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Using Days Alive and Out of Hospital to measure inequities and possible pathways for them after cardiovascular surgery in Aotearoa New Zealand: study protocol for a secondary data analysis

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ABSTRACT

Introduction In Aotearoa New Zealand (NZ), socioeconomic status and being of Māori ethnicity are often associated with poorer health outcomes, including after surgery. Inequities can be partially explained by differences in health status and health system biases are hypothesised as important factors for remaining inequities. Previous work identified inequities between Māori and non-Māori following cardiovascular surgery, some of which have been identified in studies between 1990 and 2012. Days Alive and Out of Hospital (DAOH) is an emerging surgical outcome metric. DAOH is a composite measure of outcomes, which may reflect patient experience and longer periods of DAOH may also reflect extended interactions with the health system. Recently, a 1.1-day difference in DAOH was observed between Māori and non-Māori at a hospital in NZ across a range of operations.

Methods and analysis We will conduct a secondary data analysis using data from the National Minimum Data Set, maintained by the Ministry of Health. We will report unadjusted and risk-adjusted DAOH values between Māori and non-Māori using direct risk standardisation. We will risk adjust first for age and sex, then for each of deprivation (NZDep18), levels of morbidity (M3 score) and rurality. We will report DAOH values across three time periods, 30, 90 and 365 days and across nine deciles of the DAOH distribution (0.1–0.9 inclusive). We will interpret all results from a Kaupapa Māori research positioning, acknowledging that Māori health outcomes are directly tied to the unequal distribution of the social determinants of health.

Ethics and dissemination Ethics approval for this study was given by the Auckland Health Research Ethics Committee. Outputs from this study are likely to interest a range of audiences. We plan to disseminate our findings through academic channels, presentations to interested groups including Māori-specific hui (meetings), social media and lay press.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ We will investigate inequities in outcomes after cardiovascular care in New Zealand (NZ).
⇒ Our study will be a secondary data analysis of routinely collected health data maintained by NZ's Ministry of Health.
⇒ We will use the Days Alive and Out of Hospital (DAOH) to measure outcomes. This metric has advantages over outcome measures such as mortality.
⇒ Our study may have limited generalisability due to its focus on outcomes between Māori (the indigenous people of NZ) and non-Māori.
⇒ We believe our approach and the application of DAOH scores to equity questions will have broader implications beyond NZ.

BACKGROUND

In Aotearoa New Zealand (NZ), socioeconomic status and being of Māori (Indigenous people of NZ) ethnicity are often associated with poorer health outcomes.[1–5] Ethnic inequities in socioeconomic position and the associated cumulative lifetime effects of this can partially explain some observed health disparities, but not all. Other factors including the contribution of health provider and health system bias have been hypothesised as important contributing factors to ethnic inequities in health outcomes.[6 7]

One important area in which health inequities have been identified in NZ is outcomes after cardiovascular procedures.[8–10] Differences in the quality of surgical care are often measured through qualitative studies comparing patient experience[11 12] or quantitively through measures such as 30-day mortality or infection rates.[13 14] Often, the event rate of quantitative measures is low, making estimating outcome differences by ethnicity difficult (eg, the overall surgical mortality in NZ is around 0.6%[15]).

Days Alive and Out of Hospital (DAOH) has been used as an outcome measure in cardiology, both internationally and within

NZ.[16–18] DAOH[19 20] and variations of this metric[21 22] have recently been validated as a general measure of surgical outcomes. DAOH is an objective, quantitative measure of outcomes and in NZ can easily be calculated from administrative databases. DAOH is reduced by any complication within a defined period sufficiently serious to cause death, prolong a hospital admission or lead to a readmission. It may also indirectly reflect patient experience. DAOH is a composite measure of postoperative complications and other health problems and recently, arguments have been provided for the use of composite measures over singular outcome measures.[23 24] One recent study of surgical outcomes using DAOH as an outcome measure noted as a secondary end point that Māori spent on average 1.1 fewer DAOH than non-Māori over a 9-year period.[25]

Coronary artery bypass graft (CABG) surgery is a frequently performed, relatively standardised cardiovascular procedure, which carries a high risk of postoperative complications, including a 1%–2% 30-day mortality rate in NZ.[26] This lends itself to an in-depth exploration of differences in outcomes between patient groups. Furthermore, prior evidence suggests that there are outcome differences between Māori and non-Māori.[9 10] For example, Māori were found to have lower intervention rates, even while they experienced a higher prevalence of heart disease and higher age-standardised mortality for CABG procedures, during the period from 1990 to 1999. While there was an improvement during the period from 2000 to 2012 in the rate of CABG interventions for Māori, inequities remained in rates for other heart treatments such as percutaneous coronary intervention. Inequity between ethnic groups after cardiovascular surgery has also been identified outside of NZ, for example, between indigenous groups in Australia,[27 28] following coronary surgery in the USA[8 29] and overall differences in risk factors by racial groups.[30 31]

Sandiford *et al*[10] discuss how an over-emphasis on interventions at an individual level is unlikely to completely remove any inequities, and so analysis at a system level is required to truly understand the root causes. We hope, our analysis of DAOH scores over multiple time periods while adjusting for multiple risk factors will allow elucidation of system-level pathways of inequities.

Our research has an explicit focus on Māori as the Indigenous (tangata whenua) people of NZ and reinforces the rights of Māori as tangata whenua to equitable health outcomes as reaffirmed within NZ's Treaty of Waitangi and internationally within the United Nations' Declaration on the Rights of Indigenous Peoples.[32 33]

Eliminating ethnic inequities requires first, identifying them and, second, taking actions to target and reduce them. Therefore, we aim to build on existing evidence of inequities in cardiovascular care and to explore where in the patient journey these manifest. We aim to properly contextualise our results through the expertise in Māori and Indigenous health research embedded in our team. Using DAOH as a tool to identify possible pathways related to Indigenous health inequities has wider implications for health quality and safety research in general.

The two aims of our study are outlined below:

Aim 1:

To assess the level of inequity in outcome present between Māori and non-Māori undergoing isolated CABG procedures in NZ as measured by DAOH scores.

Aim 2:

To determine which patient, healthcare access factors or currently unmeasured confounders may be contributing to any inequities identified.

METHODS

This study protocol follows the Reporting of studies Conducted using Observational Routinely-collected Data (RECORD) guidelines [34] (see online supplemental additional file 1) and the Consolidated criteria for strengthening reporting of health research involving indigenous peoples: the CONSIDER statement.[35]

Study design

This will be a secondary data analysis using datasets maintained by the NZ Ministry of Health (MoH).

Study positioning

This study is framed from a Kaupapa Māori Research positioning that Māori health outcomes are directly tied to the unequal distribution of the social determinants of health[36] and the historical (and contemporary) impacts of colonialism.[37] This study incorporates a Kaupapa Māori Research positioning via a collaborative team including senior Māori public health researchers and clinicians; a commitment to a structural analysis that will critique system responsiveness to Māori within the context of CABG inequities; a rejection of victim-blame or cultural deficit analyses; ensuring high-quality ethnicity data collection and reporting and the use of appropriate methods to investigate Māori health inequities within the study design and data analysis.[38]

Study period

This study will include isolated CABG operations that occurred in NZ between 1 January 2013 and 31 December 2021.

Participants

We will include anyone who is over 18 years of age and has an associated Australian Classification of Health Interventions code for a CABG operation (online supplemental appendix 1) at any point during our study inclusion period. Only patients who underwent isolated CABG will be included. Our primary comparison groups will be Māori versus non-Māori, with the potential for secondary analysis of other groups. Anyone who identifies as Māori through self-reported ethnicity in the National Minimum Data Set (NMDS), either alone or as part of multiple ethnicity groupings, will be considered Māori following the prioritisation guidelines for ethnicity collection from

the MoH.[39] There may be undercounting of Māori due to the quality of ethnicity data in national hospitalisation data sets and we will explore the data set to understand the extent of any undercounting by comparing the rates of CABG and hospitalisation of Māori in our data to those in other data sets such as the Perioperative Mortality explorer[40] or the Māori health chart book.[41] If needed, we will correct for undercounting as described previously.[41 42] We include each patient only once. Any patient with multiple CABG operations during our study period will have their first operation analysed.

Definition of health inequities

Health inequities are defined by McIssac *et al* as 'differences which are unnecessary and avoidable, but in addition are considered unfair and unjust'.[43] Through our Kaupapa Māori positioning, we acknowledge that inequities can arise as a result of differential access to resources and we will interpret our findings in that context. A clinically significant threshold for DAOH values, which could inform a threshold for an inequity, has not been determined and more work is needed in this area. The single previous study investigating DAOH values by ethnicity in NZ found that Māori spent on average 1.1 (0.5 to 1.7) (95% CI) fewer DAOH than non-Māori. McIsaac *et al*[44] made an attempt to estimate a minimally important difference (MID) for 'days at home' (DAH) after hip fracture and calculated 11 days to be the MID for DAH_{90}. Although, they also acknowledge that there is no optimal way to calculate an MID and using a separate technique they estimated the MID at 4 days and for lower risk operations generated an MID of 1.5–3.5 days.[44] In our study, we are not aiming to find an MID but instead we are aiming to test for any statistically significant differences in DAOH between Māori and non-Māori patients. If those are found, the value or importance of the final difference in days could be explored with patients to better understand the relationship between statistically significant differences and differences that are important to patients or healthcare providers.

Data sources

Data for this study will be requested from the MoH who manage the databases containing the information required to conduct this study. Information required to calculate DAOH, such as admission dates, readmission dates and hospital length of stay (LOS), will come from the NMDS. Mortality information will be provided from the Births and Deaths Registry and joined to the NMDS via patient National Health Index numbers.[45] The NMDS contains data on hospital admissions and other aspects of surgical care from all public hospitals and most private hospitals in NZ.[46] The NMDS contains operative codes and diagnostic coding in standard formats (ICD-9 or ICD-10-AM) as well as patient demographics (ie, self-identified ethnicity, date of birth and NZDep2018 score which is an area-based measure of socioeconomic deprivation[47]).

Due to privacy constraints the data will not be made available publicly after our study; however, interested groups can apply to MoH to access the data.

Study size

Using DAOH to compare outcomes in this way is not common, so there is no standardised method for calculating ideal sample size. However, Klein *et al* were able to detect a statistically significant difference of 2.7 days less between patients undergoing cardiac surgery with a sample size of 78 921. In NZ, Moore *et al* detected a statistically significant difference of 1 day between Māori and non-Māori patients in a secondary analysis of DAOH data with a sample size of 10 589 patients.[25 48] In 2018, there were 1229 CABG operations performed in public hospitals in NZ and 11% of the patients undergoing cardiac surgery were Māori;[49] therefore, we estimate that with a data set spanning 5 years, we would include around ~5000 operations, including >500 Māori patients after possibly needing to exclude some incomplete data. The low volume of data will be a weakness of this study.

Outcomes

This study will have three primary outcome measures, DAOH at 30, 90 and 365 days ($DAOH_{30,}$ $DAOH_{90}$ and $DAOH_{365}$). These values are calculated by considering the day of the CABG operation as day 1 and then removing 1 day from the total score for any time spent in hospital for any reason during the follow-up period. As the initial day in hospital always counts, the maximum score will be equal to one less day than the total time period. A patient who does not get discharged within the time period or dies in hospital will be assigned a score of zero. Patients who die during the follow-up period following discharge but spent time at home will get a score reflecting the time spent out of hospital. Secondary outcomes for inclusion will include, but are not limited to, 90-day mortality and hospital LOS.

Data management

All raw data will be kept on password-protected encrypted hard drive. Study members will be the only people with access to raw data. Before receiving any data, it will be deidentified by the MoH and data will be transferred using secure file transfer protocol or the University of Auckland secure web drop off system. Summary and transformed data, such as overall counts or individual DAOH scores, may be shared with people outside of the study members after removing any patient identifying information such as birth dates or home domiciles.

Data analysis

Keeping in line with the Kaupapa Māori positioning of this study, all comparisons will be performed between Māori and non-Māori. First, we will calculate unadjusted DAOH scores for each participant separately at nine deciles of the DAOH distribution (0.1–0.9 deciles inclusive). We will then perform a series of comparisons after risk adjustment to understand relationships between risk

factors and ethnic differences as measured by DAOH scores. This study will use direct-risk standardisation[50] to adjust for risk factors. This method has previously been used with DAOH data.[25]

Direct risk standardisation adjusts for non-comparability of groups arising from differences in their expected outcomes rather than their characteristics. This allows many risk factors to be combined into one model without requiring impracticably large sample sizes. Furthermore, the overall risk distribution is adjusted rather than the scores of individual patients.

After reporting raw values, we will first adjust for age and sex and report results. Age and sex will then be kept in all subsequent adjustment models. Other adjusting variables, which can all be found in the NDMS, will be added one at a time and results were recalculated. Extra adjusting variables will include, but are not limited to, NZDep18 score,[51] level of rurality in respect to health services as measured by the geographic classification for health[52] and measurements of comorbidities, such as the M3 score[53 54] or American Society of Anaesthesiologists physical status. Whenever a variable is added, new DAOH scores will be calculated and reported for each of the nine deciles. Finally, we will report 'all adjusted' scores, which incorporate every variable investigated. For any analysis, we propose performing a complete-case analysis. Final decisions about the handling of missing data will be made once we can view the datasets.

All results will be reported for $DAOH_{30}$, $DAOH_{90}$ and $DAOH_{365}$. We postulate that outcome differences directly related to hospital care are more likely to manifest in a shorter time period, that is, $DAOH_{30}$ while any differences observed over extended time periods (eg, in $DAOH_{365}$) may reflect broader issues with the health system.

As the majority of NZ's CABG procedures are undertaken at five main public hospitals, we will also perform a sensitivity analysis to assess if outcomes are different between centres and if any outcome differences identified are consistent across centres.

Patient and public involvement

Our study has not consulted with patients or the public on this proposal. But as is usual in NZ, we have consulted with Māori in our study design through presenting our plan at the Taia te Hauora Māori health research advisory group. We have also included senior Māori health experts in our team.

Limitations

Our analysis plan could have the following limitations. First, the generalisability of our findings may be limited given our focus on outcomes between Māori and non-Māori. Second, there may be limitations with our data source as the information has primarily been collected for administrative purposes and there may be undercounting of Māori patients in the data. The data set may also be limited by the information recorded about comorbidities, which could be contributing to any outcome differences. Thus, our focus is on illustrating the use of DAOH as a tool to investigate inequities on a national scale with a large data set and enable future, more detailed work.

DISCUSSION

This study has the potential to add evidence to current literature on inequities and inform future work using novel approaches to identify pathways related to inequities. The methods from this study will illustrate a novel approach to using DAOH as a measurement variable, by demonstrating how DAOH measurements combined with risk adjustment can identify possible pathways for inequities. Our study has the potential to facilitate positive change by bringing issues of Māori health inequities forward into public health dialogue, while providing targets for intervention and improvement. We anticipate that after publication other researchers may gain inspiration from our methodology and apply it at a larger scale, leading to potential further gains for Indigenous health research and health outcomes. For example, if DAOH is a good discriminator in this context, then it might be used to manage or modify access to cardiac surgery or other medical procedures with the explicit goal of improving equity of outcomes.

Previous work investigating inequities or differences in outcomes when using DAOH has assumed that a shorter DAOH time, which corresponds to more time in hospital, is a negative patient experience. However, this may not be true for all patients. Some patients, such as those lacking care in their homes or rural communities, may benefit from extra time spent in hospital. People from these communities are also more likely to be Māori or from lower socioeconomic groups. This aspect of DAOH and how it relates to patient experiences needs more investigation.

Internationally, socioeconomic status has been shown to be associated with a decrease in DAOH scores,[55] but Māori have been shown to experience poorer health outcomes even after correcting for socioeconomic status.[46 48] In respect of surgery, delayed presentation and a higher number of comorbidities are plausible explanations for poorer outcomes. There appears to be few data on whether the poor outcomes experienced by Māori persist during extended time periods postpresentation and postoperatively.

Socioeconomic factors and greater comorbidity may reflect and add to the impact of institutionalised racism and access to resources. Institutionalised racism (defined as differential access to the goods, services and opportunities of society due to a person's ethnicity)[56 57] may influence every aspect of the patient journey, including time to presentation, the number of investigations undertaken, the recommendation for management, the preoperative experience in hospital, the conduct of surgery and anaesthesia in the operating room, the postoperative care in hospital and the follow-up after discharge.[58] Regionality may also be relevant—for example, good postoperative

care may be harder to obtain in a remote rural location than in the centre of a major city.

DAOH may provide at least some clues to help unravel the question of where the differences in surgical care between Māori and non-Māori lie, and, thus, inform initiatives to address these differences. Such insights may be provided through the distribution of differences in DAOH across centiles, and through the timing of its appearance: DAOH has been measured at multiple time points, such as 30, 90 and 365 days. We postulate that differences manifesting at different time points could lead to different insights into possible pathways, for example, shorter time periods may indicate differences in hospital care, whereas those manifesting only over longer time periods may reflect problems from ongoing interactions with the health system. A strength of DAOH lies in the fact that a longer time to discharge (time to discharge is itself sometimes used as an outcome measure) may be offset by the consequent avoidance of readmission for complications of surgery, and so DAOH should reflect the optimisation of length of hospital stay for each individual patient.

A key strength of this study is the foundation of a Kaupapa Māori Research positioning. This study will illustrate how this approach can be applied to traditional quantitative epidemiology to identify inequities and offer targeted suggestions for future research of this nature. The ability to measure DAOH accurately across NZ through our strong data sources, which allows for long-term follow-up, is another key strength of this research. Through the strength of our data, NZ has the potential to be a world leader in the use and methodological development of DAOH as a research tool. While we do have access to high-quality data, we may run into sample size issues given NZ's small population of around 5 million with Māori making up ~17% of this population (Stats NZ 30 June 2021).

In summary, this research work will use a novel approach, combining DAOH values and risk adjustment to identify health inequities and possible pathways for them between Māori and non-Māori undergoing isolated CABG operations in NZ.

ETHICS AND DISSEMINATION

The study will be conducted in accordance with the principles of the Declaration of Helsinki. The study involves quantitative analysis of routinely collected government administrative data sets and all data will be deidentified before reaching our research group. Therefore, we do not anticipate any additional risks to individuals or collectives as part of this research. Ethics approval for this study was given by the Auckland Health Research Ethics Committee, reference AH24430.

Outputs from this study are likely to be of interest to a range of audiences, including the broader Māori community, patient groups, healthcare professionals, academics and policymakers. Since calculating DAOH is simple using NZ's routinely collected data, our study could be replicated across different operation types by multiple groups. We plan to disseminate our findings through academic channels, presentations to interested groups including Māori-specific hui (meetings), social media and lay press.

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Contributors All authors were involved in the design of the study. LB wrote the first draft of this article. EC, S-JP and JT were major contributors in writing the manuscript. TL, AFM supervised the study and contributed to revisions of the manuscript. All authors read and approved the final manuscript.

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