Lumbar puncture was performed in 30 subjects and returned positive VDRL tests in 4/30 (13.3%). HIV status was documented in 30 subjects and was positive in six of those tested (20.0%). All subjects with documented MSM transmission had HIV tested. Pacific peoples were more likely to have undocumented HIV status (62.5% vs 17.2%). Of the six Pacific peoples who underwent HIV testing, none were positive. HIV status was recorded in 24 non-Pacific subjects and was positive in six (25%), all of whom were MSM.

Clinical presentation

Median presenting visual acuity was 6/12 (IQR 6/7.5–6/30). MVL was present in 10 eyes (15.1%) and SVL in 12 eyes (18.2%). Isolated anterior uveitis was the most frequent presentation occurring in 22 eyes (33.3%) with anterior and intermediate uveitis in five eyes (7.6%). Two eyes had isolated intermediate uveitis (3.0%), four eyes had intermediate and posterior uveitis (6.1%). Panuveitis was the second most frequent presentation in 16 eyes (24.2%) and 10 eyes had isolated posterior uveitis or disc swelling (15.2%). In eight eyes there was no active inflammation, only optic nerve atrophy (12.1%).

There were notable differences between the clinical presentation of older Pacific peoples and others (Table 2). Older Pacific peoples (born before 1960) were less likely to have posterior uveitis (p=0.033) and less likely to have optic nerve swelling at presentation (p=0.014).

The Islands from which the Pacific Island subjects originated were Samoa (70%), Niue (18%), Tonga (6%) and the Cook Islands (6%).

Treatment

Forty-one subjects (91.1%) received treatment for syphilis. Treatment was intravenous (IV) in 32 subjects, and not

Table 1: Comparison between clinical presentation of Pacific peoples and non-Pacific peoples.

	Pacific peoples N=16 subjects	**Non-Pacific peoples N=29 subjects**	**P value**
Age (years)	65.7±12.9	51.0±13.0	0.001
Male	9 (56.3%)	25 (82.6%)	0.021
RPR	Median 3 (IQR 2-8)	Median 32 (IQR 2-64)	0.004
HIV status	Negative 6 (37.5%) Positive 0 (0%) Not recorded 10 (62.5%)	Negative 18 (62.1%) Positive 6 (20.7%) Not recorded 5 (17.2%)	0.003

documented (performed at another centre) in five subjects. Four subjects received intramuscular (IM) penicillin prior to presentation with eye symptoms and declined further IV therapy, despite guideline recommendations for IV treatment.[8] Four subjects declined any treatment. The duration of treatment in those receiving IV therapy was 10 days in 21 subjects and 14 days in 11 subjects. Inflammation resolved in 37 subjects (82.2%) following treatment, was chronic (persisting for >/= three months) in six subjects (13.3%) and was unknown in two subjects who left the country following diagnosis. In those that did resolve, five subjects (13.5%) had recurrence of inflammation. Chronic inflammation and recurrent disease did not significantly differ between the older Pacific peoples group and others. Median visual acuity at the last follow up visit was 6/7.5 (IQR 6/6–6/12). At last follow up, 11 eyes (16.7%) had MVL and four eyes (6.0%) SVL. Complications of inflammation included: glaucoma seven eyes (10.6%), epiretinal membrane five eyes (7.6%), cystoid macular oedema four eyes (6.0%), macular scar two eyes (3.0%), optic neuropathy six eyes (9.1%), and corneal scar in one eye (1.5%).

Clinic letters for eight of the 16 Pacific subjects (50%) made reference to yaws as a possible cause for the positive treponemal serology. Seven (87.5%) of these patients still received treatment for syphilis. The eighth patient declined treatment in New Zealand and returned to Samoa for follow up.

Table 2: Clinical presentation.

	Total N=66 eyes	**Pacific peoples born prior to 1960 N=16 eyes**	**Other N=50 eyes**	**P value**
Keratitis	1	0	1	0.557
Anterior uveitis	43 (65.2%)	11 (68.8%)	32 (64.0%)	0.722
Intermediate uveitis	29 (44.0%)	5 (31.3%)	24 (48.0%)	0.269
Posterior uveitis	20 (33.3%)	1 (6.25%)	19 (32.0%)	0.033
Optic nerve	Normal 45 (68.1%) Atrophic 8 (12.1%) Swollen 14 (21.2%)	Normal 14 (87.5%) Atrophic 3 (18.8%) Swollen 0 (0%)	Normal 31 (62.0%) Atrophic 5 (10.0%) Swollen 14 (28.0%)	0.014

Discussion

Ocular syphilis is a rare but sight-threatening manifestation of systemic syphilis infection.[4,7] There are no current data available regarding national ocular syphilis rates, however internationally the reported risk of a patient with syphilis developing ocular pathology is low, at 0.6–2.7% of total syphilis infections.[6,17] Uveitis is the most common manifestation of ocular syphilis,[4] accounting for 1.3% of all uveitis presentations,[6] this is consistent with the results of the current study. It can be expected that rates of ocular syphilis will continue to rise in parallel with the increasing incidence of systemic infection in New Zealand and worldwide.[17,18] The data demonstrated a sharp increase in incidence of presentations over the study time frame.

The 2016 National Sexually Transmitted Infection (STI) surveillance report produced by the New Zealand Ministry of Health (MoH) found that 64% of all reported syphilis cases in New Zealand occurred in Auckland City.[19] In context of the nationwide syphilis epidemic, the current study is therefore likely to represent a majority of ocular syphilis cases in New Zealand over a 13-year period.

Early recognition, treatment and recovery have been reported as the strongest predictors for ophthalmological recovery (cure with no recurrence of symptoms) following a diagnosis of ocular syphilis.[7,20] Treatment (91.1%) and recovery rates (82.2%) in the study population group were high. Vision impairment occurred in 22.7% of subjects.

A large focus of the current study was to examine the epidemiology of subjects presenting to the Auckland Regional Eye Clinic at Greenlane Clinical Centre with ocular syphilis and to look for differences in the clinical presentation in older Pacific peoples for whom interpretation of syphilis serology is more difficult due to possible yaws exposure. Yaws is a chronic skin infection caused by *Treponema pallidum* spp. *pertenue*. Yaws was a common infection in Pacific Island Nations until 1960, after which it was eradicated in a World Health Organization treatment campaign. The Islands from which the Pacific Island subjects in the current study originated (Samoa, Niue, Tonga and the Cook Islands), now remain free of the disease with no cases documented in recent years.[14] Pacific peoples born prior to the WHO campaign who suffered from yaws may still have antibodies to the infection.[12,13] These antibodies are the same as those tested for in serological testing when investigating for syphilis, therefore a positive treponemal serology could indicate present or past infection with syphilis or yaws.[12] Due to the inability to distinguish between these two infections on serological testing, yaws should be considered in older Pacific peoples presenting with positive treponemal serology alongside clinical signs and symptoms. The study wanted to consider whether prior yaws infection may have resulted in older Pacific peoples returning positive treponemal serology on screening tests, and therefore receiving a misdiagnosis of syphilis as a cause of their ocular pathology. It is the first study of its kind to describe the nature of presumed ocular syphilis presentations, treatment and outcomes in the Auckland Pacific Island population group.

With a lack of previous national or regional ocular syphilis data, the current study epidemiology data has been compared to that described in the National STI surveillance report. Syphilis ethnicity data from the surveillance report differed from that of the current study population, with New Zealand Europeans contributing the highest percentage of syphilis cases (56.3%), and Pacific peoples contributing only 7.4%, compared to 36% in the current study ocular syphilis population group. This may be confounded by the higher percentage of Pacific peoples living in Auckland (15.2%) compared to the National average (7.75%),[21] however this group was still over-represented in our data. The overrepresentation could reflect potential misdiagnoses of ocular syphilis in patients who had been infected with yaws earlier in life. This was considered in clinic letters for 50% of Pacific subjects, with comments made regarding the possibility of yaws being responsible for positive treponemal serology. As chronic inflammation and disease recurrence did not significantly differ between the older Pacific peoples group and others, it is difficult to comment as to whether possible misdiagnoses resulted in worse outcomes for this group. The mean age of the current study population (56.2 years) was higher

than that reported in the surveillance report (36.5 years). Gender profiles also differed, with the MoH reporting majority male patients (90.2%) compared to 75.5% in the current study.

The current study identified that older Pacific peoples (born before 1960) had lower RPR titres and presented significantly less frequently with posterior uveitis (6.25% vs 32%, p<0.033) and optic nerve swelling (0% vs 28.0% eyes p=0.014). They most commonly presented with an isolated anterior uveitis (75.0%). It is observed that RPR titers correlate with disease activity[8] and therefore worth considering whether the lower RPR titres represent a prior yaws infection or latent syphilis. If so, both the titre and the presentation differences support the idea that positive syphilis serology in older Pacific peoples with ocular inflammation should be considered a potential red herring. This is supported further by research from Auckland colleagues, who demonstrated that idiopathic anterior uveitis is a much more likely cause of uveitis in an Auckland Pacific Island population when compared to syphilis (30.4% idiopathic vs 3.0% syphilis).[6] Additionally, the mean age and gender profile of the non-Pacific peoples group were closer to those of the syphilis population group published in the national surveillance report.

Despite the above findings, as there is no way to clinically distinguish uveitis caused by syphilis compared to non-syphilitic causes, our current policy remains to treat all cases as if they were definite syphilitic infections. This is due to the potential sight-threatening complications that can arise from untreated syphilitic uveitis as well as potential burden of systemic disease. While yaws has been eradicated in Samoa, Niuea, Tonga and the Cook Islands, it remains endemic in other parts of the pacific, including Papua New Guinea, Solomon Islands and Vanuatu, in addition to parts of Indonesia and East Timor.[21] The above findings may therefore be relevant to patients born after 1960 who have resided in these parts of the world.

An interesting and unexpected result of the current study was the poor documentation of HIV status in Pacific peoples compared to others (undocumented in 62.5% vs 17.2%). It is unclear whether this is related to poor documentation or unconscious bias of the medical professionals ordering the tests, or due to higher suspicion of yaws in these patients and therefore incomplete syphilis work up. We endorse that all patients with suspected syphilis receive a complete set of work-up investigations, including HIV status, even in cases of suspected yaws.

Limitations of the current study include the small study size and low statistical power, however with a rare pathology in a relatively small population group it provides a starting point for research in an area that has yet to be investigated. Further analysis of the rates of ocular syphilis as a percentage of uveitis presentations and syphilis presentations in Auckland City would provide interesting data to follow as the syphilis epidemic develops.

Conclusion

With the current resurgence of syphilis in New Zealand and abroad, physicians need to be aware of the possible ocular manifestations in patients presenting with undifferentiated ocular pathology, particularly in patients presenting with new uveitis. While syphilis and yaws are unable to be differentiated with serological testing, it is important to consider a history of yaws in Pacific peoples living in New Zealand who were born before 1960 to avoid misdiagnosis of their ocular pathology. While the results of this study have shown interesting differences in the presentation of Pacific peoples older than 60 and others with ocular inflammation, our policy remains to treat all cases as if they were definite syphilitic infections. This is due to the potential sight-threatening complications that can arise from untreated syphilitic uveitis, the potential burden of systemic disease caused by syphilis and the low morbidity of the recommended antibiotic therapy. Consultation with an infectious diseases physician is recommended in all cases where ocular syphilis is suspected for guidance of treatment and follow up. Longitudinal follow-up of both the study population group in addition to new ocular syphilis presentations in Auckland City may be warranted to analyse for further trends in the behavior and nature of ocular syphilis within the study population, which may help to guide recognition and management of this easily treatable disease.

Competing interests:
Nil.

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Trends in prescription medicine use by older people in New Zealand 2010– 2015: a national population-based study

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ABSTRACT

BACKGROUND: Research investigating trends in the general prescription medicine use of older people in New Zealand is limited.

AIM: To examine trends in the use of outpatient medicines by older adults and assess changing patterns in use from 2010 to 2015.

METHODS: A retrospective cohort study including all New Zealand primary care patients over 65 years of age utilising data from the national pharmaceutical claims database. We calculated the prevalence of use within three age groups and by sex in each year by anatomical therapeutic class, therapeutic group and individual medicine. Rate ratios were calculated to compare the prevalence of use in 2010 and 2015.

RESULTS: The study included 829,026 patients with a mean of 4.4 years of potential drug exposure. Overall prevalence of medicine use was 92% in 2010 and 93% in 2015. The mean number of prescriptions per patient-year for patients >=85 years of age (39.2) was almost double that of patients 65–74 years (21.8). Prevalence of use was similar between females (94%) and males (92%). Antibacterials, analgesics, cardiovascular drugs and proton pump inhibitors were the most widely used medicines. The use of systemic antibiotics increased by 2% between 2010 and 2015, but there were significant decreases in use of antithrombotics (6%), beta blockers (6%), diuretics (19%), nitrates (19%) and antiarrhythmics (24%).

CONCLUSION: Our findings indicate both positive changes in response to guidance on safe and appropriate medicine use and several areas of concern. Continued monitoring of changing patterns in the medicine use of older people will be important, particularly with regard to the use of combinations of medicines that increase their risk of adverse events.

The challenge of providing safe and effective medical treatment for older people represents a growing problem for any nation experiencing rapid growth in the size of its elderly population. New Zealand is one such country: between 2008 and 2016 its population aged 65 years and over is estimated to have increased by over 30% from 535,000 to 698,000, the latter figure representing 15% of the total New Zealand population in 2016.[1] Increasing age is associated with an increasing prevalence of long-term conditions and multimorbidity,[2–4] and this adds to the complexity of pharmacotherapy indicated for illness within this patient group. Multimorbidity in a growing older population is accompanied by an increase in prescribing and polypharmacy,[5,6] and this raises the potential for drug interactions and adverse events associated with the use of multiple medicines.[7] It is therefore important that we monitor the use of medicines by older patients both to identify inappropriate drug use that may result in patient harm and drug use that may be unnecessary.

Continued monitoring of trends in this medicine use will also help inform the promotion of educational material focusing on the appropriate use of medicines by older patients and to highlight safety issues. It may also be used to assess the impact of previous educational strategies to change prescriber behaviour, to indicate the appropriateness of drug selection within a therapeutic class of drug and to identify the increasing use of medicines where unlicensed use is suspected. Monitoring the use of high-risk medicine combinations such as opioids and hypnotics may signal the need to intensify educational interventions to reduce medicine-related harm. Benchmarking against other criteria of potentially inappropriate medication (PIM) use such as STOPP/START, FORTA and Beers,[8,9] may also be employed in the assessment of the quality of medicines use in older adults.

Research assessing trends in the general use of medicines by older people is limited although a number of studies both internationally and in New Zealand have examined PIM use in this patient group.[10–13] Other New Zealand studies have focused on trends in the use of specific therapeutic groups of drugs by older patients or the use of preventive medicines,[14,15] which are being increasingly used to modify or reduce health risks.[16] Our objective in this study was to profile the prevalence of use of all outpatient medicines dispensed to older patients in New Zealand over a six-year period from 2010 to 2015 to assess evidence of potentially inappropriate prescribing and to guide future research aimed at identifying potential safety issues. The inappropriate use of medicines by these patients may change with time and it is possible that reductions in the unnecessary use of specific medicines is compromised by the increased use of other medicines as alternative therapy.

Methods

We analysed linked healthcare data from two national data collections managed by the New Zealand Ministry of Health. The study population was drawn from the Primary Health Organisation Enrolment Collection, which lists all patients registered with a New Zealand primary care clinic in each year. Approximately 95% of New Zealand's population is registered with a general practice in any year. The patient cohort included all patients registered and aged at least 65 years on 1 January in any year 2010–2015. Patient data collated from the first quarter registers for each year included their encrypted national health index (NHI) code, date of birth, sex, prioritised ethnic group and month of last general practice consultation. The encrypted NHI code is a unique patient identifier and the key to linking patient-level records in the national datasets.

The study population represented a dynamic cohort of patients changing from year to year. We grouped patients into one of three age categories within each year (65–74, 75–84 and >=85 years) with each patient potentially contributing to more than one age group across the six-year time frame. For each patient in each year we calculated the number of days of potential exposure to medicine use. For patients registered in two successive years this was the number of days in the calendar year. For patients registered in one year but not the next it was the number of days from 1 January of the first year until their last medicine dispensing date in that year. For patients not registered in the first quarter of a particular year but registered in the next year it was the number of days from the first day of the patient's last month of consultation or their first medicine dispensing date during the year, until 31 December. This criteria provided evidence that patients were living in New Zealand in a particular year and at risk for drug exposure.

Medicine use

Outpatient medicines used from 2010–2015 were recorded in the Pharmaceutical Collection, a claims database containing information on all subsidised medicines dispensed in New Zealand's community pharmacies. This includes both outpatient prescriptions prescribed by primary care providers and healthcare specialists and hospital discharge prescriptions filled at community pharmacies. Medicines sold over-the-counter without a prescription are not recorded. Data relating to each dispensed medicine included the encrypted NHI code, the date dispensed, the generic name of the chemical, its formulation and its therapeutic group based on PHARMAC's modification of the World Health Organization's five-level Anatomical Therapeutic Chemical Classification system (ATC).[17]

PHARMAC, New Zealand's pharmaceutical management agency, first classifies chemicals anatomically based on the ATC, with lower-level classification coming under section headings structured for the New Zealand medical system.[18]

Statistical analysis

We calculated the total number of patient-years at risk in each year for each age group and by sex. This provided the denominator for calculating prevalence rates for medicines used in each year. We used patient-years at risk rather than total number of patients as the denominator since the total days at risk in each age group was variable from year to year, reflecting the dynamic nature of populations and ageing. The numerator was the number of patients using a specific medicine or medicines within a therapeutic group in each year. User prevalence rates were calculated per 1,000 patient-years and represented the number of patients per 1,000 using medicines over a full year.[19]

Prevalence rates by age group, sex and year were calculated for use of medicines within the first-level main anatomical classes of the ATC classification, for the most commonly used second-level therapeutic groups, and for the most commonly used fifth-level chemical substances within each main anatomical class. Rate ratios with 95% confidence intervals were calculated to compare rates of medicine use in 2010 and 2015, between patient age groups and males and females. The number of prescriptions counted for each patient, for individual chemicals and within therapeutic groups excluded medicines dispensed as repeats of previous prescriptions. To provide a broad indication of trends in polypharmacy we also calculated the proportion of patients prescribed 10 or more different medicines ('excessive polypharmacy') in the first quarter of each year.[6,12,20] Chi-squared tests were used for differences between years.

Potentially high-risk medicine use

Many medicines are associated with an increased risk of adverse events in older patients.[8] Some may specifically increase the risk of falls,[21,22] including medicines that cause central nervous system (CNS) depression such as opioids, anticonvulsants, sedatives and antipsychotics. This risk is further increased with combined use due to additive pharmacological effects such as sedation and postural hypotension.[23] We assessed trends in the concurrent use of opioids with antipsychotics or hypnotics given their likely high prevalence of use. Non-steroidal anti-inflammatory drugs (NSAIDs) are also potentially high-risk medicines for older people due to the increased risk of gastrointestinal bleeding and kidney injury.[8]

Results

A total of 829,026 patients were included in the study (Table 1). On average each patient had 4.4 years of potential drug exposure. Fifty-three percent of patients were women and 15% of all patients were of non-European ethnicity. The mean number of prescriptions per patient per year was almost twice as high for patients >=85 years of age compared with patients 65–74 years. Māori and Pacific Island patients received the most prescriptions per patient-year and prescription rates were higher for females than males (rate ratio (RR) 1.13, 95% confidence interval (CI) 1.13–113).

The proportion of patients using any medicine increased from 91.9% in 2010 to 93.1% in 2015. In the most recent year, 2015, 91.4% of patients 65–74 years, 95.7% of patients 75–84 years, and 96.1% of patients >=85 years were prescribed at least one medicine. The proportion of females (93.9%) and males (92.2%) using medicines was similar. Across ethnic groups, 93.8% of European, 93.7% of Māori, 91.3% of Pacific and 84.7% of Asian patients were prescribed at least one medicine in 2015.

Medicine use by main anatomical class

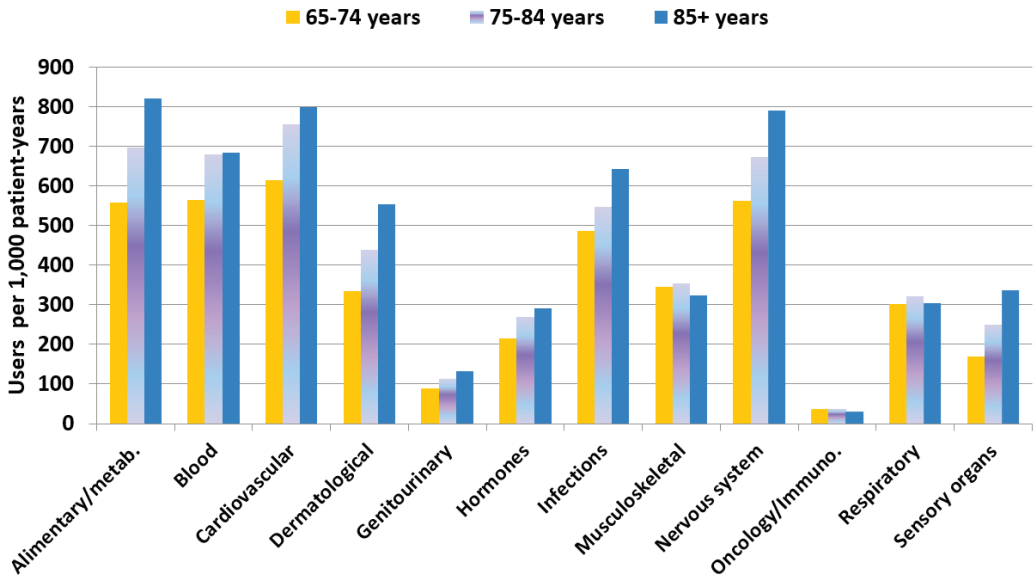
The most widely used medicines were drugs acting on the cardiovascular system, the alimentary tract and metabolism, blood and the blood-forming organs, and the nervous system (Figure 1). Prevalence rates of medicine use were highest for patients >=85 years in all anatomical classes with the exception of the musculoskeletal and respiratory systems and in oncology and

Table 1: Study population, years at risk and prescription rates 2010–2015.

	Number of patients[a]	Total person-years (%)	Total prescriptions (per person-year)
Age group (years)			
65–74	579,493	2,131,010 (58.3)	46,411,923 (21.8)
75–84	303,914	1,104,283 (30.2)	33,765,022 (30.6)
85+	128,455	418,251 (11.4)	16,391,089 (39.2)
Sex			
Female	440,711	1,970,229 (53.9)	54,987,826 (27.9)
Male	388,315	1,683,316 (46.1)	41,580,208 (24.7)
Ethnicity			
European	698,775	3,130,534 (85.7)	82,668,454 (26.4)
Māori	46,931	191,108 (5.2)	5,588,438 (29.2)
Pacific	26,261	105,709 (2.9)	2,972,591 (28.1)
Asian	45,603	180,786 (4.9)	4,104,883 (22.7)
Other	8,253	34,092 (0.9)	863,472 (25.3)
Unspecified	3,203	11,315 (0.3)	370,196 (32.7)
All patients by year			
2010	581,356	555,732 (15.2)	14,620,012 (26.3)
2011	602,410	573,080 (15.7)	15,235,931 (26.6)
2012	625,584	595,649 (16.3)	16,104,514 (27.0)
2013	645,830	618,015 (16.9)	16,488,963 (26.7)
2014	672,183	644,305 (17.6)	16,841,448 (26.1)
2015	694,954	666,763 (18.2)	17,277,166 (25.9)
All patients 2010–2015	829,026	3,653,544 (100.0)	96,568,034 (26.4)

[a]Many patients were in multiple age groups over the six-year study period.

Figure 1: Prevalence of medicine use by age group and anatomical class 2010–2015.



immunology. The most commonly used medicines for patients under 85 years of age were those acting on the cardiovascular system. Use of medicines by females was more prevalent in all classes except the cardiovascular system and blood and the blood-forming organs.

Medicine use by therapeutic group

Within the main anatomical classes, antibacterials, analgesics, antithrombotics, lipid-modifiers and antihypertensives were the most widely used medicines (Table 2). The prevalence of medicine use increased with age in the majority of the

Table 2: Most commonly used therapeutic groups by age group and sex and prevalence of medicine use per 1,000 person-years 2010–2015.[a]

		Age group (years)			Sex		All	All patients		
Class	Therapeutic group	65–74	75–84	85+	Female	Male	patients	2010	2015	Rate ratio (95% CI)[b]
INF	Antibacterials	463.6	528.0	627.0	527.7	471.4	501.8	491.9	500.5	1.02 (1.01–1.02) *
NRV	Analgesics	414.6	546.1	679.2	530.5	431.0	484.6	467.2	490.8	1.05 (1.04–1.06) *
BLD	Antithrombotics	380.1	544.1	590.3	409.8	505.2	453.7	464.9	437.8	0.94 (0.94–0.95) *
BLD	Lipid-modifying agents	451.7	481.0	319.5	396.5	502.7	445.4	428.9	444.6	1.04 (1.03–1.04) *
CVS	Renin-angiotensin system agents	409.9	470.2	427.2	422.5	439.1	430.1	420.2	430.9	1.03 (1.02–1.03) *
ATM	Antiulcerants	315.7	397.7	429.5	362.1	343.5	353.5	341.1	358.8	1.05 (1.05–1.06) *
CVS	Beta-adrenoceptor blockers	264.3	374.5	397.1	306.7	320.0	312.8	320.0	300.8	0.94 (0.93–0.95) *
ATM	Vitamins	178.6	308.6	490.8	336.9	156.2	253.6	235.6	262.5	1.11 (1.11–1.12) *
CVS	Diuretics	185.4	311.9	442.0	292.3	207.0	253.0	278.8	226.5	0.81 (0.81–0.82) *
CVS	Calcium channel blockers	221.2	296.3	286.0	264.6	235.7	251.3	245.0	252.6	1.03 (1.02–1.04) *
DRM	Corticosteroids – topical	206.6	266.7	311.8	245.4	226.7	236.8	233.1	235.1	1.01 (1.00–1.02)
MSK	Non-steroidal anti-inflammatory drugs	246.9	181.8	112.9	205.3	219.6	211.9	210.7	210.9	1.00 (0.99–1.01)
ATM	Laxatives	127.5	253.9	439.6	221.4	178.0	201.4	195.6	205.3	1.05 (1.04–1.06) *
SNS	Eye preparations	144.7	230.5	320.3	207.5	171.0	190.7	187.1	194.3	1.04 (1.03–1.05) *
NRV	Antidepressants	162.5	193.4	233.5	220.2	132.9	180.0	175.0	183.0	1.05 (1.04–1.05) *
HRM	Corticosteroids – systemic	143.7	177.3	172.3	160.3	153.4	157.1	150.4	163.8	1.09 (1.08–1.10) *
NRV	Sedatives and hypnotics	118.9	159.8	226.9	175.4	106.5	143.6	144.0	142.4	0.99 (0.98–1.00)
DRM	Barrier creams and emollients	94.1	166.7	300.4	152.0	125.2	139.7	127.0	150.1	1.18 (1.17–1.19) *
ATM	Diabetes	124.2	125.6	82.2	106.5	135.4	119.8	112.6	123.3	1.10 (1.08–1.11) *
RES	Antihistamines	121.5	116.5	104.9	134.5	98.9	118.1	104.6	129.1	1.23 (1.22–1.25) *
RES	Beta-adrenoceptor agonists	117.5	119.2	108.0	129.1	102.7	117.0	108.6	122.8	1.13 (1.12–1.14) *
NRV	Antinausea and vertigo agents	89.0	122.4	162.2	130.8	80.1	107.4	102.9	109.3	1.06 (1.05–1.07) *
ATM	Minerals	73.6	129.9	187.1	139.2	61.9	103.6	164.7	74.9	0.45 (0.45–0.46) *
RES	Nasal preparations	103.9	105.9	85.8	109.1	94.6	102.4	96.3	106.7	1.11 (1.10–1.12) *
CVS	Nitrates	62.5	124.6	169.9	86.0	102.4	93.5	104.2	84.0	0.81 (0.80–0.82) *
CVS	Alpha-adrenoceptor blockers	79.9	112.8	92.5	27.0	166.6	91.3	88.6	91.9	1.04 (1.02–1.05) *
MSK	Hyperuricaemia and antigout	78.9	100.7	91.9	46.9	133.9	87.0	81.5	91.5	1.12 (1.11–1.14) *
HRM	Thyroid and antithyroid agents	71.2	100.5	129.6	127.0	39.7	86.8	85.7	87.1	1.02 (1.00–1.03)
MSK	Drugs affecting bone metabolism	47.6	103.1	142.3	118.3	24.8	75.2	89.1	62.7	0.70 (0.69–0.71) *
DRM	Antibacterials – topical	61.5	84.1	107.4	77.4	69.1	73.6	71.1	67.3	0.95 (0.93–0.96) *
CVS	Antiarrhythmics	26.0	60.0	101.5	42.4	47.9	44.9	50.3	38.1	0.76 (0.74–0.77) *
NRV	Antipsychotics	26.7	49.5	107.6	47.7	37.1	42.9	41.1	45.0	1.09 (1.07–1.11) *
	All medicines	954.1	964.4	990.4	968.6	952.9	961.3	953.3	961.6	1.01 (1.01–1.01) *

[a]Where the prevalence of medicine use per 1,000 person-years >100 in any age group. [b]Prevalence rate ratio for all patients in 2015 compared with 2010. * P<0.001.
ATM – Alimentary tract and metabolisim; BLD – Blood and blood-forming organs; CVS – Agents affecting the renin-angitensin system; DRM – Dermatologicals; HRM – Hormone preparations – systemic; INF – Infections – agents for systemic use; MSK – Musculoskeletal system; NRV – Nervous system; RES – Respiratory system and allergies; SNS – Sensory organs.

most commonly used therapeutic groups but decreased for NSAIDs and antihistamines. Prevalence rates for diuretics (RR 2.38, 2.37–2.40, P<0.001), antiarrhythmics (RR 3.90, 3.85–3.95, P<0.001), nitrates (RR 2.72, 2.69–2.74, P<0.001), antipsychotics (RR 4.03, 3.98–4.08, P<0.001), and drugs affecting bone metabolism (RR 2.99, 2.96–3.02, P<0.001) were over twice as high for patients >=85 years than patients 65–74 years. The use of lipid-modifiers (RR 0.71, 0.70–0.71, P<0.001), NSAIDs (RR 0.46, 0.45–0.46, P<0.001), and medicines for diabetes (RR 0.66, 0.65–0.67, P<0.001) was significantly lower however. Use of analgesics, diuretics, antidepressants, sedatives and hypnotics, antinausea and vertigo agents, antihistamines, thyroid agents and drugs for bone metabolism was significantly higher in women than men.

Between 2010 and 2015 the use of systemic antibiotics increased by 1.7%, but topical antibacterial use decreased by 5.3%. There were also significant increases in the use of analgesics, antiulcerants (mainly proton pump inhibitors and H2-receptor antagonists), diabetes medicines, antihistamines, beta-adrenoceptor agonists, vitamins, systemic corticosteroids and antigout medications. Use of antidepressants had increased by 4.6%, antipsychotics by 9.5%, and antinausea and vertigo agents by 6.2%, but there was little change in the use of sedatives and hypnotics.

Most frequently used chemicals

The most widely used drugs were paracetamol, aspirin, omeprazole, simvastatin and metoprolol (Table 3). Prevalence rates for paracetamol (RR 1.86, 1.85–1.87, P<0.001), aspirin (RR 1.47, 1.46–1.47, P<0.001), codeine (RR 1.59, 1.58–1.61, P<0.001) and zopiclone (RR 1.58, 1.56–1.59, P<0.001) were significantly higher in patients >=85 years than patients 65–74 years as was the use of omeprazole (RR 1.34, 1.33–1.35, P<0.001) despite the much lower use of NSAIDs in patients >=85 years. The use of most antibiotics including amoxicillin (RR 1.21, 1.20–1.21, P<0.001), amoxicillin clavulanate (RR 1.31, 1.30–1.32, P<0.001), flucloxacillin (RR 2.11, 2.09–2.13, P<0.001) and trimethoprim (RR 2.95, 2.92–2.98, P<0.001) was also significantly higher in patients >=85 years.

Among the more commonly used medicines there were significant increases between 2010 and 2015 in the use of paracetamol, codeine, omeprazole, cholecalciferol, the respiratory medicines salbutamol and fluticasone, and allopurinol for the treatment of gout. Amoxicillin use increased by 21.0% with the use of amoxicillin clavulanate showing little change over the six years. Metformin use increased by 16.8% during this time.

Potentially high-risk medicine use

Among the potentially high-risk medicines not listed in Table 3, use of the opioid analgesic oxycodone decreased from 25.1 users/1,000 patient-years in 2010 to 19.0/1,000 in 2015. In contrast, the use of tramadol, first subsidised for outpatient use in June 2010, increased from 63.9/1,000 in 2011 to 73.6/1,000 in 2015. The use of oxycodone, gabapentin and the antipsychotics quetiapine and risperidone was highest among patients >=85 years. The proportion of patients concurrently using an opioid plus an antipsychotic or sedative/hypnotic increased substantially with age and over the six-year study period (Figure 2). Use of the anticonvulsant gabapentin more than doubled from 10.4/1,000 in 2010 to 23.6/1,000 in 2015, which is likely due to its use for neuropathic pain. Use of NSAIDs as a drug class remained unchanged between 2010 and 2015 (Table 2).

Excessive polypharmacy

The proportion of patients exposed to excessive polypharmacy increased marginally from 15.0% in the first quarter of 2010 to 15.3% in the first quarter of 2015 (P<0.001) (Figure 3). On average excessive polypharmacy rates were three times higher in patients >=85 years than patients 65–74 years. They were also higher for females than males in all age groups in all years.

Discussion

This study represents the first assessment of trends in the general use of prescription medicines by New Zealand's primary care population over 65 years of age. Their use of medicines over the study time-frame was significant accounting for 42% of all subsidised medicines dispensed to primary

Table 3: Prevalence of medicine use per 1,000 person-years 2010–2015 for the most commonly used medicines by age group, sex and anatomical class.[a]

		Age group (years)			Sex		All	All patients		
Class	Chemical	65–74	75–84	85+	Female	Male	patients	2010	2015	Rate ratio (95% CI)[b]
NRV	Paracetamol	326.1	460.7	605.7	445.0	345.7	398.8	375.4	408.8	1.09 (1.08–1.10) *
	Codeine phosphate	88.3	113.2	140.5	112.0	89.9	101.8	94.6	107.9	1.14 (1.13–1.15) *
	Zopiclone	89.1	110.9	140.7	123.5	75.9	101.6	97.2	103.2	1.06 (1.05–1.07) *
	Paracetamol with codeine	86.7	100.2	91.1	100.8	80.2	91.3	95.0	84.0	0.88 (0.87–0.89) *
	Tramadol[3]	67.5	67.4	55.0	66.2	65.9	66.0	38.7	73.6	1.90 (1.87–1.93) *
	Amitriptyline	50.2	56.3	53.2	65.1	37.5	52.4	53.3	51.5	0.97 (0.95–0.98) *
BLD	Aspirin	330.7	445.8	484.9	349.1	422.9	383.1	410.6	349.9	0.85 (0.85–0.86) *
	Simvastatin	240.2	288.6	223.3	227.4	282.8	252.9	339.5	176.9	0.52 (0.52–0.53) *
	Atorvastatin	208.9	184.9	91.7	160.1	221.1	188.2	86.8	251.3	2.89 (2.87–2.92) *
	Warfarin	41.0	86.5	87.8	49.4	72.7	60.1	70.2	52.4	0.75 (0.74–0.76) *
ATM	Omeprazole	258.9	320.2	347.3	294.7	279.1	287.5	278.2	292.4	1.05 (1.04–1.06) *
	Cholecalciferol	131.8	231.1	390.5	272.6	96.5	191.4	161.3	206.4	1.28 (1.27–1.29) *
	Docusate sodium with sennosides	76.3	166.0	312.7	142.5	116.4	130.5	115.3	141.5	1.23 (1.21–1.24) *
	Metformin	102.8	92.2	49.4	82.1	106.8	93.5	84.4	98.6	1.17 (1.15–1.18) *
	Lactulose	46.1	104.7	205.1	88.6	74.3	82.1	84.7	79.0	0.93 (0.92–0.94) *
	Calcium carbonate	45.1	74.8	98.2	91.0	24.1	60.2	125.2	31.8	0.25 (0.25–0.26) *
CVS	Metoprolol succinate	201.2	289.1	316.4	233.3	250.0	241.0	241.1	229.9	0.95 (0.95–0.96) *
	Cilazapril	146.3	179.2	189.5	147.5	177.1	161.2	157.5	161.9	1.03 (1.02–1.04) *
	Furosemide	68.9	178.7	340.4	141.3	123.7	133.2	143.5	122.9	0.86 (0.85–0.86) *
	Felodipine	105.1	135.8	129.1	124.8	108.2	117.1	118.9	112.3	0.94 (0.93–0.95) *
	Bendrofluazide	100.3	119.8	96.7	134.1	72.6	105.8	123.8	86.3	0.70 (0.69–0.70) *
	Quinapril	89.6	105.9	98.0	90.5	101.4	95.5	106.8	83.3	0.78 (0.77–0.79) *
	Glyceryl trinitrate	50.4	92.6	114.9	63.7	78.6	70.6	75.8	66.8	0.88 (0.87–0.89) *
	Diltiazem	52.6	86.7	94.9	70.6	64.4	67.7	73.8	61.1	0.83 (0.82–0.84) *
	Doxazosin	59.0	79.3	61.1	25.5	112.1	65.4	61.1	67.9	1.11 (1.10–1.13) *
	Candesartan	54.7	69.3	53.6	69.8	46.3	59.0	52.0	62.7	1.21 (1.19–1.22) *
	Amlodipine	56.5	64.0	52.1	59.9	56.3	58.3	42.7	72.2	1.69 (1.67–1.72) *
	Cilazapril with hydrochlorthiazide	59.3	49.5	28.3	52.0	53.7	52.8	52.5	49.9	0.95 (0.93–0.96) *
INF	Amoxicillin	154.8	167.5	186.6	170.4	152.8	162.3	145.4	175.9	1.21 (1.20–1.22) *
	Amoxicillin clavulanate	143.7	160.0	188.3	141.9	167.6	153.7	151.4	150.0	0.99 (0.98–1.00)
	Flucloxacillin	86.7	126.7	182.8	106.5	113.6	109.8	110.7	106.8	0.97 (0.96–0.98) *
	Roxithromycin	71.9	80.8	89.9	83.0	69.2	76.7	73.5	74.4	1.01 (1.00–1.02)
	Trimethoprim	47.6	82.0	140.2	102.1	29.4	68.6	64.2	69.5	1.08 (1.07–1.10) *
	Doxycycline	66.7	67.0	65.9	68.1	65.0	66.7	63.8	68.1	1.07 (1.05–1.08) *
	Cefaclor	37.6	64.1	107.7	68.1	36.8	53.7	52.5	50.8	0.97 (0.95–0.98) *
HRM	Prednisone	127.7	157.4	151.2	143.2	135.0	139.4	133.5	145.3	1.09 (1.08–1.10) *
	Levothyroxine	68.1	96.2	123.2	121.1	38.1	82.9	82.3	82.9	1.01 (1.00–1.02)
RES	Salbutamol	108.8	110.2	101.2	118.8	96.1	108.4	98.5	115.6	1.17 (1.16–1.19) *
	Fluticasone	107.3	107.3	89.4	113.3	95.9	105.2	84.2	110.8	1.32 (1.30–1.33) *
	Loratadine	66.6	64.8	58.9	74.9	53.7	65.1	59.3	68.9	1.16 (1.15–1.18) *
MSK	Ibuprofen	104.0	87.4	67.5	105.4	82.5	94.8	73.9	108.0	1.46 (1.44–1.48) *
	Diclofenac	106.5	62.8	27.5	70.3	100.5	84.3	100.7	70.9	0.70 (0.70–0.71) *
	Allopurinol	70.3	89.5	80.5	40.4	120.5	77.3	71.6	81.7	1.14 (1.13–1.16) *
SNS	Chloramphenicol	55.7	88.1	126.5	78.1	68.3	73.6	77.0	69.6	0.90 (0.89–0.92) *
DRM	Hydrocortisone butyrate	55.4	77.0	90.1	65.6	66.2	65.9	65.5	65.1	0.99 (0.98–1.01)

[a] Where the prevalence of medicine use per 1,000 person-years >50 for all patients. [b] Prevalence rate ratio for all patients in 2015 compared with 2010. * P<0.001. [3]Tramadol was subsidised for outpatient medicine use from 1 June 2010. ATM – Alimentary tract and metabolisim; BLD – Blood and blood-forming organs; CVS – Agents affecting the renin-angiotensin system; DRM – Dermatologicals; HRM – Hormone preparations – systemic; INF – Infections – agents for systemic use; MSK – Musculoskeletal system; NRV – Nervous system; RES – Respiratory system and allergies; SNS – Sensory organs.

Figure 2: Concurrent use of opioids and antipsychotics or sedatives/hypnotics by age group 2010–2015.

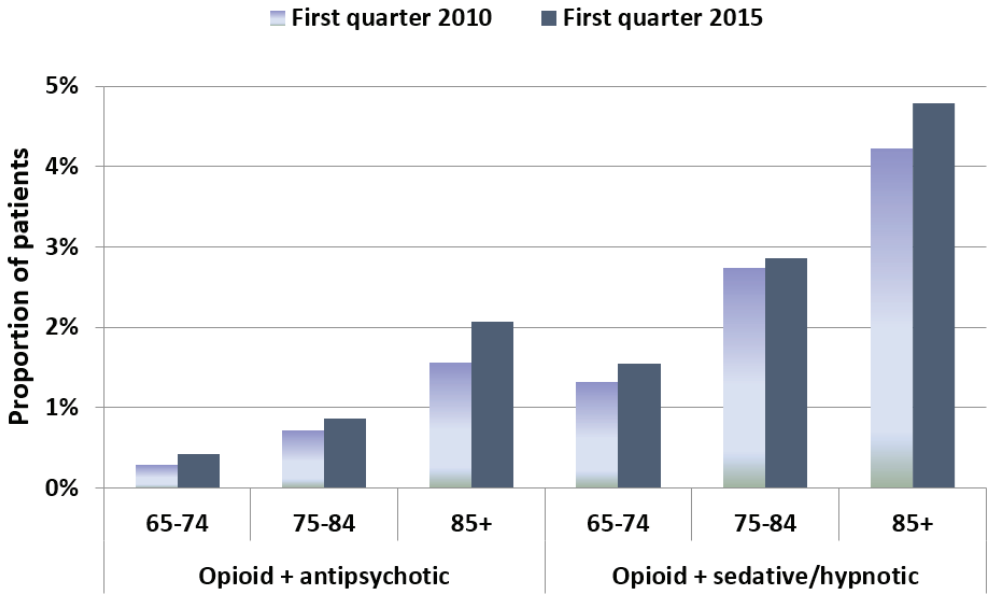
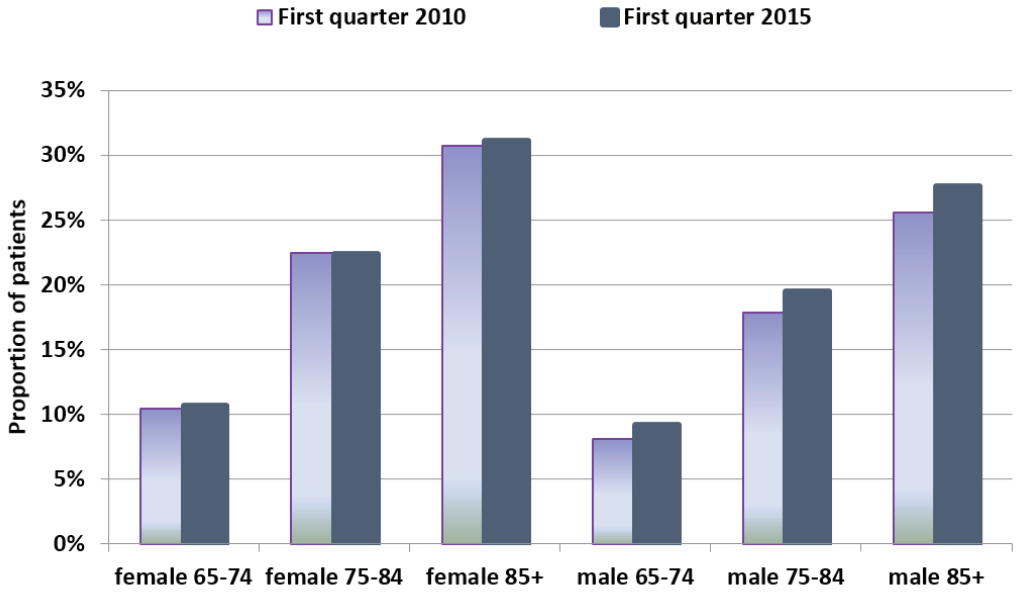


Figure 3: Excessive polypharmacy rates by age group and sex in 2010 and 2015.



care patients in the country. Although the overall prescription rate per year remained relatively unchanged from 2010 to 2015, total prescriptions per year issued to older patients increased by 18% and the prevalence of use of medicines within several drug classes changed significantly as did the use of many individual medicines.

Assessing trends in the use of all medicines as opposed to focusing on specific therapeutic groups of medicines increases our potential to determine whether changes in the pattern of medicine use may be appropriate or of concern. More appropriate use, or less use, of one medicine may be offset by an increase in the use of another medicine without a change in overall prescribing rationale. Thus a decrease in the use of the antidepressant amitriptyline, for example, frequently used for neuropathic

pain, may be offset by the risks associated with the increased prescribing of the anticonvulsant gabapentin, also used for the same indication.

Trends in the prescribing of many medicines associated with an increased risk of adverse events in older people were of concern. CNS depressants such as antipsychotics and hypnotics increase the risk of falls, and this risk increases with age and in older people with multimorbidity taking multiple medicines. We found that the use of hypnotics and antipsychotics increased significantly with age with the highest use among patients over 85 years. There was also an increase in the use of antipsychotics in all age groups. Reasons for this are unclear but it is possible that the increased use of the most commonly used antipsychotic quetiapine reflects a growth in off-label use for insomnia or anxiety. This has been reported in New Zealand and internationally.[23–25] Use of the hypnotic zopiclone also increased with age and across the study period. This may reflect a rise in the use of zopiclone instead of benzodiazepines for insomnia on the perception that it is a safer and less addictive medicine. This trend warrants further investigation as zopiclone is a CNS depressant which may increase fall risk and should only be used in the short term. Our results also indicated a decrease in the prescribing of the opioid oxycodone, which may be have been offset by an increase in tramadol use. However, subsequent data published by the Health Quality and Safety Commission indicates that the use of strong opioids has plateaued since 2015 and that tramadol use has decreased.[26] Further studies to measure the current prevalence of opioid prescribing, including its duration of use in older patients and its use in combination with other medicines will be important in informing harm reduction strategies.

The significant increase in gabapentin use in all age groups was in line with international studies showing an increase in the use of gabapentinoids,[27] although its use was under special authority in New Zealand during the study timeframe. There are concerns that gabapentin is being used inappropriately and excessively for non-neuropathic chronic pain,[28] and in common conditions such as chronic back pain where it has limited effectiveness and a significant risk of adverse effects.[29] There is also evidence that gabapentin increases the risk of respiratory depression with or without concurrent opioid use.[30] It is likely that in many older patients the harms may outweigh the benefits of gabapentin use.

The use of certain combinations of medicines can also increase the risk of adverse effects which are often exacerbated by age. As a result of common pharmacological effects, the concurrent use of opioids and sedatives or hypnotics for example, may increase sedation, fall risk and respiratory depression whereas opioids used in conjunction with an antipsychotic increases both the fall risk and the risk of postural hypotension.[8] We found that the use of both of these medicine combinations had increased in all age groups over the study period and that the prevalence of use was highest in patients over 85 years of age. The prevalence of excessive polypharmacy in females was essentially unchanged over the study time-frame but increased among male patients. This indicates the need for a national prescriber education strategy to encourage the review of unnecessary medicines use in older adults and to reduce inappropriate polypharmacy.

It is appropriate to deprescribe some medicines as people age. Treatment may no longer be appropriate following consideration of factors such as limited life expectancy and when the potential harms of treatment outweigh the benefits.[31] The application of deprescribing principles,[31,32] was possibly illustrated in this study by the lower rates of use of certain medicines for cardiovascular disease (lipid-modifying agents, ACE inhibitors and calcium channel blockers), NSAIDs and antidiabetic medicines in patients over 85 years of age than patients 65–74 years. Rates of use of other medicines recognised as appropriate for deprescribing in older patients, such as proton pump inhibitors[33] and drugs affecting bone metabolism,[34] were highest in patients over 85 years however.

Some trends in medicine use may indicate positive changes in response to guidance on safe and appropriate medicine use. There was a slight reduction in the use of risperidone across all age bands, which may be a response to concerns about an increased risk of stroke associated with risperidone

when used for psychoses associated with dementia.[35] Similarly, the reduction in oxycodone use may reflect concerns about adverse effects and excessive use for non-malignant chronic pain. However, these positive trends are offset by increases in the use of similar medicines that are also associated with harm in older patients as indicated by an increase in the use of antipsychotics as a class and by a significant increase in the use of the opioid-agonist tramadol.

Limitations

We acknowledge that there are limitations involved in using the national pharmaceutical claims database to monitor the outpatient medicine use of New Zealand's older patients. We were not able to quantify the use of medicines not subsidised for general use including Cox-2 inhibitor NSAIDs, which were not available for general prescription before 2017. Over-the-counter medicine sales for drugs such as paracetamol, aspirin, ibuprofen, omeprazole and antihistamines are also not recorded and the use of these drugs is likely to be higher than indicated in this study. The database also provides no information on the indications for which medicines were prescribed limiting our ability to assess appropriate and inappropriate prescribing practices. Patient compliance in using the medicines prescribed to them was also unknown.

Conclusions

There are high rates of medicine use in older people in New Zealand with the greatest use in patients over 85 years of age. Over a time period where a reduction in polypharmacy may have been anticipated, polypharmacy rates increased in some patient groups and the use of several high-risk medicines and combinations of medicines increased significantly.

Our findings demonstrate why the systematic monitoring of medicine use in older patients is important. In demographic terms, older adults are the patient group most at risk for harm due to the inappropriate use of pharmaceuticals. By regularly assessing their medicine use we are able to identify trends in the use of medicines with a high risk of adverse events, those with a tendency to be over or inappropriately prescribed, and those with a low benefit to harm ratio. We may also assess positive changes in the patterns of medicine use and the impact of prescriber education. This study has identified a number of issues that warrant further investigation. These include the impact of current initiatives aimed at reducing polypharmacy and the impact of educational strategies to reduce the use of drugs or drug combinations that increase the risk of falls.

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Is there a role for Rongoā Māori in public hospitals? The results of a hospital staff survey

Jonathan Koea, Glennis Mark

ABSTRACT

BACKGROUND: Rongoā Māori is the traditional form of healing for Māori. This investigation describes the results of an internet-based survey of staff at Waitemata District Health Board (WDHB) about their attitudes towards the placement of Rongoā Māori into the hospital system.

METHODS: An electronic survey was circulated to approximately 6,000 employees of the WDHB. Responders were asked questions pertaining to Rongoā Māori and issues relating to potential implementation of a Rongoā Māori service.

RESULTS: There were 1,181 responses (response rate 19.6%) of whom 80% were female, 87% aged between 20 and 60 years, 67% European ethnicity, 18% Māori and 66% worked as medical practitioners or nurses. Forty-six percent were familiar with Rongoā Māori, and 16% had used Rongoā Māori on themselves or whānau. About 32% of responders felt that Rongoā Māori should be available to patients and staff and that this service should be provided by a specially trained Rongoā Māori practitioners or WDHB staff member.

CONCLUSION: Nearly half of WDHB staff, who responded to the survey, had a knowledge of Rongoā Māori and just over a third of the total responders supported its availability within the hospital system. A larger feasibility study will consult with healer, staff and patient participants to ascertain the culturally appropriate and medically robust practices necessary for researching Rongoā Māori collaboration with medical treatment.

Rongoā Māori refers to traditional medical and healing treatments of Māori and includes medical interventions based on products of flora and fauna, massage and physical manipulation as well as practices aimed at enhancing spiritual well-being.[1] Rongoā Māori was practised prior to European contact and continued after colonisation. Traditionally, some Rongoā Māori is delivered by specially trained tohunga (defined as an expert, traditional Māori healer)[2] although many aspects, such as the use of karakia and certain health measures can be undertaken by any individual. In 1907, the Tohunga Suppression Act was passed to suppress tohunga practice and drove much of Rongoā Māori underground.[2] The Tohunga Suppression Act (1907) was repealed in 1962 and superseded by the Māori Welfare Act (1962).[3] However, analysis of the principles of the Treaty of Waitangi has emphasised that the second Article of the Treaty (the Rangatiratanga Principle) guarantees Māori control and enjoyment of resources and taonga (both material and cultural). This includes the practice of, and access to, Rongoā Māori.[4]

The potential for traditional medicine to positively contribute towards the health of indigenous peoples and to healthcare service delivery has been recognised by the World Health Organization (WHO).[5] Traditional medicine can enhance patient access to health services, assist health services in delivering culturally appropriate interventions, increase awareness of health

promotion and reduce health costs. Consequently, the WHO promotes cooperation and information sharing between western medical practitioners and practitioners of traditional medicine, and supports the development of delivery models that include both traditional and western medicine in national health systems.[5]

Rongoā Māori is classified as a traditional medicine.[6,7] The provision of Rongoā Māori is funded by the Ministry of Health[8] and a number of Rongoā Māori providers now work in New Zealand, both independently and in conjunction with primary healthcare providers.[9] In addition, all New Zealand district health boards have Māori Health Services to support and assist Māori patients and whānau. However, there is no consistent agreement between district health boards or hospitals on whether Rongoā Māori health services should be provided and what such a service would entail. This is in spite of the fact that compliance with the principles of the Treaty of Waitangi are integral to New Zealand's health service provision.[10] Previous research has shown that patients[11] and Rongoā Māori practitioners[12] are interested in seeing Rongoā Māori services become more widely available. In addition, primary healthcare providers are also receptive to the integration of Rongoā Māori services within general practice.[13,14] However, the attitudes of district health board-employed medical, nursing and paramedical staff to Rongoā Māori, and its possible integration into the public health system have never been assessed. This investigation describes the results of an internet-based survey of staff at Waitemata District Health Board (WDHB) ascertaining their attitudes towards the placement of Rongoā Māori within the hospital system.

Methods

An electronic survey was designed using the Survey Monkey platform.[15] The survey was structured in three parts. Four initial demographic questions established the respondent's gender, age band, ethnicity and profession. Responders were then asked if they understood what Rongoā Māori meant. Those who responded affirmatively to this question were directed to a series of further questions to establish the extent of their knowledge of, and use of, Rongoā Māori, as well as questions around potential implementation of a Rongoā Māori service, within a district health board structure. Responders who indicated that they did not have an understanding of Rongoā Māori were directed to a series of questions assessing their understanding and use of complementary and alternative medicines (CAM) and the potential for implementation of a CAM service within a district health board structure.

Prior to full circulation the survey was trialled on 20 members of the Department of Surgery at North Shore Hospital and a number of changes made to enhance the clarity of the questions and to make the survey easier to complete. The study protocol was reviewed by the Northern Regional Ethics Committee and approved as an audit as per the New Zealand National Ethics Committee Guidelines.[16] Circulation of the survey to Waitemata District Health Board (WDHB) staff was approved by the Chief Medical Officer, the Director of Nursing and Midwifery, the Director of Allied Health and the Māori Health Service.

The survey was circulated in an email to all WDHB staff with a hyperlink to connect to the survey questions. This email also contained contact details of the primary investigator for responders to contact with questions or concerns. A six-week period was available to complete the survey and reminder emails were sent at two and four weeks following the initial invitation. Responses were collated electronically and summarised at the survey's close.

Results

The survey was sent to 6,000 individual staff email addresses at Waitemata District Health Board and there were 1,181 responses (response rate 19.6%). The demographics of the responders are summarised in Table 1. Five hundred and forty (response rate 45.7%) of responders felt they knew what Rongoā Māori was and 641 (54.3%) did not know what constituted Rongoā Māori. All responders answered this question. The survey was structured so that the 540 positive responders then answered a number of more detailed questions on Rongoā Māori and their responses are summarised in Table 2. Twenty-five

Table 1: Summary of the demographics of responders to the survey.

	Response count	Response percentage	Did not respond
Gender			
Male	191	16%	
Female	746	63%	244 (21%)
Age range			
<20 yrs	5	0.5%	
21–30 yrs	118	10%	
31–40 yrs	185	16%	
41–50 yrs	246	21%	
51–60 yrs	269	23%	
>60 yrs	115	12.3%	243 (19.5%)
Ethnicity			
European	558	47%	
Māori	153	13%	
Pacific Island	36	3%	
Asian	86	7%	
Other	125	11%	223 (19%)
Occupation			
Medical practitioner	123	10%	
Nursing	314	26%	
Physiotherapy	24	2%	
Occupational therapy	27	2%	
Social work	55	5%	
Nutrition	12	1%	
Management	89	8%	
Orderly	6	0.5%	
Other*	299	25%	232 (20%)

*Includes healthcare assistants, engineering and building support staff and clerical staff.

responders felt that there was no place for Rongoā Māori in a DHB setting primarily due to difficulties in developing and structuring its introduction and uncertainty over how such a service would be monitored and funded. The 641 responders who were unsure of what constituted Rongoā Māori were then directed to a separate part of the survey where the questions on CAM were presented. The responses to this part of the survey are summarised in Table 3.

Discussion

This survey was undertaken to assess the attitudes and knowledge of DHB staff to Rongoā Māori and CAM with a view to later investigations exploring possible structures and mechanisms for collaboration between Rongoā Māori and medical treatment in New Zealand's hospital-based public health system. An email-based survey format was chosen since this enabled all responders to remain anonymous and allowed the survey to be sent to all WDHB staff. Over 1,000 responses were received although this represents a WDHB response rate of only 20%. Demographic analysis showed that the majority were female, part of the medical or nursing workforce, aged between 51–60 years, which may be a reflection of the WDHB staff profile where nursing and medical staff form the largest employment grouping. Two thirds were of European ethnicity and 18% were Māori, which

Table 2: Summary of responses to detailed questions regarding Rongoā Māori in 540 responders who understood what Rongoā Māori is.

Question	Yes	No	Did not respond
What is Rongoā Māori to you*			220
Karakia	258		
Rongoā rākau	200		
Pure	95		
Mirimiri	197		
Komirimiri	83		
Romiromi	103		
Wai	138		
Matakite	97		
Wairua	227		
Other	120		
Have you or your whānau used Rongoā Māori	194	205	141
Have you or your whānau provided Rongoā Māori for others	121	270	149
Do you think there is a place for Rongoā Māori in the district health board setting	381	25	134
Who should be offered Rongoā Māori in the district health board setting*			159
All patients	146		
All Māori patients	171		
Self-nominating patients	237		
Whānau	168		
Staff	154		
Who would assess, prescribe and administer Rongoā Māori in the district health board setting*			151
Rongoā Māori practitioner	324		
Specially trained DHB staff	218		
Patients	66		
Whānau	142		
Other	52		
Would you be interested in being interviewed on the topic of Rongoā Māori in the district health board setting	101	305	134
Would you be interested in receiving more information on Rongoā Māori	455	85	0
How would you like to receive more information on Rongoā Māori*			0
Seminar	137		
Rongoā Māori course taught in the hospital	149		
Online course	252		
Dedicated intranet website	194		
Other	13		

DHB: District Health Board; * multiple responses permitted.

Table 3: Summary of responses to detailed questions regarding complementary and alternative medicines (CAM) in 641 responders who did not understand what Rongoā Māori is.

Question	Yes	No	Did not respond
Do you think there is a role for CAM in the DHB environment	477	106	58
Have you or your whānau used CAM	160	384	97
Have you or your whānau provided CAM for others	39	498	104
Who should be offered CAM in the district health board setting*			193
All patients	326		
All Māori patients	41		
Self-nominating patients	129		
Whānau	62		
Staff	161		
Who would assess, prescribe and administer CAM in the district health board setting*			197
CAM practitioner	301		
Specially trained DHB staff	314		
Patients	29		
Whānau	56		
Other	22		

DHB: District Health Board; * multiple responses permitted.

is similar to the Aotearoa/New Zealand ethnicity demographic profile. In addition, significant numbers of responders did not provide answers to some questions. This may indicate that the responders are unfamiliar or uncomfortable with providing a response.

This survey can be criticised since it relied on an internet response and did not permit responders to elaborate and provide in-depth answers to questions. However, responders were asked if they wished to take part in staff focus groups addressing questions raised in the survey. This constitutes the second part of this research project and is almost complete. Similarly, only two email reminders were sent to remind responders to complete the survey. More frequent reminders were considered; however, we were conscious that WDHB staff are busy and we did not wish to create responder fatigue. Finally, because of the anonymous nature of the survey it is likely that responders with strongly negative feelings would reply. Overall, we wished to assess the sentiment of WDHB staff toward Rongoā Māori and the survey was circulated to all staff. The response rate of over 1,000 was heartening but does represent a response rate of only 20%. However, we believe that the survey gives an accurate representation of the diversity of views of WDHB staff toward Rongoā Māori.

Just under half of responders (46%) indicated familiarity with Rongoā Māori. The response rate for this question was much higher than subsequent questions pertaining to more comprehensive knowledge of Rongoā Māori, possibly indicating little detailed knowledge of the components of Rongoā Māori. However, one third of responders (n=381) indicated that there should be a place for Rongoā Māori within the DHB and ideally this would be provided by specially trained practitioners (either Rongoā Māori providers or trained DHB staff). Responders also felt this service should be made available to both patients and staff. Configuring a Rongoā Māori service for public hospitals is an attractive prospect. Durie 2004[17] has emphasised that Māori knowledge and western science should simply respect each other, not attempt to change or compromise each other and could simply co-exist within

the health system, allowing the integrity of each to be preserved.[18] A Rongoā Māori service could therefore involve Rongoā Māori practitioners and western medical practitioners working side-by-side as part of a multi-disciplinary team providing patient and staff care and there is evidence that this approach is successful in primary healthcare.[9,10] Consideration could also be given to providing training for selected New Zealand medical undergraduates in Rongoā Māori, developing a workforce that is proficient in both western medicine and Rongoā Māori. It must be emphasised that knowledge of Rongoā Māori is privileged and must remain under the care and control of Māori. However, both India and China have health systems that have integrated traditional and western medicine by teaching both methods of treatment to their undergraduates and now incorporate both methods into health delivery for patients within a hospital system,[19] and there is evidence that this approach can optimise patient outcomes.[20]

Twenty-five responders felt that there was no place for Rongoā Māori within the DHB and highlighted issues of governance, accreditation and fundamental incompatibility between western medicine and traditional medicine. These issues have been noted previously[6,10,13] and solutions have been suggested including allowing Rongoā Māori practitioners to administer and set regulations for their healing practice, and for DHBs to partner with local Iwi in the provision of a Rongoā Māori service.[6] The response to this survey suggests that many DHB staff do not feel that Rongoā Māori and western medicine are incompatible.

This survey also supports previous research demonstrating that Rongoā Māori use is common, particularly among Māori.[21] Māori report that Rongoā Māori provides a comprehensive and holistic way of treating mental and physical conditions that is in direct contrast to many of the treatments available from western medical practitioners. Interestingly, in this survey, the numbers of self-nominated Rongoā Māori users (n=194) exceed the numbers of responders with self-nominated Māori ethnicity (n=153) indicating that non-Māori are also using Rongoā Māori.

There were 54% of responders who were not familiar with Rongoā Māori and who were directed to series of questions on CAM. Of the CAM responders, there were similar findings with nearly one third using CAM, nearly three quarters feeling that CAM services should be available within the DHB, and these services should be provided by trained CAM practitioners or DHB staff.

Collectively the survey demonstrated that 10% of responding staff felt there was place for CAM within the DHB while only 6% felt this was appropriate for Rongoā Māori. This finding may be the result of a lack of awareness about Rongoā Māori components, such as massage, which was the modality most used and provided by CAM responders. Since the majority of responders to this survey were female, between 51–60 years old and involved in nursing, this demographic may provide a potential pathway for Rongoā Māori/medical collaboration since other investigators have shown that nurses are more inclined to discuss traditional medicine between themselves and patients.[22]

For any potential future Rongoā Māori/medical collaboration there are significant issues around accreditation, quality assurance, monitoring, resourcing, and medical management of patients. However, a first and initial step would be provision of Rongoā Māori education for staff who indicated an openness and desire for more information. A need for further research exploration on Rongoā Māori evidence was also noted.

Conclusion

Nearly half of DHB staff surveyed had some knowledge of Rongoā Māori and a third supported its availability within the hospital system. A larger feasibility study is in progress to explore the issues around collaboration between Rongoā Māori and medical treatment and a detailed report summarising the survey findings will be circulated.[21]

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Variation in volumes and characteristics of trauma patients admitted to a level one trauma centre during national level 4 lockdown for COVID-19 in New Zealand

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ABSTRACT

AIM: The aims of this study were to describe the variation in volumes and types of injuries admitted to a level one trauma centre in New Zealand over two 14-day periods before and during the national level 4 lockdown for COVID-19; and highlight communities at risk of preventable injury that may impact negatively on hospital resources.

METHOD: A retrospective, descriptive study of prospectively collected data in the Midland Trauma Registry in New Zealand.

RESULTS: Overall there was a reduction of 43% in all injury-related admissions with significant reductions seen in major injury (50% reduction), males (50% reduction) and children aged 0–14 years (48% reduction). Results for ethnicity and persons aged over 14 years were within 3% deviation of this overall 43% reduction. Injuries at home, particularly falls, predominate.

CONCLUSION: Despite the significant reduction in admissions during level 4 lockdown, hospitals should continue to provide full services until resource limitations are unavoidable. Immediate messaging is recommended to reduce rates of injury on the farm and at home, specifically falls prevention. Ongoing attention of road users to road safety is essential to reduce the incidence of preventable major injury. These immediate measures can potentially reduce unnecessary pressure on hospital beds and resources during the pandemic.

At the time of writing the COVID-19 pandemic is poised to challenge the capacity and capability of New Zealand's community-based and acute care facilities. If the number of patients requiring hospital-level care due to COVID-19 escalates it is likely that available resources will be repurposed to reduce the morbidity and mortality related to the virus. However, while this acute care need may rise, injuries will continue to occur in our community. In this complex situation hospital planners and clinicians must simultaneously balance the needs of these patients with those of COVID-19 patients (alongside other medical and surgical emergencies).

Little is known about the patterns and volumes of injury that can impact on hospital resources during periods of community lockdowns given the newness of this situation. The Royal Australian College of Surgeons (RACS) and the American College of Surgeons (ACS) have both warned of the possibility of the pandemic to impact on the care of critically injured patients, particularly for those patients who require time-sensitive life-saving interventions and advanced critical care to support life and recovery.[1,2] Through RACS, trauma surgeons have expressed concerns that an unintended consequence of the pandemic (with people living in lockdown conditions) may

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be an increase in preventable injury-related hospitalisations.[3] In Australia doctors have reported a spike in preventable injury cases immediately prior to community lockdown measures, with concerns that alcohol-related risk-taking behaviours were behind some of that increase.[3] The New Zealand Association of Plastic Surgeons has advised people to be vigilant and avoid injury in lockdown as they tackle jobs around the house using machinery such as power tools.[4]

In New Zealand, government-led messaging has been clear that people must stay at home and remain local if they go outside for exercise, shop for essentials or to look after other vulnerable people (at all times practising social distancing). Organisations such as Federated Farmers, mountain biking and tramping clubs across the country have also been actively communicating through multiple media channels for people to observe the lockdown measures and for those working in essential services to be particularly aware of the potential for injury.[5,6] ACC has reminded people that most injuries happen in the home so to take precautions with any do-it-yourself (DIY) activities.[7]

In response to the need to quantify any change in the volume and nature of injury resulting from lockdown conditions, the Waikato Hospital Trauma Service in partnership with the Midland Trauma Research Centre conducted this study to:

1. assist with the prediction of the volume and nature of injury load on scarce hospital resources, and
2. provide information for targeted injury awareness and prevention campaigns to reduce injury rates and admissions to hospital during a time of pandemic.

Methods

A retrospective, descriptive study was conducted on prospectively collected trauma registry data on injured patients of all age groups and injury severities admitted sequentially to a level one trauma centre before and after level 4 community lockdown in response to the COVID-19 pandemic.

The two study groups consisted of admissions over the 14 days before the declaration of alert level 2 on 19 March 2020 and 14 days after the declaration of the level 4 lockdown on 26 March 2020 by the New Zealand Government.

A week of partial lockdown between 19 March and 25 March 2020 was excluded to allow analysis of a presumed steady state of community behaviour within pre- and during-lockdown phases when national alert levels were escalating and community behaviour was changing dramatically in anticipation of level 4 lockdown.

Patients were grouped according to age group, gender, cause of injury, place of injury, injury severity, ethnicity and injury outcome. Identical patient groupings will be used in a future study of pre- and post-lockdown analyses.

Data was sourced from the Midland Trauma Registry (MTR) and analysed using Excel and R. This study was approved by and registered with the Waikato District Health Board's Clinical Audit Support Unit (registration number 4085).

Included in the MTR are patients admitted within seven days of injury; exclusions included insufficiency or peri prosthetic fractures, exertional injuries, hanging near drowning or asphyxiation, and injuries as a result of underlying medical conditions. These exclusions are broadly consistent with other registries within Australia and New Zealand.

Injuries, causes and procedures were coded using ICD10AM; additional diagnostic and injury severity scoring was done using the AIS system. The threshold for moderate to major injury is Injury Severity Score (ISS) greater than 12.[11,12]

Results

Demography

A total of 195 patients were admitted over the study period; 124 in the 14-day pre-lockdown period and 71 in the first 14 days of the level 4 lockdown period. There was an overall decrease in admissions of 43% (Table 2). Comparison was also made with corresponding 14-day periods from exactly a year before the study, confirming that the lockdown period volumes for moderate severity injury were significantly reduced from the same time period in the previous year (Table 1).

Table 1: Comparison of admission volumes for same time periods in 2019 and 2020.

Date of ED arrival				
	5 March 2020–18 March	**26 March 2020–8 April**	***P***	**Total**
Year arrival				
2020	124	71	*<0.001*	195
2019	108	142		250
Major (ISS>12)				
2020	22	11	*0.048*	33
2019	14	19		33
Moderate (ISS≤12)				
2020	102	60	*<0.001*	162
2019	94	123		217

The most marked reductions occurred in males (50% reduction), major injury (50% reduction) children 0–14 years old (48% reduction), and non-Māori (44% reduction). Lowest reductions were seen in females (28% reduction).

Cause of injury during lockdown

The relatively short study period has produced relatively low numbers of patients when spread across the cause categories (Table 3) however some trends appear. The highest volumes were seen in cause groups

Table 2: Pre-lockdown and during-lockdown period admission volumes at Waikato Hospital (date ranges represent ED arrival dates).

	Total	**Pre lockdown** ***(5 Mar 2020–18Mar 2020)***	**During lockdown** ***(26 March 2020–8 April 2020)***	**% Change**	***P***
Overall	195	124	71	43%	
Severity					
Major (ISS>12)	33	22	11	50%	0.68
Moderate (ISS≤12)	162	102	60	41%	
Gender					
Female	69	40	29	28%	*0.23*
Male	126	84	42	50%	
Ethnicity					
Māori	58	36	22	39%	0.77
Non- Māori	137	88	49	44%	
Age band (Years)					
0–14	50	33	17	48%	*0.90*
15–64	106	66	40	39%	
65+	39	25	14	44%	

Table 2: Pre-lockdown and during-lockdown period admission volumes at Waikato Hospital (date ranges represent ED arrival dates) (continued).

Cause					
Assault	7	5	2		n/a
Burns	9	6	3		
Crushed	2	2	-		
Cycling	10	5	5		
Equestrian	6	3	3		
Fall	70	46	24		
Machinery	5	4	1		
Motorcycle	20	12	8		
Other	24	12	12		
Pedestrian	9	4	5		
Quad bike	1	-	1		
Road traffic crash	29	23	6		
Struck (Unintentional)	2	1	1		
Unknown	1	1	-		
Place of injury					
Farm	18	8	10		n/a
Home	75	41	34		
Industrial	5	4	1		
Other	14	7	7		
Outdoors	2	2	-		
Public building	4	4	-		
Public admin. area	10	10	-		
Road	43	30	13		
Sidewalk	9	4	5		
Sports area	10	9	1		
Water	5	5	-		

P value from Chi-square test for independence (test of whether linkage is independent between categories of the variables, n/a- insufficient data).

for falls (n=24), followed by motorcycles (n=8), car crashes (n=6), cycling (n=5), pedestrians (n=5) and 'other' (n=12). There were two admissions related to assault.

Focus on falls

There were 70 falls in total with 65% (46) occurring during the pre-lockdown period. Falls in pre-lockdown happened in a wide variety of circumstances, including; falling down stairs, from ladders, from playground apparatus (including while at school), while riding push scooters, falling while walking and falls from mobility scooters. In comparison there were fewer falls during lockdown (n=24) by similar causes. Thirteen of the 22 falls during lockdown occurred at home—falling in the shower, from a ladder and down stairs and falling while walking.

Place of injury during lockdown

There were insufficient cases to show statistical significance in volume change by place of injury however several trends

Table 3: Pre- and during-lockdown injury events by injuries at home.

	Total	Pre-lockdown	During lockdown	P value
Overall	75	41	34	
Severity				
Major	6	4	2	n/a
Moderate	69	37	32	
Gender				
Female	31	15	16	0.36
Male	44	26	18	
Ethnicity				
Māori	25	15	10	0.51
Non- Māori	50	26	24	
Age bands (years)				
0–14	19	10	9	0.96
15–64	35	19	16	
65+	21	12	9	
Cause				
Assault	3	2	1	n/a
Burns	7	4	3	
Crush	1	1	-	
Cycling	1	1	-	
Equestrian	1	-	1	
Fall	36	23	13	
Machinery	3	2	1	
Motorcycle	3	1	2	
Other	14	6	8	
Pedestrian	5	1	4	
Struck (unintentional)	1	-	1	

occur. There was reduction of volumes seen in all places of injury except the farm, where there was a minor increase from five to eight cases. The most common places were: home (n=34), road (n=13), farm (10), 'other' (7) and sidewalk (5).

Focus on injuries occurring at home (Table 3)

Pre-lockdown there were 41 injuries at home compared with 34 during lockdown. During both time periods 'falls' were the main cause of injury; 76% (n=23) and 36% (n=13) respectively. Interaction with motor vehicles, injuries from dog bites, machinery related injuries and injuries in the kitchen were the other key categories overall, although numbers are smaller.

Limitations and strengths

As consequence of the progression of the COVID-19 and emergent need to deliver reliable information for district health boards (DHBs) and community safety agencies to act upon, an extremely contracted timeframe was available for data collection and processing. As a result the study has small numbers of patients and

statistical significance could not be gained in the analyses with larger numbers of variables such as cause of injury. It is envisioned that follow-up studies will use expanded timeframes and larger patient numbers as all hospital admissions within the Midland region will be included (covering the Waikato, Lakes, Tairawhiti, Taranaki and Bay of Plenty DHBs).

This study used prospectively collected data from the Midland Trauma Registry, a high-quality resource that contains data on admitted trauma patients of all age groups and injury severities, collected continuously since 2012.

Discussion

This study has revealed significant reductions in the overall volume of all injury admissions during level 4 lockdown of 43%. The greatest reductions were seen in major injuries and males: this suggests that males are at high risk of non-lockdown activities such as road traffic crashes, work, school and sport. Although still almost halved from pre-lockdown levels, the least reductions were seen in females. Cognisant of the small numbers in this study, a greater proportion of females aged 65+ years were injured in and around the home both pre and during lockdown compared to younger women. Five of the 10 injuries for this age group pre-lockdown were falls related; during lockdown falls contributed five of the six injury events. For this group there were four road crash-related hospital admission pre-lockdown but none during lockdown.

Not surprisingly the rates of road trauma have fallen during lockdown as road use has declined, however we would expect them to be near zero if essential road users remain committed to safe driving. Conversely, there was a slight increase in the number of injuries related to farm work, as may be expected in conditions where farm work is considered an essential service and farmers continue to work under the conditions of level 4 lockdown. It is difficult to compare data in this pandemic situation, however in the UK the Royal College of Emergency Medicine has reported a 25% fall in visits to emergency departments in the first week following their lockdown; thought to perhaps be partially attributed to fewer injury events due to lower vehicle use.[8] In Italy, several doctors have reported lower volumes of injury but with those requiring acute care being more severely injured.[9] However, these data are new (and localised) and no firm trends and analysis are currently publicly available.

ACC recently noted that across the country thousands of injury claims have come in, with people injuring themselves doing everything from home DIY to playing sports despite the country being in lockdown. There were 243 claims for DIY work in the first week of lockdown—down from 395 over the same period last year, and 116 claims related to ladder use, down from 226 the previous year. Total claims overall were down about two-thirds in the first week of level 4 lockdown.[10] In the Waikato district, despite the stay-at-home message promoted heavily in lockdown, the rate of home injuries has fallen, suggesting that the public are mindful of the consequences of moderate-to-severe injury and are reducing their risks of injury in the home. This is particularly encouraging given the enormous increase in overall time at home experienced by individuals complying with the national 'stay-at-home' message. However, there remains a large burden of injury in the community that is amenable to prevention strategies that can be enacted immediately.

Conclusion

Trauma of all age groups and severities continues to occur, albeit at greatly reduced volumes. In terms of resource allocation, hospitals should continue to provide full services until significant resource restriction occurs. This will ensure that the highest levels of service are maintained, reducing complications and ultimately improving injury outcomes. In terms of awareness raising and injury prevention, the actions of the general public to reduce the risk of home-based trauma during lockdown should be recognised and encouraged. Further emphasis could be placed on falls avoidance

techniques in the home and near-home environments. These are already well described in advice from ACC and could be supported and amplified by primary care providers, DHBs and other agencies. Likewise, strengthening safety or avoidance measures against injury on the farm is advised (both for farming and recreational activities for those where a farm is also home). Continued emphasis on reducing road trauma during essential activities is also recommended.

Competing interests:
Nil.

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Towards elimination of tuberculosis in New Zealand

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ABSTRACT

New Zealand could be the first country in the world to eliminate tuberculosis (TB). We propose a TB elimination strategy based on the eight-point World Health Organization (WHO) action framework for low incidence countries. Priority actions recommended by the WHO include 1) ensure political commitment, funding and stewardship for planning and essential services; 2) address the most vulnerable and hard-to-reach groups; 3) address special needs of migrants and cross-border issues; 4) identify active TB and undertake screening for latent tuberculosis infection (LTBI) in recent TB contacts and selected high-risk groups, and provide appropriate treatment; 5) optimise the prevention and care of drug-resistant TB; 6) ensure continued surveillance, programme monitoring and evaluation and case-based data management; 7) invest in research and new tools; and 8) support global TB prevention, care and control. In New Zealand, central government needs to take greater responsibility for TB policy and programme governance. Urgent action is required to prevent TB in higher risk groups including Māori communities, and to enable immigration screening to detect and treat LTBI. Clinical services need to be supported to implement new guidelines for LTBI that enable better targeting of screening and shorter, safer treatment regimens. Access to WHO recommended treatment regimens needs to be guaranteed for drug-resistant TB. Better use of existing data could better define priority areas for action and assist in the evaluation of current control activities. Access to GeneXpert® MTB-RIF near the point of care and whole genome sequencing nationally would greatly improve clinical and public health management through early identification of drug resistance and outbreaks. New Zealand already has a world-class TB research community that could be better deployed to assist high-incidence countries through research and training.

Tuberculosis (TB) remains a disease of public health significance to New Zealand. Progress in reducing TB incidence has stalled for more than a decade, with between 276 and 308 cases notified each year.[1] Inequities are a major feature of the epidemiology of TB in New Zealand, with people born overseas and Māori and Pacific peoples disproportionately affected. New Zealand could be the first country in the world to eliminate TB, thereby ending a public health threat and providing a template of success for other countries. We envisage a centrally coordinated TB strategy that uses enhanced surveillance and laboratory tools to promptly diagnose and successfully manage TB cases. Additionally it would more effectively focus preventive efforts on risk groups to reduce TB incidence and achieve disease elimination.

Public health impact of TB in New Zealand

Despite a relatively low overall incidence of 6.3 notifications per 100,000 population, TB remains a disease of public health significance in New Zealand because of the intensive work required to trace contacts and supervise treatment. Drug resistance also magnifies the public health impact of the disease as it causes increased treatment duration, costs and side effects, and requires prolonged isolation. Furthermore, the overall incidence belies substantially higher risk in certain populations. In 2016, the annual incidence in the Asian ethnic group was 32.7 per 100,000, 30 times greater the in the European and Other ethnic group and in Māori was eight time higher than in the European and Other ethnic group.[1]

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The high incidence of TB in Asian New Zealanders likely reflects a high proportion of recent migrants from countries where TB is common. In 2016 79% of TB notifications in New Zealand were in people born overseas,[1] despite long-term migrants undergoing radiological screening to exclude active TB disease. It is likely TB in migrants represents re-activation of LTBI acquired from having lived in high-incidence TB countries. Consistent with this, isolates in migrants to New Zealand seldom are closely genetically related, and usually reflect the TB strains prevalent in their country of origin.[2] TB can occur anytime over their lifetime but usually occurs within five years of migration. Although good management of cases and contacts means transmission outside the home is infrequent, the children of certain migrants are at risk.[3]

Elimination of TB as a public health problem is defined as <1 notified TB case per million population per year.[4] This is the rate at which it is considered that the disease cannot sustain itself in a population. In New Zealand 'pre-elimination', defined as a rate of approximately 10 per 1,000,000, has been achieved in the European and Other ethnic group. This comparatively low incidence in some sectors of the community illustrates inequities and shows that TB elimination is an achievable goal if TB risk factors and barriers to care are systematically addressed. We use the WHO action framework for low incidence countries to identify key actions for New Zealand to take.[4] New Zealand could be the first country in the world to eliminate TB, thereby providing a template of success to other countries.

Political commitment, funding and stewardship for planning and essential services

New Zealand has no central governance of TB control. Since 2001, responsibility for diagnosis, infection prevention, treatment and operational public health services, including TB, has been devolved to 20 district health boards (DHB) and 12 regional public health units respectively. A national TB advisory group comprising experienced practitioners from these operational units served as a source of technical advice and informal input into programme governance, but was disbanded in 2010. While the government has committed to TB elimination via endorsement of the UN Sustainable Development Goals,[5] in practice there is no coordinated mechanism to deliver on this commitment.

To achieve TB elimination, TB policy development and government coordination would need to be prioritised by the Ministry of Health. Currently there is not a single official whose role focuses on TB. This means TB initiatives occur on an *ad hoc* basis as other priorities and outbreaks permit. A policy for TB elimination is lacking and there is no mechanism for planning the delivery of effective national TB diagnostic services and real-time surveillance infrastructure. Responsibility for aspects of TB control is fragmented across agencies, and as a result the Ministry lacks direct control over medicines supply, surveillance and immigration screening. TB is the archetypal communicable disease of public health significance, which requires central coordination from the Ministry of Health.

Finally, despite New Zealand having a consortium-based initiative for eradication of bovine TB in animals with funding of $80M per year,[6] funding for human TB control is not ring-fenced. Public health units face a number of priorities and are insufficiently resourced for directly observed therapy to be consistently offered throughout the country.

Eliminating TB in Māori

Since the time of European colonisation of New Zealand, TB has had a significant impact on Māori communities. In 1769 the Māori population was 100,000 and in 1820 it had fallen to 42,000.[7] Although the contribution TB played in this decrease is not fully known, it is recognised that even up into the early 1900s, TB was one of the most common causes of premature death within Māori communities. In 1935 Dr Harold Turbott published a report of a high-quality prevalence survey in Māori in the Waiapu valley, East Coast.[8] The prevalence of LTBI was 48.5%, including 81% of all those aged 16 years and over. It is likely that there remains a large reservoir of LTBI in at least older Māori, which will continue to reactivate and cause disease regularly, perpetuating endemic transmission. New

Zealand's isolation means TB may have undergone a founder effect. This means isolates will appear to be part of 'outbreaks' when they are not. A recent whole genome sequencing (WGS) study of 'Rangipo' strains thought to be linked epidemiologically showed that three of the six were not in fact the same strain.[9]

Within Māori, reactivation of LTBI is likely to be promoted by higher rates of comorbidities like cancer and diabetes compared to non-Māori.[10] Timely diagnosis, care and prevention of transmission will be impacted on by higher rates of overcrowding and the added barriers that Māori have accessing health services in their current configuration. For example, Māori are more likely than non-Māori to not see a general practitioner because of cost, less likely to be referred on to specialist services and more likely to experience racism in the health system.[11,12] Yet control of TB requires significant engagement with the health sector for diagnosis, contact tracing and treatment.

Work with Māori communities is required to better understand existing TB strains and the relative contribution of LTBI reactivation versus recent transmission in driving higher TB incidence in Māori. Urgent action is needed to reduce poverty and improve housing for Māori. The professional community of TB clinicians also needs to improve its competence when engaging with Māori individuals and communites to deliver culturally appropriate care.

Addressing the needs of migrants and cross-border issues

Currently migrants applying for a visa to work, live or study in New Zealand are screened for TB using chest radiographs. This screening detects prevalent pulmonary TB, but not LTBI. Data from a number of sources indicate that most TB cases in New Zealand arise from reactivation of LTBI acquired overseas. First, active TB on arrival is unlikely to explain TB cases that develop more than two years after screening,[13] and 75% of TB cases in migrants to New Zealand are diagnosed more than two years after arrival.[1] Second, genotyping confirms infection in New Zealand is uncommon in migrants.[2] Third, we audited the screening records of 120 TB cases occurring within two years of their immigration medical and found 41% had a recent normal x-ray, meaning that a substantial proportion of early cases could also arise from reactivation of LTBI (unpublished data). Screening migrants from high TB incidence countries for LTBI is the initiative that will most substantially reduce TB in New Zealand and is a necessary step for TB elimination.

The US has screened child migrants for LTBI for over a decade. The UK National Institute for Health and Care Excellence recommends LTBI screening for all migrants from countries with an incidence >40 per 100,000 without age restriction following an analysis of cost-effectiveness.[14] In Australia the National Tuberculosis Advisory Committee recommends LTBI screening for migrants under 35 years of age from countries with an incidence >100 per 100,000 or >40 per 100,000 when resources permit.[15] International studies find the prevalence of LTBI in migrants is correlated with TB incidence in their country of origin.[16,17] Similar studies are needed in New Zealand to determine the most appropriate target population and to determine the resource required to provide quality LTBI treatment services equitably. Screening could be initiated during the immigration medical, a positive test should prompt a referral for treatment, and not influence immigration decisions. Implementing LTBI screening and treatment for migrants to New Zealand would have the single greatest impact in reducing TB incidence, addressing an important health disparity for the migrant community and progressing us towards TB elimination.

Undertake screening for active TB and LTBI in TB contacts and selected high-risk groups, and provide appropriate treatment

Public health units perform TB contact tracing to find active and LTBI in recently exposed contacts. Outside of contact tracing, LTBI screening and management in New Zealand has been unnecessarily complex. Firstly, many health sector employers implement large-scale screening of employees with interferon gamma release assays (IGRA) of low-risk individuals. Positive results in low-risk populations like this are most likely to be false positives, and

Figure 1: Who should be tested for LTBI?

- TB case contacts.
- Recent migrants from high-incidence countries.
- People with immune suppression due to HIV infection, TNF-α inhibitors or solid organ transplant, irrespective of TB exposure.
- People with immune suppression due to renal failure, haemodialysis, corticosteroid use and cancer with a history of possible TB exposure.
- Healthcare workers with a history of possible TB exposure.

From Guidelines for Tuberculosis Control in New Zealand, 2019.

the testing is wasteful. Secondly, previous guidelines lacked clarity on the interpretation of tests and did not issue specific recommendations on who should be treated.

New Guidelines for TB control in New Zealand published by the Ministry of Health seek to simplify the approach to LTBI.[18] *The Guidelines* underscore that IGRA and tuberculin skin test are largely equivalent in their performance, except in BCG vaccinated people in whom IGRA is preferred. *The Guidelines* specify clinical populations to be targeted for LTBI screening, and, if they test positive, treated (see Figure 1). New regimens for treatment of LTBI are also recommended, enabling shorter and safer treatment.

The Guidelines provide the framework for better targeted testing. It is clear that clinicians managing individuals with HIV, cancer or renal failure, transplant patients, or those receiving corticosteroids or TNF-α inhibitors must have a systematic approach to TB risk assessment and screening. Laboratories should use these indications as the basis for demand management for IGRA testing. New regimens enable faster and safer treatment of LTBI than previously possible with isoniazid alone. For example,

Capital and Coast District Health Board, has streamlined the management of LTBI in a fortnightly registrar-led clinic. Patients can start treatment at their first (and usually only) clinic visit with follow-up by scheduled telephone visits. This combined with shorter treatment regimens mean the non-attendance rate has fallen from 45% to 16%, and more patients can be treated with the same staff resource.

Optimise the prevention and care of drug-resistant TB

Over the decade ending 2016 the rate of MDR-TB among culture confirmed cases was 1.3%. While the number of referrals to the TB clinical network has increased in the last year, more recent surveillance data is needed to confirm if MDR-TB rates are increasing.

The priority issue in MDR-TB management relates to funding for WHO-recommended second-line antimycobacterial medicines. Historically, the Ministry of Health has guaranteed funding for all aspects of TB care because of the potentially catastrophic consequences of outbreaks. As new treatments for MDR-TB have been developed, the Ministry convened the TB Clinical Network to provide expert advice, including assessing the need for expensive new agents such as bedaquiline.[19]

Over the last 18 months WHO have revised their MDR-TB recommendations,[20] based on a metaanalysis of individual level data from several trails that showed bedaquiline reduced treatment failure by 70%. The new guidelines recommend a combination of highly effective bacteriocidal drugs, including bedaquline, and discourage the use of amikacin due to significant adverse reactions, such as hearing loss in a third of recipients even with therapeutic and audiometry monitoring.[21]

Over time, the TB Clinical Network's role in approving use of bedaquiline has been taken over by PHARMAC. The public health considerations that underpinned guaranteed drug funding have given way to a focus on reducing drug costs. Bedaquiline can only be accessed for MDR-TB if the patient faces exceptional clinical circumstances such as extensive drug resistance (XDR-TB) or an absolute contraindication to or intolerance of other second-line agents. In other words, for most MDR-TB cases bedaquiline is not available until the patient starts to lose their hearing. This is harmful and risks treatment failure and secondary transmission, and is

a false economy as amikacin treatment is as expensive as bedaquilline once the administration costs are considered.[22] The public health considerations in the supply of these essential medicines are poorly incorporated into Pharmac's decision making process, and an urgent review is needed.

Ensure continued surveillance, programme monitoring and evaluation and case-based data management

Active TB is a notifiable disease in New Zealand and annual surveillance reports provide a comprehensive description of TB cases and trends with respect to time, person and place as well as basic clinical, drug susceptibility and molecular typing analysis. There are various ways in which better use of existing data and additional data collection could support TB elimination in New Zealand.[23] Firstly, including TB notifications in the government's integrated data infrastructure with linkage with health, demographic and immigration datasets[24] would enable periodic analytic studies. These could better define risk factors for TB in New Zealand and would be especially useful for identifying how immigration screening (and access to funded treatment) could be improved. Secondly, performance indicators for case management and contact investigations should be developed and routinely applied by clinical and public health services for information on quality of care. Thirdly, new data on LTBI prevalence in Māori and other risk populations are needed to better understand the potential for future disease and guide prioritisation for intervention.

Invest in new tools

Over the last decade there have been significant advances in the laboratory diagnosis of TB, and the testing for drug susceptibility. The introduction of the molecular tests Xpert MTB/RIF (Cepheid, Sunnyvale, CA, US) and Xpert MTB/Rif Ultra assay now make it possible to very rapidly diagnose TB and identify resistance from clinical samples. This allows TB to be confirmed more rapidly, and results in better use of isolation. *The Guidelines for TB control in New Zealand* recommend a Xpert® MTB-RIF is performed on all smear positive samples,[18] and this needs to be available in regional laboratories to ensure the benefits of rapid diagnosis are achieved equitably.

The introduction of WGS offers many potential benefits such as providing a greater discrimination of strain relatedness, reducing unnecessary contact tracing and identifying links not established through contact tracing processes. It also supplements phenotypic drug susceptibility testing by providing rapid identification of resistance gene mutations to a wide range of drugs.[25,26] Unlike the rapid PCR tests which should be available close to patient care, WGS should be centralised allowing for expertise in the interpretation of results to support both public health and clinical decision making. Interpretation of WGS data used in case and outbreak management needs supported training for clinicians and public health staff with regular regional and national meetings to discuss findings. Models like this exist in Australia and the UK, which shows close liaison between public health, clinicians and laboratory scientists in the interpretation and application of such findings is essential. There is widespread support for a national reference laboratory providing rapid, consistent and well-interpreted results available to multidisciplinary teams.

Support global TB prevention, care and control and invest in research

Like many communicable diseases of significance in New Zealand, TB is a persistent reminder that we are connected to the wider world. Even if we can achieve elimination, we will remain vulnerable to re-entry of *M. tuberculosis*. Therefore, New Zealand needs to play a role in addressing TB on a global scale. New Zealand indicated readiness to work towards global TB elimination through adopting the sustainable development goals. New Zealand funding should go towards enhancing TB control in Low and Middle Income Countries through the New Zealand Aid Programme. This can focus on the Asia-Pacific region, which has the highest TB burden globally and the source of a substantial proportion of cases identified in New Zealand. New Zealand TB experts could play an active role in prioritising and implementing projects and are in a strong position to train TB control programme staff on scholarships in a broad array of disciplines. New Zealand has also

invested in TB research through joining the e-Asia initiative since 2014. There is a critical mass of TB-focused researchers in New Zealand who are part of the global research community, studying immune protection,[27] vaccine development,[28] new drug development,[29] diagnostics[30] and public health. These research efforts should be enhanced by more investment. Furthermore, New Zealand TB experts should be encouraged and enabled to contribute their expertise to global bodies.

Conclusion

By eliminating TB we can address the stark inequities that characterises this illness, particularly among Māori compared to others born in New Zealand. It is evident that LTBI screening of migrants from high TB incidence countries will be necessary to achieve TB elimination, whereas for Māori, further study is urgently needed to determine the appropriate action. Other priority actions include the implementation of LTBI screening recommendations for high-risk clinical populations. Ensuring laboratory capability to rapidly diagnose TB and identify drug resistance and clusters is needed. Disease intelligence needs to be extended beyond surveillance to analytic studies and periodic programme evaluation. The management of TB case contacts and other clinical populations has been streamlined, but quality projects and audit are required to ensure this is implemented.

Strong leadership by the Ministry of Health will be necessary, and can begin with the development and implementation of a TB elimination plan to prioritise these goals. New Zealand has a depth of scientific and clinical expertise in TB that can assist this implementation.

Competing interests:
Dr Perumal reports and works as the local Medical Officer of Health for TB control in the Auckland Region.

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Why BMI should still be on the table

Lisa Daniels, Wayne S Cutfield, Rachael W Taylor, Barry J Taylor

ABSTRACT

Childhood obesity is common in New Zealand with one in three 4–5 year-old children identified as overweight or obese in the before school check (B4SC) programme. Recently, the use of BMI for assessing childhood obesity in the B4SC programme has been questioned. This article provides evidence in support of the assessment of BMI during the B4SC, including specific key points:

- BMI is currently the only appropriate field tool for assessing overweight and obesity.
- Our New Zealand data show that BMI is reliable at measuring adiposity in all ethnic groups.
- High childhood BMI often leads to adult obesity and is associated with increased adult morbidity and mortality.
- We believe parents do want to know information regarding their child's obesity risk, based on recent findings in our New Zealand study.

Concerningly, childhood obesity is common in New Zealand with one in three children identified as overweight or obese from the before school check (B4SC) programme in four to five year-old children.[1] While the recent observation that the prevalence of overweight and obesity in this age group has declined slightly in all ethnic and sociodemographic groups is positive,[1] early rapid weight gain remains an issue of concern. The association between early rapid weight gain and the development of childhood obesity is well documented in meta-analyses and systematic reviews[2–5] and a recent international study demonstrated that as many as 90% of children who were obese at just three years of age remained that way as adolescents.[6]

While the opinion of Ms Carey in her recently published viewpoint "Taking BMI off the table"[7] raises an important discussion regarding the application of BMI during 'Well Child' visits and the B4SC programme, screening for overweight and obesity in childhood is important for the prevention of later morbidity and mortality associated with childhood obesity.[8–10]

Body mass index (BMI) is an indirect measure of adiposity and a simple metric which is used worldwide to define overweight and obesity. While more accurate measures of adiposity such as dual energy x-ray absorptiometry (DEXA), magnetic resonance imaging (MRI) and doubly labelled water exist, and are used in research and clinical settings, these methods are difficult to apply across large populations.[11] BMI has stood the test of time, as the best simple and most appropriate field tool to assess childhood obesity, reflected in its wide use internationally. BMI-for-age and sex specific growth standards are available across the childhood years and are recommended for use by international bodies (eg, the World Health Organization) and national organisations, including the Ministries of Health in New Zealand, Australia, the UK and Canada.[12–16]

We acknowledge that BMI is not always a good measure of body fat in every individual (eg, athletes such as the All Blacks are often misclassified—although it must be remembered that these athletes are "extreme" examples of body composition for which BMI was never designed). However, it is a commonly used screening tool for detecting unhealthy (excessive and poor) weight, which is mostly what it is designed for. We

have previously shown in a large cohort of 5–10 year-old Auckland children that BMI is highly associated with percentage body fat, in other words with higher BMI we see higher levels of body fat in these young children.[17] We have also shown that this relationship occurs across all ethnicities, including Māori and Pasifika children, and therefore it is recommended to use the same BMI-for-age and sex standards for children of all ethnicities.[17]

BMI gives an indication as to whether a family may require further support for their child's weight status. However, measurement of BMI at a single point in time does not give an understanding of their weight trajectory and whether intervention is needed or not to improve their future weight status. Ideally, measures of BMI would be available at different ages for every child, providing a better view of how their weight status has developed over time. Unfortunately, B4SC nurses do not have electronic access to growth data taken during earlier 'Well Child' visits. If they did, they would have a much better idea of where the child was at in terms of their growth and whether appropriate intervention might be warranted. A single repository for all height and weight data is currently in place across all secondary care services in the South Island of New Zealand (anthropometrics module),[18] but is yet to be integrated with 'Well Child' care and primary care; an initiative that would be of great benefit and relatively easily adopted.

Children with obesity are at an increased risk of both psychological and medical consequences of obesity during childhood,[10,19] and in adulthood (an adult who was obese as a child).[8,9] Without appropriate screening during childhood the ability to identify and manage excessive weight for prevention of the known adverse consequences associated with obesity would be difficult.

Although BMI was introduced into the B4SC programme as a population health monitoring tool, as soon as the result becomes available at the individual level, and identifies a future health risk that parents could remediate, then not informing parents of that result is itself unethical and potentially harmful. Therefore, providing feedback to caregivers to encourage awareness and future monitoring of their child's growth is justified. However, this must be done in a way that is appropriate, non-stigmatising, and encourages the whole whānau to embrace a healthy lifestyle, within any financial or other constraints they may have.

We know that the approach to "diagnosing" obesity in New Zealand is poorly handled, with reports of healthcare professionals providing inconsistent messages and weight stigmatisation (personal communication, Professor BJ Taylor). However, we also know that we can do this well. Parent's acceptance of feedback on their child's weight status has been shown to be a positive experience when the healthcare professional discussing this with them is non-judgmental and empathetic.[20] So perhaps the most important first step is improving the training and support for nurses providing this sensitive information to caregivers. We also know that around two thirds of New Zealand parents and caregivers, of all ethnicities, do want to know information about the weight status and future obesity risk of their children, as long as it is delivered by a trusted healthcare professional and done well.[21]

As part of the B4SC growth monitoring, healthy eating and healthy activity resources are supposed be provided to *every* family,[22] as recommended by Ms Carey. However, whether this information sharing is consistent nationwide is unknown. A universal approach to providing discussion around healthy behaviours during the B4SC would not be simple, but given that some evidence in adolescents suggests that a BMI even within the "normal" range is associated with increased mortality in adulthood,[23] not just those classified as overweight or obese, this may be the way forward in improving a system that is currently not working. We applaud Ms Carey for raising this very important issue and agree that we need to do this better. However, we also reiterate that continuing to measure BMI as part of the B4SC programme is critical for population health monitoring as well as for screening a child's weight status, and must stay.

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Changes to management of a non-pandemic illness during the COVID-19 pandemic: case study of invasive management of acute coronary syndrome

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ABSTRACT

The coronavirus 2019 (COVID-19) pandemic requires significant changes to standard operating procedures for non-COVID-19 related illnesses. Balancing the benefit from standard evidence-based treatments with the risks posed by COVID-19 to patients, healthcare workers and to the population at large is difficult due to incomplete and rapidly changing information. In this article, we use management of acute coronary syndromes as a case study to show how these competing risks and benefits can be resolved, albeit incompletely. While the risks due to COVID-19 in patients with acute coronary syndromes is unclear, the benefits of standard management are well established in this condition. As an aid to decision making, we recommend systematic estimation of the risks and benefits for management of any condition where there is likely to be an increase in non-COVID-19 related mortality and morbidity due to changes in routine care.

The coronavirus 2019 (COVID-19) pandemic has altered the risk-benefit ratio for standard management of many non-COVID-19 medical conditions, in some cases quite dramatically. This has required the development of new treatment approaches that deviate from national and international guidelines, and would likely be considered sub-optimal treatment in non-COVID-19 conditions. This is done for a number of reasons: firstly, to protect patients and healthcare staff from COVID-19 related morbidity and mortality; secondly, to reduce population transmission rates of the underlying virus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2); thirdly, in a pandemic setting there are extreme resource constraints, with resource used in one area (eg, bed days, staff, cleaning, administration, personal protective equipment) being unavailable for use in other, potentially more clinically important, areas. Standard methods of resource allocation require adjustment in pandemic situations. For example, it can be argued that research participants and healthcare workers should receive priority for treatment due to their instrumental value, that is their capacity to benefit others in the pandemic.[1]

Therefore treatment approaches need to be adapted in order to deliver "the greatest good to the greatest number" while minimising resource consumption and risk to patients, staff and the wider population. Furthermore, this adaptation process must be performed in the absence of complete data, which is often rapidly changing. We believe that a case study in this process may be useful for other departments hurrying to produce their own recommendations.

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In this example, we present our approach to balancing these competing risks in the management of acute coronary syndrome (ACS) in hospitals without percutaneous coronary intervention (PCI) capabilities. While high-level documents exist providing guidance in these scenarios,[2–4] local adaptation is needed due to local health capacity in the face of the pandemic, and also for geographical considerations. The Southern District Health Board (SDHB) serves a population of approximately 330,000 over the largest geographic region of any DHB in New Zealand (62,356 square kilometers, over 2.5 times the size of the Lombardy region in Italy). Healthcare provision includes one tertiary hospital with a cardiac catheterisation laboratory, one secondary care hospital and five rural hospitals. Standard operating procedures in the SDHB currently involve primary PCI for patients with ST elevation myocardial infarction (STEMI) within 90 minutes transfer time of Dunedin Hospital, and thrombolysis followed by immediate transfer for patients with STEMI more than 90 minutes from Dunedin Hospital. Early invasive management is considered in most patients with non-ST elevation acute coronary syndrome (NSTEACS), with transfer to the tertiary centre for patients presenting at secondary or rural hospitals.

Dunedin Hospital has in-house COVID-19 molecular diagnostic testing available 16 hours per day, seven days a week, with a turn-around time of 4–5 hours for hospital collected specimens (plus transport time if collected in the community or outside hospital). In this article, we will examine the benefit of invasive management for ACS, the estimated risk of COVID-19 in our specific patient population, and then attempt to balance these competing benefits and risks. We focus on ACS in patients not suspected of having COVID-19, and only mention in passing those with proven or suspected COVID-19. Although currently under investigation, it is clear that COVID-19 itself can lead to myocardial injury, with subsequent very high mortality rates (in one series of patients with an elevated troponin, 37% and 69% mortality without and with underlying cardiovascular disease, respectively),[5,6] making invasive therapy very unlikely to alter outcomes except in highly selected cases.

Benefit of invasive management in routine circumstances

There is an established benefit of both primary PCI and routine PCI after thrombolysis in STEMI. Primary PCI reduces the short-term (4–6 weeks) risk of death by 2%, the risk of non-fatal myocardial infarction (MI) by 4% and the risk of stroke by 1% (primarily driven by a reduction in intracranial haemorrhage).[7] After thrombolysis, routine invasive management (the pharmacoinvasive approach routinely followed in SDHB) compared to invasive management only if there is ongoing ischaemia after thrombolysis reduces the rate of reinfarction, but makes no difference to the risk of death.[8]

For patients with NSTEACS, invasive management reduces the risk of death at two years by 1.6%, and the risk of nonfatal MI by 1.5%.[9] This benefit is limited to those at higher risk of adverse outcome. In those at low risk (identified as thrombolysis in myocardial infarction (TIMI) risk score 0 to 2, Table 1), there is no difference in outcomes with routine invasive management.[10]

In patients with acute coronary syndrome without troponin elevation (ie, unstable angina), routine invasive management leads to an increase in procedure-related myocardial infarction and bleeding, without any improvement in long-term MI or death.[11]

Risk of COVID-19 in patients with acute coronary syndromes

While the authors acknowledge the difficulties, biases and limitations of case fatality rates calculated early in an epidemic, cardiovascular disease and cardiac risk factors seem to be a significant risk factor for COVID-19 related complications. In the general patient population, the case fatality rate in Italy was 1.0% for those aged 50–59 years, 3.5% in those aged 60–69 years, 13% in those aged 70–79 years, and 20% in those aged 80 years and older, with these risks being approximately 50% higher than those reported in China.[13] In China, those with any cardiovascular disease had the highest case fatality rate of 10.5% (non-age adjusted), compared to 7.3% with diabetes, 6.3% with COPD, 6.0% with hypertension and 0.9% for those with no comorbidities.[14] As such, nosocomial or community transmission of COVID-19 to

Table 1: Thrombolysis in myocardial infarction (TIMI) score.[12]

Variable	
Pre-existing risk	
Age 65 years or older	+1
Three or more traditional coronary artery disease risk factors (hypertension, hypercholesterolaemia, diabetes, family history of CAD, current smoker)	+1
Use of aspirin in last 7 days	+1
Known coronary stenosis >50%	+1
Markers of severity of ischaemia	
Presence of >0.5mm ST deviation on admission ECG	+1
Severe anginal symptoms (two or more episodes of angina in last 24 hours)	+1
Positive biomarker	+1

patients with a recent ACS can be expected to result in significant excess mortality.

How these numbers will change in New Zealand with likely reduced transmission due to Prime Minister Jacinda Ardern's declaration of a state of emergency and move to the highest level of public response on 23 March 2020 and, on the other hand, a lower number of Intensive Care Unit beds (approximately one half to one third of the capacity in Lombardy) is not yet known. For example, a very low community prevalence or even elimination of COVID-19 may allow earlier resumption of usual care.

Risk to healthcare workers

In Wuhan, 3.8% of confirmed cases were healthcare workers, of which 15% of cases were classified as severe or critical.[14] It is clear that some patients are potentially infectious despite minimal or absent symptoms, especially early in the disease time-course. It is arguable whether these patients contribute substantially to community transmission or not, however they may pose a potential infection risk during invasive healthcare procedures. Although other countries are moving to high-level personal protective equipment (PPE) use in patients with STEMI (ie, treating every case as potentially COVID-19 positive), it is unlikely that our current PPE supplies will allow such an approach. While it is tempting to simply suggest all patients undergoing invasive procedures receive a COVID-19 diagnostic test, this approach is not feasible within the confines of current laboratory resources (exhaustible and limited supply of diagnostic swabs and reagents) and would likely have suboptimal sensitivity to exclude early infection. Risk of transmission to cardiology staff or transferring teams (ie, aeromedical or road ambulance crews) is also unknown.

Another consideration is that, in New Zealand, staffing levels are, in general, lower than international centres—for example, Lombardy, with a population of approximately 10 million people, has 55 hospitals with cardiac catheterisation laboratories, allowing the health system to restructure to 13 "Hub" hospitals in the face of coronavirus.[15] By comparison, there are only nine hospitals with catheterisation laboratories in New Zealand suitable for interventional treatment of acute coronary syndrome,[16] serving a population approximately half that of Lombardy. Loss of even a single catheterisation laboratory team due to COVID-19 positivity would likely severely reduce interventional cardiology capacity in any of the tertiary centres in New Zealand—this is certainly the case in SDHB.

Approach to invasive management of STEMI

With these considerations in mind, we have taken the following approach to management of STEMI:

1. Patients within 90 minutes transfer time from Dunedin Hospital should be transferred immediately for primary PCI (the current standard of care).

2. For those outside this time frame, thrombolysis should be performed, following standard protocols (ie, ideally field thrombolysis where available). Patients should be taken to their local hospital for assessment, and the cardiologist on-call contacted. In low-risk STEMIs (eg, inferior STEMIs) or patients at high risk of COVID-19 complications, medical therapy will likely be the management strategy. In high-risk STEMIs (eg, anterior STEMIs) or low-risk STEMIs in patients at low risk of COVID-19 related complications, patients will be considered for transfer on a case-by-case basis.

Any patients with cardiogenic shock or heart failure due to acute ischaemia (whether due to STEMI or NSTEACS) are at high risk of cardiac death and will likely need to be transferred for immediate angiography.

Approach to invasive management of NSTEACS

While the TIMI risk score identifies those most at risk of adverse events, the likelihood of benefitting from invasive management is mostly related to the three components identifying active ischaemia (ECG changes, positive troponin, and most likely more frequent chest pain).[10] In addition, the four components of the TIMI score related to pre-existing risk are also markers of significant additional risk of COVID-19 related morbidity and mortality. As such, in those receiving points on the TIMI score primarily due to pre-existing risk, it is likely that the benefit of invasive management is not outweighed by the risk associated with potential COVID-19.

For this reason, patients with an overall low TIMI score (0–2) will in general be managed medically. As a general rule, only patients with NSTEACS and any of the following features will be considered for transfer for invasive management:

- Presence of >0.5mm ST deviation on admission ECG
- Two or more episodes of angina in last 24 hours
- Positive biomarker

Patients meeting these criteria, but who are at high risk of COVID-19 complications, may not necessarily be transferred for invasive management. Note that "positive biomarker" was defined in an era before high-sensitivity troponin assays, primarily using creatinine kinase. As such, borderline or small changes in high-sensitivity troponin are unlikely to meet this criterion.

Due to the likely lack of benefit to the patient, and high risk to the staff, the following patients will not, in general, be offered routine invasive management:

- Likely type 2 myocardial infarction (ie, not primarily due to coronary plaque rupture)
- COVID-19 positive or suspected patients

Referring physicians are encouraged to contact the on-call cardiologist for discussion of patients on a case-by-case basis.

Medical management and follow-up

For patients being managed medically, we recommend earlier discharge than normal to reduce risk of nosocomial COVID-19 acquisition. In stable patients without recurrence of chest pain, discharge can be considered on the day of admission, as the marginal potential benefit, for example from more rapid up-titration of medication, is likely to be outweighed by the risk of COVID-19 complications. As access to echocardiography is extremely limited due to COVID-19, beta-blockers should, if possible, be started in all patients.

We expect major issues with lack of clinical capacity once current restrictions are lifted. On discharge, patients are advised to attend their GP in approximately three to six months for re-assessment and referral to the cardiology clinic. Brief assessment by the GP for symptoms will allow us to better triage the likely large numbers of patients at that time that will require assessment in an outpatient setting.

Conclusions

In this article, we have described the thought processes behind significant changes to a non-COVID-19 related standard operating procedure, summarised in Table 2. We have attempted to balance the likely consequent increase in cardiovascular complications of ACS against the risk of COVID-19 to patients and staff, bearing in

mind that patients with cardiovascular disease are likely among the highest risk groups for COVID-19 related complications. In the case of the health system being overwhelmed during the pandemic, we would have to move to an even more conservative approach, as was seen in China.[17]

We believe that systematic estimation of the estimated risks and benefits may be helpful for decision making. Most interventions in medicine, whether pharmacological or invasive, have limited short-term efficacy in an individual patient, and by focusing only on those that do, we are likely to reduce risk to patients and staff, and reduce the rate of transmission in the population at large, while maximising scare resources.

Table 2: Summary of key changes to management of ACS in non-PCI capable hospitals due to pandemic.

Routine standard of care	Pandemic standard of care
STEMI	
Pre-hospital or in-hospital thrombolysis with immediate transfer to PCI capable centre	Pre-hospital or in-hospital thrombolysis with local hospital medical management for low-risk STEMI
NSTEACS	
Routine transfer to PCI capable centre in majority of cases	Transfer to PCI capable centre only for patients with: • Presence of >0.5mm ST deviation on admission ECG • Two or more episodes of angina in last 24 hours • Positive biomarker

Abbreviations: ACS, acute coronary syndrome; ECG, electrocardiogram; PCI, percutaneous coronary intervention; NSTEACS, non-ST elevation acute coronary syndrome; STEMI, ST-elevation myocardial infarction.

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The post-lockdown period should be used to acquire effective therapies for future resurgence in SARS-Cov-2 infections

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ABSTRACT

COVID-19 will be with us through the remainder of 2020 and almost certainly beyond. New Zealand needs a viable strategy to protect its populace until a vaccine is developed and in wide use. Until that time, it makes sense to protect the population by putting in place treatments that will be safe and effective, such as the use of convalescent sera and the use of direct-acting anti-virals. These treatments should be sourced externally or made locally, but steps in this direction must now begin as the lockdown ends. New Zealand has the scientists, the facilities and the will to make this happen, but the support of the government and the population will be needed if this plan is to succeed.

Since the beginning of 2020 the entire globe has experienced the inexorable spread of the SARS-CoV-2 virus and the resultant disease, COVID-19.[1] At the time of this writing there are 2.1 million total cases worldwide resulting in 134,000 deaths with both of these figures felt to be underestimations of fact.

New Zealand with its prescient imposition of a country-wide lockdown has to date avoided the worst ravages of this illness, but even so, at the time of this writing there have been 1,386 cases and nine deaths reported.[2] Analysis of the epidemic curves indicated that if this lockdown had not been imposed these numbers would have been much higher. And at the time of this writing, the lockdown is working and that it is hoped that active cases from the first phase of COVID-19 will be eliminated from the country. As a result, the government is now considering a move to Level 3 restrictions with mandatory quarantine at the border.

However, it is important to stress that the population of New Zealand as a whole is not immune to SARS-CoV-2 infection, and that a reintroduction of the virus in the future is a virtual certainty. Further it seems likely that this reintroduction will occur before the 12–24 months (or longer) required to produce and distribute an effective COVID-19 vaccine. In fact, low-level transmission may persist in New Zealand due to asymptomatic shedders that can shed virus post-infection for many days to several weeks.[3,4]

In 1918 the world experienced a global pandemic with H1N1 influenza that led to worldwide infection of 30–40% of the population and up to 40 million deaths.[5,6] There were three global phases to this pandemic; the first phase in June 1918 was severe with five deaths per 1,000 persons, but the second phase beginning in October 1918 caused 25 deaths per 1,000 persons at its peak and was thus five times more severe. The final phase, in March of 1919, peaked at 10 deaths

per 1,000 persons. If SARS-CoV-2 behaves in a similar fashion, more phases of infection will come later this year and it is important to plan accordingly.

Vaccine timeframe is long

Fortunately, the successful lockdown has bought New Zealand time to prepare for a likely second wave of COVID-19. This means more time to perfect the use of rapid diagnostics and to expand pandemic medical capability. But it also means more time to prepare effective treatments for New Zealanders severely affected by COVID-19.

In an ideal scenario a vaccine would be in place before any resurgence of SARS-CoV-2 in New Zealand, but a vaccine will require at least 12–24 months to develop and test. Once tested, production would need to be scaled up and worldwide distribution carried out. Even if the hypothetical timetable for completion comes to fruition, New Zealand is not likely to be an early recipient. In fact, one attempt to reserve a promising vaccine candidate to one country has already been seen.

It is also possible that developing a vaccine on this accelerated timetable will not be successful. For example, some vaccine constructs utilised for coronaviruses have been found to lead to potentiation of infection, suggesting that careful assessment for vaccine safety, as always, will be needed.[7,8] Over time it is anticipated that a successful SARS-CoV-2 vaccine will be produced, but a delay would not be surprising.

Short-term acquisition of effective COVID-19 treatments

While waiting on a SARS-CoV-2 vaccine to be developed, it would be prudent to put in place treatments for New Zealanders who might be severely affected by future outbreaks of SARS-CoV-2. Two treatments that are likely to be effective are convalescent sera and direct-acting anti-virals. Both could be acquired in the short term while a vaccine is still pending and both can be made in New Zealand if they are unavailable from external sources.

Convalescent sera

Convalescent sera, as the name implies, is sera from patients who have recovered from an infectious disease, in this case COVID-19. The use of convalescent sera to treat or prevent infectious diseases has been in place for over a century and has been applied to both bacterial diseases, eg, pneumococcal disease, and viral diseases, eg, measles, influenza and coronavirus (as discussed below).[8] Prior to the antibiotic era, the use of immune sera was sometimes the only possible treatment.

Neutralising antibodies were found in many patients following infection by the SARS virus.[8] This has proven to be the case as well following infection with SARS-CoV-2.[9] The results from early clinical use of convalescent sera in COVID-19 have been encouraging with pilot studies indicating that its use is both safe and effective.[10] These studies involve small numbers and are not well controlled, but they are encouraging enough that one pharmaceutical company, Takeda, has been reported to be making preparations to develop this product for clinical use.[8] However, this process will take many months.

Fortunately, New Zealand has in place all it needs to proceed with this therapy. There is a published assay to allow measurement of antibody potency.[10] There is a screening pipeline in place to test sera for active infection, eg, SARS-CoV-2, HIV, Hepatitis B and C. And most importantly, there is a base of over 1,000 people from whom it may be possible to obtain sera. With the addition of a suitable clinical protocol, therapy with convalescent sera could be in place in a matter of months.

Direct-acting anti-virals

Direct-acting anti-virals (DAAV) are small molecule drugs that directly interfere with the replication of viruses. In the case of SARS-CoV-2, there are a large number of potential DAAV and they fall into three main families—polymerase inhibitors, protease inhibitors and other.[11,12] The polymerase inhibitors targeting SARS-CoV-2 include some of the most promising options for treating COVID-19. The most notable members of this group are remdesivir and favipiravir, as well as galidesivir.[13–17] These drugs work by blocking the viral RNA polymerase enzyme that allows the virus to replicate its nucleic acid coding strand. Both remdesivir and favipiravir have had some encouraging but mixed preliminary results in early clinical trials against SARS-CoV-2, but important results of randomised

controlled trials are due out soon. Galidesivir (BCX4430, Immucillin-A) is notable for being invented in New Zealand.[16,17] BioCryst Pharmaceuticals is now recruiting patients for a clinical trial of this drug against COVID-19 patients in Brazil.

Protease inhibitors include drugs that block the main (3C-like) protease of SARS-CoV-2 or that block other cellular proteases that are needed to process the coronavirus spike protein into a form that promotes viral uptake into human cells.[11,18–22] Both of these protease actions are essential for viral replication and both are drug targets, but these proteases and their known inhibitors are very different.

During both the SARS and MERS outbreaks, it was discovered in uncontrolled case reports and series that Kaletra (lopinavir/ritonavir), a commonly used anti-HIV drug, seemed to help SARS infected patients by blocking the 3CL protease.[23,24] Early data on its use for SARS-CoV-2 suggests only weak activity against COVID-19, but this data is from studies with small patient numbers.[25] Data from other 3CL protease inhibitors against SARS-CoV-2 infection in humans is not yet available. Similarly, no human data is available for protease inhibitors that block spike protein processing. One such inhibitor, camostat mesylate, has been approved for use in humans for another condition, pancreatitis, therefore, if camostat were found to be effective against COVID-19 it could be rapidly pressed into clinical use.[22]

The final set of anti-viral drugs potentially available to treat COVID-19 fall into the 'other' category, and include agents like chloroquine, azithromycin, ivermectin and many others.[11,14] Many of these drugs have already been approved for use in humans for non-viral diseases and they have mixed or no data from clinical studies in humans against COVID-19.[26,27] As for all repurposed drugs, if they are found to be effective against SARS-CoV-2, they could be quickly drafted into use.

Data on these many drugs, some promising, some less so, has steadily emerged during the pandemic. Much more data will be coming out over the next few months, and it is likely that at least a few studies of COVID-19 treatments will be promising enough to provide a convincing argument for their clinical use in COVID-19 cases.

Sourcing needed drugs for New Zealand

The amount of anti-viral drug that New Zealand might require during the 1–2 year (or longer) vaccine development period is subject to debate, but according to modelling completed for the Ministry of Health by the HEIRU, an uncontrolled outbreak in New Zealand could lead to between 92,500 to 124,000 hospitalisations with ICU admissions ranging from 14,400 to 19,200.[28] Given that the prospect of an uncontrolled outbreak is unlikely now but that smaller and more frequent outbreaks could occur over the period before a vaccine is available, a reasonable scale of anti-viral courses to target would be in the range of 5,000–10,000.

Historically, New Zealand has adopted a plan of sourcing new pharmaceutical treatments from the manufacturers after definitive clinical trials with clear demonstration of efficacy, and it would be prudent for New Zealand to stockpile one or two of these agents for use in any significant COVID-19 repeat outbreaks in New Zealand should they take place. However, it seems likely that, due to world-wide pressure on manufacturers to supply these drugs globally, New Zealand will be required to make its own anti-virals. New Zealand law has built into it strong protection for intellectual property except in the case of a national emergency in which the acquisition of material for the public good is essential. In such a scenario New Zealand law provides a mechanism whereby patented materials can be manufactured locally. Even in such a case, it is preferred that it be done with an agreement in place with the appropriate company and with reasonable compensation.

This issue aside, New Zealand has in place all that is needed to manufacture direct-acting anti-virals for COVID-19 infection. Several large medicinal chemistry groups with excellent track records in developing drugs for clinical trials are located throughout the country. New Zealand has a Good Manufacturing Practice (GMP) facility—GlycoSyn at Callaghan Innovation—that can be employed to generate

and test the material needed to meet the anticipated needs outlined above. With Government support to facilitate the regulatory requirements for drug manufacture and distribution it will be feasible to generate pharmaceuticals in commercial form and quantity as therapeutics. New Zealand has the companies with experience in compounding, formulating, packaging and sterilising pharmaceuticals for oral and parenteral administration. Once the decision is made as to which drugs are to be synthesised, this material could be in place in a matter of months.

Competing interests:
Dr Krause reports that the authors of this paper have submitted a grant application to the MBIE COVID Innovation Acceleration Fund (CIAF) in which they propose to do some of the things described within the manuscript. This application is pending. Drs Furneaux and Tyler are inventors on a patent family that had composition of matter claims on Galidesivir. This patent family was licensed to BioCryst Pharmaceuticals, Inc, but the term of this patent family has expired in respect of Galidesivir, and we have not received, nor are we due, any royalties related to sales of Galidesivir.

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The case for New Zealand to have its own COVID-19 vaccine programme

James E Ussher, Graham Le Gros, Miguel E Quiñones-Mateu, Shivali A Gulab, Melissa Yiannoutsos

With the early success of the measures taken under COVID-19 Alert Level 4 becoming apparent over the past few days, New Zealand is well on the way to suppressing SARS-CoV-2, the virus that causes COVID-19, or even eliminating it from the population. If this happens, New Zealand will be able to manage, over the short term at least, any outbreaks through border control, aggressive contact tracing, case isolation and contact quarantine.

However, this is not a viable long-term position for New Zealand's economic future or the health of its people. New Zealand is a trading nation; cross-border trade involves not only the flow of product but also of services, people, investment and ideas. Our tourism, hospitality and education sectors are heavily dependent on the flow of people. Annual international tourism expenditure is $17.2 billion and 229,566 people are directly and another 163,713 indirectly employed in tourism, equating to 14.4% of the total number of people employed in New Zealand.[1] Furthermore, international education contributes $5.1 billion annually to the New Zealand economy.[2] Therefore, the economic cost of maintaining the current border restrictions will be in excess of $22 billion per year ($63.8 million per day).

It is clear that New Zealand needs a vaccine to prevent COVID-19 to protect ourselves and restore our economic health. Currently, the vast majority of New Zealand's population is immunologically naive and remains susceptible to SARS-CoV-2, which is likely to continue circulating in the human population indefinitely. To safely reduce the current border controls, we need to achieve a level of immunity to protect us when travelling overseas and from those arriving into New Zealand. A vaccine is the only clear exit strategy that will allow New Zealand to return to normality.[3]

In response to the pandemic, over 78 vaccines are in early-stage development.[4] Most will not reach the market and given the time it takes to develop, assess and manufacture a vaccine, it is unlikely that New Zealand will be able to access the required number of vaccine doses within the short to medium term.

CureVac, a German company which is developing an RNA vaccine, has stated that its facilities would only be able to produce up to 400 million doses a year.[5] Johnson and Johnson, who are collaborating with the US government to develop a recombinant adenoviral vector vaccine, are expecting "hundreds of millions of people, that is, a broad population, to have access to the vaccine by the end of 2021 and in the course of 2022".[6] Once developed, it will take several years to manufacture enough doses of vaccine to meet global demand.

Furthermore, experience with the last pandemic vaccine for influenza virus H1N1 in 2009, suggests that countries will almost certainly require vaccine manufacturers to meet their own requirements before allowing export to other countries.[5,7] Indeed, there was a recent report that the President of the US may have sought to buy the German company CureVac with the stipulation that any vaccine produced would be "only for the USA".[7] This risk was also evident in June 2019, when Pharmac advised that it could not source additional influenza

vaccines as "there's no way of buying more doses of flu vaccine for this winter because supplies are simply not available". Global manufacturers were starting to make stock for the northern hemisphere, and there were no more supplies of the southern hemisphere vaccine.[8]

Not surprisingly, given the global nature of pandemics, the World Health Organization has in the past[9] and once again raised concerns about the global capacity to manufacture and equitably distribute sufficient quantities of an effective vaccine.[5] There is a high risk that New Zealand will be unable to access an internationally developed vaccine in sufficient quantities to relax border restrictions, once a vaccine is approved for public use.

New Zealand is well recognised for its ability to produce outstanding scientific discoveries and technological innovation and on a global scale punches well above its weight.[10–12] It has the organisations and infrastructure capable of manufacturing vaccine at scale, once the appropriate vaccine formulation has been decided, it has world class vaccine safety and monitoring agencies, and internationally recognised scientific capabilities in its universities and medical research institutes in the design and development of leading edge therapies.[13,14] Funding and focusing this uniquely New Zealand capability will substantially reduce the timelines for having a vaccine widely available in New Zealand.

Given that the costs of vaccine development, clinical trials and manufacturing are so high, it could be reasoned that it is better for New Zealand to "wait out" the global pandemic and rely on sourcing a safe and effective vaccine from the global market in the future. The challenge with this strategy is that we do not know when that future will be, what a safe and effective vaccine against COVID-19 should look like, and whether countries will hoard vaccines behind a single supplier and close key pharmaceutical exports. This is what drove the Canadian Government's decision to secure its local vaccine supply for influenza as it had already seen its access to the limited global supply of vaccines dry up during two previous pandemic scares.[15] Establishing more depth in New Zealand's vaccine industry would improve our ability and preparedness to rapidly respond to future emerging threats, such as another variant of SARS-CoV.

The current border restrictions are costing New Zealand hundreds of millions of dollars per week. It is prudent for New Zealand to invest in a COVID-19 vaccine development programme that will provide New Zealand with the option to develop and produce its own vaccine or to produce a vaccine developed offshore. In addition, it builds the capability for the country to respond more quickly should another global pandemic emerge in the future.

This capability also facilitates New Zealand to provide vaccine access to its Pacific partners such as Samoa, Tonga, Fiji and the Cook Islands (among others), whose economies are largely dependent on tourism and trade.[16] New Zealand has key partnerships, shared national identity and critical aid relationships[17] with the Pacific Nations and with developed vaccine production capability, can play a key role in the wider region's rapid economic recovery. Ensuring the protection, health and economic viability of New Zealand can be achieved through:

1. Initiating a programme to evaluate the best vaccines being developed internationally with scalable potential in New Zealand, to be accessible to the entire population.
2. In parallel, progressing COVID-19 vaccine development programmes nationally and through global partnerships (in particular with Australia), involving leading research institutions, government and industry.
3. Building capability for vaccine production sufficient to rapidly vaccinate everyone in New Zealand when a vaccine becomes approved either nationally or internationally for public use.
4. Developing a plan for how a vaccine will be rolled out and who should receive it first.

In summary, we strongly believe New Zealand has the capability to make a significant contribution to the global COVID-19 vaccine development and manufacturing efforts. Furthermore, having its own COVID-19 vaccine programme will ensure New Zealand is well placed to access an effective vaccine at the earliest possible opportunity.

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Perry syndrome: a case of atypical parkinsonism with confirmed DCTN1 mutation

Eileen J McManus, Gemma Poke, Matthew CL Phillips, Fredrik Asztely

ABSTRACT

Perry syndrome is a rare neurological condition characterised clinically by depression, sleep disturbance, central hypoventilation and parkinsonism. Perry syndrome is a TAR DNA-binding protein 43 (TDP-43) proteinopathy associated with mutated dynactin-1 protein, inherited in an autosomal dominant manner. Several pathogenic mutations in exon 2 in the dynactin 1 gene have been identified; p. F521, p. G67d, p. G71R, p. G71E, p. G71A, p. T72p, p. Q74p and p. Y78C. We present the second known case Perry syndrome with confirmed DCTN1 mutation (p. Y78C) in New Zealand, who initially was thought to have a depressive illness. Perry syndrome should be considered in the differential diagnosis of young parkinsonism, especially if there is family history of sleep disorders, weight loss and/or marked depression.

Here we describe a patient with depression, weight loss and parkinsonism due to a rare genetic disorder, Perry syndrome.

Initial presentation

CP, a Caucasian New Zealand female, first presented at 50 years of age with a three-month history of recurrent syncope. Her only comorbidity was depression, which was treated with Fluoxetine 20mg once daily. Further assessment revealed a three-month history of worsening depressive, orthostatic and disequilibrium symptoms. She denied hallucinations, visual disturbance or falls. Examination revealed hypomimia, bradyphemia, increased tone and generalised hyperreflexia. No tremor, shuffling gait or freezing were detected. Routine bloods, telemetry, EEG, MRI brain and ENT assessment were all normal. The syncopal episodes resolved, and she was discharged without a unifying diagnosis.

Second presentation

Two years later, she developed a tremor. Examination revealed marked hypomimia, rigidity in all four limbs and a coarse resting tremor at both elbows and hands. There was some mild generalised weakness and hyperreflexia in the limbs. Cranial nerves, sensation and gait were normal. A 20mmHg postural drop and 9kg weight loss over 12 months was reported. Her mother aged 52, maternal aunt aged 72 and maternal grandfather (? age) all died of respiratory failure. Her maternal aunt had recently been diagnosed with Perry syndrome, confirmed with genetic testing. Based on this, she too underwent genetic testing. Identification of a heterozygous DCTN1 mutation: c.233A>G (p. Y78C) confirmed the diagnosis of Perry syndrome. Overnight oximetry showed no evidence of hypoventilation. A trial of low dose Levodopa was commenced.

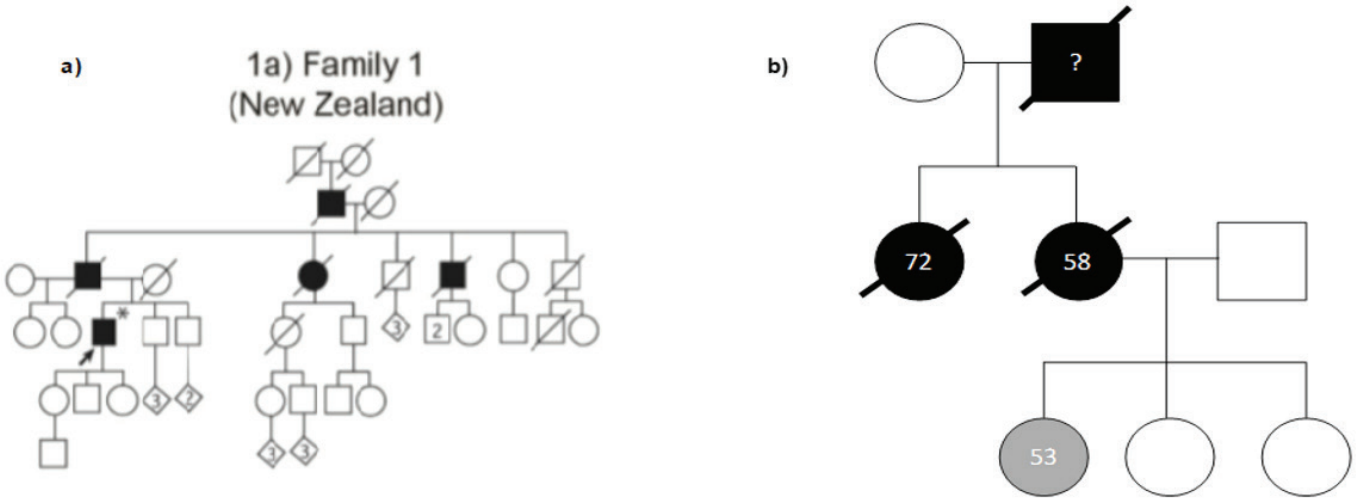
Six months

Her most recent neurological review revealed a good response to Levodopa with a subjective sense of increased strength, less tremor and better mobility. Examination showed improvement in hypomimia (able to smile), decreased rigidity and no resting tremor. Dietary supplementation had resulted in 8kg weight gain. Her mood had improved since her last assessment.

Discussion

The term “Perry syndrome” was first coined by Elibol et al in 2002.[1] It is a rare TAR DNA-binding protein 43 (TDP-43) proteinopathy associated with mutated dynactin-1 (DCTN1) protein. Dynactin is a

Figure 1: a) Adapted from Tacik et al, pedigree structure of New Zealand family with Perry syndrome with the DCTN1 p. Y78C (c.233A>G) mutation. b) Pedigree structure of our patient with the DCTN1 p. Y78C (c.233A>G) mutation who appears to have a different pedigree. Round symbols indicate females, squares males, diagonal lines indicate the individual is deceased. Grey indicates the proband. Black full-filled symbols indicate individuals who suffered from Perry syndrome.



multi-subunit protein complex consisting of 10 subunits including the DCTN1/p150Glued subunit. The DCTN1 gene codes for DCTN1/p150Glued subunit of the dynactin complex. Dynactin binds to dynein via a highly conserved glycine-rich cytoskeleton-associated protein (CAPGly) domain in its N-terminus of p150Glued. This domain is thought to be relevant to microtubule binding, axonal retrograde and membrane vesicle transport.[2] Several pathogenic mutations in exon 2 in the DCTN1 gene have been identified: p. F521, p. G67d, p. G71R, p. G71E, p. G71A, p. T72p, p. Q74p and p. Y78C. The clinical features are similar except the p.F521 mutation carriers do not usually develop depression and the p. G71A mutation is not associated with hypoventilation or weight loss.[3]

Mishima et al, 2008 have proposed definitive diagnostic criteria for Perry syndrome (Table 1). Once suspected clinically, consultation with a clinical geneticist is advised. Tacik et al described the first New Zealand family with the mutation c.233A>G (p. Y78C).[4] However, the pedigree of this proband does not fit the pedigree of our patient (Figure 1), therefore potentially identifying a second family in New Zealand with the p. Y78C mutation. However, having the same variant makes it likely that they are distantly related, rather than two separate families.

The most reported cause of death relates to hypoventilation or suicide. Response to levodopa is variable however, large doses of carbidopa/levodopa (>2g) have been used successfully to reduce rigidity and tremor. Non-invasive ventilation may prolong life expectancy. The depression is poorly responsive to pharmacological therapies.[5] Perry syndrome is very rare; this is the second confirmed case in New Zealand. It is important to consider Perry syndrome in young patients (<50 years) with a parkinsonian presentation, particularly if marked personality change, weight loss and hypoventilation.

Table 1: Demonstrating the proposed diagnostic criteria by Mishima et al 2018: a) the presence of four cardinal signs of Perry syndrome (parkinsonism, depression/apathy, respiratory symptoms and weight loss) and DCTN1 mutation or b) family history of the disease, parkinsonism and DCTN1 mutation or c) the presence of four cardinal signs and pathological findings (nigral neuronal loss and TDP-43 pathology).

Clinical features		**Laboratory features**
Cardinal	**Supportive**	
1. Parkinsonism 2. Apathy or depression 3. Respiratory symptoms 4. Unexpected weight loss 5. Positive family history of parkinsonism/respiratory symptoms	1. Rapid disease progression (five years of onset) 2. Onset younger than 50 years	1. Genetic test: mutation in the DCTN1 gene 2. Pathology: nigral neuronal loss and TDP-43 pathology in the brainstem and basal ganglia

Competing interests:
Gemma Poke received funding from the Health Research Council of New Zealand for research into epileptic encephalopathies.

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Foveal laser pointer injury: are laser pointers safe enough for public possession?

Kelvin Ngan, Sacha Moore

Combining the increasing use of laser pointers and the exponential growth of the internet and e-commerce,[1] New Zealanders have never had easier access to high-power laser pointer (HPLP) products. These devices are easily misused when directed at people, aircraft or treated as toys; this may result in permanent destructive visual impairment[2] or even death (in the event of aviation accident). Although the Custom Import Prohibition Order 2017 requires authorisation to be obtained from the Director-General of Health for acquisition or importation of HPLPs (output power more than 1mW),[3] the availability of these products on the internet makes regulation difficult. We report a case of foveal laser pointer injury in New Zealand caused by a device purchased through an overseas online retailer.

Case report

A usually well 17-year-old European male presented with a week's history of left central scotoma and headaches following seconds of direct ocular exposure to a class 3B (50mW) green laser pointer operated by himself at home. The device was purchased from an overseas online retailer through a simple internet search, without written consent from the New Zealand Director-General of Health. The patient was unaware of such regulations around HPLPs and had sought the device to be used as a toy.

His best corrected visual acuities (BCVA) were 6/4.8 right and 6/76 left. Intraocular pressures were 9mmHg right and 10mmHg left. A left relative afferent pupillary defect was noted. The left conjunctiva was not injected, the cornea was clear, anterior chamber quiet, lens clear and vitreous quiet. Dilated fundal examination (Figure 1) showed subtle left subfoveal pigmentary changes, otherwise unremarkable. Right eye dilated examination was unremarkable. OCT maculae demonstrated multiple foci of subfoveal lucency, retinal pigment epithelium irregularity, inner segment/outer segment junction loss, associated with small pockets of subretinal fluid, in the left (Figure 2). OCT discs were normal. Unfortunately, given the limited evidence-based treatment options for such an injury, no treatment other than monitoring for support and management of secondary complications was recommended.

Over two months, his left BCVA improved and stabilised at 6/30, developing multiple small left subfoveal scars, with unchanged small pockets of subretinal fluid. Given the concern with secondary choroidal neovascular membrane formation, the patient is currently being monitored for consideration of anti-VEGF treatment.

Discussion

The potential for permanent visual impairment with misused HPLP to the individual is tremendous. Due to the lack of caution, awareness and insight, younger populations, especially males, who have the most productive life years ahead, tend to be affected by such injuries.[2,4] Current New Zealand regulations dictate a permit for acquisition of HPLPs,[3] although this has not stopped consumers from purchasing them from an overseas online retailer without one. Under the Summary Offences Act 1981, it is an offence to be in possession of a

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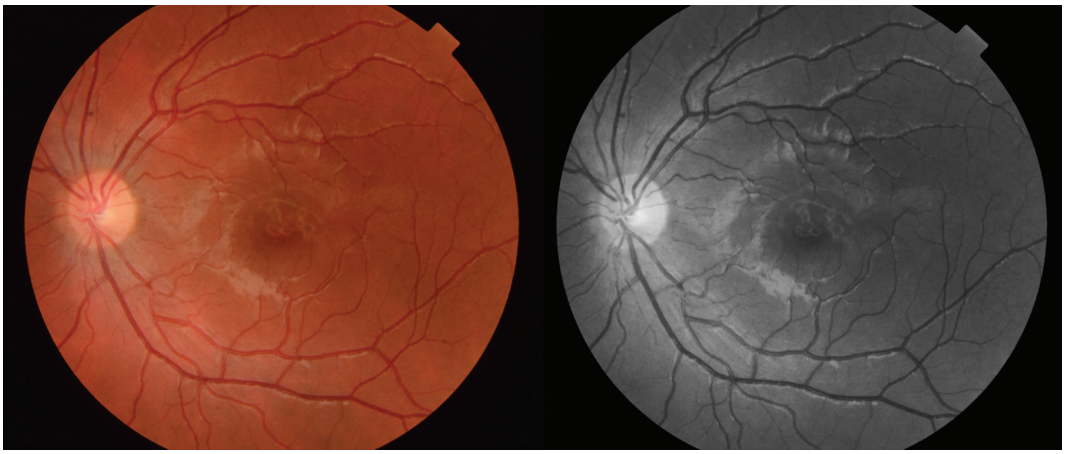
Figure 1: Left eye colour fundus photograph (left) and red-free fundus photograph (right) of the same eye showing multiple subtle central foci of pigmentary changes.

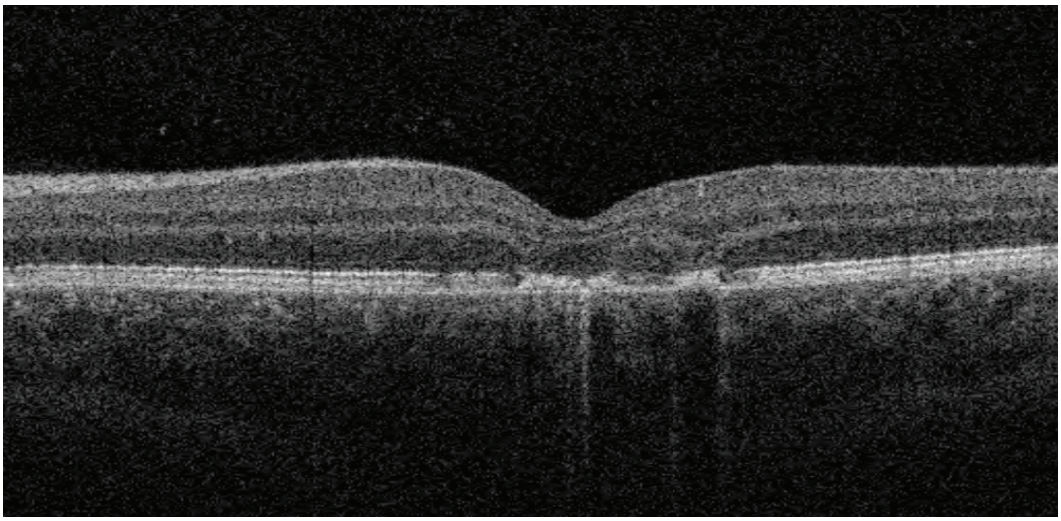


HPLP in a public place without a reasonable excuse.[5] However, none of these regulations ban the possession of these devices outright. In addition, many of these devices have incorrectly labelled power ouputs,[2,4] either by lack of testing and/or to avoid regulation.

It can be hypothesised that the increasing availability of laser pointers will increase usage and subsequently laser-related incidents and complications. Although the number of cases of retinal injuries related to laser pointers in New Zealand are unknown, there is an increasing trend to laser incidents reported to the New Zealand Civil Aviation Authority suggesting this.[6]

The authors propose an awareness campaign of the damage these devices can cause, and consideration of law proposals banning the possession of HPLPs in New Zealand without official approval ensuring safe and proper use, with a subsequent amnesty period allowing voluntary disposal prior to new law changes taking effect.

Figure 2: OCT macula of the patient's left eye showing subfoveal lucency, retinal pigment epithelium irregularity, inner segment/outer segment junction loss, associated with small pockets of subretinal fluid.



Competing interests:
Nil.

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Geoffrey Wynne-Jones

28 January 1925–24 October 2019

General Surgeon

Geoffrey Wynne-Jones, the youngest child of Frederick Arthur Jones, a monumental mason, and Catherine Emily Parker was born in Hawera. He had two brothers, David and Richard, and a sister, Elizabeth. Geoffrey commenced school at Hawera Main School and subsequently attended Hawera Technical High School, where he was dux. His uncle, Mortimer Townsend, a Fellow of the Royal Astronomical Society and an active Southern Hemisphere observer, taught him the fundamentals of astronomy, and with this interest he enrolled at Auckland University studying mathematics and physics. However, he changed direction after graduation, gaining entry to Otago Medical School.

On completing his MB ChB in 1949, Geoffrey moved to Middlemore Hospital in Auckland where he met Jenefer Fea, a nurse assisting in a medical procedure. She enthusiastically accepted his invitation for a ride on his motorbike, a strong friendship developed and they married in 1952. After undertaking a series of general practice locums around the country and under a bursary obligation, Geoffrey received call-up papers from the military. This resulted in serving a year on active service in Korea 1952–1953 with the 16th Field Regiment. Embarking as a Lieutenant, he returned as a Captain and, although he never talked much about his experiences to his family, he was clearly pleased to return home.

Following his return from Korea, Geoffrey, Jenefer and Peter, their first child born in 1954, set off by ship for London via the Panama Canal so Geoffrey could gain his surgical Fellowship. Enjoying life in London they took advantage of the many plays, concerts and musicals on offer. However, the pressure of Geoffrey's study was such that on one occasion the babysitter was despatched as concert partner for Jenefer while Geoffrey burned the midnight oil! In July 1956 he successfully gained Fellowship of the Royal College of Surgeons. Their second child, Jeremy, was born the same year. Fellowship completed, Geoffrey secured a paediatric orthopaedic run with HH Nixon and Denis Brown at Queen Mary's Carshalton and Great Ormond Street.

This was followed by two years in Sheffield where Geoffrey gained experience in general and paediatric surgery, spending some time with Bob Zachery, at that time one of only 11 designated Specialist Paediatric Surgeons in Great Britain.

Geoffrey, Jenefer and their two children returned to New Zealand in 1959 and the family was completed with the birth of Stephen 1959, Rodney 1961 and Julie, adopted in 1964. He set up practice in Hamilton, the first surgeon in the region to do so without doing any general practice, and experienced a rather a lean introduction into consulting practice until 1961, when he was appointed to a 3/10th part-time position at Waikato Hospital as "Visiting Assistant Casualty and Outpatient Surgeon". From this base he joined the Lomas team with Archie Badger. Geoffrey became a fellow of the Royal Australasian College of Surgeons in 1960. Working part-time in private practice, he initially consulted from rooms in Wesley Chambers and then later in Collingwood Street, with surgery provided at Braemar Hospital. Despite working long hours each day, he endeavoured to get home in the evenings for dinner with the family. To his children, the sound of his key in the front door was one of the happiest times of their childhoods.

Initially, Geoffrey, like all general surgeons, covered all surgical specialties except orthopaedic surgery and obstetrics and gynaecology. He took a special interest in paediatric and neonatal surgery and for a while managed most of that work in Waikato. However, with the advent of the "Neonatal/Paediatric Surgeon" that part of his work vanished. Soon after a "Plastic Surgeon" (including burns) was appointed and another segment of work dropped away. In the mid-70s gastric ulcers were a major problem and a new sophisticated operation was being reported from Leeds. Geoffrey decided from his reading that he should start doing this new procedure of "Highly Selective Vagotomy". Possibly the only one doing it in New Zealand initially, this procedure proved to be a great advance over anything else available at that time. But with introduction of Tagamet/Losec the problem of peptic ulcers vanished overnight. Yet another area of interest and great skill was removed from his tool-box. As the surgical solution to the peptic ulcer became redundant Obesity Surgery took its place and Geoffrey was one of the pioneer surgeons in stomach bypass surgery. As there was very little documented information available at the time and, having to "experiment" somewhat in terms of distances etc, Geoffrey documented all aspects of his surgery very carefully and included extensive follow up. This resulted in numerous publications and conference presentations. Then along came the specialist "Obesity Surgeon" and another area of interest was severely reduced!

Geoffrey played a role in the establishment of a Waikato Hospital Postgraduate Medical Committee and the development of an active postgraduate programme in the early 1960s. He later became head of the Waikato Department of Surgery. He was an appointed member of the 1971 Minister of Education's Committee on nursing education set up to review a report by Dr Helen Carpenter, Dean of the Faculty of Nursing at the University of Toronto (published Feb 1971). Although the Committee subsequently recommended, in the Carpenter Report, that nursing education take place in educational institutions rather than in hospitals, Geoffrey was strongly opposed to the proposed move to technical institutes, and wrote a minority report, subsequently often cited. With his early involvement in private surgical practice, he was committed to the development of the Braemar Hospital Trust and its rebuilding programme, serving a period as its chair. He was long-term member of the Hamilton Officers' Club, proudly retaining involvement until the final couple of years of his life.

Geoffrey never lost his interest in the universe. He became an active member of the Hamilton Astronomical Society, serving as President and Patron, and was often quoted in the *Waikato Times* opining on meteorites and unusual sights to watch for in the night sky above Hamilton. In the mid-1990s Geoffrey was instrumental in the fundraising and building at Rotokauri one of New Zealand's largest telescopes, a 61cm Nasmyth-Cassegrain with a polar mount and 11-metre dome. Sceptical about the Big Bang Theory he gradually developed explanations for an alternative view, which he called the Infinite Non-Expanding Universe Theory.

In 2000 he presented a paper to the Royal Astronomical Society of New Zealand on alternatives to the Big Bang Theory, largely relating to Compton Red Shifting.

In the early 1960s Geoffrey and Jenefer, deciding skiing would be a great family activity, joined the Christiania Ski Club on Mt Ruapehu. Another family love affair involved the family bach built at Waihi Beach. Travel was a passion and, once the children had left home, the couple travelled extensively. Geoffrey enjoyed golf and played bridge well into his 90s. In 2011, after Jenefer had two successful operations for her cataracts, Geoffrey followed suit. Unfortunately, his operations did not have the same positive results and his eyesight was further impaired. With the help of carers, Jenefer and Geoffrey were able to stay at their River Road home (their only home following their return to New Zealand from the UK) until their move to Possum Bourne Retirement Village in May 2018 where they were closer to family. They died within months of one another.

Geoffrey Wynne-Jones, husband of the late Jenefer; is greatly missed by his children, Peter, Jeremy, Stephen, Rodney and Julie, and 11 grandchildren.

Author information:
This obituary is based upon that prepared by Charles Riddle and published on Stuff 9 November 2019, with subsequent contributions by Dean Williams CBE, FRCS, FRACS, Peter Rothwell MNZM, FRACP and members of the Wynne-Jones family. The Royal Australasian College of Surgeons also contributed to this obituary.

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A Case of Chronic Bulbar Paralysis

By F. F. A. ULRICH, M.B.

The following case is worthy of report, partly on account of its rarity and partly to demonstrate the ease with which in a rare case a doctor can do an injustice to his patient, even though on his guard:—

Widow, aged 65, no specific history, children and grandchildren healthy, suffered from influenza during the severe epidemic, followed by pyorrhoea, worry, and fatigue. Soon after that time there commenced a slow but steadily increasing difficulty to speak and swallow. Her medical adviser and a specialist diagnosed the condition with some misgiving as hysteria, and advised a trip to the country. A few weeks later when she came under the writer's care he agreed with the diagnosis of hysteria, informed all her relatives, and advised suitable isolation treatment in a nursing home. After about one week's observation the condition became evident as one of chronic bulbar paralysis, and the "hysterical" diagnosis has taken some explaining away and undoing.

Her condition now is: Expression of upper part of face normal; expression of lower part of face suggests childlike grief; constant dribbling of saliva; buccinators are paralysed with flaccidity of cheeks, thus suggesting the purely sensory function of the buccinator nerve (fifth cranial). Lips—Lower, quite paralysed and becoming thin, is inclined to fall away from the teeth, but is occasionally bitten; upper, paretic—ability to approximate lips without assistance is almost gone. Tongue—Marked atrophy with lateral fibrillary twitching—complete inability to raise the tongue to roof of mouth, so food has to be propelled digitally; protrusion of tongue moderate, lateral movements very limited. Gustatory sense is delayed but normal when tested on different areas of tongue with sugar, salt, and pepper. Soft Palate—Early paresis showing in commencing nasal tone of voice, but food does not pass into nasal cavity. Swallowing is becoming difficult and gulping in character. Approximation of vocal chords is normal at present, but voice is becoming impaired. No anaesthesia was found in any areas, although the pharyngeal mucous membrane is supposed to be supplied by the pharyngeal plexus. Intermittent difficulty to close eyelids. Speech very difficult to interpret; only understood by those constantly with her.

The nerve centres involved in the degeneration are the seventh, ninth, tenth, eleventh, and twelfth cranial, hence the name, "Labio-glosso-laryngeal paralysis."

Government statistics over the decade 1909–1918 show the annual death-rate in New Zealand from all forms of bulbar paralysis to be 5.4, and for females alone 1.6.

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