ORTHOPAEDIC SURGERY

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A retrospective cohort study comparing outcomes following hip fractures in Australian indigenous patients with non-Australian indigenous patients

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Abstract

Background: Australian Indigenous (AI) populations face significant socioeconomic disadvantage and have poorer health outcomes when compared to their non-AI counterparts. There is a paucity of published literature on outcomes following hip fracture in the AI population.

Methods: We performed a retrospective cohort study comparing outcomes following hip fracture in AI and non- AI patients presenting to a single regional trauma centre. The primary outcome of interest was all-cause mortality. Secondary outcomes of interest were the odds of postoperative delirium and length of stay in hospital. All outcomes were adjusted against collected baseline covariates.

Results: One hundred and twenty-seven hip fractures were identified across 125 patients. There were 62 hip fractures in the AI group and 65 in the non-AI group. The adjusted hazard ratio (HR) for all-cause mortality was not statistically significant when comparing Indigenous versus non-Indigenous patients ($HR = 2.37$, $P = 0.055$). Adjusted odds of postoperative delirium was lower in Indigenous patients ($OR = 0.12$; $P = 0.018$). The AI cohort had a 4 day longer median length of stay, which was not statistically significant when adjusted for covariates.

Conclusion: AI patients with hip fractures were younger, had a higher Charlson Comorbidity Index Score and American Society of Anaesthesiologists grade, as well as a higher incidence of diabetes and associated end-organ sequalae. There was no difference in all-cause mortality. Odds of postoperative delirium was lower in the AI group. We did not find any difference in the length of hospital stay.

Introduction

Osteoporotic hip fractures are common in the Australian elderly population, with approximately 18 700 cases reported annually.[1] Hip fractures impart significant strain upon healthcare resources globally though they account for only about 0.5% of total patient hospitalization episodes. This strain is related to inpatient treatment, rehabilitation, and the need for increased levels of support upon hospital discharge.[1–3] Australian Indigenous (AI) patients are at greater risk of osteoporotic hip fractures compared to their non-AI cohort.[1] Studies postulate this higher hip fracture risk in AI to be due to their higher burden of chronic disease, as well as differences in bone morphology and bone density.[4–6]

AI people account for 3.8% of the total Australian population. Among the States and Territories of Australia the Northern Territory has the largest proportion of AI people within its population and has the highest median age of AI people.[7] It is well established that the AI population experience significant social and healthcare disparities, with associated inferior healthcare outcomes compared to non-AI population.[8–11] The "Closing the Gap" initiative launched in 2008 has had limited success in identifying and addressing such inequalities, prompting calls for a rethink in strategy and further research within this area.[12,13] Fall related hospitalisations have steadily increased among AI patients, and specific intervention strategies aiming to reduce such presentations are yet to be established.[14]

Literature surrounding long-term outcomes after hip fracture in AI patients is sparse. One such study has demonstrated a shorter length of stay in AI patients after hip fracture, when adjusted for age and sex.[14] The primary objective of our study was to compare all-cause mortality after hip fracture in AI and non-AI patients. Our secondary outcomes of interests were to compare the incidence of postoperative delirium and length of stay in hospital between these two groups.

Methods

This is a 10-year retrospective cohort study of all patients admitted with a low-energy hip fracture to a single institution, Alice Springs Hospital (ASH). Ethical approval was obtained from the Northern Territory Human Research Ethics Committee prior to commencement of the study (Approval No.: 2023-4606). Recommendations by Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) were implemented in the reporting of the study.

Setting and study design

This study was performed at ASH, a publicly funded regional trauma centre situated within the Northern Territory of Australia. ASH is the primary referral centre for Central Australia and our orthopaedic department services Alice Springs, the adjacent rural town of Tenant Creek and over more than 50 widely dispersed remote communities crossing into adjacent States of South Australia and Western Australia. The estimated total population of Central Australia was 39 317, of which 43.3% are AI people.[15] ASH has an overall volume of hip fractures that is considerably smaller when compared to other units, however we face unique challenges given our location and patient demographic.

We retrospectively identified patients who presented to Alice Springs Hospital between the first of January 2012 and the 31st of December 2022 with a hip fracture using relevant ICD diagnostic codes (ICD-10-AM S72.0 to S72.2). Following patient file review, those who had a fracture dislocation of the hip, peri-implant or periprosthetic fractures, non-acute presentations, simultaneous bilateral hip fractures and hip fractures sustained from high-energy trauma were all excluded from our analysis. The patients were then divided into AI and non-AI groups based upon self- or family/ carer identification at time of admission. Mortality was determined by examination of medical records, which are linked to the Northern Territory's Office of Births, Deaths, and Marriages. Presence of postoperative delirium and length of acute inpatient stay in hospital was also ascertained by reviewing the patient's medical records.

Data collection, outcomes of interest and statistical analysis

Baseline demographic data, comorbidities and workflow barriers were collected and recorded. Crude incidence rate was calculated for both groups by combining our data with the government-estimated 2018 population data.[15] We also calculated adjusted incidence rate for the overall population above 45 years of age. The primary outcome of interest was all-cause mortality following hip fracture. Patients were censored at death, or in the case of survival, on the 30th of June 2023. Kaplan–Meier survival analysis was performed, with survival functions of the two groups compared using log-rank test. Hazard ratios (HR) were also computed using Cox-regression analysis. Odds of mortality at 30 days, 120 days and 1 year were also determined. Secondary outcomes of interest were the incidence of postoperative delirium and length of stay in hospital. We also recorded any re-operations.

Normality of continuous variables were determined using the Shapiro–Wilk test. If normality is assumed, the data was presented as mean ± standard deviation, and unpaired t-test was used to compare the difference between groups. However, if normality could not be assumed, the data was presented as median (range), and Wilcoxon rank sum test was used instead. Discrete variables were displayed as count (percentage) and was compared using odds ratios (OR), with statistical significance determined using chi-squared test. Using regression analysis, the outcomes of interest was adjusted for age, gender, fracture pattern, comorbidities, preoperative mobility status and the type of preoperative accommodation. Patients with subsequent contralateral hip fractures were analysed separately, except in the case of survival analysis. Stata Version 18.0 (StataCorp, Texas, USA) was utilized for all statistical analyses displayed. The threshold for statistical significance was set at $P = 0.05$.

Patient and public involvement

Prior to commencement of this study, our research team have engaged and discussed the usefulness of measured outcomes with our institution's Aboriginal Liaison Officers. Within our institution, Aboriginal Liaison Officers provide advocacy, support, and cultural brokerage for all AI patients, with an aim of enhancing patient-provider relationship. The interpretation of the data was performed in consultation with our senior author, LB, who is an Aboriginal Liaison Officer in ASH. She had also verified all conclusions we had made based on the data collected.

Results

Our search strategy initially yielded 134 patients, nine of which were excluded. The reasons for exclusion were high-energy fracture dislocations (2 patients), peri-implant/ periprosthetic fractures (2 patients), healed valgus impacted hip fracture (1 patient), and incorrect coding (4 patients). In total, 125 patients (with 127 hip fractures) were included in our final analysis. There were 62 hip fractures in the AI group and 65 hip fractures in the non-AI group. Two patients in the non-AI group sustained a subsequent contralateral hip fracture during the study period. The distribution of AI and non-AI patients within our study approximately mirrored that of our population. The median survival time was 3.71 (0–10.52) years. A flow diagram is shown in Figure 1.

Incidence rate of hip fractures

The crude incidence rate of our patient population was 53.41 per 100 000 people. When standardized for age, it was 149.48 per 100 000 population above the age of 45. The crude incidence of hip fractures was 64.61 per 100 000 in AI people and 44.86 per 100 000 non-AI people in Central Australia.

Patient demographics and comorbidities

Based on our patient demographic analysis, the AI group was significantly younger than the non-AI group (median difference = 6 years; $P = 0.033$). There were no significant differences in gender, pre-fracture mobility and pre-fracture accommodation status. In terms of comorbidities, the AI group had a significantly higher incidence of diabetes, chronic kidney disease stage 3–5 and ischaemic heart disease or heart failure. There were no significant differences in the other measured comorbidities. The AI group thus had higher American Society of Anaesthesiologists (ASA) grade and Charlson Comorbidity Index. There was no significant difference in the Nottingham Hip Fracture Scores between groups, a score validated for the prediction of mortality in patients with hip fracture at 30-days and 12-months after injury.[16,17] A complete description is shown in Table 1.

Fracture characteristics, surgical management, and workflow

Intracapsular hip fractures were predominant in both groups. The surgical strategy did not significantly differ between the two groups, overall, however, a greater proportion of patients in the non-AI group received cannulated screw fixation. There was no significant difference between groups for duration between injury to hospital presentation, or hospital presentation to the time of surgery. A similar proportion of patients of each group had delay of greater than 48 hours between their injury and time to surgery, Operating room logistics was the most common cause for delay. The result of our analysis is shown in Table 2.

Fig. 1. Patient selection flowchart.

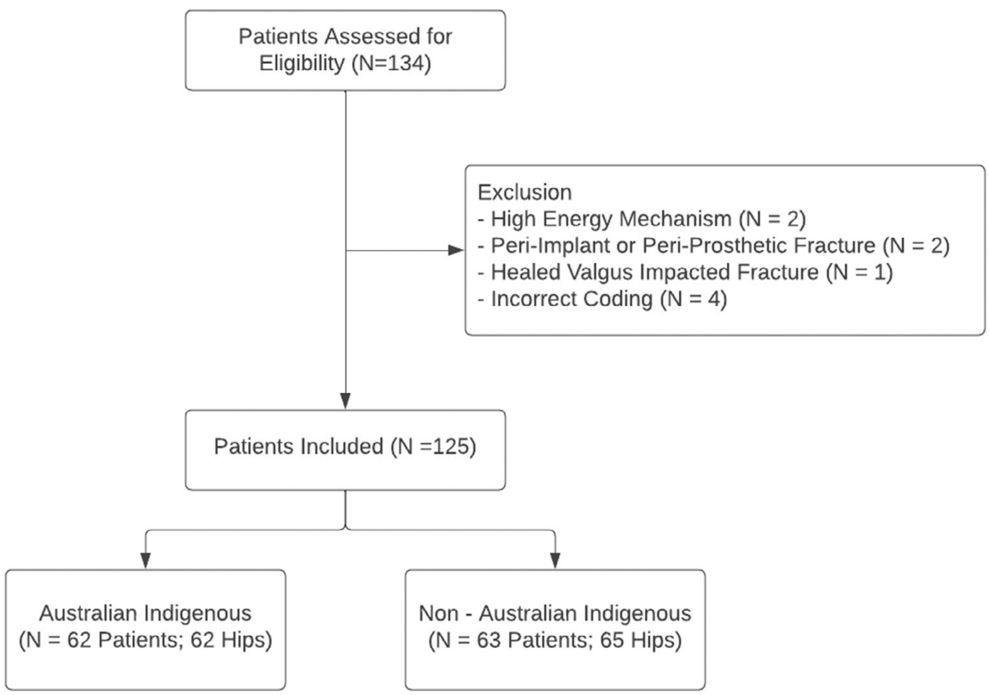

Table 1 Baseline demographic and comorbidities

	Australian Indigenous ($N = 62$)	Non-Australian Indigenous ($N = 65$)	*P*-value
Age at time of injury in years, median (Range)	69 (42–96)	75 (36–94)	**0.033**†
Gender, frequency (percentage)			0.600§
Female	40 (64.5)	39 (60.0)	
Male	22 (35.5)	26 (40.0)	
Pre-fracture mobility, frequency (percentage)			0.249§
Independent	35 (56.5)	45 (69.2)	0.136§
Single point stick/crutches¶	11 (17.7)	6 (9.2)	0.159§
Walking frame/wheelchair bound¶	16 (25.8)	14 (21.5)	0.571§
Pre-fracture accommodation, frequency (percentage)			0.079§
Home (independent)	35 (56.5)	44 (67.7)	0.192§
Home (support)	21 (33.9)	11 (16.9)	**0.028**§
Nursing home	6 (9.7)	10 (15.4)	0.333§
Chronic kidney disease, frequency (percentage)			**< 0.001**§
1–2¶	22 (35.5)	43 (66.2)	
3–5¶	40 (64.5)	17 (26.2)	
Major cardiac disorder, frequency (percentage)			
Arrhythmias	9 (14.5)	12 (18.5)	0.550§
Ischaemic heart disease/heart failure	30 (48.4)	17 (26.2)	**0.009**§
Major respiratory disorder, frequency (percentage)	15 (24.2)	17 (26.2)	0.799§
Major neurological disorders, frequency (percentage)			
Seizure disorders	4 (6.5)	3 (4.6)	0.650§
Others	4 (6.5)	6 (9.2)	0.561§
Diabetes, frequency (percentage)	42 (67.7)	15 (23.2)	**<0.001**§
Peripheral vascular disease, frequency (percentage)	15 (24.9)	16 (24.6)	0.956§
Rheumatological disease, frequency (percentage)	4 (6.5)	7 (10.8)	0.387§
Malignancy diagnosis within 20 years, frequency (percentage)	6 (9.7)	14 (21.5)	0.067§
Anticoagulant/antiplatelet use, frequency (percentage)	26 (41.9)	21 (32.3)	0.261§
Dementia/cognitive impairment, frequency (percentage)	13 (21.0)	11 (16.9)	0.561§
American Society of Anaesthesiologists (ASA) Grade, frequency (percentage)			**0.002**§
1	0 (0)	5 (7.7)	**0.026**§
2	7 (11.3)	20 (30.8)	**0.007**§
3	47 (75.8)	30 (46.2)	**0.001**§
4	8 (12.9)	10 (15.4)	0.161§
Charlson comorbidity index, median (range)	6 (2–21)	5 (0–10)	**0.006**†
Nottingham hip fracture score, Mean ± Standard Deviation	3.92 ± 2.01	4.15 ± 2.06	0.518‡

Note: These variables were omitted from the table due to small numbers but still included in multivariate analyses – Major Neurological Disorders; Rheumatological Disorders. Bold values represent statistically significant findings.

†Wilcoxon rank sum test.

‡Unpaired *t*-test.

§Chi squared test.

¶These variable outcomes were combined due to small numbers but analysed separately in multivariate regression.

Outcomes measured

The overall Kaplan–Meier survival function showed no significant difference between the two groups, when compared using log-rank test ($P = 0.222$). This is displayed in Figure 2. Cox-regression analysis showed that the HR for all-cause mortality in AI patients was 40% greater than non-AI patients. This did not meet statistical significance ($P = 0.225$). When adjusted for covariates, the HR for all-cause mortality was 2.37, which did not meet statistical significance ($P = 0.055$). Similarly, when adjusted for covariates, odds of mortality were not significantly different at 30-days (OR = 0.83, $P = 0.885$), 120-days (OR = 1.01, $P = 0.987$) and 1 year (OR = 5.01, $P = 0.109$).

The odds of postoperative delirium were lower in AI patients. Although not significant in the unadjusted analysis (OR = 0.90; $P = 0.802$), this was statistically significant in the adjusted analysis (OR = 0.12; $P = 0.018$). AI patients tended to have a longer stay in hospital than non-AI patients, but there was no statistically difference in length of stay in both adjusted and unadjusted analyses. A single patient required reoperation during the study period. These results are displayed in Table 3.

Discussion

The results of our study demonstrate that AI people with hip fracture to be younger in age and more comorbid. Though a greater proportion of AI patients required transfer into hospital, this was not associated with increase in time between injury to presentation, or to surgery. All-cause mortality was not significantly different

Table 2 Fracture characteristics, surgical management, and workflow

	Australian Indigenous (*N* = 62)	Non-Australian Indigenous (*N* = 65)	*P*-value
Fracture pattern, frequency (percentage)			0.137†
Intracapsular	47 (75.8)	56 (86.2)	
Extracapsular	15 (24.2)	9 (13.9)	
Management, frequency (percentage)			0.113†
Cannulated screw fixation	5 (8.1)	15 (23.1)	**0.020**†
Sliding hip screw	14 (22.6)	8 (12.3)	0.126†
Short cephalomedullary nail/long cephalomedullary nail§	5 (8.1)	7 (10.8)	0.602†
Hemiarthroplasty/total hip arthroplasty§	37 (59.7)	33 (50.8)	0.313†
Other	1 (1.6)	2 (3.1)	0.295†
Transfer from community/tennant creek, frequency (percentage)	33 (53.2)	21 (32.8)	**0.021**†
Time delay from injury to presentation in days, median (range)	0 (0–10)	0 (0–3)	0.053‡
Time delay from injury to presentation if patient was transferred in days, median (range)	1 (0–10)	0 (0–1)	0.076‡
Time delay from injury to surgery if patient was transferred in days, median (range)	1 (0–10)	1 (0–5)	0.100‡
Delay of >48 h to operation, frequency (percentage)	22 (36.1)	17 (27.0)	0.276†
Cause of delay, frequency (percentage)			0.701†
Operating room logistics/availability	13 (59.1)	9 (52.9)	
Patient transfer/medical optimisation/self-discharge and represent§	9 (40.9)	8 (47.1)	

Note: Bold values represent statistically significant findings.

†Chi squared test.

‡Wilcoxon rank sum test.

§These variable outcomes were combined due to small numbers.

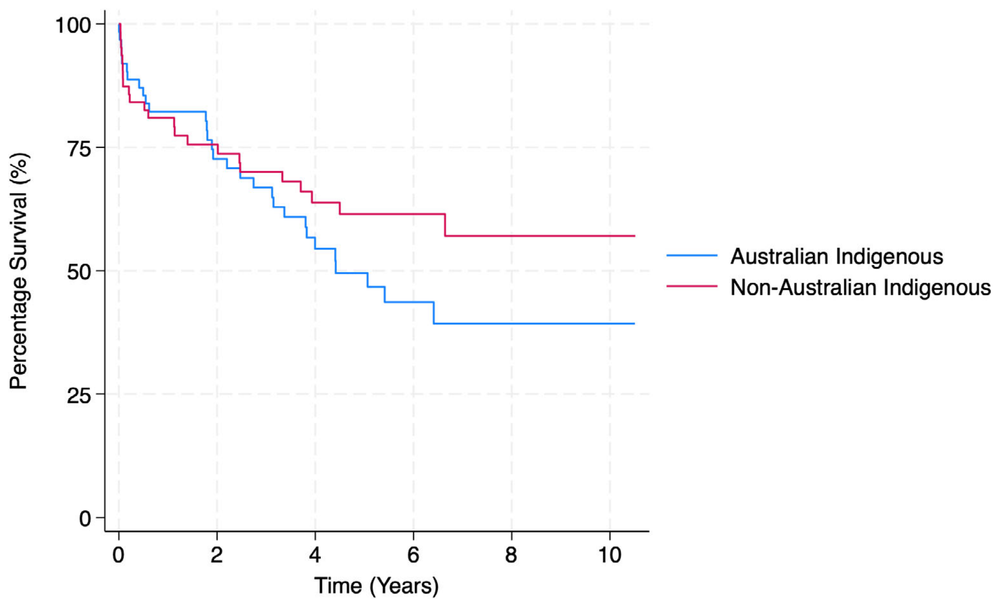

Fig. 2. Survival curve for all-cause mortality.

between the two groups, in terms of adjusted HR, as well as adjusted OR for deaths at 30 days, 120 days and 1 year. Our adjusted analysis showed significantly lower incidence of post-operative delirium in the AI group, but no difference in length of stay. The average length of follow-up was relatively short, at 3.72 years, due to the timeframe of our study with a bulk of presentations between 2016 and 2019 (Supplementary Fig. 1).

The crude hip fracture incidence rate in our population was lower than the national incidence rate (150 versus 199 per 100 000 population over 45 years of age). This may reflect an overall younger population within the Northern Territory.[1] Compared to the non-AI population, AI people had a higher crude incidence rate of hip fractures. This finding has been previously shown by Wong *et al.*[18] Although MacIntosh *et al.* have shown that AI patients present

Table 3 Patient outcomes

	Australian Indigenous ($N = 62$)	Non-Australian Indigenous ($N = 65$)	Unadjusted comparison (95% confidence interval; P-value)	Adjusted comparison (95% confidence interval; P-value)
Mortality	30 (48.39)	24 (36.92)	HR = 1.40 (0.81–2.41; 0.225)	HR = 2.37 (0.98–5.72; 0.055)
30 Days	5 (8.06)	7 (10.77)	OR = 0.73 (0.22–2.42; 0.604)	OR = 0.83 (0.06–10.97; 0.885)
120 Days	7 (11.29)	10 (15.38)	OR = 0.70 (0.25–1.97; 0.500)	OR = 1.01(0.11–9.43; 0.987)
1 Year	11 (17.74)	12 (18.46)	OR = 0.95 (0.39–2.35; 0.916)	OR = 5.01 (0.70–35.84; 0.109)
Postoperative Delirium†	15 (25.00)	17 (26.98)	OR = 0.90 (0.40–2.02; 0.802)	**OR = 0.12 (0.02–0.69; 0.018)**
Length of Stay, Days *	18 (0–235)	14 (1–86)	$\beta = 6.95$ (−1.44–15.35; 0.104)	$\beta = 0.91$ (−9.82–11.63; 0.867)

Note: Bold values represent statistically significant findings.

Abbreviations: β, β coefficient in linear regression analysis; HR, hazard ratio; OR, odds ratio.

†Measured for 123 patients (3 patients managed non-operatively and 1 patient died intraoperatively).

younger and do so with more comorbidities,[19] our study adds to the literature by describing the type of comorbidities associated with hip fractures in AI patients. We found the AI group to comprise a disproportionately greater number of diabetics and those with sequalae of diabetes, including chronic kidney disease, ischaemic heart disease and heart failure. This highlights the important role that primary care physicians, medical specialists and allied health professionals play in the management of diabetes, especially among AI patients.[20] Although the distribution of operative management did not significantly vary between groups, a smaller proportion of AI patients received cannulated screw fixation. Nevertheless, when stratified by fracture pattern, this difference was no longer statistically significant. The result of this stratified analysis is displayed in Supplementary Table 1.

We found no difference in all-cause mortality between the two groups. Of concern, when adjusted for covariates, there was an increased risk of death in AI patients following hip fracture, although this did not meet statistical significance. *Post-hoc* power analysis revealed that our study is under-powered. Based on our current survival probabilities, 278 patients in each group are required to detect a difference between groups using log-rank test. It is possible that in an adequately powered study, mortality in AI patients may be greater. Interestingly, AI patients were found to have lower odds of postoperative delirium than non-AI patients. This finding is surprising given that AI patients tend to be more comorbid. We speculate that this could be secondary to under-recognition of postoperative delirium, or due to a lack of culturally appropriate testing.[21] Gratifyingly, our length of stay was shorter than previously published averages of 25.0 days for AI and 26.5 days for non-AI patients.[14] Delays between injury and operation of greater than 48 hours was experienced by 39 operatively managed patients (31%). There was no significant difference between groups, however this falls short of accepted standard of care.[22] The most common cause for a delay in 56.4% all patients was operating room logistics or availability. This is an area for future investigation and improvement, as such delays have been associated with inferior patient outcomes.[23]

This is the first study investigating all-cause mortality after hip fracture in AI patients. There are several limitations to our study. First, its retrospective nature relies upon accurate data recording at the time of admission. Secondly, patients were classified as AI or non-AI based upon self- or family/carer identification. Due to the perceived risk of discrimination from past lived experiences, there may be under-disclosure of their status.[24] As our number of AI versus non-AI patients mirrored that of the estimated percentage population distribution, it is unlikely that there was significant under-disclosure. We did not perform a comparison of incidence rate between groups, as age-standardized incidence rates were unable to be calculated secondary to a lack of population data. The lack of population data also meant that we were unable to calculate annual incidence rates, which may have varied throughout the study period. Additionally, due to the retrospective nature of our study design, we were unable to present any patient reported outcomes, final disposition, or long-term disability. We were also unable to present data on clinical malnutrition and smoking status, as these assessments were not routinely performed. Lastly, mortality was determined based on medical records, which are linked to our local register. This may not have captured true mortality, as some patients may have died elsewhere. We were also not able to accurately analyse data on the precise cause of mortality, as this data was poorly captured. Knowledge of this missing data may be helpful in guiding future medical optimisation.

In summary, AI patients with hip fractures were younger, had a higher Charlson Comorbidity Index Score and American Society of Anaesthesiologists grade, as well as a higher incidence of diabetes and associated end-organ sequalae. They have a 2.37 times greater risk of mortality, which did not meet statistical significance. Odds of postoperative delirium was lower in the AI group. There was no difference in hospital length of stay between the two groups. Although more patients within the AI group required a transfer into hospital, there was no negative impact on delay to arrival or surgery. These results are likely generalizable to other similar centres to ours in Australia. Our study, although underpowered, is a first reporting mortality outcomes in this vulnerable population. Future research should be directed towards whether cultural bias is a significant factor in the identification of postoperative delirium in AI patients.

Author contributions

Tim Cheok: Conceptualization; formal analysis; investigation; methodology; writing – original draft. **Kate Bastick:** Conceptualization; data curation; methodology. **Daniel George:** Data curation;

investigation. **Teik Seng Chan:** Data curation; investigation; project administration. **Aayush Jaitly:** Data curation; methodology; project administration. **Narlaka Jayasekera:** Supervision; writing – review and editing. **Linda Bray:** Resources; supervision; writing – review and editing. **Pradeep Mathew Poonnoose:** Supervision; writing – review and editing. **Kanishka Williams:** Methodology; project administration; supervision; writing – review and editing.

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Conflict of interest

None declared.

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Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Supplementary Figure 1.
Supplementary Table 1.