

BRIEF COMMUNICATION

Clinical characteristics and economic impact of acute hospitalisations due to bronchiectasis exacerbations among adult Indigenous Australians in the Top End Northern Territory

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Key words

cost analysis, disease burden, ethnic disparity, health economics, remote health.

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ABSTRACT

This cross-sectional study assessed the clinical and economic costs (Inpatient Activity Database) associated with hospitalisations due to bronchiectasis exacerbations among adult indigenous patients in the Top End, Northern Territory. Twenty case episodes from 15 indigenous patients with a mean age of 51.8 ± 12.7 years were recorded in a 3-month study window. The estimated cost was AUD 400 579.9, with cost per patient AUD 26 705 over 3 months and average cost per admission AUD 20 029. Extrapolating cost data across a 10-year period gave a conservative estimate of AUD 28 million.

Bronchiectasis is reported to be highly prevalent in the adult Indigenous Australian population, more specifically in the Northern Territory (NT) of Australia, where the highest proportion of indigenous people reside in comparison to any other Australian state or territory.¹ Globally, healthcare utilisation and hospital admission rates secondary to exacerbation of bronchiectasis are reported to be substantially higher among adult indigenous patients,^{2–4} including for adult Indigenous Australians.^{5,6} The economic cost of hospitalisations secondary to bronchiectasis is beginning to emerge across various socioeconomic groups.^{7,8} A systematic review in 2019 estimated an average hospital admission of 2–17 days due to bronchiectasis exacerbations in adults, with an annual cost up to USD \$36 000–37 000 per patient.⁹ However, the economic impact of acute

hospitalisation secondary to exacerbation of bronchiectasis is sparsely reported in the adult Indigenous Australian population. Therefore, this retrospective study assessed the clinical characteristics and the direct and indirect economic costs associated with acute hospital admissions secondary to bronchiectasis exacerbations in a convenience sample of adult indigenous patients residing in a remote island community in the Top End NT region, which was identified to have a significant prevalence of bronchiectasis (90/1000 residents) from our previous study.¹ Furthermore, we extrapolated the overall economic cost to our previous indigenous bronchiectasis cohort over a 10-year period (2011–2020) utilising the hospital admission data in order to provide an estimate of long-term cost,¹ in the assumption that the costs identified in the current study would reflect the typical cost of services.

This study was approved by the Human Research Ethics Committee (HREC) of the NT, Department of Health and Menzies School of Health Research (reference: HREC 2022-4487). Indigenous patients aged 18 years and older admitted under one general medical

Abbreviations: AUD, Australian dollar; ICD, International Classification of Diseases; ICU, intensive care unit; IQR, interquartile range; NT, Northern Territory; RDH, Royal Darwin Hospital; USD, US dollar

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unit between 1 August and 30 October 2022 at the Royal Darwin Hospital (RDH) secondary to acute exacerbation of bronchiectasis (within a 3-month study window) were assessed.

Clinical data were extracted via hospital electronic medical records. Episode-level hospitalisation data were extracted from the NT Inpatient Activity Database to estimate overall direct and indirect costs (in 2022) associated with the management for individual (episode) admissions secondary to bronchiectasis exacerbation. We evaluated the overall cost of hospitalisation, both direct (medical) and indirect expenses (non-medical (excluding patients/family personal costs)) of total health service for the included study participants. Furthermore, the hospital's structural costs for each patient were calculated and added to the total cost (corresponding to staff wages and other expenses).

All data are expressed as a mean, standard deviation and range (minimum to maximum) or interquartile range (IQR) and the frequencies as a number and percentage. The mean daily cost associated with specific International Classification of Diseases (ICD) ICD-J codes for patients in the current study was utilised as the basis to extrapolate to our previously collected bronchiectasis-related hospitalisations dataset (2011–2020).¹ To do this we matched either primary or secondary diagnosis ICD-J codes from the previous dataset with those of this study (Table 1). We then multiplied the mean daily cost of hospitalisation with the length of stay in the previous dataset and summed this to report the total cost associated with each ICD-J code, and thus the estimated total cost associated with bronchiectasis admissions. This, however, did not include indirect costs to the patient (i.e. loss of work) or family, nor did our extrapolation include the cost of medical retrieval from remote communities or adjust for inflation. All analyses were conducted in STATA IC version 15 (StataCorp, College Station, TX, USA).

Table 1 In-patient cost data for hospitalisations within the current study with a principal diagnosis ICD-J code

ICD codes	Number of admissions	Total days in hospital	Average daily cost	Total cost
J 12.9	1	4.0	2307.00	9227.99
J 18.9	2	5.0	2690.79	13 625.53
J 44.0	5	18.9	2547.64	48 472.68
J 44.1	1	2.6	1967.59	5194.44
J 47	5	28.4	2482.51	84 630.06
J 90	1	28.9	1726.11	49 901.8
J 96.01	2	19.6	2509.46	47 701.94

ICD, International Classification of Diseases.

During the 3-month study window, 20 hospital admission episodes from 15 adult indigenous patients were recorded. The average age of the patients was 51.9 ± 12.7 years (IQR 44.1–62.9 years), among whom eight (53.3%) were females. Table S1 shows the baseline demographic, clinical and laboratory parameters of the 15 patients. The mean length of hospital admission was 6 ± 6.3 days (median 4.2 days (IQR 2.4–7 days)) and there were three intensive care unit (ICU) admissions. The estimated total cost of care from hospital admissions due to bronchiectasis exacerbation in the 3-month period was AUD 400 579.9 (inpatient direct and indirect costs AUD 284 606.5 and flight retrieval cost AUD 115 973.4). The average estimated 3-month cost per patient was AUD 26 705.32 \pm 20 126.22 (range AUD 7610.6–72 727.84), with an average per admission cost of AUD 20 028.99 \pm 14 912.12 (range AUD 7610.6–64 304.7). Salary and wages accounted for the major portion of the total inpatient costs (direct AUD 197 051.20 and indirect AUD 28 408.54).

From 2011 to 2020 we assessed 3431 hospitalisations including 1657 ICU admissions, and estimated a total cost of AUD 28 468 981.12 (Table 2). Notably this includes only seven ICD codes and covers 11 455 days in hospital; however, in our 10-year study period, there was a total of 15 984 days in hospital, thus 4529 days (28.3%) were not counted.

This study showed substantial economic costs for hospital admissions secondary to exacerbation of bronchiectasis among remote residing adult indigenous patients, with a total economic cost of AUD 400 580 from just 20 admission episodes in a 3-month period. When this is extrapolated out across a 10-year period, the total cost associated with bronchiectasis hospitalisations is conservatively estimated to be in excess of AUD 28 million.

During acute exacerbations, indigenous patients residing in remote communities could be inevitably retrieved to RDH at significant cost. Yet, a previous study from this region reported that the vast majority of Indigenous Australian patients prefer going to the local community centre during worsening of their respiratory symptoms, and often do not wish for transfer outside of their community.¹⁰ However, in remote community clinics, the threshold to decide to transfer a patient to a tertiary care hospital may be low due to several factors, such as lack of specialist health practitioners who are trained/confident in the management of patients with acute respiratory exacerbations. Hence, it appears that training and education for remote community health professionals in the management of patients with exacerbations of respiratory airway disease at the community level when appropriate, may help solve this conundrum and reduce hospital bed days and related healthcare

Table 2 Ten-year hospitalisation data from 2011 to 2020

ICD codes	Number of admissions	Total days in hospital	Average daily cost (AUD)	Total cost (AUD)
J 12.9	2	3	2307.00	6920.99
J 18.9	390	1802	2690.79	4 848 798.17
J 44.0	1443	6182	2547.64	15 749 529.14
J 44.1	566	1353	1967.59	2 662 149.27
J 47	373	1983	2482.51	4 922 819.28
J 90	5	67	1726.11	115 649.31
J 96.01	11	65	2509.46	163 114.96
Total	2790	11 455	16 231.10	28 468 981.12

AUD, Australian dollar; ICD, International Classification of Diseases.

costs, including fulfilling patient's wishes to stay connected to land and family.

Recurrent lower respiratory infections play an important role in the pathogenesis and pathophysiology in bronchiectasis, giving rise to a vicious cycle of frequent infections and exacerbations leading to frequent hospital admissions.¹¹ Airway clearance techniques have been shown to be beneficial in reducing bronchiectasis exacerbation frequency.^{12,13} However, despite the known higher respiratory disease burden among Indigenous Australians, there is a distinct lack of pathways for accessing regular chest physiotherapy/sputum clearance and monitoring.¹⁴ Therefore, it is reasonable to speculate that investing in simple strategies such as providing dedicated respiratory chest physiotherapy services and referral pathways for indigenous patients residing in rural and remote communities may be a cost-effective way to better manage bronchiectasis.^{15,16}

The causes of exacerbations among remote residing indigenous people are likely to be multifactorial and complex, and associated with other health determinants, such as social and environmental disadvantages compounded by remoteness and geographic isolation. Previous reports have shown that bush fire, household crowding, poor household infrastructure, prevalence of smoking and reduced access to healthcare services contribute to exacerbation of respiratory conditions and hospital admission rates.¹⁷ Currently it is unclear whether bronchiectasis *per se* is driving higher airway exacerbation rates and hospital admissions or other potential previously unexplored factors such as exposure to environmental smoke, or concurrent presence of chronic obstructive pulmonary disease.^{18,19} As such, a more personalised and culturally appropriate approach has to be adopted, especially among indigenous patients, where multi-morbidity and other socioeconomic disadvantages are highly prevalent.²⁰

The authors acknowledge that there are several limitations in this study. The study was cross-sectional in nature and limited to a 3-month timeframe. It used a

relatively small sample involving only 20 case episodes with 15 adult indigenous patients, from only one remote indigenous community, admitted to one medical unit and therefore does not accurately represent the ambulatory care provided for patients residing in the remote community. Furthermore, the extrapolation to the larger 10-year dataset was restricted only to presentations with the seven ICD J codes listed as a principal or secondary diagnosis, thus excluded 28% of the dataset presentations, and did not take into account the cost of transport (air retrievals), which accounted for almost 25% of the total cost in the current study. In addition, there could be some bias in not considering the temporal trends in cost, inflation and so forth in the extrapolated data, including omission of indirect costs. We also were not able to assess indirect personal costs incurred by patients and family members. Moreover, the data represented in this study are limited to indigenous patients residing in one Top End region of the NT community and therefore may not be generalisable to the wider Indigenous Australian populations or for indigenous people globally. Nonetheless, the results of this study may be an avenue for health organisations and stakeholders to explore and implement strategies to reduce hospitalisation rates and develop pathways to prevent exacerbations at a community/primary health care level. Future prospective studies of community-based interventions to optimise bronchiectasis management in high prevalence settings are clearly warranted.

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References

- Gibbs C, Howarth T, Ticoalu A, Chen W, Abeyaratne A, Ford LP *et al.* Bronchiectasis among Indigenous adults in the Top End of the Northern Territory, 2011–2020: a retrospective cohort study. *Med J Aust* 2024; **220**: 188–95.
- Howarth T, Heraganahally SS, Heraganahally SS. Bronchiectasis among adult First Nations Indigenous people – a scoping review. *Curr Respir Med Rev* 2023; **19**: 36–51.
- Roberts ME, Lowndes L, Milne DG, Wong CA. Socioeconomic deprivation, readmissions, mortality and acute exacerbations of bronchiectasis. *Intern Med J* 2012; **42**: e129–36.
- Bibby S, Milne R, Beasley R. Hospital admissions for non-cystic fibrosis bronchiectasis in New Zealand. *N Z Med J* 2015; **128**: 30–8.
- Heraganahally SS, Ghimire RH, Howarth T, Kankanamalage OM, Palmer D, Falhammar H. Comparison and outcomes of emergency department presentations with respiratory disorders among Australian Indigenous and non-Indigenous patients. *BMC Emerg Med* 2022; **22**: 11.
- Howarth T, Gibbs C, Heraganahally SS, Abeyaratne A. Hospital admission rates and related outcomes among adult Aboriginal australians with bronchiectasis – a ten-year retrospective cohort study. *BMC Pulm Med* 2024; **24**: 118.
- Phua HP, Lim WY, Ganesan G, Yoong J, Tan KB, Abisheganaden JA *et al.* Epidemiology and economic burden of bronchiectasis requiring hospitalisation in Singapore. *ERJ Open Res* 2021; **7**: 00334–2021.
- Biatobock DR, Paz M d SM, Olmedo DWV, Barlem ELD, Ramos DF. Bronchiectasis: morbidity and mortality in Brazil and its impact on hospitalization rates. *Rev Soc Cienc Parag* 2022; **27**: 61–73.
- Goeminne PC, Hernandez F, Diel R, Filonenko A, Hughes R, Juelich F *et al.* The economic burden of bronchiectasis – known and unknown: a systematic review. *BMC Pulm Med* 2019; **19**: 54.
- Pal A, Howarth TP, Rissel C, Messenger RL, Issac S, Ford L *et al.* COPD disease knowledge, self-awareness and reasons for hospital presentations among a predominantly Indigenous Australian cohort – a study to explore preventable hospitalization. *BMJ Open Respir Res* 2022; **9**: e001295.
- Solarat B, Perea L, Faner R, de La Rosa D, Martínez-García MÁ, Sibila O. Pathophysiology of chronic bronchial infection in bronchiectasis. *Arch Bronconeumol* 2023; **59**: 101–8.
- Lee AL. Physiotherapy management of bronchiectasis in adults. *J Physiother* 2023; **69**: 7–14.
- Huang HY, Chung FT, Lin CY, Lo CY, Huang YT, Huang YC *et al.* Influence of comorbidities and airway clearance on mortality and outcomes of patients with severe bronchiectasis exacerbations in Taiwan. *Front Med* 2022; **8**: 812775.
- Welford A, McCallum GB, Hodson M, Johnston H. Physiotherapy management of First Nations children with bronchiectasis from remote top end communities of the Northern Territory: a retrospective chart audit. *Front Pediatr* 2023; **11**: 1230474.
- Lee AL, Hill CJ, Cecins N, Jenkins S, McDonald CF, Burge AT *et al.* The short and long term effects of exercise training in non-cystic fibrosis bronchiectasis – a randomised controlled trial. *Respir Res* 2014; **15**: 44.
- Lee AL, Burge AT, Holland AE. Airway clearance techniques for bronchiectasis. *Cochrane Database Syst Rev* 2015; **2015**: CD008351.
- Ali SH, Foster T, Hall NL. The relationship between infectious diseases and housing maintenance in Indigenous Australian households. *Int J Environ Res Public Health* 2018; **15**: 2827.
- Nockles V, Hill E, Howarth TP, Browning S, Wurrawilya S, Ford PL *et al.* Effects of environmental smoke exposure on respiratory conditions – a report of an Aboriginal man ‘fire hunting’ for ‘mud turtle’ in the Top End Northern Territory of Australia. *Am J Trop Med Hyg* 2024; **111**: 1373–7.
- Howarth TP, Jersmann HPA, Majoni SW, Mo L, Ben Saad H, Ford LP *et al.* The ‘ABC’ of respiratory disorders among adult Indigenous people: asthma, bronchiectasis and COPD among Aboriginal Australians – a systematic review. *BMJ Open Respir Res* 2023; **10**: e001738.
- Fraser CS, José RJ. Insights into personalised medicine in bronchiectasis. *J Pers Med* 2023; **13**: 133.

Supporting Information

Additional supporting information may be found in the online version of this article at the publisher’s web-site:

Table S1. Demographic and clinical characteristics of 15 study participants.