Racial disparities in infection-related mortality at Alice Springs Hospital, Central Australia, 2000–2005

Lloyd J Einsiedel, Liselle A Fernandes and Richard J Woodman

ABSTRACT

Objective: To compare infection-related mortality rates and pathogens isolated for Indigenous and non-Indigenous adult patients at Alice Springs Hospital (ASH).

Design, participants and setting: Retrospective study of inhospital deaths of adults (patients aged ⩾ 15 years) associated with an infection during a medical or renal admission to ASH between 1 January 2000 and 31 December 2005.

Main outcome measures: Admission- and population-based infection-related mortality rates and mortality rate ratios (MRRs) for Indigenous versus non-Indigenous adults.

Results: There were 513 deaths, of 351 Indigenous and 162 non-Indigenous patients. For Indigenous patients, 60% of deaths were infection-related, compared with 25% for non-Indigenous patients ($P < 0.001$). The admission-based infection-related MRR for Indigenous versus non-Indigenous adults was 2.2 (95% CI, 1.6–3.1) (15.3 v 6.8 deaths per 1000 admissions; $P < 0.001$). After adjusting for age and year of death, the population-based infection-related MRR was 11.3 (95% CI, 8.0–15.8) overall (351 v 35 deaths per 100 000 population; $P < 0.001$) and 31.5 (95% CI, 16.1–61.8) for patients aged < 60 years. The median age of patients who died with an infection was 49 (interquartile range [IQR], 38–67) years for Indigenous and 73 (IQR, 58–80) years for non-Indigenous patients ($P < 0.001$). For Indigenous patients, 56% of infection-related deaths were associated with bacterial sepsis, with half of these due to enteric organisms. Other deaths followed chronic hepatitis B infection, invasive fungal infections and complications of strongyloidiasis.

Conclusion: Indigenous patients at ASH are 11 times more likely than non-Indigenous patients to die with an infectious disease. This racial disparity reflects the ongoing socioeconomic disadvantage experienced by Indigenous Australians.

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Indigenous Australians continue to live in socioeconomically disadvantaged conditions, reflected in a life expectancy 17 years less than for non-Indigenous Australians.[1] In the Northern Territory, the main contributors to this shorter life expectancy are now reported to be non-communicable diseases, such as cardiovascular disease, diabetes and malignancy, rather than infectious diseases.[2]

However, regional differences in incidence and prevalence rates of infectious diseases suggest this might not be true for all areas of the NT. In Central Australia, rates of invasive pneumococcal disease[3] and of chronic hepatitis B infection in some desert communities[4] are far higher than elsewhere, and rates of childhood bronchiectasis are among the highest in the world.[5] Bronchiectasis is associated with infection by the human T-cell lymphotropic virus type 1 (HTLV-1),[6] which is endemic to Central Australia but rare in the tropical north of the NT.[7] In resource-poor regions, HTLV-1 infection predisposes to scabies[8] and *Strongyloides* hyperinfection,[9] both of which may lead to life-threatening bacterial sepsis. The contribution of infectious diseases to Indigenous mortality in Central Australia might therefore be obscured by the inclusion of data from the more populous north.

Alice Springs Hospital (ASH) is the only hospital serving an area of more than 500 000 km^2, sparsely populated by about 15 000 Indigenous and 25 000 non-Indigenous Australians. More than 70% of all medical inpatients are Indigenous, and about 40% of all deaths in the region occur at ASH. We compared the pathogens and infective foci of patients who died during admission to a medical unit at ASH in a retrospective 6-year longitudinal study, to examine the burden of infectious diseases and associated infection-related mortality rates in Indigenous and non-Indigenous people.

METHODS

We conducted a retrospective audit of all inhospital deaths of adults (patients aged ⩾ 15 years) that occurred during a medical admission to ASH between 1 January 2000 and 31 December 2005. The primary and contributing causes of all admissions that resulted in death were determined using the ASH patient information database (CARESYS), which records morbidity codes for each patient according to the International classification of diseases, 10th revision, Australian modification (ICD-10-AM). An infection-related death was defined as one in which an infection was recorded as either the principal or an additional cause of admission. All infection-related deaths that occurred during a medical or renal admission (excluding admissions for day procedures or haemodialysis) were reviewed for details of microbiological and radiological tests.

The Central Australian Human Research Ethics Committee approved the study.

Statistical analysis

All statistical analysis was performed using Stata, version 10.0 (StataCorp, College Station, Tex, USA). Admission rates, mortality rates, and mortality rate ratios (MRRs) between Indigenous and non-Indigenous adults were assessed using Poisson regression. Admission-based mortality rates were calculated using the number of admitted adult medical and renal patients as the denominator. Population-based mortality rates were calculated using Australian Bureau of Statistics population data comprising yearly resident population estimates for people aged 15 years or older within the Alice Springs region as the denominator. Differences in proportions were calculated using the binomial test for proportions, and differences in medians using the Wilcoxon rank sum test.

RESULTS

Admission rates were consistently higher throughout the study period for Indigenous patients (547 per 1000 adults per year; 95% CI, 541–553) than non-Indigenous patients (140 per 1000 adults per year; 95% CI, 137–142) (incidence rate ratio, 3.92; $P < 0.001$).

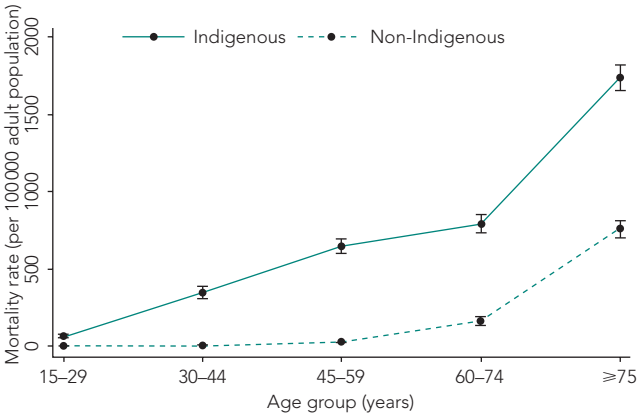
A total of 513 adult inhospital deaths (351 Indigenous, 162 non-Indigenous patients) occurred during medical or renal admissions

1 Infection-related mortality rates for Indigenous and non-Indigenous adults, Alice Springs Hospital, 2000–2005

	No. of deaths	Mortality rate (95% CI)*†	Mortality rate ratio (95% CI)‡
Admission-based mortality*			
All adults			
Non-Indigenous	41	6.8 (5.6–10.0)	1.0
Indigenous	209	15.3 (13.3–17.5)	2.2 (1.6–3.1)
Population-based mortality†			
All adults			
Non-Indigenous	41	35.3 (26.0–47.9)	1.0
Indigenous	209	350.6 (306.1–401.5)	9.9 (7.1–13.9)
15–29 years			
Non-Indigenous	1	3.0 (0.4–21.5)	1.0
Indigenous	16	62.1 (38.1–101.4)	20.5 (2.7–154.6)
30–44 years			
Non-Indigenous	1	2.4 (0.3–16.7)	1.0
Indigenous	68	343.2 (268.1–439.3)	145.9 (20.2–1052.3)
45–59 years			
Non-Indigenous	9	29.3 (13.4–63.8)	1.0
Indigenous	65	678.3 (531.9–864.9)	23.2 (11.1–48.6)
60–74 years			
Non-Indigenous	14	82.6 (39.4–173.2)	1.0
Indigenous	36	836.1 (608.4–1149.0)	10.1 (4.5–22.7)
⩾ 75 years			
Non-Indigenous	16	760.5 (465.9–1241.3)	1.0
Indigenous	24	1955.1 (1340.8–2850.9)	1.7 (1.0–2.8)

* Admission-based mortality rates are deaths per 1000 adult admissions.
† Population-based mortality rates are deaths per 100 000 adult population.
‡ Indigenous versus non-Indigenous adults. ◆

2 Population-based infection-related mortality rates among Indigenous and non-Indigenous adults by age, Alice Springs Hospital, 2000–2005



Vertical bars represent 95% confidence intervals. ◆

3 Characteristics and comorbidities of patients whose deaths were associated with an infection at Alice Springs Hospital, 2000–2005

	Indigenous ($n = 209$)	Non-Indigenous ($n = 41$)	*P* for difference
Male, female	120, 89	34, 12	0.04
Age at death, median (IQR)	49 (38–67)	73 (58–80)	< 0.001
Comorbidities*			
Diabetes	83 (40%)	7 (17%)	0.002
Alcohol dependence	80 (38%)	4 (10%)	< 0.001
End-stage kidney disease	35 (17%)	2 (5%)	0.049
Chronic liver disease	22 (11%)	4 (10%)	0.65
Congestive cardiac failure	17 (8%)	6 (15%)	0.31
Ischaemic heart disease	12 (6%)	3 (7%)	0.84
Palliative care	9 (4%)	10 (24%)	< 0.001

IQR = interquartile range. * Comorbidities obtained from the International classification of diseases, 10th revision, Australian modification (ICD-10-AM). ◆

in the period 2000–2005. The population-based all-cause inhospital mortality rate was 731 deaths per 100 000 population (95% CI, 606–803) for Indigenous adults, compared with 180 deaths per 100 000 population (95% CI, 157–206) for non-Indigenous adults. The MRR for Indigenous compared with non-Indigenous adults was 4.069 (95% CI, 4.067–4.071; $P < 0.001$).

Sixty per cent of deaths among Indigenous patients (209/351) were associated with an infection, compared with 25% among non-Indigenous patients (41/162) ($P < 0.001$). Death was related to malignancy for only 9% of Indigenous patients (31/351), compared with 39% of non-Indigenous patients (63/162) ($P < 0.001$). Infection-related mortality rates are shown in Box 1 and Box 2; characteristics and comorbidities of these patients are shown in Box 3. The overall population-based infection-related MRR for Indigenous versus non-Indigenous patients was 9.9 (95% CI, 7.1–13.9; $P < 0.001$) (Box 1). After adjusting for age and year of death in the Poisson regression model, the MRR increased to 11.3 (95% CI, 8.0–15.8; $P < 0.001$). The overall MRR for patients aged < 60 years was 31.5 (95% CI, 16.1–61.8), with no change after adjustment for year of death.

Excluding chronic viral infections, a pathogen was identified for 58% (122/209) of Indigenous and 37% (15/41) of non-Indigenous patients with infection-related deaths (Box 4). For Indigenous patients, bacterial pathogens were isolated from any site in 56% (117/209), and from blood in 38% (79/209). Half of the bacterial pathogens (58/117) were enteric organisms.

No non-bacterial infections occurred in non-Indigenous patients (Box 4). In Indigenous patients, non-bacterial infections identified were the parasitic infection strongyloidiasis (2), invasive fungal infections (3) and chronic hepatitis B viral infection (10). HTLV-1 serological status was determined for only one patient with proven strongyloidiasis. This patient was seropositive, as were all those with invasive fungal infections. Of 64 Indigenous patients whose HTLV-1 serological status was determined, 30 were seropositive.

A further 28% (59/209) of Indigenous and 34% (14/41) of non-Indigenous patients had radiological evidence of pneumonia, but no pathogen was isolated. The respiratory tract was therefore the main focus of infection for both groups (Box 5). Microbiology and imaging tests failed to identify a focus of infection for the remaining 9% (19/209) of Indigenous and 37% (15/41) of non-Indigenous patients.

At least one recognised risk factor for bacterial sepsis was recorded for 145 Indigenous (69%) and 23 non-Indigenous (56%) patients. For Indigenous patients, this was most frequently diabetes (40%), excess alcohol consumption (38%) or end-stage kidney disease (ESKD) (17%) (Box 3). Nearly a third of patients had no risk factors, and alcohol was the only identified risk factor for 28% of Indigenous patients.

DISCUSSION

We found marked racial disparities in infection-related mortality rates and in the types of pathogens isolated at ASH. Indigenous patients were 11 times more likely than non-Indigenous patients to die with an infectious disease, and this was associated with a 24-year difference in the median age of death compared with their non-Indigenous peers. Bacterial sepsis, often due to enteric pathogens, preceded the deaths of nearly 60% of all Indigenous patients. Our findings illustrate the large burden of infectious diseases in the Indigenous people of Central Australia.

Parasitic infestation, invasive fungal infections and chronic hepatitis B infection are also likely to have contributed to adverse outcomes for Indigenous patients. Internationally, HTLV-1 infection is a major risk factor for *Strongyloides* hyperinfection[9] and in our recent audit of complicated strongyloidiasis in the Central Australian Indigenous population, seven of 11 patients tested were HTLV-1 seropositive.[10] In this study, nearly 50% of Indigenous patients tested were HTLV-1 seropositive, compared with background HTLV-1 seroprevalence rates of 7.2%[11]–13.9%.[7] This difference is unlikely to result solely from a predisposition to strongyloidiasis, and most bacterial pathogens isolated were not those typically associated with scabies. Whether HTLV-1 infection increases the risk of bacterial sepsis or worsens its outcomes in some other way warrants further study.

In this study, 10 Indigenous patients with chronic hepatitis B infection died with complications of end-stage liver disease (ESLD). Prevalence rates of chronic hepatitis B infection have previously been reported to be as high as 26% in some Australian desert communities.[4] While incidence rates are now low since the introduction of vaccination, a cohort of older patients continues to progress to ESLD.

Possible limitations of this study are the accuracy of ICD-10-AM coding at ASH and an inability to establish the actual cause of death, as discharge coding is based on reasons for admission, not death. Nevertheless, microbiology and imaging tests independently confirmed the coded reason for admission for 91% of the Indigenous patients with infection-related deaths. Moreover, the infection-related mortality rate for the non-Indigenous patient group (0.35 per 1000 population) is consistent with estimated rates for white people in the United States (0.41–1.0 per 1000 population)[12-14] and rates of

4 Identified pathogens associated with terminal admission at Alice Springs Hospital, 2000–2005*

Pathogen	Indigenous (*n* = 209)	Non-Indigenous (*n* = 41)
Bacterial	**117**	**15**
Enteric pathogens	58	5
Klebsiella pneumoniae	24	1
Escherichia coli	12	0
Pseudomonas sp.	9	3
Other	13	1
Staphylococcus aureus	21	2
Methicillin-sensitive	12	2
Methicillin-resistant	9	0
Streptococcus pneumoniae	17	4
Haemophilus influenzae	6	0
Streptococcus pyogenes	4	1
Other	11	3
Chronic hepatitis B infection	**10**	**0**
Invasive fungal infection†	**3**	**0**
Strongyloides stercoralis	**2**	**0**

* Pathogens isolated from any site (sputum, urine, blood or other sterile site) during terminal admission, with the exception of one patient with biopsy-proven *Scedosporium prolificans* skull base osteomyelitis readmitted with extension of disease, and patients with chronic hepatitis B infection.
† *S. prolificans* skull base osteomyelitis (1) and *Cryptococcus neoformans* meningitis and pulmonary disease (2). ◆

5 Foci of infection associated with inhospital mortality at Alice Springs Hospital, 2000–2005

	Indigenous (*n* = 209)		Non-Indigenous (*n* = 41)	
	No. (%)	Median age (range)	No. (%)	Median age (range)
Pneumonia	111 (53%)	44 (16–102)	17 (41%)	72 (23–90)
Community acquired*	97 (87%)		16 (94%)	
BSI no focus†	23 (11%)	40 (23–72)	2 (5%)	88 (86, 89)
Community acquired‡	18 (78%)		2	
Bronchiectasis	19 (9%)	42 (16–71)	1	70
Pneumonia	10		1	
Infective exacerbation	5			
Empyema	2			
Unspecified sepsis§	19 (9%)	55 (26–89)	15 (37%)	78 (47–91)
Peritonitis	17 (8%)	46 (30–73)	2 (5%)	52 (45–58)
CAPD	7 (41%)			
SBP	10 (59%)		2 (100%)	
Other	14 (7%)	49 (25–81)	1 (2%)	57
Pyelonephritis	6 (3%)	50 (41–65)	3 (7%)	78 (75–80)

BSI = blood stream infection. CAPD = chronic ambulatory peritoneal dialysis. SBP = spontaneous bacterial peritonitis. * Radiological evidence of consolidation within 48 h of admission. † BSI with no focus of infection found after investigation. ‡ Pathogen isolated within 48 h of admission (excluding transplant and haemodialysis patients). § Cause of admission coded as due to sepsis but no pathogen or focus found. ◆

severe sepsis in major Australian centres (0.77 per 1000 population).[15] The contribution of infectious diseases to other deaths that were coded as being unrelated to infection, that occurred in other units or that followed transfer to tertiary referral centres was not studied. The observations reported here are therefore likely to underestimate the actual number of infection-related deaths at ASH.

Although reported rates of diabetes (31%)[14] and ESKD (13%)[16] for African Americans who died with sepsis approach those reported here, the major contributor to racial disparities in infection-related mortality in the US is HIV infection,[17] which remains rare in Central Australia. Nevertheless, racial differences in sepsis-related mortality rates between adult white and African Americans are far less than those we found, with a twofold difference consistently reported for hospital-based incidence and mortality rates in the US.[13,14,16] In contrast, Indigenous Australian adults were 11 times more likely overall, and those aged less than 60 were 31.5 times more likely, than non-Indigenous adults to suffer an inhospital infection-related death.

Infection-related mortality rates for Indigenous Australian patients are more comparable to those from other resource-poor regions. The proportions of infection-related adult deaths and admission-based mortality rates at ASH are similar to those in African hospitals before the current HIV pandemic (13.3%–34% and 1.45 per 100 admissions, respectively).[18,19] However, population-based infection-related mortality rates at ASH are considerably worse than those for some African hospitals before the arrival of HIV (0.56 and 1.1 per 1000 adults in rural South Africa[20] and Kenya,[18] respectively).

The relative increase in risk of death due to sepsis associated with diabetes[21] is reportedly 1.3, for alcohol dependence,[22] 1.46, and for established cirrhosis,[23] 2.0. Thus, these comorbid conditions are unlikely to fully account for the racial disparities in infection-related deaths at ASH. However, infection-related mortality rates at ASH are consistent with the known high incidence and prevalence rates of infectious diseases and their sequelae in Central Australia.[3-5,7] Very high background rates of infectious diseases in the Indigenous population are therefore likely to be the major contributor to racial differences in infection-related mortality. Inadequate housing, overcrowding and poor sanitation inevitably expose susceptible individuals to *Strongyloides stercoralis* and virulent bacterial pathogens. In some communities, the median number of people living in a house is still as high as 17,[24] and nearly 50% of houses are without functioning sanitation facilities.[25]

These data support the need for urgent intervention to improve housing infrastructure, sanitation and education, and reiterate the importance of regional clinical research to guide public health initiatives. Particularly important are prospective studies to determine whether infectious diseases, rather than chronic diseases,[2] are indeed the major cause of mortality in Central Australia. Studies are also needed to elucidate the clinical significance of HTLV-1 in the region and to define risk factors for bacterial infection, especially with the enteric pathogens associated with many deaths in this study. Such knowledge may allow Indigenous people to develop locally appropriate interventions that could reduce these alarming infection-related mortality rates.

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COMPETING INTERESTS

None identified.

AUTHOR DETAILS

Lloyd J Einsiedel, PhD, FRACP, Infectious Diseases Physician[1]
Liselle A Fernandes, BMedSci(Hon), Research Officer[2]
Richard J Woodman, PhD, MBiostat, Senior Lecturer in Biostatistics[3]
1 Department of Medicine, Alice Springs Hospital, Alice Springs, NT.
2 Clinical Research, Northern Territory Rural Clinical School, Alice Springs, NT.
3 Department of General Practice, Flinders University, Adelaide, SA.
Correspondence: lloyd.einsiedel@nt.gov.au

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