Clinical paper

Ethnic disparities in the incidence and outcome from out-of-hospital cardiac arrest: A New Zealand observational study

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Abstract

Background: New Zealand (NZ) has an ethnically diverse population. International studies have demonstrated significant differences in health equity by ethnicity; however, there is limited evidence in the context of out-of-hospital cardiac arrest in NZ. We investigated whether heath disparities in incidence and outcome of out-of-hospital cardiac arrest exist between NZ ethnic groups.

Method: A retrospective observational study was conducted using NZ cardiac arrest registry data for a 2-year period. Ethnic cohorts investigated were the indigenous Māori population, Pacific Peoples and European/Others. Incidence rates, population characteristics and outcomes (Return of Spontaneous Circulation sustained to hospital handover and thirty-day survival) were compared.

Results: Age-adjusted incidence rates per 100,000 person-years were higher in Māori (144.4) and Pacific Peoples (113.5) compared to European/Others (93.8). Return of spontaneous circulation sustained to hospital handover was significantly lower in Māori (adjusted OR 0.74, 95% CI 0.64−0.87, p < 0.001). Survival to thirty-days was lower for both Māori (adjusted OR 0.61, 95% CI 0.48−0.78, p < 0.001) and Pacific Peoples (adjusted OR 0.52, 95% CI 0.37−0.72, p < 0.001). A higher proportion of events occurred in all age groups below 65 years old in Māori and Pacific Peoples (p < 0.001), and a higher proportion of events occurred among women in Māori and Pacific Peoples (p < 0.001).

Conclusions: There are significant differences in health equity by ethnicity. Both Māori and Pacific Peoples have higher incidence of out-of-hospital cardiac arrest and at a younger age. Māori and Pacific Peoples have lower rates of survival to thirty-days. Our results provide impetus for targeted health strategies for at-risk ethnic populations.

Keywords: Ethnic health inequalities, Māori, Pacific Peoples, Out-of-hospital cardiac arrest, Emergency medical service, Paramedic

Introduction

In Aotearoa (New Zealand) the ethnicity of population groups is measured via the national Census and the Ministry of Health Primary Health Organisation (PHO) enrolment data.[1,2] In the first quarter of 2019, the population of NZ was 4.59 million, of which 15.8% were indigenous Māori, 7.3% Pacific Peoples (Polynesian people from Pacific Ocean island nations of Samoa, Tonga, Cook Islands, Niue, in order of numbers, plus others) and 77.0% European/Others (includes other residual ethnicities).[1] It is well established, both internationally and in NZ, that indigenous peoples and those from minority ethnic groups suffer inequity of health outcomes across a range of measures.[3,4]

In NZ, life expectancy at birth is considerably shorter for Māori and Pacific Peoples compared to non-Māori. For Māori, life expectancy at birth is 77.3 years for females and 73.5 years for males, compared with 84.3 years for non-Māori females and 80.9 years for non-Māori males.[5] Similarly for Pacific Peoples, life expectancy at birth is

78.3 years for females and 75.0 years for males. Notably these results amounted to differentials in life expectancy of 7.4 years in Māori males, 7.0 years in Māori females, 5.9 years in Pacific males, and 6.0 years in Pacific females.[5] Following cancer, coronary artery disease was the second highest contributor to these differentials, with Māori almost twice as likely, and Pacific Peoples 1.5 times as likely, to die of ischaemic heart disease as Europeans.[5−7]

Given these established stark differences in life expectancy and mortality rates due to heart disease it is imperative that all facets within the healthcare system, including emergency medical services (EMS), measure outcomes and contribute to making improvements in health equity. The largest provider of EMS in NZ is St John, serving 90% of the NZ population. In 2013 the St John NZ Out-of-Hospital Cardiac Arrest (OHCA) Registry was established and included within this registry dataset is a record of the patient's ethnicity. This allows us a unique opportunity to measure if heath disparities exist in the incidence and outcomes from OHCA between ethnic groups in NZ.

Methods

Design

This was a descriptive, cross-sectional study of OHCA incidence and outcomes according to ethnicity. The study was performed at a national level within NZ, with the exception of the Wellington region. The Wellington region, which contains 10% of the NZ resident population, was excluded from this study as it is serviced by the Wellington Free Ambulance service and, at the time of the study, data was unavailable for this service. The St John NZ OHCA Registry contains data for all OHCA attended by St John EMS, variables collected in this registry are described elsewhere.[8]

Inclusion and exclusion criteria

All OHCA events during the period 1 November 2016 to 31 October 2018 were included irrespective of whether a resuscitation attempt was made by St John EMS, the patient's age, event aetiology, or occurrence in the presence of EMS.

Population demographics

In NZ, individuals can identify with more than one ethnicity. However, the NZ Ministry of Health has developed a standard for reporting a single ethnicity per individual based on a prioritisation hierarchy.[9] These prioritised-ethnicity data were utilised for all calculations within this study.[1] The 2013 PHO Enrolment data from the NZ Ministry of Health (excluding the Wellington region) was used as the baseline from which to calculate age-adjusted incidence.[1,10]

Ethnicities analysed were: Māori (the indigenous population of NZ), Pacific Peoples (people predominantly from South Pacific Islands including Samoa, Cook Islands, Tonga and Niue), and European/Others. Residual ethnicities, which made up less than 5% of the St John OHCA Registry dataset, were included within the European/Others cohort. Asian ethnicity, although contributing to 13% of the NZ population, was included in the European/Other cohort as Asian patients made up less than 5% of the OHCA registry data.

Rurality

Rurality (urban versus rural) was determined by Statistics NZ 2013 Census Meshblocks aligned to the address/location of the OHCA event.[11] For the purposes of this study, urban and rural were defined by the following Statistics NZ Meshblock descriptors: urban included 'Main Urban Area' and 'Secondary Urban Area', whilst rural included 'Minor Urban Area', 'Rural Centre' and 'Other Rural'.[11]

Ethics

Ethical approval for this study was provided by the NZ Health and Disabilities Ethics Committee (No. HDEC 13/STH/192/AM02) and the Auckland University of Technology Ethics Committee (No. 13/367).

Statistical analyses

Variables were described as totals and percentages of total numbers. Pearson's Chi-Square test and the z-test for column proportions were used to compare nominal values. Binary logistic models were used to investigate differences in the outcomes; return of spontaneous circulation (ROSC) sustained to handover at hospital and survival to thirty-days. Data are presented as odds ratios (ORs) with 95% confidence intervals (CI). All variables investigated were used as covariates for the adjusted model. Data analysis was performed using IBM SPSS (V.25.0). A value <0.05 was considered statistically significant.

Results

Incidence (all events: includes events both with and without a resuscitation attempt)

During the study period, a total of 9995 OHCA events were attended by St John EMS. The total age-adjusted incidence (all events) during this period was 105.0 per 100,000 person-years. Of these events, European/Others made up 69.7% (n = 6495), Māori 22.1% (n = 2058) and Pacific Peoples 8.2% (n = 766) (Table 1).

The age-adjusted incidence per 100,000 person-years was greatest for Māori (144.4), followed by Pacific Peoples (113.5), then European/Others (93.8) (Table 1 and Fig. 1). When stratified by sex and ethnicity, the age-adjusted incidence was greatest for males of all ethnicities, with Māori males having the highest incidence at 189.1 events per 100,000 person-years, followed by Pacific Peoples (144.1), then European/Others (132.1). A similar trend was seen in females, with Māori females (101.6) followed by Pacific Peoples (83.5), then European/Others (57.6) (Table 1). When stratified by age and ethnicity, incidence was higher across all ages for Māori and Pacific Peoples with the exception of those older than 65 years old where rates in European/Others were the highest (Fig. 1).

Population characteristics (resuscitation attempted events only)

The proportion of the Māori population that had an OHCA event in the 0−14 year age group (6.9%) was higher than Pacific Peoples (4.1%) and both of these higher proportions than European/Others (1.9%), (p < 0.001) (Table 2).

Table 1 – Incidence of OHCA per 100,000 person-years. Stratified by ethnicity (all events, n = 9995).

Ethnicity[a]	N (%)	Age adjusted incidence[b]	Male Age adjusted incidence[b]	Female Age adjusted incidence[b]
European/Others	6495 (69.7%)	93.8	132.1	57.6
Māori	2058 (22.1%)	144.4	189.1	101.6
Pacific Peoples	766 (8.2%)	113.5	144.1	83.5
Total	9319 (100%)	105.0	144.1	67.7

[a] Missing data n = 676 (6.8%).
[b] Age adjusted to 2013 PHO enrolment data.

In the young adult to middle-age ranges (15−44 and 45−64 years), both Māori and Pacific Peoples had higher proportions of events than European/Others. Conversely, in the oldest age range (65-plus years), Māori and Pacific Peoples had significantly lower proportions of events (32.0% and 36.1% respectively) compared to European/Others (62.9%) (p < 0.001). When stratified by sex, Māori and Pacific peoples had higher proportions of events in females (37.7% and 34.2% respectively) compared to European/Others (29.1%), (p < 0.001) Table 2.

Cardiac arrest characteristics (resuscitation attempted events only)

Māori had a higher proportion of events that were of non-cardiac aetiology (30.0%) than Pacific Peoples (19.5%) or European/Others (20.2%), (p < 0.001) Table 2.

In terms of witnessed status, a lower proportion of events were witnessed by a bystander for Māori (44.8%) than Pacific Peoples (50.6%). A lower proportion of events were witnessed by EMS in both Māori (13.9%) and Pacific Peoples (11.4%) compared to European/Others (18.1%). Overall there was a higher proportion of unwitnessed events in Māori (41.4%) compared to European/Others (35.4%) (p < 0.001) (Table 2).

System response to cardiac arrest (resuscitation attempted events only)

There was a higher proportion of bystander CPR performed in Māori (65.7%) compared to European/Others (59.9%), (p < 0.001) Table 2. However, there was a lower proportion of community defibrillation in Māori (8.2%) compared to European/Others (11.0%). Māori also had

a lower proportion of shockable presenting rhythms (31.3%) compared to European/Others (38.0%). Pacific Peoples had faster EMS response times at 6 min (IQR 5−8), compared to Māori (7 min (IQR 5−10) or European/Others (7 min (IQR 5−11). Location analysis indicated lower proportions of Māori (0.8%) and Pacific Peoples (0.6%) were attended in aged care facilities than European/Others (4.1%). A higher proportion of OHCA events for Māori were in rural locations (39.6%) than both Pacific Peoples (6.1%) and European/Others (30.1%).

Outcomes (resuscitation attempted events only)

Unadjusted odds ratios suggested that both Māori and Pacific Peoples were less likely to have ROSC sustained to hospital compared to European/Others (Table 3). However, the adjusted odds ratio for ROSC sustained to hospital was significantly lower only for Māori (OR 0.74, 95% CI 0.64−0.87, p < 0.001) compared to European/Others.

Unadjusted odds ratio indicated lower thirty-day survival in both Māori and Pacific Peoples compared to European/Others (Table 3). This outcome was retained after adjusting for confounders, with significantly lower odds of survival to thirty-days in Māori (OR 0.61, 95%CI 0.48−0.78, p < 0.001) and Pacific Peoples (OR 0.52, 95% CI 0.37−0.72), p < 0.001) compared to European/Others.

Discussion

There are very clear differences in OHCA incidence, characteristics, and thirty-day survival between ethnicities within NZ. Both Māori and Pacific Peoples had higher incidences of OHCA than European/Others, which occurred at earlier ages. The proportions of OHCA by
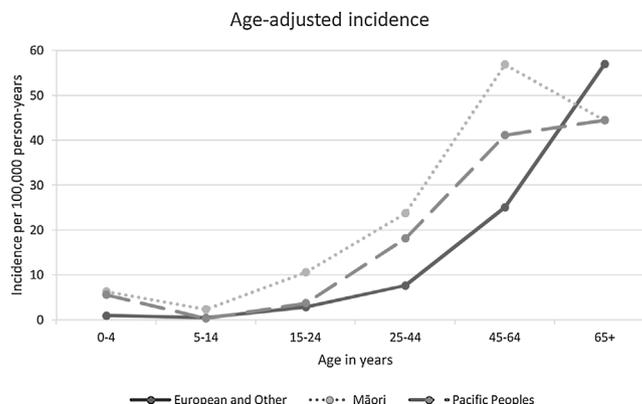

Fig. 1 – Age-adjusted incidence of OHCA per 100,000 person-years (stratified by age and ethnicity, age-adjusted to 2013 PHO enrolment data).

Table 2 – Characteristics of OHCA in New Zealand stratified by ethnicity (only includes events where resuscitation was attempted by EMS, n = 4749).

		Total (n = 4749)		European/ Others (n = 2989)		Māori (n = 1061)		Pacific Peoples (n = 466)		P values
		n	%	n	%	n	%	n	%	
Population characteristics										
Age	0–14	149	3.3%	57	1.9%	73	6.9%	19	4.1%	*<0.001
	15–44	547	12.1%	265	8.9%	189	17.8%	93	20.0%	
	45–64	1433	31.7%	788	26.4%	459	43.3%	186	39.9%	
	65 plus	2387	52.9%	1879	62.9%	340	32.0%	168	36.1%	
Sex	Female	1424	31.7%	867	29.1%	398	37.7%	159	34.2%	*<0.001
Cardiac arrest characteristics										
Aetiology	Cardiac	3502	77.5%	2384	79.8%	743	70.0%	375	80.5%	*<0.001
	Non-cardiac	1014	22.5%	605	20.2%	318	30.0%	91	19.5%	
Witnessed status	Bystander	2096	46.4%	1385	46.3%	475	44.8%	236	50.6%	*<0.001
	EMS	741	16.4%	541	18.1%	147	13.9%	53	11.4%	
	No	1679	37.2%	1063	35.6%	439	41.4%	177	38.0%	
System response										
Bystander CPR	Yes	2772	61.4%	1789	59.9%	697	65.7%	286	61.4%	*<0.001
Community defibrillation	Yes	460	10.2%	329	11.0%	87	8.2%	44	9.4%	*0.03
Shockable presenting rhythm	Yes	1636	36.2%	1136	38.0%	332	31.3%	168	36.1%	*<0.001
Response time (mins). Median, (IQR)	Response time	7 (5–10)		7 (5–11)		7 (5–10)		6 (5–8)		*<0.001
Location	Home	3261	72.2%	2100	70.3%	808	76.2%	353	75.8%	*<0.001
	Aged care facility	134	3.0%	123	4.1%	8	0.8%	3	0.6%	
	†Healthcare facility	124	2.7%	87	2.9%	22	2.1%	15	3.2%	
	Other	150	3.3%	101	3.4%	36	3.4%	13	2.8%	
	Public	847	18.8%	578	19.3%	187	17.6%	82	17.6%	
Rurality	Rural	1291	29.2%	880	30.1%	383	36.9%	28	6.1%	*<0.001
	Urban	3132	70.8%	2046	69.9%	654	63.1%	432	93.9%	
Outcomes										
ROSC on handover	Yes	1407	31.2%	982	32.9%	283	26.7%	142	30.5%	*<0.001
Thirty-day survival	Yes	755	16.7%	554	18.5%	137	12.9%	64	13.7%	*<0.001

* P < 0.05 is significant; χ2 test for nominal values. Mann Whitney U-test for continuous values. Missing values were 4.9% for all variables except sex (5.3%), Response time (5.2%) and Rurality (6.9%). Percentages may not add to 100% due to rounding. †Healthcare Facility refers to non-hospital treatment localities such as a general practice clinic. CPR, cardiopulmonary resuscitation; ROSC, return of spontaneous circulation.

Table 3 – Logistic regression evaluating the relationship between OHCA outcomes and ethnicity.

	Unadjusted OR	95% C.I.	Sig.	Adjusted OR[a]	95% C.I.	Sig.
ROSC on handover						
European/others (reference)	1.00			1.00		
Māori	0.72	(0.59–0.86)	<0.001	0.74	(0.64–0.87)	*<0.001
Pacific peoples	0.71	(0.55–0.90)	0.01	0.90	(0.72–1.11)	0.31
Thirty-day survival						
European and other (reference)	1.00			1.00		
Māori	0.65	(0.53–0.80)	<0.001	0.61	(0.48–0.78)	*<0.001
Pacific peoples	0.70	(0.53–0.93)	0.01	0.52	(0.37–0.72)	*<0.001

[a] Adjusted for age, sex, aetiology, witnessed status, bystander CPR, community defibrillation, shockable rhythm, response time, location, rurality.
* Statistically significant (p < 0.05).

patient sex also differed, higher proportions of OHCA occurred in females within the Māori and Pacific Peoples ethnicities. Notably, fewer OHCA events were EMS-witnessed in Māori and Pacific Peoples, indicating that ambulance help might not be sought as immediately in these ethnic groups. Pacific Peoples suffered OHCA predominantly in urban settings; this was reflected in the quicker response time taken by ambulances to reach the scene. Despite this, thirty-day survival in Pacific Peoples was not increased over other ethnicities. Māori received CPR from bystanders significantly more often than European/Others but still exhibited lower survival rates, in both ROSC sustained to hospital admission and thirty-day survival. Overall, European/Others had higher survival rates following OHCA; their ROSC rate was significantly higher compared to Māori, and their thirty-day survival rate was significantly higher compared to both Māori and Pacific Peoples. A number of factors may contribute to these disparities between ethnic groups within NZ.

Systemic inequities in healthcare delivery

The quality of care delivered both in-hospital and out-of-hospital is directly connected to the staff within these sectors. Culturally inappropriate care may frequently lead to negative interactions and poorer patient outcomes.[12] As observed in other healthcare professions, EMS personnel have a significant underrepresentation of Māori and Pacific Peoples. Although the NZ population has more than 15% Māori and more than 7% Pacific Peoples, in 2013 only 4.3% of EMS staff identified as Māori and 0.4% of the EMS personnel identified as Pacific Peoples.[13] Moreover, the same study found that over a 5-year period Māori accounted on average for only 7.5% of enrolments in tertiary paramedic education. Similar findings exist within the occupations of nursing (6.5% Māori, 2.6% Pacific Peoples) and medicine (3.6% Māori, 1.9% Pacific Peoples).[14,15] In order to deliver culturally appropriate care the workforce must represent the community that it serves, which in NZ it currently does not.

Alongside this underrepresentation of Māori and Pacific Peoples within the health workforce there is evidence of both institutional and interpersonal racism.[16] Data from the 2002/2003 NZ Health Survey captured via 12,500 face-to-face interviews revealed that Māori experienced the highest levels of racial discrimination at 34% and Pacific Peoples marginally less at 25% while European/Others (excluding Asian) were far less likely to experience discrimination at 4.5%.[17] A similar study, conducted as part of the 2011/12 NZ Health Survey, directly investigated the experience of racism towards a patient by a health professional.[18] Māori (4.4%) and Pacific Peoples (3.9%) were around five times more likely to experience racism by a health professional than European/Other (excluding Asian) (0.8%). In addition, the experience of racism by a health professional was associated with a higher unmet need for general practitioner care. Institutional racism has been demonstrated within the NZ social welfare system, a system with direct impacts on population health, in the seminal Ministerial Advisory Paper on social welfare, Puao te ata tu.[19]

Ischaemic heart disease (IHD)

Known risk factors for IHD are more prevalent in both Māori and Pacific Peoples than European/Other. The following data are from the April 2019 NZ Health Survey.[20] Tobacco smoking rates are 33.5% among adult Māori, 22.9% among Pacific Peoples, while the rate for European/Other (excluding Asian) was 13.5%. Obesity (BMI > 30) rates are 47.5% among Māori adults, 65.0% among Pacific Peoples, in comparison to 30.7% for European/Other (excluding Asian). The incidence of diabetes is similarly skewed: 7.8% of adult Māori suffered from diabetes, 12.2% of Pacific Peoples, and 4.9% of European/Other (excluding Asian). These risk factors contribute to a notably raised prevalence of IHD among Māori and Pacific Peoples.[20] For Māori, the adjusted odds ratio (OR) for IHD is 1.64 in comparison to non-Māori (adjusted for age and sex), and for Pacific versus non-Pacific Peoples the adjusted OR is 1.19.[20]

Socioeconomic status and deprivation

Socioeconomic factors are key determinants of health. The NZ Health Survey provides a Deprivation Index with data divided by quintiles for many aspects of population health.[21] All the risk factors for IHD described above demonstrate a direct relationship with deprivation — prevalence of each risk factor rose as deprivation increased. Tobacco smoking rose from 7.1% to 24.9% (from least to most deprived quintile). Obesity rose with deprivation from 26.0% (least deprived) to 43.8% (most deprived). The prevalence of diabetes in the adult population rose from 4.4% to 8.7% from least to highest Deprivation Index quintile. Overall, the prevalence of IHD in NZ displayed an adjusted OR of 2.03 between least and most deprived neighbourhoods.[20]

Socioeconomic status impacts on primary health in NZ in numerous ways. Pacific Peoples and Māori were more than twice as likely to have unfilled pharmacist prescriptions compared to non-Pacific Peoples and non-Māori.[20] Not visiting the GP through lack of transport was 2.18 times higher for Pacific versus non-Pacific Peoples, and this need rose steeply from least to most deprived neighbourhoods, from 1.0% to 5.8%.[20] Cost proved a barrier for seeking after-hours medical care; this affected women more than men, and was seen in both Pacific Peoples and in Māori.[20]

It is noteworthy that Pacific Peoples tend to live in urban centres; nearly two-thirds live in Auckland, NZ's largest city.[22] Shorter ambulance response times were seen in this group, which may help explain why rates of ROSC sustained to hospital admission were similar between Pacific Peoples and European/Others. Despite a high rate of transportation to percutaneous coronary intervention (PCI)-capable facilities in Pacific Peoples, thirty-day survival is still lower in this group.[23] Māori tend to live more rurally than either Pacific Peoples or European/Others.[22] Rurality can impact survival from OHCA, for example, there are fewer public automated defibrillators in rural locations, longer EMS response times and reduced numbers of EMS crew.[24−26] Moreover, distance and transport time to a 24/7 PCI-capable facility is increased; these facilities are currently only located in the bigger cities of NZ. We have recently shown that Māori have the lowest rate of transportation to PCI-capable facilities after OHCA.[23]

We observed higher rates of OHCA from a non-cardiac cause for Māori in this study. The rates of Sudden Unexpected Death in Infants (SUDI) are ethnically disparate in NZ: the number of Māori infants dying of SUDI was significantly higher than all other ethnicities over the five-year period from 2009 to 2013.[27] Māori have a higher unintentional harm rate than non-Māori, for all ages up to 65 years. The unintentional harm mortality rate for 15−64 year olds is more than 1.5 times the rate for non-Māori.[28] The main cause of OHCA from unintentional harm is motor vehicle accidents, but falls, drownings and accidental poisonings are also included. In the current study all aetiologies of OHCA were

included, such as presumed cardiac or traumatic. Consequently, the ethnic disparities revealed are likely to be multi-factorial.

The EMS sector in NZ is in its infancy in measuring and tackling ethnic inequities in health care. Current EMS initiatives support communities through delivery of free CPR courses and programs specifically targeting Māori in traditional community marae settings and to Pacific Peoples through neighbourhood churches.[26] Interestingly, these focused interventions may be having their desired effect since it was European/Others who had the lowest rate of bystander CPR across the ethnicities that we investigated. The relationships between socioeconomic inequity, risk factors for cardiac disease, institutional racism, alongside healthcare discrimination need to be addressed in ongoing and ethnically appropriate ways if OHCA incidence and outcomes for Māori and Pacific Peoples in NZ, and indigenous and ethnic minorities internationally are to improve.[18] As EMS providers, we have a responsibility to make iterative improvements to resuscitation techniques, transport destination decisions, community awareness, and access to public defibrillators to increase patient survival.

Limitations

The registry study is observational and descriptive, so causation cannot be demonstrated. Our analysis only covers two years of data and may not be truly representative of all populations; Pacific Peoples in particular may be under-represented due to the hierarchy of prioritised ethnicity in the NZ healthcare system because individuals who identify as both Māori and Pacific People are prioritised as Māori. The small number of events occurring in other ethnicity groups, such as Asian, prevented us from investigating a broader range of relationships in the NZ context. Although we have analysed the OHCA data for standard Utstein factors, there may well be other factors, perhaps within cultural contexts, that we have not accounted for.

Conclusions

Significant disparities in incidence and outcome from out-of-hospital cardiac arrest exist between ethnic groups within the NZ context. Both Māori and Pacific Peoples have a higher incidence of out-of-hospital cardiac arrest and are younger compared to Europeans/Others. Māori and Pacific Peoples also have lower survival to thirty-days compared to European/Others. This provides impetus for targeted health strategies for these ethnic populations. EMS initiatives in resuscitation technologies can only make limited inroads against these inequities; deeper societal changes are needed to correct the social determinants of health and disease.

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Competing interests

BD and VT are employees of St John.

Acknowledgements

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