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Health Service Use and Mortality of the Elderly Blind

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Purpose: To determine whether blindness in older people is associated with increased health service use and mortality.

Design: Retrospective matched cohort study from July 1, 1999, through June 30, 2010.

Participants: A blind cohort 65 years of age and older from a volunteer blind register and a cohort of age- and gender-matched controls selected randomly from the Western Australian electoral roll.

Methods: Person-level linked hospital, emergency department (ED), mental health, and death records for the blind and control cohorts were used. Generalized estimating equations assuming a negative binomial distribution were used to estimate relative rates of hospital admissions, lengths of stay, and mortality after adjusting for sociodemographic variables and comorbidity. Emergency department and mental health service visits also were quantified.

Main Outcome Measures: Relative rates of hospital admissions, lengths of stay, and mortality, as well as crude proportions of ED and mental health service visits.

Results: The blind cohort comprised 1726 individuals alongside 1726 matched controls; 39% were men, and the mean age was 83 years. Combined, the cohorts accumulated a total of 34 130 hospital admissions amounting to 201 867 bed-days. After adjusting for the principal reason for hospital admission and comorbidity, the blind cohort was admitted to the hospital 11% (95% confidence interval [CI], 6%−17%) more often than the control cohort. The blind cohort also stayed in the hospital longer than the controls, but this effect varied by age. Blind participants 65 to 69 years of age spent 88% more days (95% CI, 27%−178%) in the hospital compared with age-matched controls, whereas there was no difference in length of stay between the cohorts by 80 years of age (rate ratio, 1.10; 95% CI, 0.97−1.25). A larger proportion of the blind cohort visited a hospital ED and accessed mental health services compared with the control cohort.

Conclusions: Health service use is increased for the elderly blind compared with age-matched controls after accounting for comorbidity. The elderly blind have more hospital admissions, ED visits, and mental health-related visits. The younger elderly blind stay longer in hospital. However, there was no evidence of worse mortality outcomes after adjusting for comorbidity. *Ophthalmology 2015;122:2344-2350 © 2015 by the American Academy of Ophthalmology.*

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Blindness is principally a disease of aging in developed countries. In Western Australia (WA), the prevalence of blindness in persons 50 years of age and older is estimated at 0.4%[1] and is expected to increase with an aging population. It has been well established that visual impairment in the elderly is associated with reduced independence, physical mobility, social connectivity, and activities of daily living.[1,2] An increased prevalence of both physical and mental comorbidities, particularly anxiety and depression, also have been reported in the elderly with vision loss.[3−5]

Despite well-documented data on the incidence, prevalence, and causes of vision loss and blindness[1,6,7] and the associated comorbidities, little information exists on how vision impairment impacts health service use in the elderly blind. Several studies have reported poor vision in the elderly as a risk factor for single and recurrent falls[8] and for hospital admissions for falls.[9,10] Integrated mental health interventions in an outpatient setting have shown improvements in depressive symptoms.[11] However, the extent of hospital admissions, length of hospital stays, emergency department (ED) presentations, mental health outpatient contacts, and mortality outcomes in the elderly blind relative to their sighted contemporaries has not been quantified.

Herein we report the findings from a retrospective cohort study that used linked population-based administrative data sets to compare health service use and mortality outcomes in individuals who were registered legally blind at 65 years of age and older with an age-matched sighted cohort. The Western Australia Data Linkage System is a validated process that creates links that allows records from multiple health-related data sets to be brought together for all individuals living in WA.[12] Western Australia is the largest

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state of Australia with a population of 2.5 million, with most of the population living in the southwest corner that includes the only major metropolitan city, Perth.

Methods

Individuals 65 years of age or older at the time they were first registered as legally blind were identified from the voluntary register of the Association for the Blind of Western Australia from January 1, 2003, through December 31, 2009, and formed the blind cohort. The terms *blind* and *blindness* used throughout refer to legal blindness in Australia which is defined as having a best-corrected visual acuity of more than 1 logarithm of the minimum angle of resolution or a visual field of less than 10° in diameter, or a combination of both reduced visual acuity and field restriction, resulting in an equivalent level of vision loss in the better eye. We previously validated the accuracy of the clinical ophthalmic information on the register and established that approximately 50% of the eligible blind in WA were registered.[1,13]

A 1:1 age-matched (±2 years) and gender-matched control cohort was selected randomly from the state electoral roll. Because voting is compulsory in Australia, the electoral roll is considered representative of the adult population. The control selection and de-identified extraction of all hospital morbidity, ED, mental health outpatient, and death registration records for both cohorts from July 1, 1999, through June 30, 2010, were performed by the Data Linkage Branch, Department of Health of Western Australia.[14]

Each blind participant was assigned an index date that corresponded to the date of confirmed blindness from the blind registry. The corresponding age- and gender-matched control was assigned the same index date after confirming they were still alive at the index date. The hospital morbidity data were manipulated so that multiple episodes of care within the same hospital admission were combined into a single hospital stay record. Episodes of care followed by a transfer to another hospital also were combined into a single admission record. The length of stay for each admission was defined as the latest discharge date minus the earliest date of admission plus 1. The exposure time that an individual was at risk of a hospital stay was defined as time from July 1, 1999, through June 30, 2010, or until date of death if earlier.

The principal reasons for each hospital admission were categorized into 218 Clinical Classification Systems groups using published International Classification of Diseases, 10th Edition, Clinical Classification Systems translation codes.[15] Comorbidity associated with each hospital admission was identified from up to 21 codiagnosis fields in the hospital record and was classified as the presence or absence of the 30 different Elixhauser comorbidity conditions associated with increased risk of in-hospital death.[16] The proportion of participants with hospital admissions via the ED, any record of spending time in an inpatient psychiatric unit, and death during the study period also were determined.

The Accessibility and Remoteness Index of Australia was used to describe geographical accessibility to health services.[17] This index uses information about populations based on their access, by road, to service centers (towns) of various sizes, and ranges from major cities to the very remote. The Index of Relative Socio-economic Disadvantage was based on the most recent residential postcode.[18] This index combines census collected data on income, education, and unemployment of people and families, as well as dwellings within an area, and ranks these areas on a scale of relative disadvantage.

Age was classified into 10-year age groups to demonstrate overall trends. Being recorded as married or in a de facto relationship at the time of the 3 most recent hospital admissions was classified as partnered. Identification with being aboriginal or of Torres Strait Islander ethnicity on any hospital record was classified as being indigenous. Limited demographic information was available for participants who were not admitted to a hospital at all during the follow-up period and were classified as unknown where necessary.

Statistical Analysis

Bivariate associations of the various demographic factors and blind status were tested using Pearson's chi-square test for proportions, *t* tests for normally distributed continuous variables, and the Wilcoxon rank-sum test for medians. Because of multiple testing (218 identified diagnostic groups, 30 comorbidity groups), Bonferroni-adjusted critical *P* values were used when appropriate. Bivariate tests of associations with count variables were performed using negative binomial regression models with a single independent variable. All hospital admissions (including renal dialysis) were included in all regression analyses.

The association of being blind with hospital use was investigated using regression modeling adjusted for potential confounders, in particular comorbidity, because of the known association of blindness with increased morbidity. There were several steps involved in the modelling process. First, the records of each participant were collapsed such that the total number of hospital admissions, combined total length of stay (number of bed-days), and the presence or absence of all principal diagnostic and comorbidity groups at any time during follow-up were summarized onto a single record per participant. The length of follow-up (exposure time) for each participant also was recorded. Second, each of the large number of possible principal diagnostic and comorbidity combinations were reduced further into 2 empirically derived variables for each of the 2 main outcome measures: total number of admissions and the total number of bed-days. To create these empirically derived variables, each outcome was modeled using negative binomial regression models that included either all 218 identified principal diagnostic groups or all 30 comorbidity groups and accounted for exposure time. Based on these 4 models, the predicted total number of admissions and predicted total length of stay per person were estimated for each covariate pattern represented by the different possible combinations of either the principal diagnoses or comorbidity variables.

Finally, the effect of blindness on the 2 main outcome measures was estimated in 2 further models that included the newly created empirically derived variables containing the predicted outcome based on principal diagnosis and comorbidity. Other variables included in the final modeling process were age, gender, marital status, accessibility to services, and whether the participant underwent renal dialysis or chemotherapy or died during the follow-up period. To account for any similarity (lack of independence) between blind participants and their matched control, generalized estimating equations assuming a negative binomial distribution were used to estimate rate ratios after accounting for exposure time.

Mortality rates were age standardized using the 2009 WA population. Poisson regression was used to model mortality rates. Analysis was carried out using IBM PASW software version 18 (IBM Corporation, Armonk, NY) and Stata software version 13 (StataCorp LP, College Station, TX). This study was approved by the Human Research Ethics Committees of Curtin University and the Western Australia Department of Health.

Results

The blind cohort consisted of 1726 people confirmed as being legally blind and older than 65 years with 1726 age- and gender-matched persons in the control cohort. The mean age was

83 years (standard deviation, ±7 years) and 39% were male. Demographic characteristics of the cohorts are summarized in Table 1. More of the blind cohort lived in major urban areas compared with the control cohort, but there were no differences in socioeconomic status, marital status, or aboriginal ethnicity observed between the cohorts.

Cause of Blindness

The most frequent single causes of blindness in the blind cohort were age-related macular degeneration (n = 1096; 63.5%) followed by glaucoma (n = 98; 5.7%) and diabetic retinopathy (n = 47; 2.7%). Other less frequent single causes of blindness were optic neuropathy (n = 33), retinal dystrophies (n = 24), corneal conditions (n = 14), lens conditions (n = 15), and occlusions (n = 14). Multiple causes of blindness were observed in 246 people (14.3%), with almost half being the result of macular degeneration and glaucoma with or without cataract (n = 118; 48.0%). There were 77 people (4.5%) for whom a definitive cause of blindness could not be determined because of lack of information on the blind register.

Overall Health Service Use

The average number of hospital admissions per person did not vary significantly between the blind and control cohorts after taking length of follow-up into account (Table 2). However, after excluding admissions for renal dialysis, the blind cohort experienced more nonrenal hospital admissions than the control cohort. On average, each person in the blind cohort stayed in the hospital longer than persons in the control cohort regardless of whether days of renal dialysis were excluded. A higher proportion of persons in the blind cohort attended a hospital ED and received public mental health outpatient care over the study period compared with the control cohort. Overall, there were 208 individuals who did not attend the hospital during the study period, but this did not vary between the cohorts. There was no difference in the number of patients in each cohort who had day admissions for routine renal dialysis or chemotherapy or who spent time in a hospital psychiatric unit.

Table 1. Summary of Social and Demographic Characteristics of Control (n = 1726) and Blind (n = 1726) Cohorts

Characteristics	Control No.	Control %	Blind No.	Blind %	P Value
Gender					
Male	675	39.1	675	39.1	1.000
Female	1051	60.9	1051	60.9	
Age at index date (yrs)					
65–69	79	4.6	85	4.9	0.957
70–79	452	26.2	443	25.7	
80–89	907	52.5	909	52.7	
90+	288	16.7	289	16.7	
Accessibility index (ARIA+)					
Major cities	1142	66.2	1265	73.3	**<0.001**
Inner regional	280	16.2	204	11.8	
Outer regional	147	8.5	116	6.7	
Remote	37	2.1	26	1.5	
Very remote	10	0.6	8	0.5	
Unknown/missing	110	6.4	107	6.2	
Socioeconomic status (IRSD)					
Most disadvantaged	388	22.5	383	22.2	0.891
More disadvantaged	299	17.3	280	16.2	
Average disadvantaged	287	16.6	296	17.1	
Less disadvantaged	365	21.1	364	21.1	
Least disadvantaged	387	22.4	403	23.3	
Indigenous					
Yes	6	0.2	9	0.5	0.327
No	1614	93.5	1617	93.7	
Unknown	108	6.3	100	5.8	
Partnered					
No	738	42.8	803	46.5	0.084
Yes	880	51.0	823	47.7	
Unknown	108	6.3	100	5.8	

Boldface indicates significance level of 0.05.
ARIA = Accessibility and Remoteness Index of Australia; IRSD = Index of Relative Social Disadvantage.

Hospital Admissions

Combined, there were 34 309 hospital admissions during the follow-up period with just over half (53%) attributed to the blind cohort (Table 3). The distribution of total admissions per person was highly skewed because 19 patients had a combined total of 7450 admissions for renal dialysis. Just 3% (n = 483) of hospital admission records for the blind cohort included blindness (International Classification of Diseases, Tenth Edition, code, H54.0) as a diagnosis or codiagnosis. A higher proportion of admissions by persons in the blind cohort were via the ED compared with the control cohort.

There were 14 principal diagnostic groups that accounted for more than half (51%) of all hospital admissions for both cohorts combined (Table 3). Admissions for chronic renal failure were the most numerous, although the relative proportions did not vary between the blind and control cohorts. Of the most frequent diagnostic groups, there were more admissions for diabetes with complications, pulmonary disease, and anemia in the blind cohort compared with controls. In contrast, there were more admissions related to cataracts and cancer treatments in the control cohort. Of the less frequently observed diagnostic groups, persons in the blind cohort also were more likely to be admitted with immunity disorders, disorders of the jaw and teeth, schizophrenia and related disorders, glaucoma, retinal detachments, eye infections, and peripheral and visceral atherosclerosis (all $P < 0.00023$, data not shown).

Comorbid conditions recorded at the time of admission were classified into 30 Elixhauser comorbid conditions (Table 4, available at www.aaojournal.org). Persons in the blind cohort were significantly more likely to have had hypertension, chronic obstructive pulmonary disease, or diabetes with complications recorded as comorbidity compared with the control cohort.

The mean number of admissions that excluded renal dialysis were significantly higher in the blind cohort compared with the control cohort, but there was no difference between the cohorts for number of admissions that included renal dialysis (Table 2). To determine if these differences remained after adjusting for the social, demographic, and clinical variation between the cohorts, a multivariate regression model was constructed (Table 5). The blind cohort had 11% (95% confidence interval [CI], 6%–17%) more hospital admissions than the control cohort after accounting for the number of admissions predicted by the principal diagnosis along with comorbidity, renal dialysis, chemotherapy, and whether participants died during the follow-up period (hospital admission rates are known to increase in last year of life). Women had 9% fewer admissions than men, and those living in outer regional areas tended toward more hospital admissions. Socioeconomic status and marital status were not associated with the number of hospital admissions.

Table 2. Health Service Use and Mortality per Person by Cohort Status

	Controls (n = 1726)	Blind (n = 1726)	*P* Value
Average number of admissions per person-year, mean (SE)			
All admissions	0.9 (0.1)	1.1 (0.1)	0.252*
Admissions excluding renal dialysis	0.7 (0.02)	0.8 (0.02)	**<0.001***
Admissions for renal dialysis	0.2 (0.1)	0.3 (0.1)	0.660*
Average length of stay per admission (days), mean (SE)			
All admissions	5.7 (0.2)	6.6 (0.2)	**0.005***
Admissions excluding renal dialysis	5.5 (0.2)	6.4 (0.2)	**0.003***
Admissions for renal dialysis	0.2 (0.1)	0.3 (0.1)	0.653*
Average follow-up per person (yrs), mean (SE)	10.3 (1.5)	10.2 (1.5)	0.311†
Admission of patients during study period, no. (%)			
No hospital admissions at all	108 (6.3)	100 (5.8)	0.567‡
Admitted for renal dialysis	7 (0.4)	12 (0.7)	0.250‡
Admitted to hospital psychiatric unit	28 (1.6)	43 (2.5)	0.072‡
Received in-hospital chemotherapy	44 (2.5)	36 (2.1)	0.365‡
Attended emergency department	1324 (76.7)	1397 (80.9)	**0.002‡**
Mental health outpatient contact	146 (8.5)	204 (11.8)	**0.001‡**
Died during study period	491 (28.5)	577 (33.4)	**0.002‡**

SE = standard error.
All significance levels 0.05. Boldface values indicate significance.
*Wald test *P*-value from unadjusted negative binomial model taking length of exposure into account.
†*t* test.
‡Pearson chi-square test for equality of proportions.

Length of Stay (Bed-Days)

The combined blind and control cohorts spent a total of 201 867 bed-days in hospital over the 11-year study period. Renal dialysis accounted for 7476 (3.7%) of total bed-days. The unadjusted mean number of days spent in the hospital by each person over the 11-year period on average was greater for the blind cohort compared with controls regardless of whether renal dialysis was excluded (Table 2).

The number of days spent in the hospital for different medical conditions varied between the cohorts (Table 3). Almost 5% of bed-days in the hospital for the blind cohort was for complications of diabetes compared with only 2% of the control cohort bed-days. The blind cohort also had an increased proportion of bed-days in hospitals for acute cerebrovascular disease, lower limb fractures, chronic lung disease, heart conditions, and mood disorders compared with the control cohort. Interestingly, the control cohort had a higher proportion of bed-days for hip and other fractures compared with the blind cohort. There was no difference between the cohorts in the proportion of bed-days for chronic renal failure, back problems, or dementia and related conditions.

Regression models showed that blindness developing after 65 years of age was associated with an average 10% increase in the average number of days in the hospital over the study period compared with the control cohort after accounting for clinical features (Table 5). There was evidence that this increase in the blind cohort varied by age (interaction term $P = 0.004$). Blind persons 65 to 69 years of age spent 88% (95% CI, 27%−178%) more days in the hospital compared with controls of the same age, and blind persons 70 to 79 years of age spent 23% (95% CI, 3%−48%) more days in the hospital, whereas by 80 to 89 years of age, there were no significant differences in the mean number of bed-days between the blind and control cohorts (rate ratio, 1.10; 95% CI, 0.97−1.25). The number of days in the hospital also was increased for those without a partner at last admission, older persons, and those living in outer regional and remote areas.

Mortality

Of the study population, 31% (1068) died between the index date and the study end date, with more deaths in the blind cohort (n = 577) than the control cohort (n = 491; Table 2). The mortality rate for those older than 65 years was 79 per 1000 person-years for the blind cohort (95% CI, 69−89) and 58 per 1000 person-years for the control cohort (95% CI, 51−66) when age was standardized to the WA population, a 20% increased death rate (95% CI, 7−135) for aged blind persons. However, the observed difference in mortality rates between the blind and control cohorts disappeared after adjusting for comorbid conditions in a Poisson regression model that also included age and gender (rate, 1.08; 95% CI, 0.95−1.21).

Discussion

This study is unique in that it used linked health data sets to evaluate the use of health care services by a large cohort of blind elderly persons. Overall, the blind elderly went to the hospital more frequently, more often as an emergency, and stayed longer, particularly for those younger than 80 years, and were more likely to attend an ED and access mental health outpatient services.

It is well established that blindness is associated with increased comorbidity, with the vision loss itself often a consequence of underlying chronic disease.[4,19] Therefore, it is not unexpected that the elderly blind would have increased health service use. However, our observed differences remained after taking comorbidity and the principal reason for hospitalization into account. This suggests that blindness-related factors such as loss of functional ability to carry out activities of daily living and increased requirement for social and community support could result in a lower threshold for

Table 3. Summary of Admission Characteristics for Blind and Control Cohorts (n = 34 309, All Admissions)

Admission Characteristics	Controls		Blind		P Value*
	No.	%	No.	%	
Total no. of admissions	16 012	46.7	18 297	53.3	
Total length of stay (days)	93 236	46.2	108 631	53.8	
Hospital admission via emergency department	4863	30.4	6362	34.8	**<0.00023**
Most frequent principal diagnosis (CCS)					
Chronic renal failure	3465	21.5	4010	21.8	0.462
Cataract	1083	6.7	907	4.9	**<0.00023**
Coronary atherosclerosis and other heart disease	365	2.3	517	2.8	0.001
Other nonepithelial cancer of skin	418	2.6	446	2.4	0.315
Diabetes mellitus with complications	331	2.1	493	2.7	**<0.00023**
Spondylosis, intervertebral disc disorders, back problems	361	2.2	419	2.3	0.787
Maintenance chemotherapy, radiotherapy	413	2.6	337	1.8	**<0.00023**
Other aftercare	335	2.1	393	2.1	0.709
Rehabilitation care, fitting of prostheses, adjustment of devices	282	1.7	338	1.8	0.541
Osteoarthritis	315	2.0	275	1.5	0.001
COPD and bronchiectasis	202	1.3	363	2.0	**<0.00023**
Congestive heart failure, nonhypertensive	206	1.3	321	1.7	0.0004
Cardiac dysrhythmias	275	1.7	251	1.4	0.010
Deficiency and other anemia	194	1.2	319	1.7	**<0.00023**
Principal diagnoses associated with most bed days					
Diabetes mellitus with complications	2002	2.1	4979	4.6	**<0.00023**
Acute cerebrovascular disease	3211	3.4	4194	3.9	**<0.00023**
Chronic renal failure	3508	3.8	4167	3.8	0.738
Fracture of lower limb†	2841	3.0	4102	3.8	**<0.00023**
Osteoarthritis	3686	4.0	3572	3.3	**<0.00023**
COPD and bronchiectasis	2129	2.3	3437	3.2	**<0.00023**
Congestive heart failure, nonhypertensive	2374	2.5	3297	3.0	**<0.00023**
Other fractures‡	3242	3.5	3292	3.0	**<0.00023**
Fracture of neck of femur (hip)	2675	2.9	2905	2.7	0.008
Spondylosis, intervertebral disc disorders, back problems	2362	2.5	2752	2.5	0.995
Pneumonia	2571	2.8	2637	2.4	**<0.00023**
Rehabilitation care, fitting of prostheses, adjustment of devices	2809	3.0	2588	2.4	**<0.00023**
Senility and organic mental disorders§	2071	2.2	2478	2.3	0.366
Affective disorders‖	1357	1.5	2433	2.2	**<0.00023**
Coronary atherosclerosis and other heart disease	1385	1.5	2312	2.1	**<0.00023**

CCS = Clinical Classification Systems; COPD = chronic obstructive pulmonary disease.
*Significance level Bonferroni-adjusted critical P value of 0.00023 to account for multiple (n = 218) comparisons. Boldface values indicate significance.
†Includes femur but not neck of femur.
‡Includes nonlimb fractures (spinal vertebrae, rib, pelvis, etc).
§Includes all dementias.
‖Includes mood disorders (depressive, bipolar, mania).

hospital admissions and subsequent longer stays independent of comorbidity. It is also likely that findings are subject to some residual confounding from unmeasured aspects of comorbidity, such as severity, a limitation that can be overcome with a prospective randomized study.

The blind cohort spent more days in the hospital with mood disorders and had more contact with public mental health outpatient services compared with the control cohort. These data support previous reports of significant levels of mental illness and depression, estimated to affect up to one-third of severely visually impaired and blind people.[20] Generally, only severe affective disorder is treated in an acute care hospital setting, so the extent of depression in either the blind or control cohort is likely an underestimate. Rather, the present data represent the severe end of psychiatric conditions.

Our findings that the blind cohort spent more days in the hospital for lower limb fractures (excluding neck of femur), but proportionally fewer days in the hospital for neck of femur and other fractures, compared with controls is surprising. It is well known that vision impairment is a risk factor for falls and injuries,[21,22] but our findings seem to suggest that the blind elderly cohort experienced a different type of fracture profile than the controls. This finding remains to be verified in a more detailed study, but if it was this case, it could assist with design of rehabilitation programs targeting the blind.

We previously reported higher mortality rates in working-age blind people (age range, 18–65 years) when compared with normally sighted and age-matched controls.[23] Here, the increased crude mortality in elderly blind was explained entirely by the increased comorbidity. This suggests that blindness per se did not increase the death rate in the elderly blind, but rather the combination with associated comorbidity. This is in contrast to other observational studies that report greater excess mortality in the elderly with vision loss.[24,25] These studies were able to adjust for functional ability, which we could not, a limitation of our

Table 5. Two Regression Models Estimating (1) the Relative Rate of Hospital Admission and (2) the Relative Number of Days in the Hospital Estimated Using Generalized Estimating Equations Assuming a Negative Binomial Distribution (n = 34 309, All Admissions Included)

	Admissions			Bed Days*		
	Rate Ratio	*95% Confidence Interval*	*P Value*	*Rate Ratio*	*95% Confidence Interval*	*P Value*
Vision status						
Controls	1	Ref	—	1	Ref	—
Blind	1.11	1.06–1.17	**<0.001**	1.10	1.02–1.19	**0.012**
Age at index date (yrs)						
65–69	1	Ref	—	1	Ref	—
70–79	1.05	0.91–1.20	0.514	1.02	0.82–1.26	0.876
80–89	1.15	1.01–1.32	**0.041**	1.26	1.02–1.55	**0.030**
90+	1.00	0.87–1.16	0.947	1.37	1.09–1.72	**0.007**
Married/de facto						
No/unknown	1	Ref	—	1	Ref	—
Yes	0.96	0.90–1.01	0.132	0.81	0.73–0.89	**<0.001**
Gender						
Male	1	Ref	—	1	Ref	—
Female	0.91	0.86–0.96	**<0.001**	1.05	0.96–1.15	0.316
Accessibility classification						
Major cities	1	Ref	—	1	Ref	—
Inner regional	0.93	0.87–1.00	**0.041**	0.84	0.76–0.93	**0.001**
Outer regional	1.11	1.03–1.20	**0.005**	1.24	1.00–1.53	**0.047**
Remote	1.03	0.86–1.22	0.781	1.35	1.05–1.74	**0.019**
Very remote	1.05	0.87–1.26	0.610	1.08	0.68–1.72	0.750
Health-related variables						
Renal dialysis						
No	1	Ref	—	1	Ref	—
Yes	0.91	0.37–2.20	0.825	1.86	1.13–3.06	**0.015**
Chemotherapy						
No	1	Ref	—	1	Ref	—
Yes	2.10	1.82–2.41	**<0.001**	1.39	1.17–1.64	**<0.001**
Died during follow-up						
No	1	Ref	—	1	Ref	—
Yes	1.62	1.53–1.71	**<0.001**	2.30	2.09–2.53	**<0.001**
Predicted no. of events†						
Based on principal diagnosis	1.02	1.02–1.02	**<0.001**	1.01	1.01–1.01	**<0.001**
Based on comorbidity	1.00	1.00–1.01	**<0.001**	1.03	1.02–1.03	**<0.001**

Ref = referent group.
Significance level, 0.05. Boldface values indicate significance.
*Conditional on having at least 1 hospital admission during the study period (excluded 208 persons with no hospital admissions).
†Refers to relative change in either the number of admissions or number of days, with each increase of 1 in the empirically derived variables that predicted the number of events (admissions or bed days) based on principal diagnosis and comorbidity alone (see "Methods" for more details). Empirically derived prediction variables were entered as continuous variables and final rate ratios are interpretable only as an adjustment for comorbidity and principal diagnosis.

study. However, these previous studies were restricted to self-reporting of a limited set of comorbid conditions, whereas we were able to account for a large range of comorbidity.

The strength of the present study was the ability to combine large health-related data sets at the individual person level across the entire state population, avoiding bias limitations associated with single-center studies. To the best of our knowledge, no other data are available on the health service use of such a large cohort of elderly legally blind persons. We previously validated the clinical information in the register of the Western Australia Association for the Blind and found it accurately recorded the level of vision loss.[13] However, only 50% of those eligible were actually registered with the Western Australia Association for the Blind,[1] and thus misclassification bias of a blind individual into the control cohort theoretically was possible, although unlikely. Although we believe that the blind elderly cohort was broadly representative, those registered as blind were more likely to have accessed a range of rehabilitation services compared with those not registered, and the impact of this on health service use currently is unknown. It is particularly difficult to assess because of the poor coding of blindness as a comorbid condition. Only 3% of hospital admission records for the blind cohort listed blindness as a comorbidity.

These data suggest that blindness is not only a significant burden for the individual, but also the health care system, from being prone to more comorbidity and potentially the condition of blindness itself. Programs improving self-esteem that enable and encourage social connectivity may reduce depression and related mental health problems. Further research is required to provide insight into whether encouraging and directing the blind elderly toward existing, community-based rehabilitation programs reduces the frequency of emergency presentations and length of time spent in hospitals.

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Abbreviations and Acronyms:
CI = confidence interval; **COPD** = chronic obstructive pulmonary disease; **ED** = emergency department; **WA** = Western Australia.

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