

# Assessment of unmet secondary elective healthcare need—itself in need of acute care in Aotearoa New Zealand

COVID-19 among University of Otago students living in North Dunedin households in the first half of 2022: was the prevalence underestimated?

Effective and respectful interaction with Māori: how the regulators of health professionals are responding to the Health Practitioners Competence Assurance Amendment Act 2019

Manifestation of anterior necrotising scleritis and reactive infectious mucocutaneous eruption after COVID-19: a case report

The  
New Zealand  
**Medical Journal**

Te ara tika o te hauora hapori

## Publication information

published by the Pasifika Medical Association Group



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The *New Zealand Medical Journal (NZMJ)* is the principal scientific journal for the medical profession in New Zealand. The *Journal* has become a fundamental resource for providing research and written pieces from the health and medical industry.

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ISSN (digital): 1175-8716

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New Zealand  
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**Further information**

ISSN (digital): 1175-8716  
Publication frequency: bimonthly  
Publication medium: digital only

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# Summaries

## **Effective and respectful interaction with Māori: how the regulators of health professionals are responding to the *Health Practitioners Competence Assurance Amendment Act 2019***

*Susan Shaw, Keith Tudor*

The 2019 amendment of the HPCA explicitly references the cultural competency of practitioners and effective and respectful interaction with Māori. This analysis explored the extent to which RAs have incorporated cultural competence into professional competencies three years after this amendment. The majority of the RAs have yet to integrate references to engaging with Māori in this way into their professional competencies.

## **Celestial risk factors in groin hernia repair and random statistical association: a nationwide register-based study**

*Camilla Christophersen, Siv Fonnes, Jason J Baker, Kristoffer Andresen, Jacob Rosenberg*

This study found that surgeons' zodiac sign significantly affected the risk of recurrence after surgical repair of groin hernias, and surgeons born under the Sagittarius seemed to perform better than Capricorn, Pisces, Aries, Taurus, Cancer and Virgo. However, this exemplifies that statistical analyses might reveal random statistical associations that should be interpreted with a grain of salt.

## **A comprehensive methodology report for maternity and perinatal mortality research in the New Zealand integrated data infrastructure**

*Esti C de Graaff, Lynn Sadler, Lesley McCowan, Robin Cronin, Ngaire Anderson*

In Aotearoa New Zealand, national datasets are commonly used for pregnancy research, although data availability and understanding of data quality are often lacking. This paper provides a detailed breakdown of New Zealand's national pregnancy data collection and quality, and proposes a more standardised method for its use, while offering recommendations for future improvements. By doing this we hope to contribute to the quality of pregnancy studies in New Zealand. Ultimately, with the aim to improve the outcomes for all mothers and babies in Aotearoa New Zealand.

## **COVID-19 among University of Otago students living in North Dunedin households in the first half of 2022: was the prevalence underestimated?**

*Lianne Parkin, Polly Tenci, Samantha Grace, Bryony Harrison, Judd Irving, Luke Jarvie, Eric Johnson, Tze Koon Ler, Georgia Louise Malcolm, Kristy Watson*

COVID-19 began to spread through the University of Otago student population in Dunedin in mid-February 2022, and reported case numbers rose rapidly between late February and early March. The University, residential colleges, and the Otago University Students' Association mounted huge operations to provide support (including food and care packages) for hundreds of students self-isolating in colleges and flats. While good mechanisms were established in colleges and other supported accommodation for identifying and reporting COVID-19 cases, anecdotal reports suggested that students living in flats might have been less likely to report positive COVID-19 test results to the University, or to upload their positive rapid antigen test (RAT) results to My Covid Record. We conducted short interviews at 135 randomly selected North Dunedin flats in which at least one resident was a University of Otago student and found that COVID-19 was very common between the start of Flat Orientation Week (14 February) and the end of Semester 1 (week beginning 30 May)—94.1% of households had at least one confirmed COVID-19 case during that period and about three quarters (73.6%) of residents had tested positive. We also found there was considerable under-reporting of cases with just under two-thirds (60.4%) of University of Otago student cases notifying the University that they had COVID-19 and two thirds (66.9%) of all cases with a positive RAT uploading their result to My Covid Record.

## **Specialist medical toxicologist consultations provided by the New Zealand National Poisons Centre, 2018–2020**

*Adam C Pomerleau, Paul Gee, D Michael G Beasley, Eeva-Katri Kumpula*

Medical (or clinical) toxicology is a field of medical practice focussed on the treatment of poisoning in all its forms. There have been very few medical toxicologists in Aotearoa New Zealand historically, yet free 24/7 access to these specialists is available to medical practitioners across the country through the National Poisons Centre. This study describes consultations with NPC medical toxicologists from 2018–2020 and finds increasing numbers of consultations, involving a wide range of poisonings. The growing utilisation suggests healthcare professionals derive value from this consultation service for the care of their patients.

## **A case of purpura fulminans precipitated by trimethoprim-sulfamethoxazole**

*Yassar Alamri, Ignatius Chua, Nicholas M Douglas*

Trimethoprim-sulfamethoxazole is a commonly used antibiotic. To the best of our knowledge, this is the first report of purpura fulminans associated with exposure to trimethoprim-sulfamethoxazole. We review the literature for mechanistic explanations of this potentially life-threatening idiosyncratic complication.

# Assessment of unmet secondary elective healthcare need—itself in need of acute care in Aotearoa New Zealand

Phil Bagshaw, John D Potter, Andrew Hornblow, Ben Hudson, Les Toop, M Gary Nicholls, Chris Frampton, Sue Bagshaw, Robin Gauld, Frank Frizelle

**U**nmet need in healthcare is a global issue, not least in Aotearoa New Zealand. Whether the health needs of a population are met—or not—is a critical indicator of the extent to which a health system provides comprehensive and equitable care. Although the health workforce may be aware of unmet healthcare needs on a local day-to-day basis, the issue for policy makers is deciding how best to allocate scarce national or regional resources. A central database that makes use of internationally standardised measures of unmet health need is vital for the development and implementation of health policy, despite the discomfort that arises when such a database inevitably exposes health system weaknesses and resource constraints. Without the use of standardised measures of unmet need, estimates are biased, international comparisons are flawed, and robust policy development and implementation is compromised. Improvements in health not only have enormous social value, they also lead to economic benefits for society.<sup>1-8</sup> Access to healthcare is a recognised determinant of health;<sup>9</sup> hence a strategy to make universal health coverage a worldwide objective (SDG Target 3.8) has been adopted by the United Nations.<sup>10</sup> Despite this, even in countries with state-funded health systems, there is evidence of unmet need and inequitable access to healthcare.<sup>11-13</sup>

In Aotearoa, although unmet primary healthcare need (UPHN) has been extensively and repeatedly estimated through the New Zealand Health Survey (NZHS), unmet secondary elective healthcare need (USEHN) has not. In this context, “elective” is to be distinguished from “acute or emergency” and characterises those to be admitted for care from a waiting list. Given that neither governments nor the New Zealand Ministry of Health have ever committed to the accurate assessment of USEHN, it is reasonable to wonder whether they really wish to know its true extent.

There have always been unacceptable ethnic and other socio-economic inequities in healthcare access and outcomes and these require urgent attention. USEHN, specifically, is a cause of unnecessary suffering, disability and death, and is also a modifiable cause of health inequalities.<sup>14,15</sup> In our 2017 pilot survey of USEHN, in which 29% of respondents reported UPHN, 9% reported USEHN that had been identified by a health professional.<sup>16</sup> Aotearoa has no accurate estimate of the prevalence of USEHN among Māori, so we lack basic understanding of the extent to which USEHN contributes to health inequalities between Māori and non-Māori.

Inclusion of appropriate questions on USEHN in the NZHS that can be benchmarked internationally would take advantage of the methods currently used in the national survey to obtain a representative sample<sup>17</sup>—methods similar to those also used in the New Zealand National Mental Health Survey: Te Rau Hinengaro.<sup>18</sup> How well our health system is meeting the needs of an increasingly diverse population requires a representative sample across ethnic, social, and regional sub-populations. Inclusion of USEHN in the NZHS would also bring us into line with the many countries that routinely undertake relevant population surveys, countries that recognise that unmet need is an essential indicator of the effectiveness of healthcare systems.<sup>19-21</sup>

Health systems evolve, incrementally or as a result of structural reform. The New Zealand Health Reforms of the 1990s were based on neo-liberal philosophy of a market for health with austerity budgeting. Hardy remnants of this failed philosophy remain embedded in the health system;<sup>22</sup> scant attention is still paid to the European and US studies that show investment in healthcare pays large fiscal dividends.<sup>1,2,7,23</sup> Prior to the Health Reforms of the 1990s, there were no procedural or structural obstructions to outpatient assessment and admission to hospital

waiting lists which, therefore, gave at least a gross indication of the performance of the hospital systems and the level of USEHN. The Health Reforms of the 1990s included the introduction of clinical guidelines and movement from waiting lists to maximal waiting times. These and other barriers to access have left us with no barometers of the level of USEHN.

Central to the current Aotearoa health reforms is the aim of addressing inequalities, particularly for Māori, as well as ensuring improved access to health services, especially for those currently not well served by the system. To achieve these aims, the functions of the disestablished district health boards have been merged into Te Whatu Ora – Health New Zealand, a centralised model to provide “a simpler and more coordinated health system” (<https://www.tewhatuora.govt.nz/>) and a separate Te Aka Whai Ora – Māori Health Authority. Robust data, including those that cover both UPHN and USHN, will be essential to assess whether or not these aims of the current reforms are achieved.

Regular national surveys of USEHN are done in many countries.<sup>16</sup> The questions used have been validated in massive surveys and are still undergoing refinement.<sup>24,25</sup> Aotearoa New Zealand

needs to adopt these tools to allow international benchmarking. The needed survey of USEHN must be done as part of the New Zealand Health Survey; they have the relevant expertise and would ensure a far more cost-effective approach than establishing a *de novo* study. As a result of our pilot study, we believe that there needs to be an initial broad survey of all aspects of USEHN, including Māori oversampling to assess regional and other fine details of disparities, followed by a focus on particular areas of USEHN as a core part of subsequent NZHSs.

Routine assessment of both PHN and SHN in the NZHS will be critical to monitor how well the health system is meeting health needs across the Aotearoa New Zealand population and to establish whether the current reforms and future evolution of the New Zealand health system achieve desired outcomes. Now, more than ever, with these health reforms underway with core goals of improving access and equity, it is time to act to properly measure unmet need. Without this, we will continue to live and work in a country that fails to understand and respond to the needs and suffering of our most poorly served.

**COMPETING INTERESTS**

Nil.

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# Effective and respectful interaction with Māori: How the regulators of health professionals are responding to the *Health Practitioners Competence Assurance Amendment Act 2019*

Susan Shaw, Keith Tudor

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## ABSTRACT

**AIMS:** To ascertain the response of registered health professional regulators to the legislated requirement under the *Health Practitioners Competence Assurance Amendment Act 2019 (HPCA Amendment Act)* that practitioners are culturally competent and, specifically, enabling “effective and respectful interaction with Māori”.

**METHOD:** A document analysis of the extent to which the culturally competent requirement is indicated in information about professional competencies within publicly available information of the 17 responsible authorities (RAs) that govern health practitioners under the *Health Practitioners Competence Assurance* legislation.

**RESULTS:** Three years after the amendment to the original *Act (HPCA Act)* requiring health professionals to be culturally competent specifically in relation to interacting with Māori, only four of the 17 RAs fully reference the amended requirement, and only two RAs link this specific cultural competence to the requirements of the amended *Act (HPCA Amendment Act)*. The majority of the RAs have yet to integrate references to engaging with Māori in this way into their professional competencies.

**CONCLUSIONS:** Culturally competent practice is only meaningful once it is enacted by individual practitioners in their interactions with others. It is imperative for RAs to include the cultural competence requirement into their published information about professional competencies as this would signal to the profession, practitioners, and wider community that effective and respectful interaction with Māori is a fundamental expectation of all health practitioners in this country. Other issues identified during the analysis suggest an emphasis on administration and bureaucracy. This presents an opportunity for consolidating the practice of RAs including how key functions are expressed and promulgated.

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It has been widely recognised that structural changes are required to address clear inequities in health and wellbeing outcomes within Aotearoa New Zealand and, in the context of Te Tiriti o Waitangi, specifically for Māori.<sup>1</sup> Indeed, this was a large part of the current Government’s motivation to restructure the health system and establish Te Aka Whai Ora – The Māori Health Authority, which, amongst other things, aims to enhance rangatiratanga over hauora Māori.

Legislative change is a clear mechanism for bringing about change and the *Health Practitioners Competence Assurance Amendment Act 2019 (HPCA Amendment Act)*<sup>2</sup> included expectations about how practitioners engage with Māori. An existing function of the responsible authorities (RAs) to set standards of clinical and cultural competence was

extended with an explicit reference to competencies enabling “effective and respectful interaction with Māori”<sup>2</sup> (s37 (2)). In 2021, the *NZMJ* published an analysis of compliance with Te Tiriti o Waitangi in competency documents published by an RA<sup>3</sup> that found a lack of compliance with Te Tiriti o Waitangi. The analysis presented in this paper complements and extends upon that work by seeking to answer questions about the extent to which the RAs have responded to the amended requirement and function, three years after its enactment.

Practitioners, educators, researchers, policy makers, and professional leaders are engaged in work to ensure Te Tiriti o Waitangi and meaningful, respectful and empowering engagement with Māori is at the heart of developments across

the health, wellbeing and disability support sectors.<sup>4</sup> For educators this includes considering the design and oversight of curricula;<sup>4,5</sup> how students experience curricula and are supported to move through it;<sup>6</sup> and by confronting the history and current practice regarding access and selection.<sup>7</sup> Workforce planning requires consideration beyond professional boundaries and a greater emphasis on serving the community,<sup>8</sup> particularly those who are inadequately served and, here in Aotearoa New Zealand, specifically Māori.

The original Act (*HPCA Act*)<sup>9</sup> outlined a list of functions of RAs, which included the clause: “to set standards of clinical competence, cultural competence, and ethical conduct to be observed by health practitioners of the profession” (s118 (i)).<sup>9</sup> Section 37 of the 2019 amendment to this Act<sup>2</sup> included an extension to this function with “cultural competence” being defined in relation to working with Māori. The function became: “to set standards of clinical competence, cultural competence (including competencies that will enable effective and respectful interaction with Māori), and ethical conduct to be observed by health practitioners of the profession” (s118 (i)).<sup>2</sup>

It is now three years since the amendments to the Act came into law. While there have been many distractions and pressures, including COVID-19, other changes required by the *HPCA Amendment Act*<sup>2</sup> have been made on the websites of the RAs, such as temporary scopes of practice and professional recognition,<sup>10</sup> not least to address issues of workforce surge capacity as has been necessary in the context of the COVID-19 pandemic, and other information has been updated. Ongoing reviews of generic competencies have also continued during this time, one example being the Dental Council of New Zealand | Te Kaunihera Tiaki Niho (Dental Council) updating competencies as recently as the end of 2021.<sup>11</sup> However, as researchers working in the area of health regulation,<sup>4,10</sup> from our reading of documents produced by the RAs, it appeared that they were not picking up this particular challenge.

## The research

Against this background and in the context of previous research,<sup>4,10</sup> we wanted to answer the following questions:

1. Have the RAs updated the competence-related function to include reference to working with Māori?
2. If so, to what extent do RAs explain the functions outlined in the *HPCA Amendment Act*?
3. To what extent have RAs incorporated engaging with Māori into their professional competencies?
4. Are there any other indications in published information that RAs are responding to the expectation that they assure the competence of practitioners registered within them to enable effective and respectful interaction with Māori?

## Method

We began by visiting the page on the Manutū Hauora | New Zealand Ministry of Health (2022) website that lists all of the RAs and provides internet links to their respective websites. On the RA websites we searched information and documents posted online. The first two questions (referring to the extended function) were investigated by searching for descriptions of the work of the RAs. This included checking for any navigation features such as tabs with relevant terms such as “functions”, “role”, “responsibilities”, “about us”, “what we do”, and “our work”. If this was unsuccessful, the same terms were entered into a search function (if it existed).

The third question (the extent to which engaging with Māori was incorporated into competencies) was investigated by exploring the RAs’ competency documents and statements. We interrogated what the documents were, when they were developed, and whether they had been updated since the original *HPCA Act*<sup>9</sup> was amended. The search terms we used within the documents were “Māori”, “Maori”, “Tiriti”, “Treaty”, “engage”, “interaction”, “respectful”, “effective” and “Waitangi”. All instances in which these terms were identified were carefully considered in relation to their context, which enabled a judgement to be made about the intention of the text.

Where there were multiple documents, we focussed on those with titles referencing cultural competence/competencies and cultural safety. Finally, the fourth question was addressed by means of notes we kept of any other indicators of engagement with the extended competency such as whether the terms “Te Tiriti o Waitangi” or “Treaty of Waitangi” were used, and the presentation of te reo Māori, including the use or absence of macrons.

## Results

Three years following the legislative amendment to the function of RAs explicitly to include engaging with Māori as a cultural competency, it is clear that only a minority of them have fully responded to this requirement.

One of the functions of the RAs is to publish competencies for practitioners. There are a number of formats that are used such as a series of individual documents (clinical competencies, ethical standards, cultural competence) or a “live” site, which updates information and includes interactive features. The extent to which RAs have incorporated engaging with Māori into their professional competencies was explored by identifying and reading published text and is summarised in Table 1.

Eight of the RAs have updated competencies with reference to engaging with Māori; the remaining nine RAs do not appear to have updated their published information following the *Amendment Act*.<sup>2</sup>

In the process of undertaking this exploration of websites and published documents, we identified other issues that provided insights into how individual RAs appreciate the extended reference to cultural competence within the context of the amended *Act*, and of healthcare in Aotearoa New Zealand.

The Dieticians Board | Te Mana Mātanga Mātai Kai (Dieticians Board) and the New Zealand Psychologists Board | Te Poari Kaimāta Hinengaro o Aotearoa (Psychologists Board) use almost identical text to refer to Māori and “the Treaty”, with the Dietetics statement reading: “The Government affirms that Māori as Tangata Whenua hold a unique place in our country, and that the Treaty of Waitangi is the nation’s founding document” (page 6),<sup>30</sup> the only difference being the insertion of “te Tiriti o Waitangi” following “the Treaty of Waitangi” in the psychology statement (page 2).<sup>38</sup>

We also noticed the wide range of variation in the extent to which te reo Māori was used on web sites and within documents. All RAs incor-

porate some te reo into the information that is available online. The naming of the RA and the navigation tools such as tabs and headings commonly incorporate te reo Māori, and some refer to—and hopefully integrate—principles from Te Ao Māori into their thinking and work (see, for example, Te Poari o ngā Kaihaumanu o Aotearoa | The Psychotherapists Board of Aotearoa New Zealand [Psychotherapists Board], 2022).<sup>39</sup> Some RAs also profile Te Tiriti o Waitangi as the first tab on their front page (Te Kaunihera Tapuhi o Aotearoa | Nursing Council of New Zealand, Psychotherapists Board). RAs take different positions in affirming Te Tiriti o Waitangi and the place of Māori. Some indicate the Government has recognised Māori while most assert that the RA itself affords Māori the respect of being Indigenous.

In addition to the similarities between information published by the Dieticians and Psychologists Boards, noted above, the New Zealand Medical Radiation Technologists Board | Te Poari Ringa Hangarua Iraruke (Medical Radiation Technologists Board) and the Medical Sciences Council of New Zealand | Te Kaunihera a Pūtaiao Hauora Aotearoa (Medical Sciences Council) have what appear to be an identical website design. The very close similarities extend to published statements, including those referencing cultural competence. Thus, the following statement appears in publications by the Medical Radiation Technologists Board (2018)<sup>21</sup> and the Medical Sciences Council (2018)<sup>32</sup> with the only difference being the reference to the title of the board/council:

*“The [Board/Council] acknowledges Te Tiriti o Waitangi as the founding document of Aotearoa New Zealand and the importance it has in informing legislation, policy and practice. As tangata whenua of Aotearoa New Zealand, Maori hold a unique position in our society and the Board acknowledges and respects the specific importance of health services for Maori” (page 3).<sup>21,32</sup>*

**Table 1:** Extent to which documents published by responsible authorities (RAs) reference the amended Health Practitioners Competence Assurance (HPCA) text regarding “respectful interaction with Māori” following the 2019 Amendment Act.<sup>2</sup>

Responsible authority	Documents	Specific text
<b>Specifically references “respectful interaction with Māori” within competency documentation</b>		
Te Kaunihera Rāta o Aotearoa   Medical Council of New Zealand	Statement on Cultural Safety (2019) <sup>12</sup>	“This includes standards of clinical competence, cultural competence (including competencies that will enable effective and respectful interaction with Māori), and ethical conduct that doctors will have to meet” (paragraph 11)
	He ara hauora Māori: A pathway to Māori health equity (2019) <sup>13</sup>	“Where appropriate, incorporating Māori models of health, patient and whānau-centred models of care, or mātauranga Māori (Māori knowledge)” (paragraph 26)
Physiotherapy Board of New Zealand   Te Pōari Tiaki Tinana o Aotearoa	He kawa whakaruruhau ā matatau Māori – Māori cultural safety and competence standard (2021/2022) <sup>14</sup>	“This document explains how physiotherapists may demonstrate their cultural safety and competence to interact effectively and respectfully with health consumers who identify as Māori (ngā kiritaki hauora Māori)” (page 1)
<b>Does not specifically use the amended text but prioritises/profiles Māori, including reference to cultural safety</b>		
Occupational Therapy Board of New Zealand   Te Pōari Tiaki Tinana o Aotearoa	Competencies for registration and continuing practice (2022) <sup>15</sup>	“As tangata whenua and tangata Tiriti, you recognise your role and responsibilities under te Tiriti o Waitangi and apply your knowledge to work for equitable outcomes for Māori wellbeing. Te Ao Māori, tikanga, wairua, whanau hauora and taonga such as te reo Māori are respected and supported” (page 7)
Te Tatau o te Whare Kahu   Midwifery Council	Statement on cultural competence for midwives (2011) <sup>16</sup>	“It means having the knowledge, skills and attitudes to understand the effect of power within a healthcare relationship and to develop respectful relationships with people of different cultures” (page 3)
	Competencies for entry to the register of midwives (online, undated) <sup>17</sup>	“Applies the principles of cultural safety to the midwifery partnership and integrates Tūranga Kaupapa within the midwifery partnership and midwifery practice” (competency 1.3)
Kaunihera Manapou   Paramedic Council	Standards of cultural safety and clinical competence (2020) <sup>18</sup>	“...culturally safe for Māori health consumers and their hanau/family to access safe and responsive healthcare, free of racism and bias” (page 12)
Te Kaunihera Tapuhi o Aotearoa   Nursing Council of New Zealand	Competencies for registered nurses (September 2016 (amended), June 2022 (reformatted)) <sup>19</sup>	“Understands the Treaty of Waitangi/Te Tiriti o Waitangi and its relevance to the health of Māori in Aotearoa/New Zealand” (page 5)
	Guidelines for cultural safety, the Treaty of Waitangi and Maori Health in nursing, education and practice (2005/2011) <sup>20</sup>	“Most nurses are employed by Crown funded agencies and can, therefore, be considered agents of the Crown... need to develop their knowledge, skills and practice to work effectively with Maori to achieve positive health outcomes and health gains. This involves the recognition, respect and acceptance that Maori are a diverse population, and have worldviews that differ from most nurses. It also requires nurses to deliver care in a culturally safe manner” (page 16)

**Table 1 (continued):** Extent to which documents published by responsible authorities (RAs) reference the amended Health Practitioners Competence Assurance (HPCA) text regarding “respectful interaction with Māori” following the 2019 Amendment Act.<sup>2</sup>

Responsible authority	Documents	Specific text
<b>Does not specifically use the amended text but prioritises/profiles Māori, including reference to cultural safety</b>		
New Zealand Medical Radiation Technologists Board   Te Pōari Ringa Hangarua Iraruke	Cultural competency policy (June 2018) <sup>21</sup>	“As tangata whenua of Aotearoa New Zealand, Maori hold a unique position in our society and the Board acknowledges and respects the specific importance of health services for Maori” (page 3)
	Competence Standards for Medical Imaging and Radiation Therapy Practitioners in Aotearoa New Zealand (July 2018) <sup>22</sup>	“...uphold tikanga best practice guidelines when working with Maori patients and their whanau” (page 11)
<b>References interacting with Māori in the context of “other” or “all” cultures</b>		
Dental Council of New Zealand   Te Kaunihera Tiaki Niho	Statement on best practice when providing care to Māori patients and their whānau (updated 2021) <sup>23</sup>	“Oral health practitioners should learn the preferences of each patient, Māori or non-Māori, and strive to put them at ease in order to create and sustain a respectful and trusting relationship” (page 3)
The Osteopathic Council of New Zealand   Kaunihera Haumanu Tuahiwi o Aotearoa	Code of conduct (2020) <sup>24</sup>	“Practise in a way that respects each health consumer’s identity and right to hold personal beliefs, values and goals” (page 7) “Acknowledge and respond to the identity, beliefs, values and practices held by Māori and incorporate these into osteopathic care” (page 7)
Optometrists and Dispensing Opticians Board of New Zealand   Te Poari a ngā Kaimātai Whatu me ngā Kaiwhakaarato Mōhiti	Standards of cultural competence and cultural safety (updated 2021) <sup>25</sup>	“Showing respect for your patients’ cultural beliefs, values and practices” (page 3) Background section of this document references text of amendment and this is one of 10 standards that reference Te Tiriti o Waitangi in relation to health and equity.
Pharmacy Council   Te Pou Whakamana Kaimatāu o Aotearoa	Competence standards for the pharmacy profession (January 2015) <sup>26</sup>	“Recognises the differing health status of Māori and non-Māori and incorporates strategies in own practice to attempt to address these” (page 12)
	Towards culturally safe practice (2021) <sup>27</sup>	“Understanding how our colonial history, systemic bias and inequities have impacted Māori and Māori health outcomes, and ensuring that your interactions with and care of patients do not perpetuate this” (page 3)
<b>References Māori in context of health indicators and social context</b>		
New Zealand Chiropractic Board   Te Poari Kaikorohiti o Aotearoa	Board policy: standards of cultural competence (November 2017) <sup>28</sup>	“Ensures knowledge of the Treaty of Waitangi and its relevance to Maori health remains current, by undertaking relevant CPD, where appropriate” (paragraph 4)
	Competency based professional standards (2010) <sup>29</sup>	“Understands the needs of Maori and areas of concern in Maori health” (page 5)

**Table 1 (continued):** Extent to which documents published by responsible authorities (RAs) reference the amended Health Practitioners Competence Assurance (HPCA) text regarding “respectful interaction with Māori” following the 2019 Amendment Act.<sup>2</sup>

Responsible authority	Documents	Specific text
<b>References Māori in context of health indicators and social context</b>		
Dietitians Board   Te Mana Mātanga Mātai Kai	Professional standards and competencies for dietitians (November 2017) <sup>30</sup>	“Respect Tikanga when communicating with Māori” (page 13)
	Cultural development guidelines (December 2016) <sup>31</sup>	“Demonstrate awareness of the factors impacting on health status of Maori and other cultures, and recognise Maori health is a health gain priority area for New Zealand” (page 2)
Medical Sciences Council of New Zealand   Te Kaunihera Pūtaiao Hauora Aotearoa	Cultural competence policy and guideline (June 2018) <sup>32</sup>	“Understand how differences in culture, language and migration experience may have an impact on the way health services are delivered” (page 4)
	<i>Competency standards</i> - Anaesthetic Technicians - Medical Laboratory Scientists (November 2018) <sup>33</sup>	“...uphold tikanga best practice guidelines when working with Maori patients and their whanau” (page 8)
New Zealand Psychologists Board   Te Poari Kaimāta Hinegaro o Aotearoa	Core competencies for the practice of psychology (February 2018) <sup>34</sup>	“The cultural beliefs and values situated within tikanga Maori. Understanding of Maori models of health (e.g., Te Whare Tapa Wha)” (page 6)
<b>Has generic reference to cultural context within competency documentation</b>		
Podiatrists Board of New Zealand	Podiatry competency standards (Sept 2019) <sup>35</sup>	“Culture, values and lifestyle impacts are identified and considered” (page 16)
Te Poari o ngā Kaihaumanu o Aotearoa  The Psycho- therapists Board of New Zealand	Psychotherapist core clinical competencies (July 2019) <sup>36</sup>  Psychotherapist cultural competencies (July 2019) <sup>37</sup>	“Respectful of your clients and willing to gain understanding of their personal and cultural beliefs, values and practices” (page 5)

**Table 2:** Examples of the incorporation of “Te Tiriti o Waitangi” and te reo Māori into text about competencies.

Responsible authority	Example
<b>RAs incorporating “Te Tiriti o Waitangi” and te reo Māori into text</b>	
Te Kaunihera Rāta o Aotearoa   Medical Council of New Zealand <sup>13</sup>	“We recognise the status of Māori as the tangata whenua of Aotearoa New Zealand and our obligations and responsibilities that arise from Te Tiriti o Waitangi (the Treaty of Waitangi)” (paragraph 3)
Te Tatau o te Whare Kahu   Midwifery Council <sup>40</sup>	“Aotearoa/New Zealand has a unique bicultural heritage. The bicultural relationship between Māori as indigenous people and other New Zealanders is based on New Zealand’s founding document, Te Tiriti o Waitangi/the Treaty of Waitangi” (page 3)
Te Kaunihera Tapuhi o Aotearoa   Nursing Council of New Zealand <sup>41</sup>	“We acknowledge and recognise the journey we are on to improve our responsive to Māori and Te Tiriti o Waitangi” (page 12)
Occupational Therapy Board of New Zealand   Te Pōari Tiaki Tinana o Aotearoa <sup>15</sup>	“Te Tiriti o Waitangi is the founding document of Aotearoa New Zealand. It shapes the diverse historical and sociopolitical realities of Māori and all other settlers and their descendants” (page 2)
Optometrists and Dispensing Opticians Board of New Zealand   Te Poari a ngā Kaimātai Whatu me ngā Kaiwhakaarato Mōhiti <sup>25</sup>	“The Board recognises the status of Māori as the tangata whenua of Aotearoa New Zealand and its obligations and responsibilities that arise from Te Tiriti o Waitangi (the Treaty of Waitangi)” (page 2)
Osteopathic Council of New Zealand   Kaunihera Haumanu Tuahiwi o Aotearoa <sup>24</sup>	“The principles of Te Tiriti o Waitangi/The Treaty of Waitangi, partnership, protection and participation, are integral to providing appropriate osteopathic services for Māori” (page 2)
Kaunihera Manapou   Paramedic Council <sup>18</sup>	“...understand Te Tiriti o Waitangi (including its goals and principles) and its relevance to the health of Māori in Aotearoa New Zealand” (page 11)
Pharmacy Council   Te Pou Whakamana Kaimātāu o Aotearoa <sup>26</sup>	“This extends to understanding the contemporary application of Te Tiriti o Waitangi through the principles of partnership, participation and protection” (page 15)
Physiotherapy Board of New Zealand   Te Pōari Tiaki Tinana o Aotearoa <sup>14</sup>	“The Board acknowledges Te Tiriti o Waitangi/Treaty of Waitangi as a founding document of Aotearoa New Zealand, which informs legislation, policy and practice and aims to reduce the health inequalities between Māori and non-Māori. It recognises and respects the specific importance of health services for Māori as the indigenous people of Aotearoa New Zealand” (page 1)
New Zealand Psychologists Board   Te Poari Kaimāta Hinegaro o Aotearoa <sup>42</sup>	“The Government affirms that Māori as tangata whenua hold a unique place in our country, and that Te Tiriti o Waitangi/the Treaty of Waitangi is the nation’s founding document” (page 15)
Medical Sciences Council of New Zealand   Te Kaunihera Pūtaiao Hauora Aotearoa <sup>32</sup>	“The Council acknowledges Te Tiriti o Waitangi as the founding document of Aotearoa New Zealand and the importance it has in informing legislation, policy and practice. As tangata whenua of Aotearoa New Zealand, Maori hold a unique position in our society and the Council acknowledges and respects the specific importance of health services for Maori” (page 3)

**Table 2 (continued):** Examples of the incorporation of “Te Tiriti o Waitangi” and te reo Māori into text about competencies.

Responsible authority	Example
New Zealand Medical Radiation Technologists Board   Te Pōari Ringa Hangarua Iraruke <sup>21</sup>	“The Board acknowledges Te Tiriti o Waitangi as the founding document of Aotearoa New Zealand and the importance it has in informing legislation, policy and practice. As tangata whenua of Aotearoa New Zealand, Maori hold a unique position in our society and the Board acknowledges and respects the specific importance of health services for Maori” (page 3)
<b>RAs yet to integrate “Te Tiriti o Waitangi” into text referring to competencies</b>	
New Zealand Chiropractic Board   Te Poari Kaikorohiti o Aotearoa <sup>28</sup>	“Acquires cultural knowledge and skills relevant to their patient base: (a) Ensures knowledge of the Treaty of Waitangi and its relevance to Maori health remains current, by undertaking relevant CPD, where appropriate” (paragraph 4)
Dental Council of New Zealand   Te Kaunihera Tiaki Niho <sup>11,43</sup>	“Disparities in Māori health persist even after controlling for confounding factors such as poverty, education, and location, suggesting that culture is an independent determinant of health status and access to services” <sup>11</sup> (page 3)  “Recognise the unique place Māori hold as tangata whenua in New Zealand and honour the Treaty of Waitangi principles of partnership, participation and protection in the delivery and promotion of oral healthcare” <sup>43</sup> (page 10)
Dietitians Board   Te Mana Mātanga Mātai Kai <sup>30</sup>	“The Government affirms that Māori as tangata whenua hold a unique place in our country, and that the Treaty of Waitangi is the nation’s founding document” (pages 1 and 6)
Podiatrists Board of New Zealand <sup>35</sup>	“Recognise the unique place Māori hold as tangata whenua in New Zealand and honour the Treaty of Waitangi principles of partnership, participation and protection in the delivery and promotion of podiatry” (page 7)
Te Poari o ngā Kaihaumanu o Aotearoa   The Psychotherapists Board of New Zealand <sup>36</sup>	“The initial stimulus for discussion of cultural competencies in Aotearoa New Zealand was the disparity of health outcomes between Maori and non-Maori along with recognition of the Treaty of Waitangi” (page 3)

## Discussion

The original *HPCA Act*<sup>9</sup> was designed to protect the public and RAs are responsible for enacting the functions listed within it in the process of affording protection. The *HPCA Amendment Act*<sup>2</sup> added more detail to the function specific to competence. The definition of cultural competence was extended to include enabling “effective and respectful interaction with Māori” (s118 (i)).<sup>2</sup> Formally establishing this level of specificity provides a powerful mandate to ensure that students and practitioners in the health professions (and therefore serving the community in health, wellbeing, and disability contexts) are required to have the skills to engage with and support Māori. Addressing Māori health, wellbeing, and disability inequities<sup>44</sup> are imperative from a human rights perspective and on the basis of Te Tiriti o Waitangi, the founding document of

Aotearoa New Zealand,<sup>4,45</sup> and responding to the extension of the requirement for cultural competence both imperative and courteous. With regard to understanding the position of Māori as tangata whenua, we note that some RAs refer to *the Government* as recognising Māori, a language that distances the particular RA from this recognition and suggests that they don’t recognise Māori as tangata whenua and/or only engage with this at a transactional level of compliance.

The results from this analysis of published information indicate that, three years following the enactment of the *Amendment Act*<sup>2</sup> there is, at best, an equivocal response to the extended cultural competence. The extent to which enabling “effective and respectful interaction with Māori” has been embedded into the work of the RAs can be seen in the extent to which they have updated their functions, competencies and related guidance to reflect the amendment. For instance, the

Dental Council's (2021)<sup>11</sup> statement on "Best practices" includes the phrase "respectful and trusting relationship" (page 3), some detail under the heading of "Māori culture competence standards" with regard to attitudes, awareness and knowledge, skills and practice, and the provision of a list of supporting resources. By contrast the New Zealand Chiropractic Board | Te Pōari Kaikorohiti o Aotearoa makes only passing references to engaging with Māori and "The Treaty" in the context of "understanding the needs of Maori" (page 5)<sup>29</sup> and "undertaking relevant CPD, where appropriate" (paragraph 4).<sup>28</sup>

The adoption of the reference to "Te Tiriti" rather than "the Treaty" and the utilisation of te reo Māori may also provide some insights into the level of engagement of individual RAs in relation to the extended cultural competence function and, more broadly, a bicultural perspective on health. Language conveys meaning; te reo Māori is an official language of Aotearoa New Zealand; and language and culture are inextricably connected. Being responsive to Māori (an absolute requirement under Te Tiriti o Waitangi) requires meaningful and genuine engagement. Our colonial history of preventing people speaking te reo<sup>47</sup> makes it even more critical that the first language of this country is afforded appropriate respect. In a similar vein, recognising Te Tiriti o Waitangi as distinct from "The Treaty" is also essential to appreciate the history and issues that have resulted in poor access to and outcomes from health, wellbeing and disability support services. This is closely connected to debates about the reference to principles of the Treaty<sup>48</sup> as distinct from the Articles of Te Tiriti (see, for instance, Berghan<sup>49</sup>). As the Waitangi Tribunal (2019) put it: "Contemporary thinking on Treaty principles has moved on significantly from the "three Ps" approach favoured in the health sector" (page 80), finding that "the Crown's "three Ps" articulation of Treaty principles is outdated and needs to be reformed" (page 163).<sup>50</sup> In this context, we were surprised to see that not all RAs referenced Te Tiriti o Waitangi.

A number of RAs do not spell "Māori" with a macron, a very basic step in respecting te reo. There is also a variation between RAs in how they refer to this land mass and country as New Zealand, Aotearoa, Aotearoa New Zealand, or Aotearoa/New Zealand, all of which are referents that imply different understandings of the nation.

While specialist knowledge and expertise require

experts, different disciplines and, ultimately, different RAs, other elements of practice, education and professional development may be more efficiently served within a more cohesive and synergistic model.<sup>4</sup> Cultural competence and engaging with Māori in the pursuit of fair and equitable health outcomes is arguably better served in a more joined-up or integrated rather than separate and separatist approach to competencies, the functions of RAs, and how educational curricula are developed, and students gain access to and engage within them.

The similarities between the websites and content published by some RAs suggests that information and resources may be shared to some degree. This in turn raises questions about the efficient use of resources and an emphasis on administrative or bureaucratic priorities rather than meaningful engagement with, and reflection of, professional practice and context. A further issue worth noting in this space is the titles of the RAs. The titles of the RAs and the emphases we identified within their websites suggest they are all seeking to balance the identity and profile of the RA itself, access for and engagement with the public, and the RA's relationship with practitioners. Six RAs emphasise practitioners in their title (Dietitians Board, Medical Radiation Technologists Board, Psychologists Board, and The Psychotherapists Board, Optometrists and Dispensing Opticians Board of New Zealand | Te Poari a ngā kaimātau Whatu me ngā Kaiwhakaarato Mōhiti and the Podiatrists Board of New Zealand). These titles imply that the RAs associate with the practitioners they register and suggest an organisational culture that emphasises practitioners (as distinct from the public or the practice/profession).

In summary, there is evidence that three years following the amendment to the *HPCA Act*<sup>2</sup> only two of the RAs appear to have amended their published information to expressly reflect the extension of the concept of cultural competence to refer to "respectful interaction with Māori". While the majority of the RAs refer to "Te Tiriti o Waitangi", five of them continue to refer to the "Treaty of Waitangi". Other relevant insights include a high level of similarity between some of the RAs and a tendency towards administrative or bureaucratic information, which raises issues about the duplication of resources and presents opportunities to consolidate language, quality assurance information and competencies.

## Conclusion

The complexity of the RAs' websites, the variable emphases they present (regarding practitioners, the public, and themselves) along with the use of different terminology and navigation tools can cause confusion. Paradoxically, the shared design, content (text), and cross referencing between RAs suggests a considerable amount of interaction between them. This also raises questions about the need for individual authorities to be undertaking many tasks that could reasonably be consolidated and begs the question whether we need 17 (or more) individual health professional regulators to be consulting about professional, ethical and cultural competencies, a point that has been the subject of reviews of the *HPCA Act*.<sup>9</sup> The expertise and context of practice of each of the professions warrants a level of discipline-specific oversight. However, generic expectations of health professionals are fundamental and, apart from discipline-specific nuances, are not radically different between professions. Another clause in the *Amendment Act*<sup>2</sup> specifically relates to such working across professional boundaries, listing an RA function as "to liaise with other authorities appointed under this Act about matters of common interest" (s118 (j)).<sup>9</sup> This function was extended (in the Amendment Act)<sup>2</sup> to "promote and facilitate inter-disciplinary collaboration and co-operation in the delivery of health services" (s118 (ja)).<sup>9</sup> The amendment to this function of RAs underlines the expectation that

they will facilitate collaboration and co-operation.

Working across professional boundaries has the potential to change and extend the workforce. Professional association and regulation tend towards insular silos. The COVID-19 pandemic has required rapid changes at national and local levels, with colleagues from across the regulated professions supporting one another. There have been opportunities to appreciate the similarities across professional boundaries, driven by the needs of the community being served. The protectionist culture of health professional regulators is widely understood,<sup>46</sup> and whilst it serves the purpose of maintaining expertise and professional identity it can also exclude radical and alternative practice, free and critical thinking, and informed dissent.

It is clear that three years following the amendment to the original *HPCA Act*,<sup>2,9</sup> defining "effective and respectful interaction with Māori" as a function of the RAs has not resulted in wholesale appreciation of this as a competence, its adoption, or change in practice. It is equally clear that some RAs have genuinely engaged and have a sound vision based on the need to address inequity. Others, however, have yet to engage fully. We suggest it is timely to reconsider consolidating key functions of the RAs to enable them to focus expertise on what sets them apart from one another and utilise administrative and leadership resource to bring about essential change across the sector as a whole for the improved health of Māori and of all New Zealanders.

**COMPETING INTERESTS**

Nil.

**ACKNOWLEDGEMENTS**

The authors acknowledge the assistance and support of Rumén Rachev, Research Assistant in AUT's Health Futures (Health Professional Education) project team, in the preparation of this manuscript.

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# Celestial risk factors in groin hernia repair and random statistical association: a nationwide register-based study

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## ABSTRACT

**AIM:** We aimed to investigate how celestial phenomena like zodiac signs, lunar phases, and Friday the 13th impacted the risk of reoperation after groin hernia repair.

**METHODS:** We conducted a nationwide register-based study based on the Danish Hernia Database and Danish Patient Safety Authority's Online Register between 2000–2019. We included patients  $\geq 18$  years undergoing open Lichtenstein or laparoscopic groin hernia repair. The main outcomes were risk of reoperation after groin hernia repair in relation to patient and surgeon zodiac sign, lunar phase at the time of the repair, and Friday the 13th vs other Fridays.

**RESULTS:** 151,901 groin hernias were included in the analysis of patient zodiac sign, and 25,075 groin hernias were included in the analysis of surgeon zodiac sign. Compared with the Sagittarius, there was a significantly higher risk of reoperation (HR [95% CI]) if the performing surgeon was born under the Capricorn (1.93 [1.16–3.12]); Pisces (1.68 [1.09–2.57]); Aries (1.61 [1.07–2.38]); Taurus (1.62 [1.04–2.54]); Cancer (2.21 [1.48–3.28]); or Virgo (1.71 [1.13–2.59]). Repairs performed under the waxing (1.23 [1.03–1.46]) and the new moon (1.54 [1.11–2.13]) had significantly higher risk of reoperation (HR [95% CI]) compared with the waning moon. Neither patient zodiac sign nor Friday the 13th affected risk of reoperation after groin hernia repair.

**CONCLUSIONS:** Surgeons' zodiac sign and lunar phase significantly affected the risk of reoperation after groin hernia repair. Neither patients' zodiac sign nor Friday the 13th influenced on the risk of reoperation after groin hernia repair. This indicates why significant findings should be considered carefully to distinguish between random statistical association and cause-and-effect relations.

Celestial phenomena like lunar phases and zodiac signs have been part of human culture since ancient times.<sup>1,2</sup> Many still believe that both zodiac signs and lunar phases influence daily life and to some extent even health.<sup>3,4</sup> However, these beliefs are often regarded as being superstitions without scientific evidence.<sup>5</sup> Nevertheless, zodiac signs and lunar phases are attributed significant meaning and value in daily life,<sup>5</sup> and many believe celestial factors carry significant attributes regarding health.<sup>6</sup> Additionally, there are ill-fated beliefs surrounding Friday the 13th, some say it is an “unlucky” day and some even believe it is an omen of death.<sup>7</sup>

The Danish Hernia Database provides data on almost all groin hernia repairs performed in Denmark with approximately 100% follow-up,<sup>8</sup> making it possible to assess the long-term effect of lunar phases, zodiac signs, and Friday the 13th on reoperation rate after groin hernia repair. There are many known patient-related and procedure-related risk factors for reoperation after groin hernia repair.<sup>9–11</sup> However, the impact of celestial-

related risk factors have not previously been investigated.

We wished to investigate if it was possible to find an association between celestial phenomena and the reoperation rate after groin hernia repair. This study aimed to investigate how the 12 zodiac signs from Western astrology,<sup>12</sup> lunar phases, and Friday the 13th impacted the risk of reoperation after groin hernia repair.

## Methods

We performed a register-based cohort study with nationwide prospectively collected data on groin hernia repairs which followed the REporting of studies Conducted using Observational Routinely collected health Data (RECORD) statement.<sup>13</sup> Data were obtained from the Danish Hernia Database<sup>8</sup> and the Danish Patient Safety Authority's Online Register.<sup>14</sup> Data from the two databases were linked via surgeons' unique authorisation IDs. The Danish Hernia Database contains data on patients' sex, age, birth-date, (used to obtain patients' zodiac sign), and date

of operation (used to obtain the lunar phase at the time of operation). Furthermore, the Danish Hernia Database contains perioperative data such as side of the hernia, whether the repair was primary or recurrent, elective or emergency, type of hernia, and method of repair: Lichtenstein or laparoscopic TransAbdominal PrePeritoneal (TAPP) repair. The Danish Hernia Database also draws data from the Danish National Patient Registry<sup>15</sup> and the Danish Civil Registration System,<sup>16</sup> providing data on reoperation status, emigration, and deaths. The Danish Patient Safety Authority's Online Register contains data on all surgeons registered in Denmark such as surgeons' authorisation ID,<sup>14</sup> which was included in the Danish Hernia Database from 2011, and the surgeons' date of birth, making it possible to determine the surgeons' zodiac sign.

Patients were included between January 2000 and December 2019. Recurrent groin hernia repair was defined as an operation for a new hernia on the same side as a previous repair. Since the same patient could be operated for a groin hernia on both sides, either at the same time or independently, we considered groins for inclusion rather than patients. This also ensured that a recurrent hernia was in fact on the same side as a previous hernia. Patients were followed until death, reoperation, or the end of the study period (1 January 2020).

Eligibility criteria for inclusion were primary groin hernia repairs performed in patients  $\geq 18$  years with either Lichtenstein or laparoscopic TAPP repair. TAPP technique accounts for  $>98\%$  of laparoscopic repairs in Denmark,<sup>17</sup> therefore other laparoscopic approaches were not included. Both elective and emergency repairs were included. Groin hernias were considered primary if the repair was registered as a primary repair. Furthermore, we performed a "look back" for each groin from 1998 for previous repairs to identify recurrent hernias. Groin hernias were excluded if the first registered operation was a reoperation, the type of hernia was not registered, the repair was performed before 2000, or if patients had either emigrated or were living outside of Denmark. The inclusion criterion for surgeons was a valid authorisation ID entry. Surgeons were excluded if the authorisation ID was registered  $\leq 2$  times. The groin hernias were divided into two overlapping cohorts and analysed separately: one cohort with patients' zodiac sign as the variable and one cohort with the surgeons' zodiac sign as the variable.

The outcomes were risk of reoperation after groin hernia repair in relation to surgeons' zodiac sign, patients' zodiac sign, lunar phase at the time

of repair, and whether the repair was performed on Friday the 13th vs other Fridays. The 12 zodiac signs used were from Western astrology based on the tropical zodiac.<sup>12</sup> The zodiac signs used in Western astrology originates from the ancient Babylonians who mapped the zodiac approximately 3,000 years ago.<sup>18</sup> Zodiac signs were assigned to the included surgeons and patients based on their birthdate.<sup>19</sup> In Western astrology, there are 12 signs: Capricorn, Aquarius, Pisces, Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio and Sagittarius. During a lunar cycle, the moon passes through four phases: the new, the waxing, the waning, and the full moon.<sup>20</sup> Data on lunar phases at the time of the repair (2000–2019) were obtained from the Copenhagen Planetarium's Astronomy Department via personal contact. The day of the repair was assessed according to the Gregorian calendar which was used to identify Friday the 13th and other Fridays.

Subgroup analyses were performed to investigate the impact of lunar phases on the risk of reoperation for each surgeon zodiac sign. The reference for the subgroup analyses was the lunar phase with the lowest reoperation rate where all 12 surgeon zodiac signs were represented.

The statistical analyses were performed with SPSS (version 25.0, IBM, Armonk, NY, USA). Q-Q-plots and histograms were used to evaluate the distribution of data. Normally distributed, continuous data were presented as mean with standard deviation (SD), while non-normally distributed, continuous data were presented as median with interquartile range [IQR]. Categorical data were presented as crude reoperation rates and tested with the Chi-squared test. The difference in distribution of zodiac signs within groups was evaluated with 95% confidence intervals (CIs). Cox proportional hazard analyses was used to assess the risk of reoperation in relation to zodiac signs and lunar phases. The analyses were adjusted for patients' sex, age, hernia type, and type of repair. Furthermore, the analyses for zodiac signs were adjusted for lunar phases while the analyses for lunar phases were adjusted for surgeons' zodiac sign. The group with the lowest reoperation rate was used as reference. Risk of reoperation was presented as hazard ratios (HR) with 95% CIs. Findings were considered significant when  $p < 0.05$ .

Approval for this study was obtained from the Danish Data Protection Agency (P-2020-380). According to Danish law, approval from ethics committees and written informed consent were not required to conduct this study.

## Results

In the surgeon zodiac sign cohort, we included 25,075 groin hernia repairs performed in 2011–2019. In the patient zodiac sign cohort, 151,901 groin hernia repairs were included between 2000–2019. The selection process of groin hernias in patients is shown in Figure 1.

The patient demographic and operative characteristics for the surgeon zodiac sign cohort and patient zodiac sign cohort are shown in Table 1.

The surgeon zodiac sign cohort included 541 surgeons, performing 25,075 repairs in 22,916 patients (see characteristics in Table 1). Of these repairs, 4%, 15%, and 5% were performed by surgeons born under the Capricorn, Aries and Scorpio, respectively, which differed significantly from the other surgeon zodiac signs. Among the 541 included surgeons, the 12 zodiac signs were evenly distributed (data not shown). The median follow-up [IQR] was 23 (12–33) months. The crude reoperation rates after groin hernia repair for each surgeon zodiac sign are shown in Figure 2.

The adjusted risk of reoperation after groin hernia repair based on surgeons' zodiac sign is shown in Table 2. Surgeons born under the Sagittarius were used as reference since they had the lowest crude reoperation rate (1.5%). The adjusted analyses showed significantly higher risk of reoperation when the performing surgeon was born under the Capricorn, Pisces, Aries, Taurus, Cancer, or Virgo compared with the Sagittarius, see Table 2.

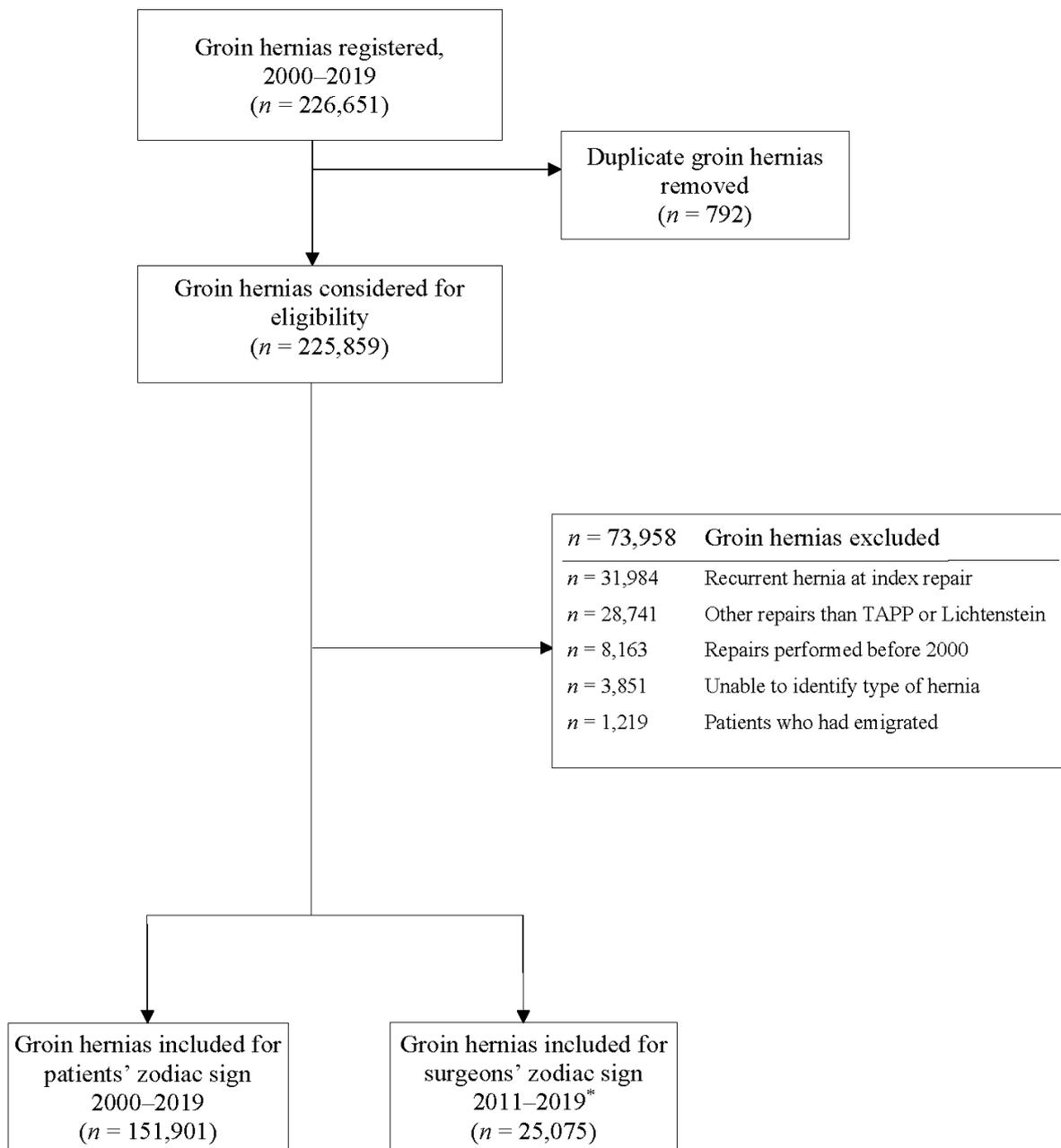
We performed subgroup analyses, investigating how lunar phases at the time of repair affected the risk of reoperation for each of the 12 surgeon zodiac signs. The waning moon was used as reference since it was the phase with the lowest reoperation rate, where all 12 surgeon zodiac signs were represented. The

subgroup analyses (see Table 3) showed increased risk of reoperation after repairs performed by surgeons born under the Capricorn (HR 5.39) and Aquarius (HR 4.81) during the new compared with the waning moon. In addition, surgeons born under the Capricorn had an increased risk of reoperation (HR 9.13) during the full compared with the waning moon. Lastly, we found an increased risk of reoperation after repairs performed by surgeons born under the Pisces (HR 1.99) and Libra (HR 2.24) during the waxing compared with the waning moon.

Crude reoperation rate based on lunar phases seemed higher during the new (2.9%) and the waxing moon (2.5%) than during the waning (2.1%) and the full moon (2.0%). Table 4 shows the risk of reoperation after groin hernia repair in relation to the lunar phase on the day of the repair in the surgeon zodiac sign cohort. There was a significantly higher risk of reoperation after repairs performed during the new and the waxing moon compared with the waning moon.

The patient zodiac sign cohort included 151,901 groins hernia repairs, performed in 142,872 patients (see characteristics in Table 1). The median follow-up [IQR] was 93 [43–156] months. The crude reoperation rates were similar for all 12 patient zodiac signs (Appendix 1). Furthermore, there were no differences in the HRs amongst the different patient zodiac signs. The Cox regression was adjusted for patients' sex, age, type of hernia, type of repair, and lunar phase (analyses not shown).

There were 20,406 repairs performed on regular Fridays and 675 repairs on a Friday that fell on the 13th of the month. The crude reoperation rate after repairs performed on Friday the 13th was 4.5% and 4.3% on regular Fridays ( $p=0.826$ ).

**Figure 1:** Flowchart of inclusion of groin hernias in patients.

Abbreviation: TAPP = TransAbdominal PrePeritoneal.

\*Patients included in the period when surgeons' zodiac signs were available, where 126,826 groins were excluded since data on surgeon zodiac sign were not available.

**Table 1:** Patient demographics and operative characteristics for the 25,075 groin hernia repairs in the surgeon and 151,901 patient zodiac sign cohorts, respectively, including distribution of repairs on zodiac sign and lunar phases. Data are presented as number (%) if not otherwise stated.

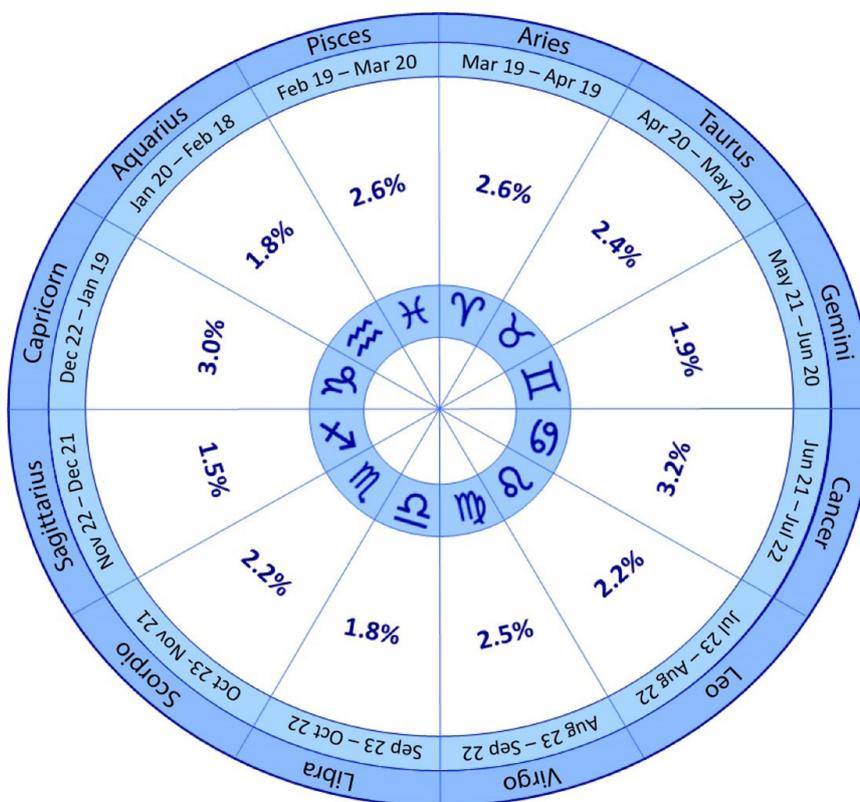
	Surgeon zodiac sign cohort	Patient zodiac sign
	n (%) n=25,075	n (%) n=151,901
<b>Patient characteristics</b>		
Age, years, mean±SD	60±15	59±15
Males	22,356 (89)	139,130 (92)
Emergency repair	1,002 (4)	4,464 (3)
<b>Type of hernia</b>		
<b>Inguinal</b>		
Lateral	14,009 (56)	82,857 (54)
Medial	8,285 (33)	57,266 (38)
Pantaloon	1,636 (7)	8,402 (5)
Femoral	814 (3)	2,364 (2)
Combined	329 (1)	1,012 (1)
<b>Method of repair</b>		
Lichtenstein	9,870 (39)	107,694 (71)
Laparoscopic (TAPP)	15,203 (61)	44,207 (29)
Reoperations	582 (2)	7,051 (5)
<b>Zodiac sign</b>		
Capricorn	873 (4)	10,657 (7)
Aquarius	1,639 (6)	11,416 (8)
Pisces	2,068 (8)	11,951 (8)
Aries	3,883 (15)	11,926 (8)
Taurus	1,744 (7)	13,551 (9)
Gemini	1,897 (8)	14,444 (10)
Cancer	2,587 (10)	14,286 (9)
Leo	2,490 (10)	13,373 (9)
Virgo	2,571 (10)	13,157 (9)
Libra	1,726 (7)	12,359 (8)
Scorpio	1,183 (5)	12,057 (8)
Sagittarius	2,412 (10)	12,724 (8)

**Table 1 (continued):** Patient demographics and operative characteristics for the 25,075 groin hernia repairs in the surgeon and 151,901 patient zodiac sign cohorts, respectively, including distribution of repairs on zodiac sign and lunar phases. Data are presented as number (%) if not otherwise stated.

	Surgeon zodiac sign cohort	Patient zodiac sign
	n (%) n=25,075	n (%) n=151,901
<b>Operations during lunar phases</b>		
Waning moon	11,181 (45)	68,136 (45)
New moon	1,446 (6)	8,934 (6)
Waxing moon	11,356 (45)	68,747 (45)
Full moon	1,090 (4)	6,084 (4)

Abbreviations: SD = Standard deviation; TAPP = TransAbdominal PrePeritoneal.

**Figure 2:** Astrological chart wheel of the crude unadjusted reoperation rate in percent after groin hernia repair based on the performing surgeons' zodiac sign. The defining dates of birth for each zodiac sign is listed along with the respective zodiac sign.<sup>19</sup>



**Table 2.** Adjusted risk of reoperation after groin hernia repair based on the performing surgeon's zodiac sign.<sup>19</sup> Adjusted for patients' sex, age, the type of hernia, the type of repair (Lichtenstein vs laparoscopic), and the lunar phase on the day of the operation.

Zodiac sign	Birthdate	Hazard ratio	95% CI	P value
Capricorn	22 Dec–19 Jan 19	1.93	1.16–3.12	0.011
Aquarius	20 Jan–18 Feb	1.35	0.83–2.20	0.231
Pisces	19 Feb–20 Mar	1.68	1.09–2.57	0.018
Aries	21 Mar–19 Apr	1.61	1.07–2.38	0.018
Taurus	20 Apr–20 May	1.62	1.04–2.54	0.035
Gemini	21 May–20 Jun	1.28	0.80–2.04	0.307
Cancer	21 Jun–22 Jul	2.21	1.48–3.28	<0.0001
Leo	23 Jul–22 Aug	1.50	0.97–2.28	0.067
Virgo	23 Aug–22 Sep	1.71	1.13–2.59	0.012
Libra	23 Sep–22 Oct	1.31	0.80–2.12	0.280
Scorpio	23 Oct–21 Nov	1.38	0.83–2.29	0.218
Sagittarius	22 Nov–21 Dec	1	–	–

Abbreviation: CI = confidence interval.

**Table 3:** Subgroup analyses of the risk of reoperation during different lunar phases for each surgeon zodiac sign, reported as hazard ratio (95% confidence interval). The analyses were adjusted for patients' sex, age, the type of hernia, the type of repair (Lichtenstein vs. laparoscopic), and the surgeon zodiac sign.

					
Lunar cycle <sup>a</sup>		New moon Day 1	Waxing moon Day 2-14	Full moon Day 15	Waning moon Day 16-29.5
Surgeon zodiac sign					
	Capricorn	5.39 (1.19-24.32)*	3.04 (1.00-9.29)	9.13 (2.44-34.14)*	1
	Aquarius	4.81 (1.74-12.30)*	1.38 (0.60-3.15)	0.85 (0.11-6.56)	1
	Pisces	1.95 (0.65-5.90)	1.99 (1.08-3.67)*	3.38 (0.98-11.69)	1
	Aries	1.08 (0.43-2.71)	1.08 (0.72-1.63)	0.78 (0.24-2.51)	1
	Taurus	0.71 (0.17-3.03)	0.98 (0.53-1.83)	-	1
	Gemini	-	0.81 (0.41-1.58)	0.50 (0.08-3.76)	1
	Cancer	1.72 (0.67-4.45)	1.53 (0.96-2.44)	1.05 (0.32-3.46)	1
	Leo	1.26 (0.44-3.58)	0.74 (0.43-1.29)	-	1
	Virgo	2.10 (0.90-4.91)	1.33 (0.77-2.28)	1.44 (0.43-4.85)	1
	Libra	0.99 (0.13-7.81)	2.24 (1.02-4.90)*	-	1
	Scorpio	1.55 (0.34-7.12)	1.06 (0.47-2.41)	0.93 (0.12-7.14)	1
	Sagittarius	1.62 (0.47-5.61)	0.99 (0.48-2.02)	1.24 (0.28-5.41)	1

<sup>a</sup>The total length of the moon cycle is approximately 29.5 days, varying slightly from phase to phase.<sup>20</sup>

\* $p \leq 0.05$ .

-: No operations were performed during these lunar phases by surgeons born under these zodiac signs.

**Table 4:** Adjusted risk of reoperation after groin hernia repair based on the lunar phase at the day of operation. Adjusted for patients' sex, age, the type of hernia, the type of repair (Lichtenstein vs laparoscopic), and the surgeon zodiac sign.

				
Lunar cycle*	New moon Day 1	Waxing moon Day 2–14	Full moon Day 15	Waning moon Day 16–29.5
Hazard ratio	1.54	1.23	0.99	1
95% CI	1.11–2.13	1.03–1.46	0.64–1.53	–
P value	0.01	0.02	1.0	–

Abbreviation: CI: confidence interval.

\*The total length of the moon cycle is approximately 29.5 days, varying slightly from phase to phase.<sup>20</sup>

## Discussion

We found a significantly higher risk of reoperation after groin hernia repair performed by surgeons born under the Capricorn, Pisces, Aries, Taurus, Cancer, or Virgo compared with the Sagittarius. Repairs performed under the new or the waxing moon were associated with higher risk of reoperation compared with repairs performed under the waning moon, whereas patients' zodiac sign or Friday the 13th did not affect the risk of reoperation.

Surgeon zodiac sign was a significant risk factor for reoperation after groin hernia repair, and we investigated whether the lunar phases could reduce the effect of the surgeons' zodiac sign. This indicated that there was a significantly increased risk of reoperation during the full moon for surgeons born under the Capricorn and Aquarius. Furthermore, repairs performed by surgeons born under the Capricorn were associated with an increased risk of reoperation during the new moon. Surgeons born under the Pisces or Libra had higher risk of reoperation during the waxing moon. In the surgeon zodiac sign cohort, repairs performed during the waxing or the full moon were associated with a higher risk of reoperation compared with the waning moon. It could therefore be argued that surgeons could consider lunar phases when scheduling groin hernia repairs to minimise the risk of reoperation associated with the waxing moon. However, the moon is in the waxing phase approximately two

weeks during every cycle of 29.5 days<sup>20</sup> and, thus difficult to avoid.

This study is an example of how statistical analyses can yield significant findings and the interpretation of such findings are key when distinguishing between random association and actual causality. We presented various analyses indicating that surgeons' zodiac sign and lunar phases impacted the risk of reoperation after groin hernia repair. According to our data and analyses, one possible conclusion could be that surgeons born under the Sagittarius were better hernia surgeons than surgeons born under the Capricorn, Pisces, Aries, Taurus, Cancer, or Virgo. However, such a conclusion cannot be drawn without careful consideration: is it plausible that there is a cause-and-effect relation between the risk of reoperation after groin hernia repair and factors such as surgeons' zodiac sign and lunar phase? To answer this question, we considered the aspect of causality. When assessing causality Bradford Hill's nine criteria for causality are considered the golden standard.<sup>21</sup> Particularly, we will highlight the specificity, the plausibility, and the coherence of the evidence presented in this study. The specificity of our findings is difficult to quantify, but since there are many risk factors associated with the risk of reoperation after inguinal hernia repair,<sup>9–11</sup> it is likely that other factors could have affected the risk of reoperation, and thus the specificity of our findings is likely not high. Most health personnel would deem it biologically implausible that zodiac sign and lunar phase could affect the out-

come of surgical interventions since zodiac sign and lunar phase are considered popular superstitions without supporting evidence. Furthermore, there are no biological pathways where factors such as zodiac sign or lunar phases are known to affect the outcome, and this assumption would seem contradictory to the bases of modern Western medicine. To our knowledge, only one previous study has investigated the impact of lunar phases and the short-term outcome after inguinal hernia repair and found that the lunar phase did not affect the risk of post-operative pain.<sup>22</sup> Other previous studies have investigated the impact of zodiac sign at the time of operation and the lunar phases on intraoperative blood loss,<sup>23</sup> various outcomes in radical cystectomy,<sup>24</sup> intracranial aneurysm rupture,<sup>25</sup> and elective spine surgery.<sup>26</sup> However, these results cannot be compared with our findings regarding groin hernia repair. Thus, there is no coherent evidence in the literature supporting the findings of the present study, and the findings presented here should be interpreted with caution before making conclusions regarding causality between zodiac sign, lunar phases and the risk of reoperation after groin hernia repair. Our findings should be interpreted as random associations rather than a cause-and-effect relationship, underlining that researchers, editors, peer reviewers, and readers should interpret data analyses and statistical associations with caution. A conclusion regarding a cause-and-effect relation between celestial risk factors and groin hernia repair cannot be made solely based on the evidence presented in this study. That would require further studies, adding evidence to the cause-and-effect relationship.

This study has several methodological strengths. The Danish Hernia Database<sup>8</sup> and the Danish Patient Safety Authority's Online Register<sup>14</sup> both have nationwide coverage. Furthermore, the Danish Hernia Database draws data from the National Patient Registry,<sup>15</sup> ensuring a follow-up close to 100% in the Danish Hernia Database.<sup>8</sup> Data on lunar phases were obtained from the Copenhagen Planetarium's Astronomy Department, ensuring high accuracy of the dates

and times of the lunar phases. However, there are also limitations to this study. Data on the hernia defect size were not available in the majority (70%) of the included groins hernias and were therefore not reported. It is important to highlight the statistical analyses of the present study. We conducted several analyses with multiple variables. In theory, one in 20 analyses will coincidentally result in a significant finding with a significance level of 0.05. This study included a large, representative sample size and we do not suspect a type II error in the patient zodiac sign cohort, where we did not find any significant effect of patients' zodiac sign on the risk of reoperation. In the surgeon zodiac sign cohort, we found a significant effect of both surgeon zodiac sign and lunar phase on the risk of reoperation. It is possible that this significant finding was in fact a statistical type I error, thus falsely rejecting the null hypothesis. Furthermore, we conducted 62 Cox regressions (11 for patient zodiac sign, 11 for surgeon zodiac sign, 36 for the subgroup analyses for lunar phases in the surgeon zodiac sign cohort, and 3 for lunar phases alone), and we did not adjust for multiple testing, which again increased the risk of a type I error. Thus, the findings in this study may have statistical significance; however, the clinical significance is debatable, and the evidence presented in this study can be regarded as a random association as a result of statistical analyses with large sample sizes, and not necessarily a causal relation.

In conclusion, surgeons' zodiac sign significantly affected the risk of reoperation after groin hernia repair, and surgeons born under the Sagittarius had a significantly lower risk of reoperation after groin hernia repair. The new and the waxing moon were associated with a significantly increased risk of reoperation. Patients' zodiac sign or Friday the 13th did not affect the risk of reoperation. This study showed that it is relatively easy to find random associations in research with very large sample sizes, and it is important that findings, although statistically significant, should be considered with caution before concluding that there is a cause-and-effect relation.

**COMPETING INTERESTS**

The authors have no competing interests.

**ACKNOWLEDGEMENTS**

We thank Lasse Valentini Jensen for assistance with acquisition of data.

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**Appendix 1:** Crude reoperation rate after groin hernia repair based on 151,901 groins with data on patients' zodiac sign.

Patient zodiac sign		Reoperation, <i>n</i> (%)
	Capricorn	490 (5)
	Aquarius	556 (5)
	Pisces	564 (5)
	Aries	552 (5)
	Taurus	629 (5)
	Gemini	668 (5)
	Cancer	676 (5)
	Leo	610 (5)
	Virgo	584 (4)
	Libra	592 (5)
	Scorpio	553 (5)
	Sagittarius	577 (5)

# A comprehensive methodology report for maternity and perinatal mortality research in the New Zealand Integrated Data Infrastructure

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## ABSTRACT

**AIM:** The highest quality perinatal data in New Zealand is collected and collated by the Perinatal and Maternal Mortality Review Committee (PMMRC) and is made available to a limited number of researchers. Therefore, maternity, and perinatal mortality studies are generally performed on Government-held data. This report offers an alternative approach with in-depth justification for the methodology, while simultaneously improving the understanding of the data sources.

**METHOD:** A standardised method for creating a comprehensive maternity dataset within the Statistics New Zealand Integrated Data Infrastructure (IDI) was developed and a validation dataset was created to include all births between 2008 and 2017.

**RESULTS:** A close approximation to the PMMRC annual report data was found, with 4.0% over-reporting of perinatal deaths and 0.05% over-reporting of live births in the IDI dataset. Several variables, including important pregnancy risk factors, were validated for use. Limitations to the datasets were explored and additional tables in the IDI were proposed, to include variables on pregnancy complications, ethnicity and country of birth, and socio-economic data.

**CONCLUSION:** This methodological report describes an opportunity for standardised, high-quality maternity research in New Zealand using the IDI, including a variety of national data sources. Recommendations for further enhancement of these resources have been offered.

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Observational studies are a useful tool in epidemiology.<sup>1</sup> One study revealed that approximately 68% of published articles in the four leading United States obstetrics and gynaecology journals were of observational nature.<sup>2</sup> In obstetric research, they provide the opportunity to study relatively rare adverse events like stillbirth or neonatal death (NND). Despite their value, observational studies come with biases and investigators have an obligation to identify and mitigate these,<sup>3</sup> which includes adequate reporting of the study design and methodology.<sup>4</sup>

Epidemiological maternity research in New Zealand is usually performed on national Government-held data. The highest quality perinatal data in the country is collected and held by the Perinatal and Maternal Mortality Review Committee (PMMRC), which is an independent committee under the Health Quality & Safety Commission New Zealand. PMMRC data is only made available to a limited number of researchers, due to data sovereignty issues. An alternative data source for maternity research in New Zealand is provided by the Statistics New Zealand (NZ) Integrated

Data Infrastructure (IDI). The IDI is a collection of New Zealand Government and non-government administrative and survey data, held by Statistics NZ. Researchers are granted access to merge and interrogate data sources only available within the strict privacy rules of the IDI environment; as projects are required to meet all “five safes” (safe people, safe projects, safe settings, safe data, and safe output).<sup>5</sup> Data in the IDI is linked at the individual level, which allows personal information to be connected across different sectors (such as income, migration, and health). Each person is provided with a unique identification (ID) number in a central “spine”, by which the various datasets can be joined. All people ever resident in New Zealand (i.e., citizens or those with visas that allow residency, work or study) and captured in one of the data sources, are included. The IDI data are “refreshed” (i.e., updated, to include newer data, and additional data sources) up to four times a year. By connecting data from multiple sources not otherwise linked on an individual level, questions around complex issues can be researched with high quality across the population.<sup>6</sup>

As both maternal and infant data are generally necessary in perinatal analyses, creating datasets for maternity research can be complicated. This methodological report was prepared to assist New Zealand researchers in developing comprehensive datasets for national pregnancy studies, with a focus on perinatal death. We describe a standardised method for creating a “core” dataset within the IDI, allowing for consistent national reporting, and include suggestions for additional tables. We additionally aim to improve the understanding of the used datasets and variables.

## Method

An application was made with Statistics NZ to use the data within the IDI. Once approved, a dataset for perinatal research was built in Microsoft SQL Management Server Studio (using IDI refresh IDI\_Clean\_20211020). National data sources used, were the Maternity Collection (MAT),<sup>7</sup> Births, Deaths and Marriages (BDM),<sup>8,9</sup> the National Minimum Dataset (NMDS),<sup>10</sup> the Mortality Collection (MORT),<sup>11</sup> the Chronic Conditions dataset (CC),<sup>12</sup> Census,<sup>13</sup> and Immigration data.<sup>14</sup> “General” or “central” IDI tables used included the full birth date, full death date, and address notification tables.<sup>15</sup> A succinct and essential summary of these data sources has been provided in Appendix 1. See Table 1 for an overview of abbreviations used in this methodological report. Finally, PMMRC publicly available annual report data was used as the gold standard to validate the tables created.<sup>16</sup>

A numerator table (including all perinatal deaths) and a denominator table (including all births) were created separately, to include all births between 2008 and 2017. The main dataset used was the MAT collection. Data quality of the MAT collection varies by item but has improved significantly since 2008.<sup>17</sup> Thus, data from 2008 onward are most useful for perinatal research. The proposed method for creating the core dataset, as well as two corresponding full SQL codes (for a table in and excluding multiples) are provided in Appendices 2–4.

## Pregnancy risk factors

Even though data quality has improved since 2008, some variables still have a high degree of missing data. This is particularly true for women cared for exclusively by district health boards (DHB), due to a funding change introduced in

July 2007. DHB employed midwifery teams are no longer required to claim for primary maternity services, while self-employed community-based lead maternity carers (LMCs; midwives, general practitioners, or obstetric specialists) must submit pregnancy data prior to payment from the Ministry of Health (MoH).<sup>18</sup> As a result, completeness of some data for DHB-registered pregnancies varies widely, while the same data for non-DHB pregnancies is mostly complete. It should also be noted that since 2008 the variable “LMC type” is inaccurate for women under DHB care.<sup>17</sup> Finally, when considering data quality issues, some variables can be taken from either MAT or BDM data sources. We validated the following variables for use: maternal age, fetal sex, gestational age, and birthweight.

## Pregnancy complications

Pregnancy complications such as gestational diabetes (GDM) or hypertensive disorders of pregnancy are important outcomes in routine maternity research. The MAT delivery table in the IDI identifies births that were complicated by pre-eclampsia or eclampsia, identified by NMDS. MAT, however, does not identify pregnancies of mothers with pre-existing hypertensive disorders or gestational hypertension. Secondly, the indicator for GDM is not offered in the IDI as this field is incorrectly labelled. It indicates both pre-existing diabetes and GDM, and according to the MoH no validation process is undertaken for this field. For that reason, we propose to add NMDS and CC datasets to the core dataset. Unfortunately, data on primary care diagnoses are not available in the IDI. Hospital admissions can be joined to the correct pregnancy by maternal ID and admission dates. Following a similar method, mothers with pre-existing diabetes (as an important risk factor) can be identified by joining the CC dataset.

## Ethnicity and country of birth

Ethnicity is an important demographic risk factor widely used in pregnancy research in New Zealand, and key to examining health equity. Characteristics of ethnicity recorded in New Zealand include that it is self-defined, it can change over time and an individual may identify with more than one ethnic group. The use of ethnicity data in health research is addressed by the *Ethnicity Data Protocols for the Health and Disability Sector* by the MoH.<sup>19</sup> According to this protocol, ethnicity data can be categorized at four different “levels” following a hierarchical structure;

with level four being the most detailed level of reporting (containing 231 ethnicity codes). These codes are then aggregated into ethnicity levels three to one. As an illustration, code “43112” stands for Fijian Indian and aggregates into “431” Indian (level three), “43” Indian (level two) and “4” Asian (level one). Generally, level two ethnicity data are used in health research for reporting, which includes 22 groups. In this aggregation a high level of detail is maintained for some ethnicities (such as Māori, Pacific Peoples, Chinese or

Indian), while other minority groups are merged despite large heterogeneity (such as other Asian ethnicities, African or Latin American).

Unfortunately, the MAT dataset only holds level two ethnicity data. Due to the data collection methods of MAT, ethnicity data may also have been completed by a healthcare provider, leading to potential inaccuracy or lack of detail. Moreover, someone’s ethnicity can reflect a contextual response. This might occur, when a mother believes she will receive better care

**Table 1:** Abbreviations used in this methodological report (in alphabetical order).

Abbreviation	Definition
BDM	Births, Deaths and Marriages
BMI	Body mass index
CC	Chronic Conditions
COB	Country of birth
DHB	District Health Board
GDM	Gestational diabetes
ID	Identification
IDI	Integrated Data Infrastructure
LMC	Lead maternity carer
MAT	Maternity Collection
MOH	Ministry of Health
MORT	Mortality Collection
NMDS	National Minimum Dataset
NND	Neonatal death
NZ	New Zealand
NZDep	New Zealand Socioeconomic Deprivation Indices
PMMRC	Perinatal and Maternal Mortality Review Committee

when reporting a different ethnicity. In contrast, BDM birth registration provides high-quality level four ethnicity data, including information reported by the parents directly outside of the healthcare setting. The requirement for parents to complete birth registration separately from the LMC leads to ethnicity data akin to ethnicity reported in the national Census and is generally considered second choice to Census ethnicity data.<sup>20</sup> However, since ethnicity can change and BDM is recorded closer to the birth event than Census, we argue that BDM should be used as the main source in maternity studies. Note that in cases where ethnicity data is missing, the source-ranked ethnicity table (“central” table in the IDI) may be consulted, although only level one ethnicity is provided.

Some research questions will require both ethnicity (i.e., a subjective belief, related to cultural behaviours and practices) and country of birth (COB; i.e., an objective measure, more closely linked to ethnic origin), considering increasing migration and ethnic diversity globally.<sup>21</sup> Combining these variables in analyses might provide a better understanding of pregnancy risk factors, since common issues associated with migration in first generation migrants (such as socio-economic deprivation or diverse health literacy) may result in differential health outcomes compared to second and third generation women.<sup>22-24</sup> COB data are not available from the standard birth tables and should therefore be obtained from alternative datasets. Census or immigration data present as the highest quality sources for this variable. Since COB is fixed, the datasets can simply be linked by maternal ID, regardless of the correct pregnancy event. An alternative method for consideration, when solely interested whether a mother was New Zealand born or not, is to join parent ID on the infants BDM birth record, with the BDM births table. If the mother’s birth was registered, she was New Zealand born. In contrast, if the mother’s birth cannot be identified in BDM births, she was most likely born overseas.

### Socio-economic data

The MAT or BDM datasets do not contain any information on individual level socio-economic status. The current classification system used to monitor deprivation, which is widely used in health and social research, is the New Zealand Socioeconomic Deprivation Indices (NZDep).<sup>25</sup> NZDep is a decile score based on area of domicile, divided into meshblocks or larger Census

Area Units where a higher level of confidentiality is required. The NZDep is based on census data; with decile one representing 10% of the population who live in the least deprived areas and decile ten representing 10% of the population who live in the most deprived areas in New Zealand. The NZDep2013 is the fifth updated version since 1991 and combines nine variables from the 2013 Census. A limitation of this method is that the NZDep represents area-level deprivation and does not necessarily reflect the socio-economic status of an individual, although it is a close approximation and may be used as a proxy in large datasets.<sup>26</sup> Alternative proxy variables for consideration, include the New Zealand Indices of Multiple Deprivation,<sup>27</sup> region of domicile (sourced from the address notifications table), DHB of domicile (sourced from MAT), or personal income level (sourced from Census), although the researchers of this paper have no experience using these alternative sources.

To provide an estimation of socio-economic status in our birth cohort, the registered address closest to the date of birth, and prior to delivery, was chosen for each delivery event, to allow for geographic movement over time, and to best capture mothers socio-economic status during pregnancy. Note that where a full date of birth is missing (primarily among perinatal deaths), birth year and month sourced from the BDM births or MAT table may be used. The meshblock associated with this address was then extracted and linked to the corresponding NZDep2006 and 2013 decile scores (births after 2008 and before 2013 linked to NZDep2006 and from 2013 linked to NZDep2013).

## Results

### Birth outcome

Six thousand, seven hundred and ninety perinatal deaths (4,768 stillbirths and 2,022 NNDs) and 617,375 live births were identified in our dataset. In comparison, PMMRC annual report data comprised 6,518 perinatal deaths (4,779 stillbirths, including 1,456 terminations, and 1,739 NNDs) and 617,321 live births.<sup>16</sup> As a result, our numerator dataset includes 272 more perinatal mortalities compared to the gold standard (an approximate 4.0% overreporting in deaths). Our denominator dataset includes 54 more live births compared to PMMRC report data (a 0.05% overreporting in live births). Thus overall, our datasets represent a close approximation to the gold standard. We found that 99.2% of all births (99.5% of

live births and 77.4% of perinatal deaths) in our final dataset had a record from both MAT delivery and BDM births; providing complete data for the majority of cases. Cases that could not be joined to both sources, were mostly missing BDM data (example in Table 2).

### **Pregnancy risk factors**

Smoking status at registration was unknown for 44.0% of women with a DHB-registered pregnancy, while this was only 0.04–1.5% for women under the care of an LMC provider. This was even higher for maternal BMI, with 58.0% and 0.1–2.2% of missing data among these groups respectively. The variable “booking trimester” was missing for 48.5% of women with a DHB-registered pregnancy, compared to 0.01–0.2% of women booked with another LMC type. 37.1% of DHB cases were noted as LMC type “unknown” in our dataset. The following variables were validated.

#### **Maternal age**

While maternal age is provided by MAT, it was calculated from maternal birth year, month and delivery date in BDM. In our cohort, there was a 95.6% overlap where this variable was available from both datasets. 95.4% of the 4.4% non-matches only differed by one year. Consequently, the MAT dataset may be used for maternal age (accounting for 99.9% of all cases).

#### **Fetal sex**

The overlap in fetal sex was 99.96% where both MAT and BDM variables were available. Hence, either variable can be used in analysis (accounting for 98.2% of all cases).

#### **Gestational age**

The MAT dataset notes gestational age in weeks, while BDM also registers days. There was an 89.1% overlap in gestational age week where both variables were available. Of the remaining 10.9%, it appeared that 0.7% only differed by one day (e.g., 37 and 36+6), while 7.0% differed by one day to one week (e.g., 39 and 40+0). Among cases in which a larger difference existed (3.2% of total), birthweight was more likely to correlate with MAT gestational age and therefore MAT may be prioritised for use. However, BDM should be used in analyses including customised birthweight centiles,<sup>28</sup> where the absence of gestation in days leads to systematic over-estimation of birthweight centiles. Using both tables, 98.0% of cases are accounted for.

#### **Birthweight**

The overlap in birthweight was 96.6% where both MAT and BDM variables were available. Of the remaining 3.4%, 1.7% only differed by 100 grams and 0.6% differed by more than 500 grams. Either variable can be used in analysis, accounting for 94.0% of all cases.

#### **Socio-economic data**

Close to 99.0% of deliveries could be linked to a NZDep score.

#### **Ethnicity and country of birth**

Level four ethnicity from the 2013 Census had an 89.4% overlap with BDM ethnicity, in cases where only one ethnic group was recorded in both sources (N=392,004). The corresponding overlap for level three ethnicity was 90.6% and level two ethnicity 95.7%. Therefore, if BDM is missing, Census provides a good alternative. If both are missing, MAT ethnicity can be used as a surrogate. This method may also mitigate some data quality differences between ethnicities, as the availability of BDM ethnicity data for perinatal deaths differs per group (Table 2).

Between 2008 and 2017 88.3% of mothers had a known COB from the 2018 Census. Where Census 2018 data was missing, Census 2013 data was used, with a 99.2% agreement between the two surveys among women where both were available. If both were missing, then immigration data was used, with an 89.7% and 88.8% agreement with Census 2018 and 2013 respectively. Immigration metadata suggests using nationality over COB, however in our dataset this resulted in less agreement with Census (82.1% and 80.7%). Finally, in this report nationality was used as a surrogate for COB if all other COB data was missing. This is justified by an 85.4% agreement between COB and nationality in the immigration dataset. By combining all four variables, COB was available for 98.9% of all mothers.

### **Discussion**

This methodological paper describes an opportunity for standardised, high-quality maternity research in New Zealand using the IDI. A strength of this proposed approach is the ability to create a comprehensive dataset including perinatal deaths and live births from a variety of national sources, using our combined knowledge, and defining PMMRC data as the gold standard; thereby utilising the best quality data from

**Table 2:** Availability of ethnicity data per data source, for all perinatal deaths between 2008–2017.

	European		Māori		Pacific Peoples		Asian		MELAA	
	PND (N=3,036)	LB (N=316,284)	PND (N=1,710)	LB (N=140,553)	PND (N=855)	LB (N=62,982)	PND (N=963)	LB (N=86,781)	PND (N=126)	LB (N=10,221)
BDM births	2,646 (87.2%)	313,902 (99.2%)	1,248 (73.0%)	138,663 (98.7%)	621 (72.6%)	62,424 (99.1%)	783 (81.3%)	85,392 (98.4%)	93 (73.8%)	9,390 (91.9%)
Census 2013	2,592 (85.4%)	277,251 (87.7%)	1,215 (71.1%)	102,936 (73.2%)	579 (67.7%)	44,028 (69.9%)	666 (69.2%)	62,178 (71.6%)	75 (59.5%)	6,873 (67.2%)
MAT delivery	2,943 (96.9%)	315,996 (99.9%)	1,668 (97.5%)	140,445 (99.9%)	834 (97.5%)	62,835 (99.8%)	936 (97.2%)	86,670 (99.9%)	120 (95.2%)	10,194 (99.7%)

Abbreviations: PND = perinatal deaths; LB = live births; MELAA = Middle Eastern/Latin American/African; BDM = births, deaths, and marriages; MAT = maternity collection.  
 Prioritisation: BDM births, Census 2013, MAT delivery.

each dataset available. All steps in creating this dataset have been justified and validated. Complete understanding of the data sources, including the quality of the variables used and general inconsistencies in metadata, will also improve the accuracy of research output. Since these data sources are available to all researchers who are granted permission to use the Statistics NZ IDI, this will increase accessibility.

In developing this methodology, some limitations to the IDI were discovered, such as restricted use of the MORT dataset. Even though MORT is considered the best source for stillbirths, this methodology uses the MAT and BDM datasets to create the numerator table. This is justified as while MORT identified 6,270 perinatal deaths between 2008 and 2017, only 1,955 (31.2%) of these could be matched to MAT or BDM tables. Thus, clinical data including important variables would be unavailable for almost 70% of all mortalities. We suspect this low matching rate is due to a linking error within the IDI, which should be addressed by Statistics NZ. In addition, only 59 cases had a different birth status according to MORT, validating this approach.

We also offer recommendations to improve the quality of perinatal data, to further enhance these resources. Firstly, the transfer of BMI and smoking data from DHB primary care facilities to the MAT datasets should be facilitated to eliminate systematic bias in analyses that control for these variables, as the highest degree of missing data is among high-risk mothers under DHB care, and who are also more likely to suffer perinatal mortalities. Consideration should be given to excluding DHB-registered pregnancies from analyses that require adjustment for these variables. For many years the PMMRC has recommended the MoH to “urgently require DHBs to provide complete and accurate registration data to the MAT dataset”, without success.<sup>29</sup> Additionally, the variable “booking trimester” was missing for almost half of women with a DHB-registered pregnancy, despite late booking being associated with poorer perinatal outcomes and socio-economic deprivation.<sup>30,31</sup>

Collection of important obstetric risk factors such as maternal pre-existing chronic conditions, should be included in the MAT dataset. Others, such as GDM or hypertensive disorders of pregnancy, may need to be validated as the quality

of these variables is not clear. For instance, Lawrence et al. investigated the prevalence of GDM according to some commonly used data sources in New Zealand and found an underreporting in NMDS (3.8%, compared to 5.9% reported by DHBs or 6.9% reported by laboratories).<sup>32</sup> There was 70% agreement on the presence of GDM between the data sources. We also suggest that validation studies of routine maternity datasets are performed. This will assist researchers in the interpretation of results of a widely used data source. Furthermore, pregnancy research requires both mother and infant data in most analyses. Mothers may appear in a table more than once with consecutive pregnancies or a pregnancy may result in multiple infants, which complicates the building of a perinatal dataset. Including stillbirths into the MAT infant dataset will provide more detailed information about the birth and simplify the process of creating a dataset. However importantly, although this methodology report offers quality improvement for maternity research, making the PMMRC national dataset available within the IDI should be considered. Use of this dataset would eliminate many data quality issues described in this paper associated with perinatal mortality studies.

Even though the IDI provides a promising avenue for perinatal studies, there are barriers to accessing the data. Each new project requires a comprehensive application process. New research projects are assessed seven times a year, with a turnaround time of approximately six weeks. Successful applications are required to pay a one-off fee (\$500). Once approved, specific users of the IDI will need to be authorised by Statistics NZ, undergo confidentiality training, and any changes to the project are subject to evaluation. Researchers are granted access to merge and interrogate data sources only available within the strict privacy rules of the DataLab; available in a few cities across New Zealand. Finally, researchers are recommended to have intermediate SQL coding skills.

In conclusion, this methodological report aims to improve the quality of routine maternity studies in New Zealand by offering an alternative approach to conventional data sources, while simultaneously increasing knowledge and accessibility.

**COMPETING INTERESTS**

Nil

**ACKNOWLEDGEMENT**

The authors would like to acknowledge the University of Auckland and the NHMRC Centre of Research Excellence in Stillbirth for scholarship support.

**DISCLAIMER**

These results are not official statistics. They have been created for research purposes from the Integrated Data Infrastructure (IDI) which is carefully managed by Stats NZ. For more information about the IDI please visit <https://www.stats.govt.nz/integrated-data/>.

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## Appendices

### Appendix 1: Background to Integrated Data Infrastructure datasets.

The following tables were used for this methodological approach:

- The Maternity Collection (MAT):** This dataset, compiled from various sources, is held by the Ministry of Health (MoH) and includes all births in New Zealand from 20 weeks' gestation. MAT consists of two separate tables, one including data on all birth events ("MAT delivery") and the other including data on the individual infants ("MAT infant"). Despite inconsistencies in metadata, we understand MAT integrates information from three sources: 1) data collection by maternity care providers, including Lead Maternity Carers (LMCs; midwives, general practitioners (GPs) or obstetric specialists), reported to the MoH for funding purposes, and hospital providers of primary maternity care; 2) public and private hospital discharge coded data with health event information, sourced from the National Minimum Dataset (NMDS); and 3) demographic information from the National Health Index (NHI) dataset. Each live born infant is assigned a unique NHI number and is included in the NMDS and both MAT datasets. Since 1 July 2008, registration of maternal NHI has been mandatory for all births in NMDS, enabling mother and infant records to be linked. Stillborn infants, however, are not officially admitted to hospital and thus no individual discharge event is reported to the NMDS. Consequently, stillbirths are excluded from the MAT infants table, but included in the MAT delivery table through maternal discharge record data. It should be noted that stillbirths were not always included in the MAT dataset, although consistent assignment of NHI numbers for stillbirths is evident by 2009. MAT provides demographic and clinical information on women and infants for the duration of pregnancy until three months post-partum. It is used for annual national reporting of clinical indicators, evaluation of provided maternity services and can be requested for research purposes. Within the MAT delivery table in the Integrated Data Infrastructure (IDI),
- each birth is registered as a single entry and provided with a specific pregnancy-key (i.e., with a shared key for twins or higher order multiple pregnancies). Each individual mother also has a unique ID, allowing for identification of sequential pregnancies to the same mother.
- Births, Deaths and Marriages (BDM):** This dataset is held by the Department of Internal Affairs (DIA). BDM consists of three separate tables; "births", "deaths" and "marriages" of which the first two were used in this report. Infant and parent data on all deliveries in New Zealand are registered in the births table. Parents and LMCs are mutually responsible for providing information on the birth event to BDM. The LMC (or the public hospital in case of a hospital birth) is expected to provide an online birth notice within five working days, including information on infant birthweight and gestational age. Parents supply data on infant sex, birth status (i.e., live or stillborn), plurality (i.e., a singleton or multiple birth), location of birth, parental demographics, occupation, ethnicity and relationship status through a birth registration form. This is generally done online within two months after birth. Birth registration is only completed when both parties have provided this notification, with a few exceptions (i.e., where one parent is unknown, deceased, or missing; unable to complete the form because of a mental or medical condition; overseas with no delivery address or contact details; or a danger to the mother or child). In the case of a stillbirth  $\geq 20$  weeks' gestation or  $\geq 400$  grams in birthweight, the birth is registered with an indication that the infant was stillborn, in accordance with the Births, Deaths, Marriages, and Relationships Registration Act 1995. The deaths table registers all deaths in New Zealand, excluding stillbirths. Thus, only neonatal deaths (i.e., death of a live born infant under the 28th day of life) are noted here. The person handling the disposal of the body is responsible for notifying BDM of the death, by a death registration form.
- National Minimum Dataset (NMDS):** This dataset is held by the MoH and includes public and private hospital discharge data (as two separate tables) for inpatients and day-patients admitted for three hours or

more, all birth events and all admission where a procedure was performed. Information is provided by hospitals in an agreed (electronic) file format and is used for both statistical and funding purposes. Clinical coded data follows the Australian modification of the International Classification of Diseases (ICD-AM), which is updated over time. Mapping between subsequent ICD-AM editions can be done within the IDI. All hospital births are regarded as admission events and will therefore have been recorded. All complications of that pregnancy should be included in this coding.

- **The Mortality Collection (MORT):** This dataset is held by the MoH. It is a collection of data, recording cause of death by ICD-AM on all mortalities in New Zealand and used for annual reporting of vital statistics. MORT integrates information from (among other sources) BDM, NMDS, certificates by funeral directors and coroners' reports. A subset of MORT includes all fetal and infant deaths sourced from BDM and medical certificates or post-mortem reports.
- **The Chronic Conditions dataset (CC):** This dataset is held by the MoH, as a subset of data from several sources, for all residents in contact with the healthcare system during at least two quarters of that year. Individuals with one or more out of eight chronic conditions or significant health events are recorded here: acute myocardial infarction, cancer, coronary heart disease, chronic obstructive pulmonary disease, diabetes, gout, stroke and traumatic brain injury. The table also tracks the first and last incidence dates for the condition registered. In maternity research, this dataset can be used to identify mothers with pre-existing diabetes. Note that gestational diabetes is not recorded in this table. This dataset was supplied as a one-off by the MoH. A limitation to this dataset is that currently no updates are planned by Statistics NZ, with the latest incidence dates reported 31 December 2017. Studies including births after 2018 should be cautious of using this data source.
- **Census:** The Census of Population and Dwellings is a survey on all people living in New Zealand at a defined point in time. The last Census was completed in 2018

and is usually carried out once every five years, as set out in The Statistics Act 1975. Each individual is required to answer questions on personal affairs such as country of birth and religion, and socio-demographic variables such as housing and income. The Census is used for population counts, research purposes and planning by government and city councils. The IDI currently holds data from the 2013 and 2018 Census.

- **Immigration data:** This dataset is held by the Department of Labour, within the Ministry of Business, Innovation and Employment. It provides information on an individual's border movements, country of birth and visa type, sourced from immigration visa application forms and electronic passenger movement records. With increasing global migration this data may be useful to identify mothers born outside New Zealand.

Besides administrative datasets and surveys, the IDI provides some "general" or "central" tables. The following general tables were used for this methodological approach:

- **Full birth date, and full death date tables:** This data is available for all individuals in the IDI, sourced from the MoH. Generally, only a person's birth/death "month" and birth/death "year" are provided to researchers for privacy reasons. For a full date of birth/death (in the format dd/mm/yyyy), this table needs to be requested from Statistics NZ.
- **Address notification table:** This table holds data on address notifications of all individuals in the IDI. In addition, it identifies when a change in postal address occurred. Naturally, this depends on an individual updating address information. Geographical unit codes such as meshblocks (the smallest reported geographical units, representing on average 30 to 60 dwellings, with an average population of 100 people per unit) can be identified and used for other purposes, for example, area-based measures of socio-economic status.

### The "gold standard"

In New Zealand, details of the deaths of still-born fetuses and infants (all perinatal related

mortalities from 20 weeks gestation up to the 28th day after birth) are collected by the Perinatal and Maternal Mortality Review Committee (PMMRC) using a standardised reporting tool. The PMMRC publishes annual reports on mortality. In addition, the Otago Data Group, contracted to the PMMRC, creates a total perinatal dataset by

#### **Appendix 2:** Creating the core dataset.

The following steps describe the method used, to create a “core” dataset for maternity research in the Integrated Data Infrastructure (IDI). A numerator table (including all perinatal deaths) and a denominator table (including all births) were created separately. Note that the final tables are not available for other users in the IDI. Users must run the code with the appropriate IDI refresh and adopt the code to each specific research project.

### **Step one: stillbirths**

Statistics New Zealand (NZ) metadata recommends that stillbirths should not be identified from the Maternity Collection (MAT) or Births, Deaths and Marriages (BDM) datasets, as the available variables have not been validated. This was confirmed by data custodians at the Ministry of Health (MoH) and the Department of Internal Affairs. Instead, the Mortality collection (MORT) is considered the best source for stillbirths. Besides birth outcome, however, MORT does not provide any clinical information on the delivery event, maternal demographics, or other pregnancy risk factors.

To generate a table with all stillbirths, a full outer join was performed between the MAT delivery and BDM births datasets on maternal ID (“parent1”). Two additional joins on year and month of delivery ensure the link to the correct birth event. A filter will need to be applied to the variables “delivery outcome” (MAT) and “stillbirth indication” (BDM). A second filter for delivery year(s) will specify the targeted birth cohort. By performing a full outer join we ensure that all possible perinatal deaths are included, and no cases are missed. A disadvantage of this method is the risk of including some infants twice, where a wrong entry of birth month in either dataset will result in a non-match. Cases where linking seems appropriate (for instance, where only a one-month difference exists between delivery

merging PMMRC Data with MAT. This data collection is only available for specific perinatal-related research after formal application to the PMMRC and is not offered within the IDI. Due to the superior quality of these data, PMMRC annual report data were used as the gold standard to validate the tables created in this report.

dates, plus overlapping maternal demographics), can be merged in a separate step. In contrast, performing an inner join between the two datasets will provide an underrepresentation of the number of stillbirths in a cohort. This can be explained by the following rhetoric: if a birth registration has not been completed (e.g., when parents do not register a stillbirth), then DIA do not provide a record of this birth to Statistics NZ. However, for this same birth, the MoH may have provided Statistics NZ with the birth notice information (MAT). Finally, a small number of the identified stillbirths will be able to be joined to the MAT infant table (through their pregnancy-key), or BDM deaths datasets (by infant ID). These most likely include cases where it was unclear if the infant died before or soon after birth (as a day 0 neonatal death [NND], i.e., death of a live born infant up to the 28th day of life).

### **Step two: neonatal deaths**

As no datasets in the IDI classify NNDs (and therefore do not distinguish them from infant mortalities  $\geq 28$  days of life), it is not possible to perform outer joins. A temporary table created from the full birth and death date tables will firstly identify all perinatal mortalities. To make the distinction between stillbirths and day 0 NNDs, cases with similar dates of birth and death can be matched to the MAT infant table by an inner join on infant ID. As stillbirths are not registered in the MAT infant dataset, this step should only return NNDs. A second link can then be made with the MAT delivery table, by performing a left join on pregnancy-key. Here, an inner join would result in a slight underestimate of NNDs as the tables don’t match perfectly, while a full outer join would not distinguish NNDs from other live births. A subsequent inner join by infant ID will match to the correct case in the BDM births dataset. As a final step, overlapping cases between the temporary stillbirth and NNDs tables should be investigated and adjusted where necessary.

### Step three: perinatal deaths

To create a full numerator table including all perinatal deaths, the temporary stillbirth and NND tables should be combined. A conservative linking method applied by Statistics NZ estimates a <2% false positive linking rate of individuals in the IDI (i.e., where records of two people are incorrectly matched), thus allowing for a relatively high false negative linking rate (i.e., where two records of one person have not been matched). In addition, the use of full outer and left joins rather than inner joins as described in this report, will result in a further increase in duplicates of cases. The newly created perinatal deaths table is therefore expected to hold a larger number of cases compared to gold standard Perinatal and Maternal Mortality Review Committee (PMMRC) numerator data at this point. To correct for this difference as much as possible, we propose further probabilistic linking by using overlapping variables between the various datasets (e.g., delivery year and month, maternal birth year and month, gestational age, birthweight, area of domicile, District Health Board of birth, or facility code). For example, BDM cases without a MAT record can be joined to MAT cases without a BDM record, and vice versa. This approach should result in a dataset similar to our gold standard, while still guaranteeing conservative linking.

Where possible, a join to the BDM deaths dataset can be performed by infant ID. A new variable for delivery outcome will most accurately represent the true birth outcome, by applying the following prioritisation: 1) If a death can be joined to the MORT dataset, this delivery outcome should

be used as the best available source; else 2) if a death is registered in the BDM deaths dataset, it should be considered a NND; else 3) if a death is registered as a stillbirth in BDM births, it should be considered a stillbirth; else 4) if a death is registered in the MAT infant table, it should be considered a NND; and else 5) if MORT, BDM and MAT infant data are missing, the MAT delivery table birth outcome should be used.

### Step four: live births

To create a denominator table including all births, all live births will need to be identified first. A full outer join between the MAT delivery and infant datasets on pregnancy-key, plus a full outer join on BDM births by infant or maternal ID, will return all matches and non-matches of any birth outcome. A filter by delivery year(s), “delivery outcome” (MAT) and “stillbirth indication” (BDM) will allow selection of all live births. Duplicates with the numerator table, should be deleted. Further probabilistic linking can be performed by matching between overlapping variables from the various datasets as previously described. Finally, a full denominator table is created by unifying the numerator set with all live births.

The PMMRC and BDM use marginally different definitions for stillbirth. For consistency in this report, we followed PMMRC definitions. Infants born <20 weeks’ gestation (or <400g of birthweight if gestational age was unknown) should be removed from the dataset, since these infants do not meet the PMMRC criteria for perinatal mortality. Further data cleaning can be based on rules outlined in the PMMRC methodology report.

#### Appendices 3 & 4:

[https://uploads-ssl.webflow.com/5e332a62c703f6340a2faf44/63c9c0dd41fd76cd48e8b15b\\_5912%20-%20Appendices%203%20%26%204\\_final.pdf](https://uploads-ssl.webflow.com/5e332a62c703f6340a2faf44/63c9c0dd41fd76cd48e8b15b_5912%20-%20Appendices%203%20%26%204_final.pdf)

To see copies of the original SQL files, please contact corresponding author Esti C de Graaff at [e.degraaff@auckland.ac.nz](mailto:e.degraaff@auckland.ac.nz)

# COVID-19 among University of Otago students living in North Dunedin households in the first half of 2022: was the prevalence underestimated?

Polly Tenci, Lianne Parkin, Samantha Grace, Bryony Harrison, Judd Irving, Luke Jarvie, Eric Johnson, Tze Koon Ler, Georgia Malcolm, Kristy Watson

## ABSTRACT

**AIMS:** To estimate the prevalence of COVID-19 among occupants of North Dunedin student flats between Flat Orientation Week (Flo-Week, week starting 14 February 2022) and the end of Semester 1 (week starting 30 May 2022); to investigate the potential under-reporting of cases to the University of Otago and under-recording of positive rapid antigen test (RAT) results in My Covid Record; to explore the COVID-related experiences of students during the above period.

**METHODS:** Randomly selected households in the North Dunedin area were visited at the end of Semester 1 and oral consent was sought for a short interview comprising closed- and open-ended questions. Households were eligible for inclusion if at least one resident was a University of Otago student.

**RESULTS:** One hundred and thirty-five (96.4%) of 140 eligible households participated, and in 94.1% of these households at least one resident tested positive for COVID-19 between the start of Flo-Week and the date of the interview (a mean period of 109 days [standard deviation 3.6]). In total, 73.6% of the occupants in the participating households tested positive. Of the cases who were University of Otago students, 60.4% reported their positive status to the University. Of all cases diagnosed via a RAT, 66.9% uploaded their result to My Covid Record. Students reported various academic, financial and mental health stresses associated with the general COVID-19 situation during the study period.

**CONCLUSIONS:** These findings suggest that the number of COVID-19 cases reported to the University of Otago between Flo-Week and the end of Semester 1 was a substantial underestimate of the true number, as was the number of cases recorded in My Covid Record. The findings also highlight the considerable impact that COVID-19 had on students during Semester 1.

Dunedin (the second largest city in Te Waipounamu, Aotearoa New Zealand) is often referred to as a student city, with the majority of University of Otago students coming from out of town and living in residential colleges in their first year and student flats in subsequent years. Much of this accommodation is concentrated in the North Dunedin area. In Semester 1 of 2022, there were about 16,965 University of Otago students enrolled in Dunedin-based courses (and 3,674 enrolled at campuses in other centres);<sup>1</sup> about 21% of these students lived in residential colleges, 4% lived in managed accommodation that mainly houses single-semester international students (University Flats, commonly known as Uni Flats), while the remainder mostly lived in student flats.

In mid-February 2022, COVID-19 began to spread through the University of Otago student population in Dunedin.<sup>2,3</sup> As has been the case

throughout the pandemic, students were asked to (i) get tested if they had any symptoms suspicious of COVID-19 or if they were a close contact of a case, (ii) report positive results to the University via a designated channel, and (iii) follow the Ministry of Health's guidance about self-isolation and other public health measures to minimise the spread of infection.<sup>4</sup> The number of student cases rose rapidly throughout late February and early March and the University, residential colleges and the Otago University Students' Association (OUSA) mounted huge operations to support hundreds of students self-isolating in colleges and flats, including the delivery of food and care packages.<sup>5</sup>

With increasing community transmission of the Omicron variant of the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) throughout Aotearoa New Zealand in early 2022, COVID-19 testing shifted from laboratory-based reverse transcription polymerase chain reaction (RT-PCR)

tests using samples taken by health professionals to community-based rapid antigen tests (RATs), which can be self-administered.<sup>6</sup> One consequence of this shift was that individuals became responsible for reporting their RAT results via the Ministry of Health's My Covid Record (RT-PCR test results continued to be automatically uploaded).<sup>7,8</sup>

While good mechanisms were established in residential colleges and Uni Flats for identifying and reporting COVID-19 cases among University of Otago students, anecdotal reports suggested that students living in other settings might have been less likely to report positive COVID-19 test results (RT-PCR or RATs) to the University, or to upload their RAT results to My Covid Record. However, the extent of any such under-reporting was unknown.

We undertook a study among the residents of North Dunedin student flats, to (i) estimate the prevalence of COVID-19 between the start of Flat Orientation Week (Flo-Week) and the end of Semester 1, (ii) investigate the potential under-reporting of positive COVID-19 test results to the University, (iii) investigate the potential under-recording of positive RAT results in My Covid Record, and (iv) explore the COVID-19 related experiences of students during the above period.

## Methods

### Random selection of households

We restricted the study area to North Dunedin, as this is the area with the highest density of student flats. For operational purposes, this was defined as the area covered on foot by the University of Otago Campus Watch (which corresponds to the Dunedin City Council's designated "University area"). We used the online Dunedin City Council Rates Map<sup>9</sup> to create a list of all potential residential addresses within the study area and used the random number generator function within Microsoft Excel to randomly select 160 addresses. Households were eligible for inclusion in the study if at least one resident was a student enrolled at the University of Otago; other residents could include Otago Polytechnic students, as well as non-students.

### Interviewer-administered questionnaire

We developed a short interviewer-administered questionnaire to collect a range of information from each household, including the number of people living in the household, the number of household members who had tested positive for COVID-19 between the start of Flo-Week on 14

February 2022 and the date of the interview (the study period), the number of University of Otago student cases within the household who notified the University that they had COVID-19, the number of cases who were diagnosed via a RAT and uploaded their result to My Covid Record, behaviour in households with cases, adherence to isolation requirements and the number of household members with confirmed re-infection. We also asked open-ended questions to explore the reasons for not reporting a positive COVID-19 status to the University, not uploading a positive RAT result to My Covid Record or not adhering to isolation requirements, and to learn about the general COVID-related experiences of household members during the study period.

### Data collection

Interviews commenced during the final week in which Semester 1 lectures were held (the week starting 30 May). If no one was at home on the first visit, a maximum of two repeat visits were made on different days and at different times. Ensuring the safety of the interviewers (final year medical students) and household members in this field study was essential. To maximise physical safety, we approached households in pairs and notified a third team member when we started and finished a data-collection session. To minimise the risk of infection, we wore N95 face masks and conducted physically distanced interviews outside. In addition, we asked a screening question at the start of the interview to identify any households that unexpectedly had active COVID-19 cases (i.e., there were no signs at the entrance to indicate that the household was isolating); at these addresses the only information collected was the number of residents and the number of cases.

We sought verbal consent for an interview at each randomly selected household and gave assurances that any information provided would not be linked to the address. In order to ensure anonymity still further, we did not collect names or demographic data. All household members who were at home were free to take part in the interview, however, in practice, most interviews were conducted with one member of the household who responded to questions on behalf of the whole household. At the end of the interview, the participants were provided with a card that listed support services available to students, as well as information about how to notify the University of a positive COVID-19 test and how to upload a positive RAT result to My Covid Record.

We used Research Electronic Data Capture (REDCap) software,<sup>10,11</sup> a secure web-based survey application hosted by the University of Otago, for data collection and management. Although REDCap is hosted by the University, access to the study data was restricted to the members of our team.

## Analyses

For the quantitative data, we conducted simple descriptive analyses and report numbers and proportions (percentages). Qualitative responses to the open-ended questions were analysed by identifying key themes.

## Ethical approval

The project received ethical approval from the University of Otago Human Ethics Committee (Health), reference number: H22/050.

## Results

In total, 1,720 potentially eligible households were identified in the study area (Figure 1). Of the 160 randomly selected households visited, 20 were found to be ineligible (no University student(s) living in the household, derelict/unoccupied residence, residence part of a residential college, or commercial premises). Of the remaining households, three declined to participate, two were visited on three occasions but no one was at home, and 135 (96.4%) agreed to take part. The majority of the interviews (n=111) took place between 30 May and 3 June, and the remainder on 9 June (n=21) and 16 June (n=3). Three of the participating households reported active cases in response to the screening question and therefore a full interview was not undertaken.

In 127 of 135 households, at least one resident tested positive for COVID-19 between the start of Flo-Week and the date of the interview (a mean period of 109 days [standard deviation 3.6]), giving a period prevalence at the household level of 94.1%; the period prevalence among individuals in the households surveyed was 73.6% (513/697). As noted above, at the time of data collection, three households had active cases of COVID-19 infection (9 of 13 residents), giving a point prevalence at the household and individual levels of 2.2% (3/135) and 1.3% (9/697), respectively.

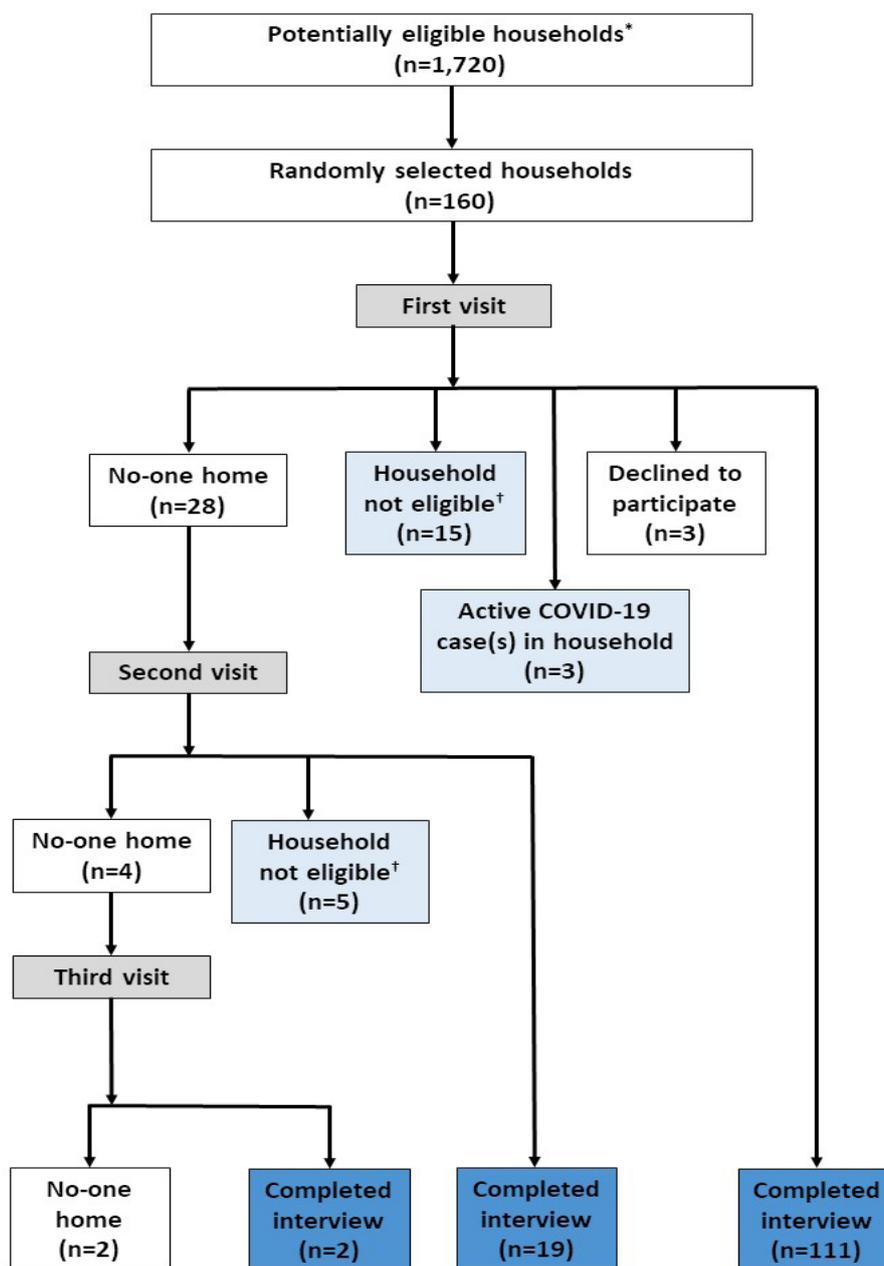
Table 1 provides information about the numbers of confirmed COVID-19 cases per household according to the number of residents in the household. Household size ranged from two to 14 residents, with the majority (72.6%) of households

containing four to six residents. The proportion of households in which at least one resident tested positive for COVID-19 during the study period increased with increasing household size (75% of households with two and three residents, 90% of households with four residents, 97.6% of households with five residents, and 100% of households with six or more residents).

Table 2 shows the numbers and percentages of households in which everyone had tested positive for COVID-19 between the start of Flo-Week and the date of the visit, according to the number of residents in the household. In 56 of 135 (41.5%) households, every occupant had confirmed COVID-19 at some time during the study period. When restricted to the 127 households with at least one case, the proportion was 44.1%.

The findings discussed from this point onwards relate to households without active COVID-19 cases at the time of the interview (n=132). Of the 684 residents living in these households, 504 (73.7%) tested positive for COVID-19 during the study period. Of the 444 cases who were University of Otago students, 268 (60.4%) reported their positive status to the University, 130 (29.3%) did not report, and for 46 (10.4%) the reporting status was unknown. Reasons for not reporting were explored at a household level and of the 43 households in which at least one student did not report their positive status, 26 (60.5%) stated that they were unaware that reporting was a requirement, eight (18.6%) did not know how to report, and 10 (23.3%) felt that reporting provided no benefit for individuals. Others noted technical difficulties, that it was “a hassle”, or that there was “no need to report” as they did not require any extra support.

The diagnosis of COVID-19 was made via a RAT for 429 of the 504 cases; 287 (66.9%) of these cases uploaded their result to My Covid Record, 71 (16.6%) did not upload their result, and for 71 (16.6%) the upload status was unknown. Of the 29 households in which at least one resident did not upload their result, four (13.8%) stated that they were unaware that this was required and 11 (37.9%) considered that reporting provided no benefit for individuals. Several households also noted that COVID-19 was so widespread in the student community that they felt there was no point in uploading positive results as it “would not change anything”, while others forgot, felt it was a hassle, were unable to backdate a positive result in My Covid Record or believed that they had “the right not to report”.

**Figure 1.** Selection of households and participation in the study.

\* Households in North Dunedin area patrolled on foot by the University of Otago Campus Watch.

† No University student(s) living in household, derelict/unoccupied residence, residence part of a residential college, commercial premises.

**Table 1:** Number of COVID-19 cases in the household between the start of Flo-Week and the date of the interview by the number of residents in the household. \*

Number of residents in the household	Number of cases in the household											Total (%) households	
	0	1	2	3	4	5	6	7	8	9	10		
2	1	1	2										4 (3.0)
3	3	5	2	2									12 (8.9)
4	3	5	5	4	13								30 (22.2)
5	1	6	4	4	6	20							41 (30.4)
6	0	4	1	0	4	6	12						27 (20.0)
7	0	0	0	0	0	2	6	3					11 (8.1)
8	0	0	1	0	0	0	1	2	2				6 (4.4)
9	0	0	0	0	0	0	0	1	0	2			3 (2.2)
14	0	0	0	0	0	0	0	0	0	0	1		1 (0.7)
<b>Total (%) households</b>	8 (5.9)	21 (15.6)	15 (11.1)	10 (7.4)	23 (17.0)	28 (20.7)	19 (14.1)	6 (4.4)	2 (1.5)	2 (1.5)	1 (0.7)		135

\*The numbers in the cells represent the number of households.

**Table 2:** Number (%) of households in which everyone had tested positive for COVID-19 between Flo-Week and the date of the interview, by the number of residents in the household.

Number of residents in the household	Total number of households	Number of households in which everyone became a case	Proportion (%) of total households	Proportion (%) of households with at least one case
2	4	2	50.0	66.7
3	12	2	16.7	22.2
4	30	13	43.3	48.1
5	41	20	48.8	50.0
6	27	12	44.4	44.4
7	11	3	27.3	27.3
8	6	2	33.3	33.3
9	3	2	66.7	66.7
14	1			
Total	135	56	41.5	44.1

In households in which there was at least one confirmed COVID-19 case during the study period (n=124), behaviour within the household during the required isolation period(s) varied; 29.0% of households reported that COVID-19 negative residents actively avoided the case(s) (including some households in which residents took particular care to protect immunocompromised members), 53.2% reported they interacted normally with the case(s), and 24.2% reported they deliberately attempted catch COVID-19 from the case(s). The sum of these percentages is greater than 100 because some households described a dynamic approach—initially attempting to avoid infection, but subsequently behaving normally or making an effort to contract the virus. Reasons cited for attempting to become infected included trying to reduce the total isolation period (at a time when each new infection reset a 10-day isolation period for all occupants of a household), minimising time off paid employment and the desire to “get it over with”.

While most households adhered to isolation requirements, six (4.8%) reported they did not. Three cited the need to meet social commitments and one cited academic obligations. Non-adherent households also commented on the need for exercise, the need to obtain food, and that it was “pointless” isolating from others in the neigh-

bourhood who also had COVID-19.

In relation to re-infection, three (2.3%) households reported that at least one resident had more than one episode of confirmed COVID-19 during the study period.

Responses to an open-ended question about students’ experiences revealed that the general COVID-19 situation during the study period had created various academic, financial and mental health stresses. Academic challenges arising from personal illness or a requirement to isolate as the household contact of a case, as well as the University-wide introduction of online learning for the first half of Semester 1, included IT issues, fatigue from increased screen time, difficulties in maintaining motivation, concerns about missing important practical aspects of courses (such as laboratory sessions and field trips) and problems in catching up on work that had been missed due to illness. Some students also reported significant financial consequences arising from the COVID-19 situation, including being made redundant, withdrawing from papers as fewer casual and evening/weekend employment opportunities were available and variable access to COVID-19 hardship relief funds and wage subsidies due to the type of work in which students were engaged. For some students, their mental health and well-being suffered during the study period, with can-

celled social events and feelings of loneliness, and apprehensiveness about returning to situations in which there were large numbers of people. The experience of isolating as a household was mixed—for some it was difficult, while others reported that it strengthened their relationships. There were also physical impacts for those who had caught COVID-19, with some students describing being very unwell and having ongoing issues. Some also described the negative impact of contracting influenza or other respiratory illnesses during the study period, in addition to COVID-19. Finally, many households reported that the University and OUSA initiatives to supply food and care packages were of huge benefit, alleviating a lot of stress and supporting them to meet their isolation requirements.

## Discussion

In this field study of randomly selected University of Otago student households in North Dunedin, the period prevalence of COVID-19 between the start of Flo-Week and the end of Semester 1 was very high; about 94% of households had a least one confirmed COVID-19 case during that period and this corresponded to about three quarters of the residents in the participating households. We also found that just under two thirds of University of Otago student cases notified the University that they had COVID-19 and two thirds of cases with a positive RAT uploaded their result to My Covid Record.

Key strengths of this study include the random selection of households and very high participation proportion, the use of a standardised interviewer-administered questionnaire and the collection of both quantitative and qualitative data. In addition, the interviews were conducted by final year medical students and it is likely that these “peer interviewers” elicited more open responses from participants than would have been the case if non-student interviewers had been used.

The study also has some limitations that should be considered. For pragmatic reasons, interviews were generally carried out with one member of each household, and this has implications for the potential accuracy of their responses. While these individuals knew whether their fellow household members had tested positive for COVID-19, they were sometimes less certain about their flat-mates’ reporting behaviours—as reflected in the number of “unknown” responses. However, even in the best-case scenario (in which it is assumed

that all of these students did report their positive status), the proportions who notified the University and uploaded their RAT results to My Covid Record would only be 70.7% and 83.4%, respectively. Moreover, when asking people about their behaviour there is always the potential for social desirability bias (in which participants tell interviewers what they think they want to hear); if such bias had occurred in this study, the effect would have been to over-estimate the reporting proportions. Hence, while there might be some uncertainty about the exact proportions, it is still apparent that there was considerable under-reporting. This conclusion is supported by University data; in total, the University was notified of 3,820 cases during the study period (22.5% of the 16,965 students studying on campus in Dunedin).<sup>1</sup> About half (n=1,958) of these cases were self-reported by students (the remainder were reported by support teams at residential colleges and Uni Flats), and considering that our random sample of about 10% of potentially eligible households in North Dunedin identified 513 cases, this is consistent with substantial under-reporting.

Our interviews with one household member also mean that some of the barriers to reporting might have been missed. Nonetheless, the responses that were given have provided valuable information to assist with planning for future COVID-19 waves, including ensuring that students understand the importance for themselves and the community of reporting their positive status to the University and uploading positive RAT results to My Covid Record—and making it easy for them to do so.

Our findings also provide insights into the behaviour within households with at least one case, with less than a third initially taking active steps to avoid within-house transmission. Fortunately, the Omicron variants circulating during the study period generally did not cause very severe illness among the predominantly young and healthy student population, however, this might not be the situation with future variants of SARS-CoV-2.

We focussed on a particular group of students and therefore our findings cannot necessarily be generalised to University of Otago students living outside the North Dunedin area. For instance, many of the cases in our study occurred during the orientation period before classes began, whereas for students living elsewhere in Dunedin, potentially different patterns of social mixing mean that COVID-19 infections might have occurred later

and therefore created even more academic stress. In addition, we focussed on a time when COVID-19 vaccination was mandatory for enrolled students; hence transmission rates in future waves might differ, depending on vaccination rates and the transmissibility of the predominant SARS-CoV-2 variants at the time.

We found no published investigations of self-reporting of positive COVID-19 status by university students elsewhere; however, the Ministry of Health's recent COVID-19 Trends and Insight Reports assume considerable under-reporting in the general population which may differ by age, ethnicity and deprivation,<sup>12</sup> and national COVID-19 modellers have assumed that reported case numbers capture only 50% of symptomatic cases.<sup>13,14</sup>

Finally, our findings regarding the academic, financial and mental health impacts for students of

the COVID-19 situation are consistent with findings from elsewhere, including at other universities in Aotearoa New Zealand<sup>15-17</sup> and internationally.<sup>18-23</sup>

## Conclusions

The proportion of University of Otago student households in North Dunedin that had to isolate between Flo-Week and the end of Semester 1 because at least one resident had COVID-19 was extremely high. At the same time, there was substantial under-reporting of student cases to the University of Otago and under-recording of positive RAT results in My Covid Record—this has obvious implications for authorities responsible for making prevention and control decisions, as well as for students who could miss out on key support from the University and their healthcare providers.

**COMPETING INTERESTS**

Nil.

**ACKNOWLEDGEMENTS**

We thank Michael Butchard and Susan Jack for their role as clients for this project. We also thank Patricia Priest for her early input into the design of the study, and Paul McNamara for providing the numbers of enrolled students at the University of Otago and the numbers of COVID-19 cases reported to the University.

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# Specialist medical toxicologist consultations provided by the New Zealand National Poisons Centre, 2018–2020

Adam C Pomerleau, Paul Gee, D Michael G Beasley, Eeva-Katri Kumpula

## ABSTRACT

**AIMS:** The National Poisons Centre (NPC) provides 24/7 specialist medical toxicologist consultations to healthcare professionals regarding the clinical management of poisoning cases. The use of toxicologist services was investigated to characterise the extent and content of consults to inform further development of this service.

**METHODS:** A retrospective analysis of 2018–2020 medical toxicologist consultations summarised contact numbers, professional backgrounds and district health boards (DHBs) of the people contacting the NPC, and the patient(s) and substance(s) involved.

**RESULTS:** There were 3,451 medical toxicologist consultations with 2,400 (67%) provided directly to healthcare professionals. Crude rates of consults increased across all DHBs. Of all 2,603 therapeutic substances that were consulted about during the study period, 1,492 (57.3%) were drugs affecting the nervous system, and paracetamol was the most common individual drug (528; 20.3%). Of all 1,185 non-therapeutic substance exposures that were advised on, 66 (5.6%) were unidentified mushrooms, 51 (4.3%) unidentified substances, and 47 (4.0%) lead exposures.

**CONCLUSIONS:** There was increasing utilisation of the NPC service by healthcare professionals from all 24 areas of the country, covering a wide range of substance exposures and scenarios. The growing utilisation suggests healthcare professionals derive value from this consultation service for the care of their patients.

Poisonings are a common type of injury in Aotearoa New Zealand.<sup>1,2</sup> They can be life-threatening, time-dependent emergencies requiring specialist input for optimal diagnosis and treatment. Since there are hundreds of thousands of chemical substances to which a person may be exposed, there are myriads of unique poisonings with the potential to cause morbidity and mortality.

Medical (or clinical) toxicology is a field of medical practice that concerns itself with the evaluation, management and prevention of poisoning in all its forms. Historically, there have been few physicians in Aotearoa New Zealand who practised medical toxicology. Currently there are no formal training pathways available to obtain expertise in this field here, but physicians can develop knowledge through a small number of distance learning programmes, professional organisation conferences or by seeking formal training abroad. Overseas, there has been a small but increasing number of physicians seeking specific training in medical toxicology.<sup>3</sup> For example, in the United States, medical practitioners who have already attained a primary vocational scope will train for at least two additional years

in medical toxicology, following an extensive curriculum that forms the basis for certification as a specialist medical toxicologist.<sup>4</sup>

Poisons centres are promoted by the World Health Organization (WHO) to operate as integral parts of the healthcare system, helping members of the public and healthcare professionals and providing multiple benefits.<sup>5</sup> For example, studies have demonstrated how poisons centres can save costs and resources by triaging patients when an exposure can be safely managed at home,<sup>6</sup> and by assisting primary care clinicians in managing patients and avoiding tertiary care presentations when appropriate.<sup>7</sup> In various settings and across multiple countries, consultations with poisons centres and involvement of medical toxicologists in patient care has been associated with a variety of benefits including decreased length of stay, reduced healthcare costs and reduced resource utilisation.<sup>8–13</sup>

The National Poisons Centre (NPC) operates with 15 full-time equivalent staff roles, two of which are medical toxicologist roles. The toxicologist roles are currently filled by registered, vocationally certified emergency medicine specialists who also have formal training and certifications in medical toxicol-

ogy from overseas. The NPC also utilises a small casual pool of experienced emergency medicine specialists who have additional medical toxicology training to provide a few days of on-call availability throughout the year, with back-up available from the core medical toxicologists as required. Collectively, this group of specialists provide 24/7 availability for consultation and engage in peer review activities for governance of the clinical consultations provided. Healthcare professionals anywhere in Aotearoa New Zealand can contact the NPC any time to access real-time consultation and advice from medical toxicologists through its free phone number 0800 POISON (0800 764 766). Once connected with frontline NPC staff, healthcare professionals can request medical toxicologist consultation (or this may be offered by frontline staff if not requested by the caller) and then the caller is put in direct phone contact with the medical toxicologist, usually within a few minutes. Being a telehealth-based service, this aspect of NPC's operation brings a limited and unique clinical expertise to all areas of the country with easy accessibility, which helps to promote health equity.

In late 2017, the NPC adopted new strategic goals to increase the links between the NPC and the clinical community with an aim to make medical toxicologist consultation more integrated across the broader healthcare system. A range of activities supported this goal, such as targeted outreach to clinician groups, educational sessions and discussion forums hosted by the NPC, revision of NPC protocols for consulting with medical toxicologists, word-of-mouth promotion and others. This study aimed to describe the contacts to the NPC where one of its medical toxicologists was consulted and provided management advice between 2018–2020. This information will highlight relevant areas where NPC medical toxicologists offer advice to clinicians in their patient care.

## Methods

Ethical approval was obtained from the University of Otago Human Research Ethics Committee (ref: HD19/064), and the study was conducted according to the principles of the Declaration of Helsinki.<sup>14</sup> All data were de-identified before analysis.

This was a retrospective study utilising the NPC's electronic medical record database to characterise contacts about human patients who had been exposed to various substances and where a medical toxicologist was consulted. All matching

records from 1 January 2018 to 31 December 2020 were included in the study. It should be noted that a record may not always necessarily correspond to a single unique patient and exposure, as there may be multiple contacts to the NPC about the same incident and patient. Such records are considered "linked records". As linked records may overestimate the incidence of unique exposures, this study does not attempt to determine population prevalence rates for poisoning, but simply a crude rate of numbers of contacts in proportion to the district health board (DHB) or national population size. The subnational population estimates (DHB, DHB constituency) on 30 June of each respective study year were used as the population number for calculating crude rates.<sup>15</sup> The rate of linked records was determined for reference. Records where the person contacting the NPC was a healthcare professional were analysed further. Data extracted and summarised from matching records included: number of records, date and time of contact, geographic location (and corresponding DHB) and healthcare setting (where applicable) of the person contacting the NPC, relationship of the person contacting the NPC to the patient, types of doctors (when and if documented; it is not a requirement to capture this information in the record), patient demographics (age, gender, Ministry of Health prioritised ethnicity<sup>16</sup>), reason for exposure incident and the number and identities of substances involved in exposure incidents. As patient age was not normally distributed, a median with an interquartile range (IQR) was calculated for the study sample. Therapeutic substances involved in these exposures were coded into WHO Anatomical Therapeutic Chemical (ATC) Classification System codes where applicable,<sup>17</sup> and non-therapeutic substances or products were classified according to the NPC in-house chemical classification system. The 20 most frequent therapeutic and non-therapeutic substances involved in these exposures were also determined. The total number of contacts made about human exposures for each study year was also determined to investigate time trends.

## Results

During the study period, contacts relating to human patients exposed to various substances increased annually by 5.3–7.5%, whereas medical toxicologist consultations to healthcare professionals increased by 25.8–70.4% (Table 1). Of all 23,259 contacts relating to human patients in 2020, 1,526 (6.6%) involved toxicologist consultations.

**Table 1:** Contacts to the NPC regarding human patients exposed to various substances and involving medical toxicologist consultations, 2018–2020.

Year of contact with NPC	2018	2019	2020	Total
Total contacts about human patients	20,544	22,090	23,259	65,893
% change since previous year		+7.5%	+5.3%	
Contacts with no toxicologist consultation	19,832	20,877	21,733	62,442
% change since previous year		+5.3%	+4.1%	
Contacts with a toxicologist consultation	712	1,213	1,526	3,451
% change since previous year		+70.4%	+25.8%	

Abbreviation: National Poisons Centre = NPC

**Table 2:** Contacts from healthcare professionals involving medical toxicologist consultations: professional background, 2018–2020.

Healthcare professional type	Records (% of total)
Doctor	2,015 (84.0%)
General practitioner	331 (13.8%)
Consultant	335 (14.0%)
Registrar	380 (15.8%)
House surgeon	19 (0.8%)
Medical student	3 (0.1%)
Other or unspecified doctor	947 (39.5%)
Nurse	267 (11.1%)
Pharmacist	41 (1.7%)
Ambulance	20 (0.8%)
Caregiver	28 (1.2%)
Other or public health	29 (1.2%)
Total records	2,400 (100%)

**Table 3:** Contacts from healthcare professionals involving medical toxicologist consultations: geographical area of contact origin, 2018–2020.

		Crude rate of consulted records/100,000 DHB area inhabitants*		
Contact origin/DHB	Records 2018–2020 (% of total)	2018	2019	2020
<b>North Island</b>				
Northland	135 (5.6%)	14.53	23.73	32.37
Waitematā	251 (10.5%)	6.99	13.29	19.55
Auckland	199 (8.3%)	7.91	15.46	16.42
Counties Manukau	159 (6.6%)	5.82	10.70	10.75
Waikato	153 (6.4%)	10.93	9.56	15.06
Bay of Plenty	86 (3.6%)	8.41	14.06	10.99
Lakes	56 (2.3%)	10.58	15.64	22.15
Tairāwhiti	18 (0.8%)	4.04	13.97	17.75
Taranaki	88 (3.7%)	22.26	17.09	32.08
Whanganui	84 (3.5%)	29.99	28.19	65.69
Hawkes Bay	126 (5.3%)	23.80	25.71	22.41
MidCentral	38 (1.6%)	4.95	10.31	5.34
Capital and Coast	101 (4.2%)	6.01	12.21	13.26
Hutt Valley	38 (1.6%)	5.85	10.90	7.55
Wairarapa	23 (1.0%)	8.55	10.48	28.63
<b>South Island</b>				
Nelson Marlborough	71 (3.0%)	10.93	17.08	16.75
West Coast	35 (1.5%)	12.35	68.11	27.78
Canterbury	210 (8.8%)	8.56	11.59	16.48
South Canterbury	19 (0.8%)	4.93	11.40	14.52
Southern	325 (13.5%)	19.86	41.11	33.46
Unknown DHB	185 (7.7%)	N/A	N/A	N/A
Total records	2,400 (100%)	10.77	17.19	19.98

Abbreviations: DHB = district health board; N/A = not applicable.

\*Subnational population estimates (DHB, DHB constituency), by age and sex, at 30 June each year used as reference populations.<sup>15</sup>

**Table 4:** Contacts from healthcare professionals involving medical toxicologist consultations: reason for exposure incident by gender, 2018–2020.

Reason for exposure	Female	Male	Other or unknown gender	Total records
Intentional	643 (52.9%)	267 (26.4%)	41 (23.8%)	951 (39.6%)
Substance abuse	32 (2.6%)	51 (5.0%)	3 (1.7%)	86 (3.6%)
Unintentional	252 (20.7%)	351 (34.6%)	47 (27.3%)	650 (27.1%)
Child exploratory*	98 (8.1%)	131 (12.9%)	25 (14.5%)	254 (10.6%)
Therapeutic error	104 (8.6%)	132 (13.0%)	20 (11.6%)	256 (10.7%)
Other reason	15 (1.2%)	13 (1.3%)	4 (2.3%)	32 (1.3%)
Unknown reason	71 (5.8%)	68 (6.7%)	32 (18.6%)	171 (7.1%)
Total records	1,215 (100%)	1,013 (100%)	172 (100%)	2,400 (100%)

\*This is defined as an age-appropriate exploratory behaviour exhibited by children that results in an exposure (e.g., a toddler putting something they find in their mouth).

**Table 5:** Contacts from healthcare professionals involving NPC medical toxicologist consultations: ATC codes of substances involved in exposures, 2018–2020.

ATC codes	n (% of total)
<b>Total therapeutic substance exposures</b>	<b>2,603 (100%)</b>
A – Alimentary tract and metabolism	157 (6.0%)
B – Blood and blood-forming organs	114 (4.4%)
C – Cardiovascular system	356 (13.7%)
D – Dermatologicals	12 (0.5%)
G – Genitourinary system and sex hormones	16 (0.6%)
H – Systemic hormonal products, excl. sex hormones and insulins	26 (1.0%)
J – Anti-infectives for systemic use	53 (2.0%)
L – Anti-neoplastic and immunomodulating agents	32 (1.2%)
M – Musculo-skeletal system	183 (7.0%)
N – Nervous system	1,492 (57.3%)
P – Anti-parasitic products, insecticides and repellents	11 (0.4%)
R – Respiratory system	105 (4.0%)
S – Sensory organs	6 (0.5%)
V – Various	2 (0.1%)
X – Unknown product content [unknown ingredients]	17 (0.7%)
Y – Unknown indication, unable to assign ATC code	21 (0.8%)

Abbreviations: ATC = Anatomical Therapeutic Chemical classification; NPC = National Poisons Centre.

**Table 6:** Contacts from healthcare professionals involving medical toxicologist consultations: 20 most frequent specific therapeutic substances, 2018–2020.

<b>Therapeutic substance</b>	<b>n (% of total)</b>
<b>Total therapeutic substance exposures</b>	<b>2,603 (100%)</b>
Paracetamol	528 (20.3%)
Quetiapine	109 (4.2%)
Ibuprofen	81 (3.1%)
Zopiclone	68 (2.6%)
Iron-only supplements (various)	58 (2.2%)
Citalopram or escitalopram	53 (2.0%)
Venlafaxine	52 (2.0%)
Metoprolol	49 (1.9%)
Tramadol	45 (1.7%)
Codeine	42 (1.6%)
Sertraline	42 (1.6%)
Amitriptyline	41 (1.6%)
Lithium	38 (1.5%)
Diltiazem	35 (1.3%)
Cilazapril	33 (1.3%)
Fluoxetine	33 (1.3%)
Lorazepam	33 (1.3%)
Acetylsalicylic acid	30 (1.2%)
Morphine	30 (1.2%)
Amlodipine	30 (1.2%)

**Table 7:** Contacts from healthcare professionals involving medical toxicologist consultations: 20 most frequent specific non-therapeutic substances, 2018–2020.

Non-therapeutic substance	n (% of total)
<b>Total non-therapeutic substance exposures</b>	<b>1,185 (100%)</b>
Ethanol*	114 (9.6%)
Unidentified mushroom	66 (5.6%)
Unidentified substance	51 (4.3%)
Lead (various)	47 (4.0%)
Ethylene glycol	44 (3.7%)
Carbon monoxide	23 (1.9%)
Methamphetamine	23 (1.9%)
MDMA	19 (1.6%)
Cannabis**	19 (1.6%)
Hypochlorite (various)	16 (1.4%)
Liquefied petroleum gas (LPG)	11 (0.9%)
Hydrogen sulphide (H <sub>2</sub> S)	10 (0.8%)
Mercury	10 (0.8%)
Arsenic	9 (0.8%)
Glyphosate	9 (0.8%)
Methyl bromide	9 (0.8%)
Petrol	9 (0.8%)
Tutu plant or honey (tutin)	9 (0.8%)
Hydrochloric acid	8 (0.7%)
Ciguatoxin	8 (0.7%)

MDMA = ecstasy; 3,4-methylenedioxymethamphetamine.

\*Contains 106 beverage, 4 hand sanitiser and 4 methylated spirit exposures.

\*\*Excluding synthetic cannabinoids.

A total of 3,451 medical toxicologist consults occurred during the study period, of which 2,614 occurred between 8 am and 7:59 pm (75.7%), while 837 occurred between 8 pm and 7:59 am (24.3%). The 3,451 contacts where NPC medical toxicologists were consulted resulted in 3,591 patient records (due to some exposure incidents involving more than one patient). A total of 2,400 records (66.8%) involved consultations with healthcare professionals contacting the NPC, while 1,191 (33.2%) involved consultations with NPC staff advising callers other than healthcare professionals. Of the 2,400 records involving consultations to healthcare professionals, 84.0% were to doctors (Table 2). When these were further analysed, 1,422 (70.6%) records indicated that the doctor was based in a hospital, 438 (21.7%) were in a medical centre, and 155 (7.7%) in other or unknown workplace settings. Table 2 summarises information about the types of doctors and other healthcare professionals who contacted the NPC.

Medical toxicologist consultations were provided to healthcare professionals from all DHBs. In proportion to DHB catchment area population size, Whanganui DHB had the highest rate of medical toxicologist-consulted records in 2020 (Table 3).

Among the 2,400 records, the median age of the patient was 25 years (IQR 13–48 years), patient ages ranged from 0 to 96 years, and 323 records (13.5%) had patients of unknown age. Patient ethnicities in these records were 12% Māori, 2% Pasifika, 2% Asian, 1% Middle Eastern/Latin American/African, 3% other ethnicity, 31% European (including New Zealand European) and 49% were of unknown ethnicity. A total of 951 of 2,400 records (39.6%) indicated that the exposure reason was intentional, and the rate was higher among females (52.9%) than males (26.4%; Table 4).

A total of 2,208 records (92.0%) indicated that the exposure was acute, while 192 (8.0%) were chronic exposures. The median number of substances involved in the exposure that were noted in the record was one (IQR 1–1; range 1–14); 1,764 of the 2,400 records (73.5%) had one substance involved, 302 (12.6%) had two, 147 (6.1%) had three, and 187 (7.8%) had four or more. There were 1,517 of 2,400 records (63.2%) that had at least one ATC-classifiable therapeutic substance involved in the exposure, while 883 (36.8%) did not and had only non-therapeutic substances. The 2,400 records contained a combined total of 3,788 substance exposures; 2,603 (68.7%) were therapeutic substances and 1,185 (31.3%) were non-therapeutic. Most of the therapeutic substances

were from ATC groups N – Nervous system, and C – Cardiovascular system (Table 5).

Paracetamol was the most frequently consulted specific therapeutic substance in healthcare professional contacts with 528 of the total 2,603 therapeutic substance exposures (20.3%) involving paracetamol (Table 6). Ethanol was the most frequently encountered of all 1,185 non-therapeutic substance exposures, though mostly as a coingestant; it was the sole substance involved in an exposure in only 9 out of 114 records involving ethanol (Table 7).

## Discussion

This retrospective study identified significant increases in annual numbers of consultations provided by NPC medical toxicologists. In 2017, prior to implementing a goal to increase links between the NPC and the broader clinical community, medical toxicologists provided a total of 253 consultations. During the study period, the number of consultations increased from 712 in 2018 to 1,526 in 2020. A quarter of NPC medical toxicologist consults occurred between 8 pm and 8 am, illustrating the importance of the service being available 24/7. There was use of the medical toxicologist consultation service from all DHBs. DHB catchment area populations were used to give comparison points for the number of toxicologist consultations to healthcare professionals in each DHB. Patients may have been exposed in or transported to another DHB for care, so these denominators are used simply as a means to compare numbers of consults in proportion to theoretical catchment area population numbers. The rates of consultation do not therefore indicate prevalence of poisoning. In proportion to area population size, less densely populated DHBs such as West Coast and Whanganui had higher rates of contacts compared to larger DHBs. This free access in any geographical area and at any time of the day or week can be used to promote health equity, as a specialist's input can be used via telephone contact to optimise patient care.

Medical doctors of various scopes of practice and seniority (from house officers to specialist consultants) were the most frequent health professionals to consult NPC medical toxicologists. Although it was not possible to investigate medical specialties in this study, anecdotally most healthcare professionals requesting medical toxicologist consultation work in emergency departments, general practices or intensive care

units. However, medical toxicologist consultations are also provided to a wide variety of other specialty fields including paediatrics, public health, internal medicine, gastroenterology, neurology, dermatology, general surgery, orthopaedics, etc.—emphasising how poisonings present in a large diversity of clinical scenarios. Consulting with an NPC medical toxicologist is similar to consulting any other specialist physician, although there is the limitation that the medical toxicologist cannot typically come to the patient's bedside for an in-person evaluation. Clinicians seeking consultation are, however, given real-time advice relevant to the patient in front of them that includes practical considerations about ongoing management.

NPC enquiries typically involve young children (median age 3 years) with a “child exploratory” reason underlying the exposure.<sup>18</sup> In contrast, this study found that NPC medical toxicologist consultation exposures involved patients who were older with a median age of 25 years. Further, almost 40% of medical toxicologist-consulted records in this study involved intentional exposures, compared to a rate of only 5.5% observed in all NPC patient records in 2018.<sup>18</sup> An increase in rates of serious self-inflicted injuries including poisoning has been noted in Aotearoa New Zealand in recent years.<sup>19,20</sup> Intentional exposures often involve larger ingested doses not normally seen in unintentional exposures, multiple substances combined, undisclosed other substances and possibly delays in seeking treatment—which together introduce complexities in management and can result in serious morbidity and mortality.<sup>21–23</sup> The specialist expertise of medical toxicologists can be used to assist in such toxicologically complex cases.

Medical toxicologist consultations involved a wide range of different substances. Drugs primarily affecting the nervous system were the most commonly queried group of medicines in medical toxicologist consultations, similar to recent reports from Lebanon,<sup>24</sup> Singapore<sup>25</sup> and the United Kingdom (UK).<sup>26</sup> Paracetamol was the most frequent therapeutic substance in medical toxicologist consultations, similar to exposures reported to the NPC in general,<sup>18</sup> and in similar consultations of the UK's National Poisons Information Service (NPIS) in 2020/2021.<sup>26</sup> Of note, the Australia and New Zealand guidelines on management of paracetamol poisoning encourage contact with medical toxicologists or poisons centres in several clinical scenarios, as written guidelines cannot cover all possible variations of circum-

stances.<sup>27</sup> As seen in Table 7, a wide variety of generally “uncommon” exposures (e.g., heavy metals, industrial chemicals) and exposures with public health implications (e.g., lead contamination, novel psychoactive substances) were advised on within the study period. The NPC is well placed to provide advice on rarely encountered clinical poisonings and to detect changing trends, e.g., in recreational drug use or intentional self-poisoning.

This study could not assess reasons why healthcare professionals sought consultation with a medical toxicologist, nor the value obtained. There are many reasons why a healthcare professional might desire consultation advice: medically complex patients or exposure scenarios, unfamiliar situations, uncertainty about management, multiple ingestions not easily addressed by existing protocols, evolution of new practice recommendations, newly emerging substances, advice on best practice or current evidence, etc. Value obtained from medical toxicologist consultation can be to the healthcare professional, the healthcare system and to the patient. Medical toxicologist advice can guide use of resources and interventions, including consulting on specific, complex interventions such as antidote use, decontamination strategies and extracorporeal elimination,<sup>28</sup> while also avoiding unnecessary, costly and even harmful interventions.<sup>9,13</sup> A recent study from the Netherlands found that 23% of hospital-admitted poisoning patients were retrospectively found not to require any active intervention.<sup>29</sup> Medical toxicologists can also advise on escalation of care if tertiary care in a larger facility is needed, or if other specialist input ought to be obtained. Further research is needed to determine healthcare professionals' satisfaction with NPC medical toxicologist consultations, areas for further service development and ultimately whether there are measurable benefits to patients, e.g., in the form of shorter in-hospital and/or ICU stays, or to the health system in general in the form of cost savings, or others.

## Limitations

Some limitations of this study should be noted. First, reasons for choosing to contact the NPC service beyond the need for obtaining toxicological patient management information were not determined in this retrospective record audit. Contacting the NPC is voluntary and therefore the data cannot be used to make any assessment of the prevalence of exposure rates in the community, as an unknown proportion of exposures are not

reported to NPC. Some data, such as type and specialty of doctor, is not required to be captured in NPC records and thus a fuller description of the healthcare professional callers cannot be provided. Substance identities are recorded as reported by the person contacting the NPC and may contain inaccuracies or omissions, and in multi- as well as single-substance exposures all substances reported are counted in this study, regardless of whether they were of specific toxicological concern in the case. It is possible that population growth during the study period could have impacted the change in medical toxicologist consultations; between 2018–2020 the population of Aotearoa increased by 4%<sup>15</sup>—this factor alone is unlikely to explain the growth in medical toxicologist consultations. Lastly, NPC data do not systematically capture eventual outcomes for patients, and we are therefore unable to assess benefits to patients and/or treating clinicians from using the service in this study.

## Conclusion

In summary, during 2018–2020 NPC medical toxicologists provided advice to medical professionals about various therapeutic and non-therapeutic substance exposures, and there was an increasing trend in the number of consultations over time across all areas of the country. These findings support the assertion that healthcare professionals across Aotearoa New Zealand derive value from this NPC specialist service and take advantage of 24/7 access to medical toxicologists from anywhere within the country. Moreover, the growth trend observed suggests further demand being present in the healthcare system for ongoing and continued development of the NPC's medical toxicologist service. It is a priority for the NPC to develop its services further and continue to actively engage with the broader healthcare community.

**COMPETING INTERESTS**

None declared. All authors are employees of or otherwise affiliated to the National Poisons Centre at the University of Otago. Dr Pomerleau, Dr Gee and Dr Beasley have provided medical toxicologist consultations during the study period.

**ACKNOWLEDGEMENTS**

The authors would like to acknowledge Dr Martin Watts, Dr Sarah Buller and Dr Chip Gresham for also providing medical toxicologist consultations during the study period, and the staff at the National Poisons Centre for their work in recording the information used in this study as part of their routine case-documentation practice.

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# A case of purpura fulminans attributed to trimethoprim-sulfamethoxazole

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**P**urpura fulminans is a life-threatening condition in which there is extensive cutaneous haemorrhagic necrosis in the setting of disseminated intravascular coagulation (DIC). Three sub-types of purpura fulminans have been described in the literature: acute infectious purpura fulminans (often due to overwhelming sepsis commonly due to *Neisseria meningitidis* bacteraemia), neonatal purpura fulminans (due to hereditary protein C or S deficiency) and idiopathic purpura fulminans (either drug-induced or of unknown aetiology). Here, we describe a case precipitated by trimethoprim-sulfamethoxazole, and review the relevant literature for possible mechanistic explanations.

## Case presentation

A 29-year-old non-binary patient (pronoun “they”) presented to the emergency department with left-sided neck swelling, painful swallowing, discharge from the left ear, subjective fevers and a rapidly spreading itchy rash over the arms, torso and upper legs. The patient thought they were taking oral flucloxacillin in the community prior to presentation. The patient had a background of chronic mild neutropaenia of unknown cause, atopic eczema, recurrent skin furuncles and previous episodes of otitis externa secondary to methicillin-susceptible *Staphylococcus aureus*, primarily treated with oral flucloxacillin.

On examination, the patient was febrile. They had an indurated left pinna with mild cellulitis, mild preauricular and level II cervical adenopathy, keratinous debris within the left auditory canal and an extensive maculopapular rash covering the arms, torso and upper legs.

Blood tests revealed isolated severe neutropaenia ( $0.22 \times 10^9/L$  from a baseline of  $1.4 \times 10^9/L$ ), a normal eosinophil count ( $0.01 \times 10^9/L$ ), and an elevated C-reactive protein (CRP) of 72 mg/L (normal  $<5$  mg/L). A swab of the left auditory canal showed no pathogens. The patient was presumed to have recurrent otitis externa, as well as a cutaneous eruption secondary to flucloxacillin. They were prescribed ciprofloxacin ear drops, and intravenous cefazolin; the latter was switched to meropenem

after receipt of the very low neutrophil count.

Within 48 hours of admission, the patient's fevers had settled, the rash had significantly faded, the CRP had fallen to 23 mg/L and the neutrophil count had risen to  $0.8 \times 10^9/L$ . The patient was discharged on a course of daily oral trimethoprim-sulfamethoxazole for combined treatment of potential otitis externa and recurrent staphylococcal skin boils.

The following day (approximately 8 hours after commencing the course of trimethoprim-sulfamethoxazole, and 28 hours after their last dose of meropenem), the patient re-presented to the emergency department with facial swelling, posterior headache, nausea and vomiting, acute generalised asthenia and an extensive and rapidly progressive purple rash. Collateral history from the patient's general practitioner revealed that the patient had, in fact, taken trimethoprim-sulfamethoxazole (rather than flucloxacillin) for nine days leading up to the initial admission, and that was their first exposure to trimethoprim-sulfamethoxazole.

On examination this time, the patient looked unwell, and was hypotensive (80/40mmHg) and tachycardic with facial oedema, but had no oral mucosal ulceration. The left pinna was dermatitic without evidence of cellulitis. There was minimal ear canal oedema with some keratinous debris present, but no obstruction or purulence. There was no evidence of middle ear or mastoid infection. An extensive, and in many places coalescent, purpuric rash was noted over the chest, abdomen and back, and this later progressed to include the limbs and digits (Figure 1).

Blood tests revealed evidence of disseminated intravascular coagulation ([DIC]; INR 1.9, D-dimer  $>20,000 \mu\text{g/L}$ , and platelets  $40 \times 10^9/L$ ), acute kidney injury (creatinine  $106 \mu\text{mol/L}$ ), modest mixed-pattern liver enzyme derangement and a CRP of 24mg/L. A computed tomography (CT) scan of the brain and cervical spine showed mild stranding around the left lower external ear and mild adenopathy in the parotid space and left neck with no drainable collections. There was no intracranial pathology or skull base bony erosion. The patient's trimethoprim-sulfamethoxazole therapy was ceased. Due to concerns about septic shock as

the cause of purpura fulminans, the patient was commenced on broad-spectrum intravenous antibiotics (meropenem, amoxicillin and vancomycin), and admitted to the intensive care unit for vasopressor therapy. Over the course of the next 48 hours, the patient's clinical condition significantly improved, and they were weaned off vasopressors.

Multiple microbiological investigations returned with negative results, including four sets of blood cultures, urine microscopy and culture, bilateral ear swabs and HIV serology. The patient underwent punch biopsies of the skin lesions which revealed features consistent with DIC, but no other pathology (see Figure 2).

Antibiotic therapy was de-escalated in a stepwise manner, and ceased altogether by day 6. Subsequent bone marrow examination three weeks later showed increased granulopoiesis, but otherwise no abnormality. The patient was given a probable diagnosis of trimethoprim-sulfamethoxazole-induced disseminated intravascular coagulation, and advised to strictly avoid this agent in the future.

On clinical review 2 months later, the patient's skin had returned to normal aside from mild discoloration in the region of the previously most extensive purpuric changes of the right forearm. The left ear remained indurated and mildly dermatitic, similar to its appearance during the patient's hospitalisations. A subsequent flucloxacillin challenge did not cause a cutaneous reaction.

## Discussion

Only a handful of case reports have suggested a causal link between a drug exposure and purpura fulminans. These cases were reportedly caused by non-steroidal anti-inflammatory drugs (2 cases,<sup>1,2</sup>), levofloxacin (1 case<sup>3</sup>), paracetamol (2 cases; one patient had chronic alcoholism,<sup>4</sup> and the other had concomitant *Klebsiella* bacteraemia<sup>5</sup>), tocilizumab (1 case<sup>6</sup>), granulocyte colony-stimulating factor (1 case, although the patient had concomitant staphylococcal sepsis<sup>7</sup>), contaminated cocaine (1 case<sup>8</sup>) and phenytoin (1 case<sup>9</sup>). Trimethoprim-sulfamethoxazole has been implicated in many cutaneous reactions, including purpuric rashes related to immune thrombocytopenia. However, a scoping review of the published literature revealed no cases of purpura fulminans triggered by trimethoprim-sulfamethoxazole. The World Health Organization collaborating Centre for International Drug Monitoring (VigiAccess)<sup>10</sup> has reported a total of 128,908 reactions against trimethoprim-sulfa-

methoxazole. The main categories of reactions are: skin and subcutaneous tissue disorders (40%), "general" disorders (10%), gastrointestinal disorders (9%), blood and lymphatic system disorders (6%), and immune system disorders (4%).

Several mechanisms of drug-induced purpura fulminans have been proposed. The offending drug may act as a hapten, triggering a systemic immune response to an antibody-drug complex.<sup>3</sup> Some patients appear to have developed a leucocytoclastic vasculitis precipitating small vessel thrombosis and purpura fulminans.<sup>3</sup> A T-cell mediated mechanism has been proposed in other cases due to absence of detectable pathological antibodies or immune complexes.<sup>9</sup> Drug-induced liver injury may cause acquired protein C or S deficiency,<sup>4,5</sup> or enhanced release of coagulation factors, leading to a hyper-coagulable state.<sup>6</sup> Finally, drug excipients or contaminants may cause direct vasculopathy.<sup>8</sup> Some authors have refrained from speculating on a potential mechanism, but have argued for a causal link between drug exposure and purpura fulminans based upon close temporal association and absence of feasible alternative causes (e.g., infections).<sup>2,11</sup>

Based upon published criteria<sup>11</sup> for causality of associations between drug exposure and adverse events, we believe exposure to trimethoprim-sulfamethoxazole was by far the most likely cause of purpura fulminans in our patient's case. The patient initially presented with a generalised maculopapular rash, fever and worsened neutropenia 9 days after commencing trimethoprim-sulfamethoxazole. The rash and fever promptly subsided after changing the patient to meropenem and topical ciprofloxacin. Having been clinically well on discharge, the patient then re-presented critically unwell with purpura fulminans 8 hours after re-exposure to trimethoprim-sulfamethoxazole—following which they again had relatively prompt clinical improvement on cessation of this agent. The patient's calculated Naranjo score was 5 ("probable adverse drug reaction" with score of 5–8).<sup>12</sup>

The patient has not had a recurrence of purpura fulminans since this event, indicating that the cause was acquired and transient rather than due to a heritable coagulopathy. Although difficult to exclude entirely, microbiological testing did not suggest an infectious cause, and in retrospect, the appearances of the patient's ear and neck were in keeping with chronic changes from prior recurrent otitis externa.

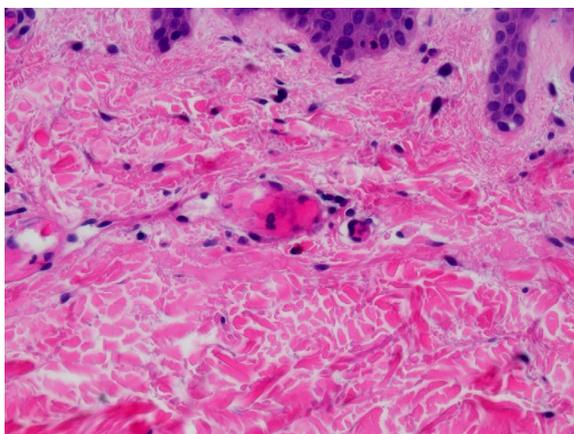
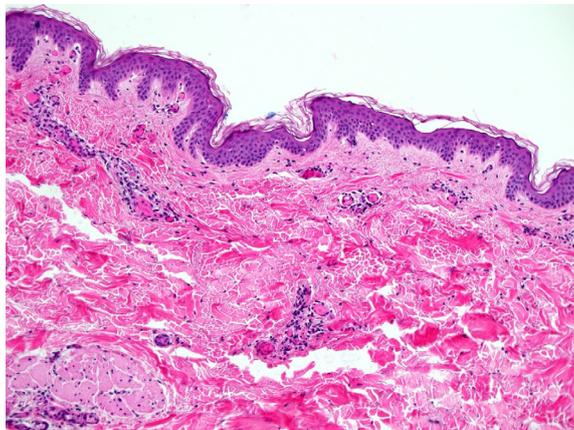
**Figure 1:** An extensive, and in many places coalescent, purpuric rash is seen over the patient's face, chest, abdomen, back, limbs and digits.



**Figure 1 (continued):** An extensive, and in many places coalescent, purpuric rash is seen over the patient's face, chest, abdomen, back, limbs and digits.



**Figure 2:** a) Low power shows fibrin thrombi in dermal capillaries with some surrounding inflammation and b) high power shows fibrin in a capillary with a neutrophil.



**COMPETING INTERESTS**

Nil.

**ACKNOWLEDGEMENTS**

The authors would like to thank the patient for agreeing to share their clinical details and photos, and to Dr Heather Smith (Pathology Department, Christchurch Hospital) for providing the histological slides.

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# Manifestation of anterior necrotising scleritis and reactive infectious mucocutaneous eruption after COVID-19: a case report

Vince MT Wilkinson, Kris Sweetapple, Rachael L Niederer, Corina M Chilibeck

**M**ulti-system inflammatory syndrome is a recognised syndrome caused by SARS-CoV-2 (COVID-19).<sup>1,2</sup> Reactive infectious mucocutaneous eruption (RIME) is a relatively recent umbrella term describing post-infectious rash and mucositis.<sup>3</sup> There are increasing reports of COVID-associated RIME<sup>4,5,6,7</sup>—particularly among children and young adults—exhibiting significant mucositis (oral, conjunctival and anogenital) but absent or minimal cutaneous involvement.<sup>5</sup>

Ocular manifestations of COVID-19 occur in 4–11% of patients<sup>8,9</sup> and are most commonly dry eyes and conjunctivitis.<sup>8</sup> Scleritis and posterior segment manifestations are uncommon.<sup>9,10,11</sup> There have only been three prior reported cases of COVID-associated scleritis, none of which had severe systemic manifestations or associated RIME.<sup>10,11</sup>

## Case report

A 24-year-old male was admitted to hospital 9 days after testing positive for COVID-19 with a Rapid Antigen Test (RAT). At day 5, he developed generalised oral ulceration, odynophagia and painful red eyes, and was subsequently started on oral amoxicillin 500mg for a possible peritonsillar abscess. He had no past medical history, no regular medications and received his second dose of the Pfizer COVID-19 vaccine 2 months prior.

Examination of the mouth revealed haemorrhagic lip crusting with ulceration and widespread desquamative oral lesions of buccal mucosa, hard and soft palate and floor of mouth, sparing the tongue and genitals (Figure 1, A–D). He was empirically started on IV acyclovir 5mg/kg and following consultation with the dermatology and dental team, the patient was screened for autoimmune and other infectious causes including ACE, ANA, ANCA, Quantiferon TB Gold, FRH (IA), anti-CCP antibodies, skin autoantibodies (pemphigoid, pemphigus), Hepatitis, HIV, herpes

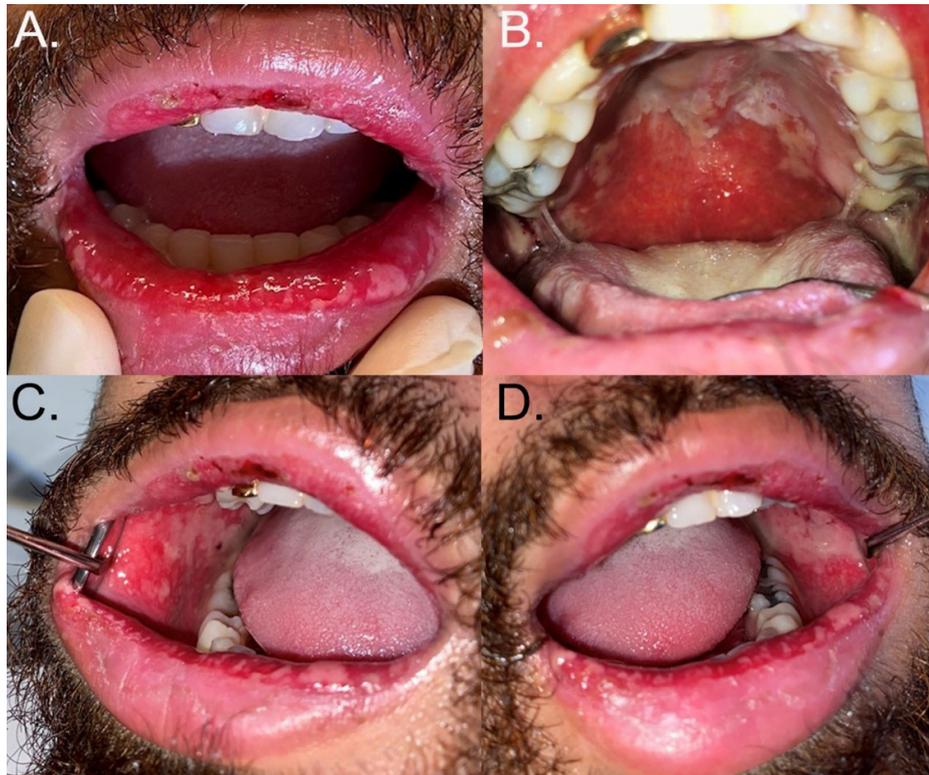
virus group DNA, influenza PCR screening, syphilis, chlamydia and gonorrhoea, which all returned negative. There was serological evidence of past cytomegalovirus and Epstein-Barr virus infection. Chest radiograph showed no significant abnormalities. Laryngoscopy was normal and oral biopsies were undertaken.

Worsening ocular pain and conjunctival injection prompted ophthalmology review. Ocular examination revealed normal visual acuity and intraocular pressures, bilateral diffuse conjunctival injection with deep scleral involvement bi-temporally, and pain on retropulsion. The redness remained in the sclera despite topical application of phenylephrine 10% (Figure 2, A–B), and fluorescein examination revealed an epithelial defect consistent with bilateral anterior sectoral necrotising anterior scleritis (Figure 2, C–D). There was no intraocular or posterior segment inflammation. After specialists' consultation, conjunctival swabs were performed for HZV, VZV, and COVID-19, and he was promptly started on 1g IV methylprednisolone daily for 3 days followed by 1mg/kg oral prednisone tapered off over 8 weeks.

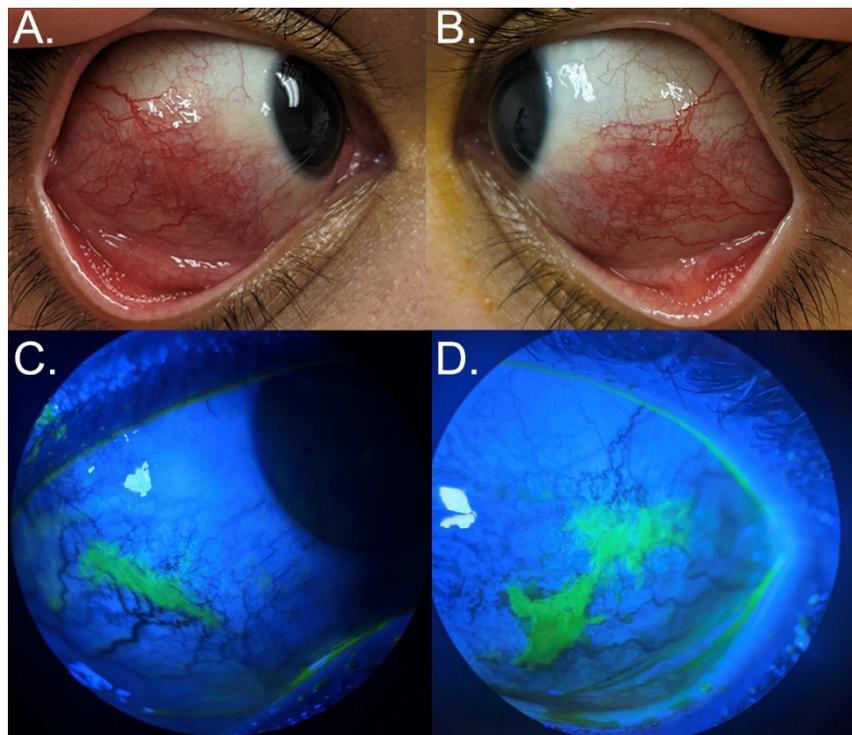
Conjunctival viral swabs were negative. Histology from buccal mucosa biopsies confirmed presence of ulceration with underlying granulation tissue, hyperplastic reactive mucosa and lymphohistiocytic infiltrate. Immunofluorescence studies were negative for IgG, IgA, IgM or C3.

The investigation findings were consistent with RIME. Improvement in pain, mucosal ulceration and necrotising scleritis was observed at 36 hours after the initiation of IV methylprednisolone, followed by rapid improvement over the following 4 days. He was discharged from hospital and regularly monitored during his outpatient follow-up with dental and ophthalmology. At his last ophthalmology follow-up 10 weeks after discharge, there were no signs of rebound RIME or scleritis.

**Figure 1:** Clinical photographs of a) upper and lower haemorrhagic lip crusting and ulceration, and desquamation of b) the palate and c-d) the buccal mucosa.



**Figure 2:** Clinical photographs after topical phenylephrine 10% illustrating deep scleral injection of the temporal globes of a) the right eye, b) left eye; and cobalt blue filter illustrating the corresponding areas of fluorescein uptake at epithelial defects of c) the right eye, and d) left eye.



## Discussion

This is the first reported case of COVID-associated bilateral anterior necrotising scleritis in a patient that was double-vaccinated against the virus, highlighting that severe ocular complications can still occur. This is also the first reported case of necrotising scleritis co-presenting with RIME.

RIME is defined by evidence of an infectious trigger in the preceding 7–10 days, a non-contributory medication history and erosive mucositis or vesiculobullous lesions affecting two or more sites.<sup>3</sup> In this case, the investigation findings implicate COVID-19 as the trigger for RIME and bilateral anterior necrotising scleritis.

Anterior scleritis should be considered by all

clinicians when a patient presents with ocular pain and erythema following or during COVID-19 infection. Careful consideration must be taken to avoid automatically dismissing such cases as conjunctivitis. Initiation of high-dose systemic steroids for necrotising scleritis is required to prevent severe complications such as perforation. When such sight-threatening diseases do not respond to IV methylprednisolone, there is the potential need to rapidly escalate treatment to anti-TNF or tocilizumab.

This case highlights two differing non-respiratory systemic manifestations of COVID-19 during the convalescent phase. Consequently, it underlines the importance of collaboration among specialists when faced with multisystem involvement.

**COMPETING INTERESTS**

Nil.

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# Present State of Medical Literature

NZMJ, 1923

No one who reads diligently at the present day medical literature and journalism, as distinguished from surgical, can fail to be impressed with the vast extent he surveys, but it is for the most part an arid waste, with only here and there an oasis to gladden the eye. It has not the fertility for which Bacon strove. The cause and result are alike loose thinking, and advance is in a circle rather than in progression. The readers are as much to blame as the writers, for if the style is dark and diffuse it is thought to be more profound and philosophical than if it were terse and perspicuous. In the same way muddy water is usually considered deeper than it is because the observer cannot see to the bottom. What seems obviously hard thinking must be accurate and original, such as certain forms of German philosophy and science—but this view, to borrow Gibbon's immortal phrase, "though probable is certainly false." Many apparently profound conclusions are based only upon hasty, scanty and careless observation, for no architectural adornment will make a building firmer than the foundation on which it rests.

It is impossible for any man of average intelligence to understand much of the jargon written by so-called medical authorities on, for instance, psycho-analysis and the psychology of dreams, and yet attempts are made to foist these fantasies on the innocent through the medical

curriculum. This is not to say that there may not be some truth in the new thought of the medical psychologist, but it is overlaid with verbiage, with nonsense, and, sometimes, with filth. Away with the indecent Oedipus complex and such turgid nonsense as, for instance, "If we now examine the day-dream as a product of affective thinking on the fore-conscious level we cannot deny it a teleological character." Are we to go back to the ways of the schoolmen and abandon neurology for psychological speculation? God forbid. Medicine is becoming less rational and more speculative at a time when Religion, on a foundation of faith and experience is more and more set free from credulity. If we cannot explain by medical psychology what Coleridge called the "myriad-mindedness" of Shakespeare, there are many who will attempt the task with the aid of advanced endocrinology and sesquipedalianism, and one extravagance leads to another. Criminals are to be put in hospital instead of the jail, and free-will and personal responsibility, and scientific observation, experiment and deduction will all disappear in the Golden Age that is heralded. Let us not be carried off our course by every wind of doctrine and forget the helm and compass. The speculation of many medical writers is like a fog-bank at sea which at first sight looks like the Delectable Mountains but, seen through a clear glass, it is only unsubstantial vapours.