

Chronic disease comorbidity analysis

ISAAC 2012-2020



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Introduction

Chronic conditions are an ongoing cause of substantial ill health, disability and premature death. The prevalence of chronic diseases is increasing in Australia. In 2017-18, 47% of Australians had one or more chronic conditions, an increase from 42% in 2007-08. This was associated with a number of factors including the ageing population, improvements in the treatment and management of chronic conditions which extends life expectancy, and social and behavioural risk factors such as poor diet and physical inactivity [1].

As the prevalence of chronic conditions increases, it is expected that comorbidities – the presence of one or more conditions – and multimorbidity – the presence of two or more conditions in a person at the same time – will also become more common [1]. Multimorbidity can make treatment more complex and requires ongoing management and coordination of specialised care across the health system [2].

South Australia has an ageing population, which in itself is associated with higher rates of chronic disease, comorbidity and multimorbidity. Compared with the rest of Australia, South Australia has the second highest rate of type 2 diabetes (7.0%) and cardiovascular disease (6.9%) [3]. Data collected in the South Australian Population Health Survey in 2020 show that 55.8% of South Australian adults had at least one chronic condition, with around one quarter (25.9%) having two or more chronic conditions [4].

Over the last decade, there has been an increase in risk factors related to chronic disease. Data collected from the most recent National Health Survey have shown an increase in the proportion of South Australians who were overweight or obese (60.9% in 2007-08 increased to 68.3% in 2017-18) [6].

Subsequently, there is an ongoing challenge to manage the large numbers of people presenting to South Australian Emergency Departments and increasing need for hospitalisation.

This study aims to better understand the interrelated factors of chronic disease risk factors and chronic disease diagnoses in the population, and whether these trends have had an effect on the presentations to hospitalisations now.

The questions considered were:

- Was there an increase in comorbidity/complexity of people presenting to hospital between 2012 and 2020 in South Australia?
- If there was an increase in comorbidity/complexity, did this impact on total number of bed days?

Methods

Data

Data from all South Australian public hospitals were included from January 2012 to December 2020. Data were sourced from the Integrated South Australian Activity Collection (ISAAC). The data items provided by SA Health are presented in Appendix 1.

Analysis

To quantify the complexity of comorbidity, the Charlson Comorbidity Index [7] was used. The Charlson Comorbidity Index is a method of categorising comorbidities of patients based on the International Classification of Diseases (ICD) diagnosis codes found in administrative data, such as hospital abstracts data. Each comorbidity category has an associated weight (from 1 to 6), based on the adjusted risk of mortality or resource use, and the sum of all the weights results in a single comorbidity score for a patient. A score of zero indicates that no comorbidities were found. The higher the score, the more likely the predicted outcome will result in mortality or higher resource use [8].

Ratings were applied across all admissions and trends in those determined over time. Associations of co-morbidity with age, likelihood of admission, likelihood of a greater length of stay, likelihood of admission to ICU/ventilation were investigated. Long stay patients, defined as either ≥ 14 bed days or ≥ 30 bed days were analysed as separate cohorts.

All cases that were discharged on the same day of admission were excluded from analyses given the focus was on complexity of admission.

In order to serve the purpose of exploring the complexity of hospitalised patients over the study period, the principal diagnosis was included in the calculation of Charlson Comorbidity Index. Charlson Comorbidity Index scores were investigated both as a continuous variable and as categorical variables. The results were consistent across both methods. For illustration purposes, regression results from the later are presented.

SEIFA 2011 were used for 2012-2015 data and SEIFA 2016 were used for 2016-2020 data [9].

Because there was over dispersion of data in both the Charlson Comorbidity Index and bed days, a generalised linear model with negative binomial distribution and maximum likelihood optimisation was used.

All analyses were performed using Stata/SE 17.0 (StataCorp, Texas).

Results

Patient Characteristics

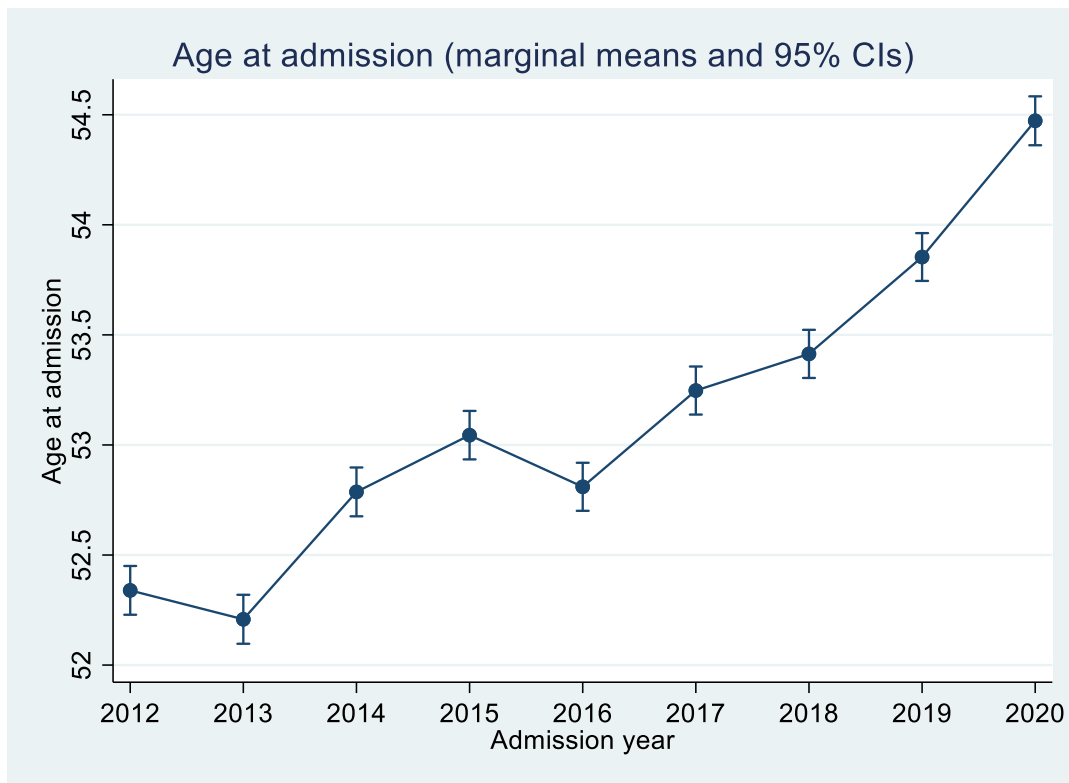
Table 1 presents the characteristics of hospitalised patients in South Australian public hospitals from 2012 to 2020. The number of admissions to hospital has increased over time, from 222,279 in 2012 to 231,616 in 2019. In 2020 there were 221,155 admissions, this reduction being because of the assumed impact of the coronavirus pandemic on non-essential and elective health services. Because of this, while 2020 data are presented in this report, comparisons will be made between 2012 and 2019. Consistently over time, the majority of patients were female, born in Australia, and admitted as an emergency. The average age at admission increased over time, from 53.2 years in 2012 to 53.9 years in 2019 (54.5 years in 2020). This trend was significant, $p < 0.001$ (Figure 1 and Figure 2). The proportion of elective admissions (including elective on a waiting list) decreased from 21.9% in 2012 to 16.9% in 2019, and the emergency admissions increased from 65.6% in 2012 to 67.4% in 2019. Both of these changes were statistically significant ($p < 0.001$).

Table 1 - Characteristics of hospitalised patients in South Australia, 2012-2020

	2012	2013	2014	2015	2016	2017	2018	2019	2020
Admissions, number	222,279	220,548	221,937	225,002	228,982	228,930	228,138	231,616	221,155
Male, %	46.8	46.8	46.6	46.4	46.6	46.7	46.8	46.7	46.7
Country of birth, %									
Others	28.5	28.6	29.1	29.2	29.4	29.1	28.3	28.1	28.0
Australia	71.6	71.4	71.0	70.8	70.6	70.9	71.7	71.9	72.0
Admission category, %									
Elective	10.0	9.7	10.1	9.9	8.1	8.1	8.2	7.0	6.6
Emergency	65.6	65.5	66.0	66.9	69.2	69.4	67.5	67.4	67.5
Elective: Waiting list	11.9	12.0	11.1	10.7	9.9	9.4	9.9	9.9	9.1
Not applicable	12.5	12.9	12.8	12.6	12.7	13.2	14.3	15.8	16.8
Source of referral, %									
Others	61.5	61.1	60.7	59.5	58.4	58.9	59.0	58.8	58.3
Casualty/emergency	38.6	38.9	39.3	40.5	41.6	41.2	41.0	41.2	41.7
ICU, %	3.9	3.8	3.9	4.1	3.9	3.7	3.8	3.8	3.7
On ventilator, %	1.5	1.5	1.5	1.5	1.5	1.3	1.1	1.2	1.3
Age at admission, mean (SD)	52.3 (26.6)	52.2 (26.7)	52.8 (26.6)	53 (26.6)	52.8 (26.6)	53.2 (26.9)	53.4 (26.7)	53.9 (26.8)	54.5 (26.4)
Hours in ICU, median (IQR)¹	46 (23,100)	46 (23,100)	45 (23,95)	45 (22,93)	45 (23,95)	45 (23,92)	45 (23,93)	44 (22,91)	45 (23,92)
Hours on ventilator, median (IQR)²	30 (16,87)	30 (13,93)	23 (11,77)	28 (12,91)	28 (12,93)	28 (12,92)	41 (16,114)	40 (16,106)	36 (15,98)

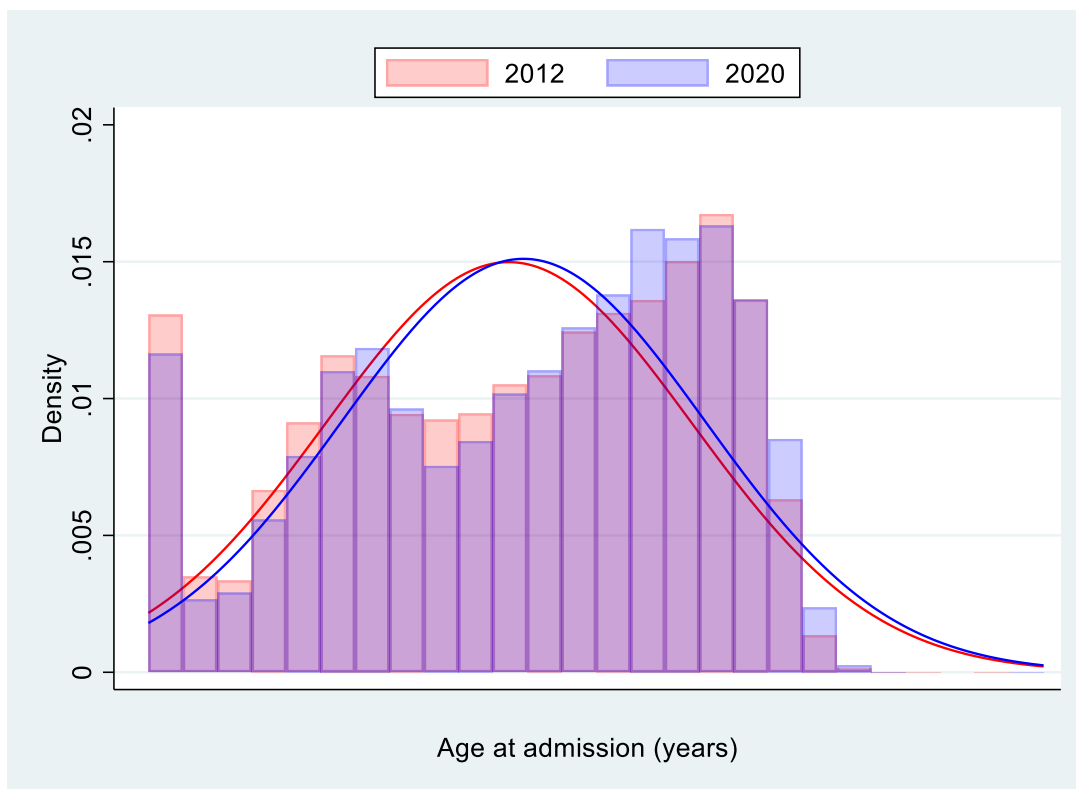
¹ Among patients who were admitted to ICU; ² Among patients who were on ventilator.

Figure 1 - Age at admission (years) over time period 2012-2020



Note: results are derived from a univariate generalised linear model ($p < 0.001$ for time trend, Wald test).

Figure 2 - Age distribution in 2012 and 2020



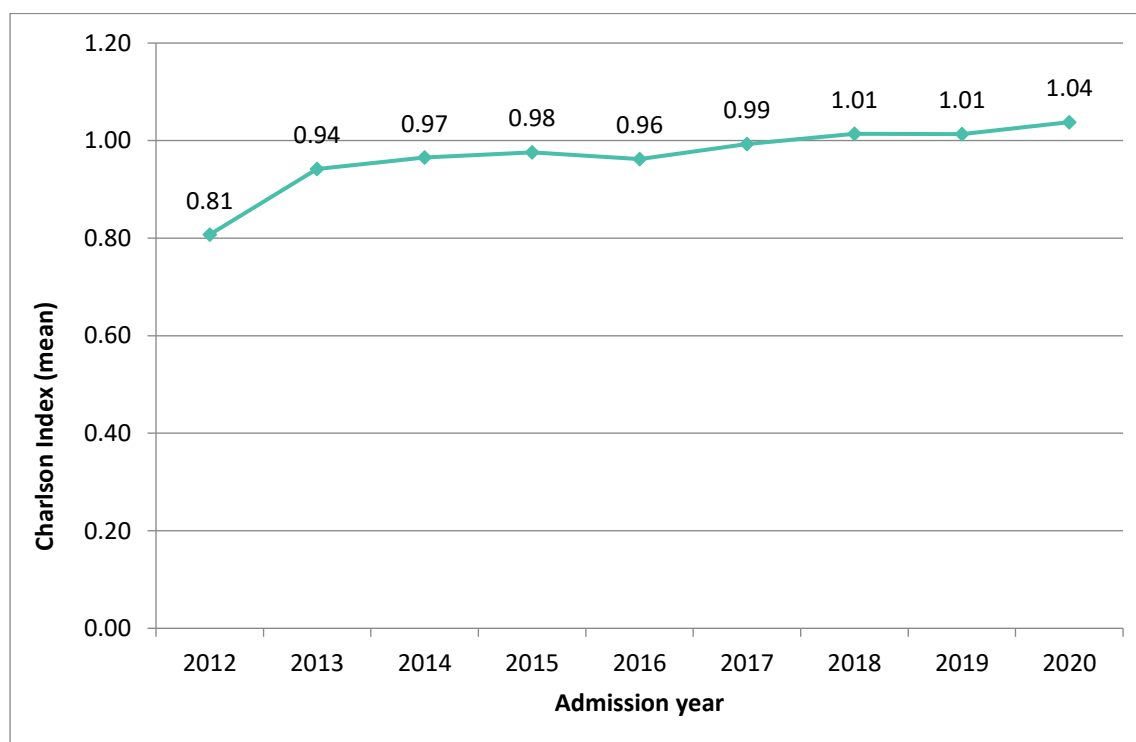
The Charlson Comorbidity Index

Table 2 presents the Charlson Comorbidity Index, both continuously and categorically. The Charlson Comorbidity Index increased significantly over time ranging from 0.81 (SD 1.72) in 2012 to 1.01 (SD 1.86) in 2019 (2020 M 1.04, SD 1.91) (Figure 3). The remaining analyses have been undertaken with the Charlson Comorbidity Index grouped into four categories being an index score of 0, 1, 2 and 3 or more. The proportion of admissions with a Charlson Index of 0 (that is no co-morbidity) decreased from 68.3% in 2012 to 60.4% in 2019 (2020 60.6%), while the proportions of admissions with a Charlson Comorbidity Index of 1, 2 or 3 or more increased over the same time period (Table 2).

Table 2 – Charlson Comorbidity Index of hospitalised patients in South Australia, 2012-2020

	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mean (SD)	0.81 (1.72)	0.94 (1.83)	0.97 (1.85)	0.98 (1.85)	0.96 (1.81)	0.99 (1.84)	1.01 (1.87)	1.01 (1.86)	1.04 (1.91)
Median (IQR)	0 (0,1)	0 (0,1)	0 (0,1)	0 (0,1)	0 (0,1)	0 (0,1)	0 (0,1)	0 (0,1)	0 (0,1)
Categorical (%)									
0	68.3	63.4	62.6	62.0	61.6	60.8	60.7	60.4	60.6
1	13.9	15.8	16.2	16.3	16.5	16.5	15.9	16.0	15.5
2	8.1	9.3	9.3	9.8	10.2	10.5	10.9	11.1	11.1
≥3	9.8	11.5	12.0	11.9	11.7	12.2	12.5	12.4	12.8

Figure 3 - Charlson Comorbidity Index (mean), South Australia, 2012-2020



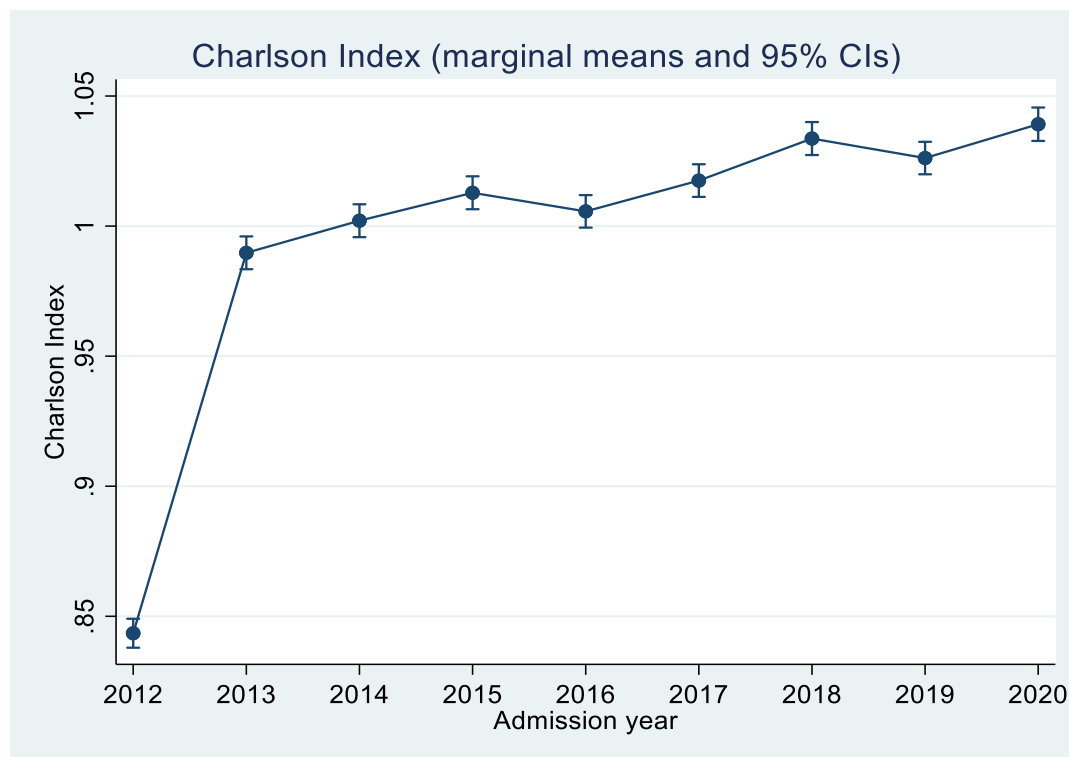
When the Charlson Comorbidity Index was categorised into four groups (score 0, 1, 2, and ≥ 3), and treated as a continuous variable in the model, the Charlson Comorbidity Index significantly increased in 2019 compared to 2012 (coefficient=0.24, 95% CI 0.23 - 0.25). This trend was independent of age at admission. After adjusting for age at admission, the Charlson Comorbidity Index in 2019 increased 0.21 units when compared to 2012 (coefficient=0.21, 95%CI 0.20 - 0.22) (Table 3 and Figure 4).

Table 3 - Charlson Comorbidity Index (categorical) trends over time period, 2012-2020

Year of admission	Univariate model coefficient (95% CI)	Multivariable model coefficient (95% CI)
2012	0	0
2013	0.15 (0.14 - 0.16)	0.15 (0.14 - 0.16)
2014	0.17 (0.16 - 0.18)	0.17 (0.16 - 0.18)
2015	0.19 (0.18 - 0.20)	0.18 (0.17 - 0.19)
2016	0.19 (0.18 - 0.20)	0.19 (0.18 - 0.20)
2017	0.22 (0.21 - 0.23)	0.20 (0.19 - 0.21)
2018	0.24 (0.23 - 0.24)	0.21 (0.20 - 0.22)
2019	0.24 (0.23 - 0.25)	0.21 (0.20 - 0.22)
2020	0.25 (0.24 - 0.26)	0.21 (0.20 - 0.22)
Age at admission		0.03 (0.03 - 0.03)

Results are from two generalised linear models with negative binomial distribution and maximum likelihood optimisation, and $p < 0.001$ (Wald test) for linear time trend for both univariate and multivariable models for year of admission. The Charlson Comorbidity Index has been categorised into four groups (score 0=0, score 1=1, score 2=2 and score 3 or more=3) and treated as a continuous variable in the model (each category is equal to one unit).

Figure 4 - Charlson Comorbidity Index (age adjusted means and 95% CI), 2012-2020, South Australia



Results are derived from a generalised multivariable linear regression model on Charlson Comorbidity Index (in continuous unit level), in which the age at admission was adjusted ($p < 0.001$ for time trend, Wald test).

Comorbidities

The mean number of diagnoses on admission has increased from 4.1 in 2012 to 5.8 in 2019 (5.9 in 2020) (Figure 5). The percentages of each comorbidity group are shown in Table 4. Consistently over time, diabetes with a chronic complication, diabetes with end organ damage and chronic obstructive pulmonary disease were the highest comorbidity groups among hospitalised patients. Of note is the significant increase in the proportion of admissions with diabetes with a chronic complication (4.4% absolute increase from 2012 to 2019, $p<0.001$) and diabetes with end organ damage (4.6% absolute increase from 2012 to 2019, $p<0.001$).

Figure 5 –Number of diagnoses (mean), South Australia 2012-2020

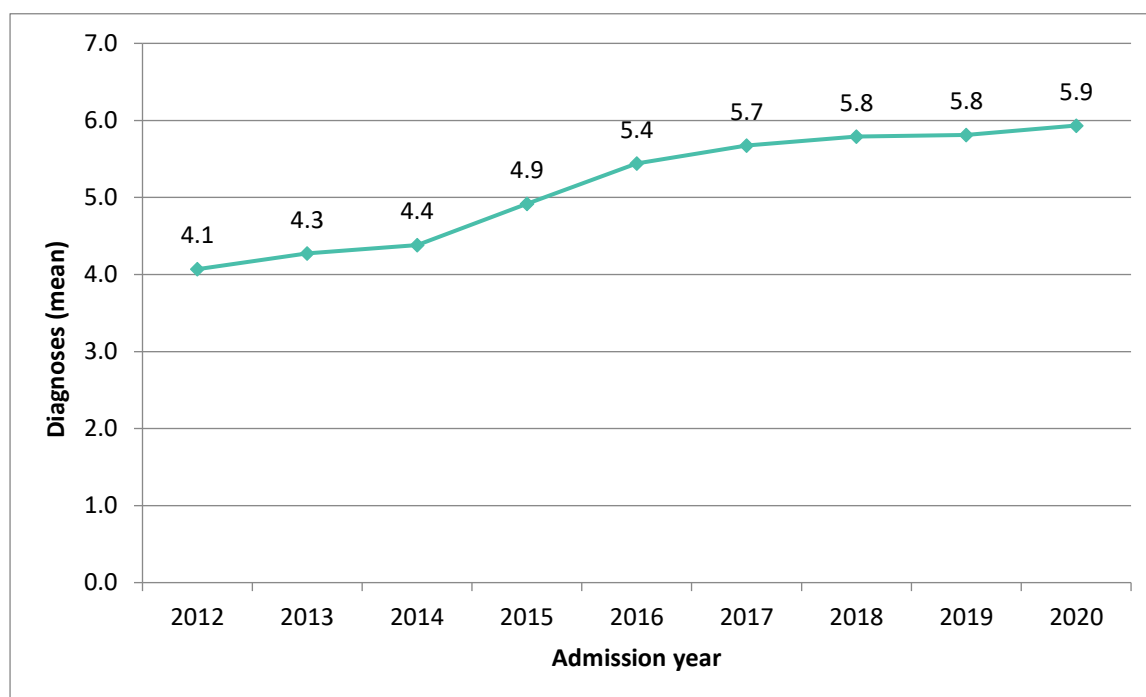


Table 4 - Percentage of comorbidity groups among hospitalised patients in South Australia, 2012-2020

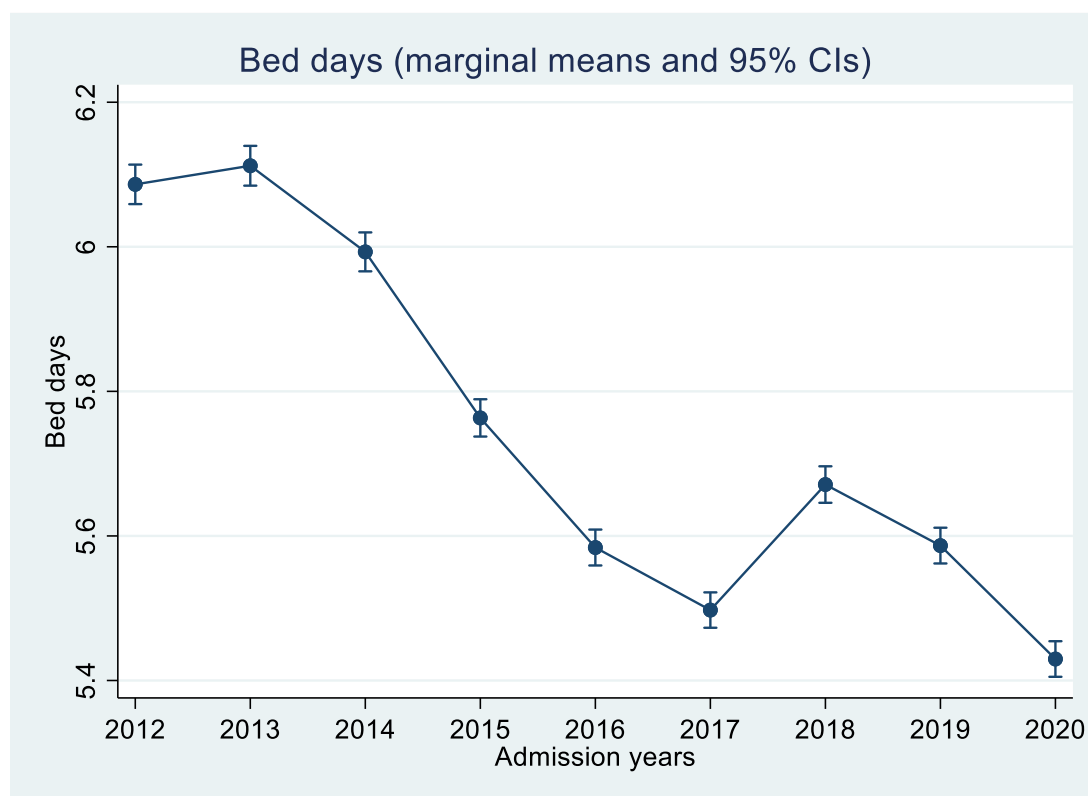
	2012	2013	2014	2015	2016	2017	2018	2019	2020	Change (2012-2019)	P value*
Number of patients	222,279	220,548	221,937	225,002	228,982	228,930	228,138	231,616	221,155	9,337	
Disease groups	%	%	%	%	%	%	%	%	%	%	
Myocardial infarction	2.1	1.9	2.0	1.9	1.8	1.8	1.9	1.9	2.0	-0.2	<0.001
Congestive heart failure	4.2	4.2	4.4	4.4	4.3	4.5	4.5	4.7	4.8	0.5	<0.001
Peripheral vascular disease	1.1	1.1	0.9	1.0	1.0	1.0	1.0	0.9	1.0	-0.2	<0.001
Cerebrovascular disease	3.0	3.1	3.1	3.1	3.1	2.9	3.0	2.9	3.1	-0.1	0.23
Dementia	2.8	2.8	2.3	2.2	2.2	2.5	2.4	2.6	2.8	-0.2	<0.001
Chronic obstructive pulmonary disease	5.5	5.6	5.6	5.8	6.0	6.6	6.2	6.3	5.2	0.8	<0.001
Rheumatic disease	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.0	0.14
Peptic ulcer disease	0.4	0.3	0.3	0.4	0.3	0.3	0.3	0.4	0.4	0.0	0.29
Mild liver disease	1.2	1.9	2.5	2.8	2.9	2.7	2.5	2.4	2.5	1.3	<0.001
Diabetes with chronic complication	7.0	11.0	11.5	11.5	11.8	11.6	11.4	11.4	11.4	4.4	<0.001
Diabetes with end organ damage	4.9	6.9	7.4	7.8	8.4	8.9	9.4	9.5	9.4	4.6	<0.001
Hemiplegia/paraplegia	1.6	1.7	1.7	1.6	1.5	1.5	1.5	1.5	1.5	-0.2	<0.001
Renal disease	4.3	5.5	5.9	5.2	4.5	4.8	5.0	5.0	5.4	0.6	<0.001
Any malignancy/lymphoma/leukaemia	6.5	6.9	6.8	7.1	6.8	7.0	7.3	7.3	7.6	0.8	<0.001
Moderate or severe liver disease	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.0	0.42
Metastatic solid cancer	2.8	3.1	3.1	3.2	3.0	3.1	3.3	3.3	3.4	0.5	<0.001
AIDS/HIV	0.06	0.06	0.05	0.06	0.06	0.05	0.04	0.03	0.04	-0.02	<0.001

* p values are derived from chi square test to compare the proportion of disease between 2012 and 2019 for each disease group.

Bed Days

The median number of bed days remained relatively consistent at 3 (IQR 1-6), on occasion dropping to 2 (IQR 1-6) throughout the study period. The mean number of bed days decreased from 6.1 in 2012 to 5.6 in 2019. This is supported by the overall number of bed days decreasing from 1,352,868 in 2012 to 1,293,953 in 2019 (Table 5). This trend is statistically significant ($p < 0.001$, Figure 6).

Figure 6 - Bed days (mean), South Australia 2012-2020



Note: results are derived from a univariate generalised linear model ($p < 0.001$ for time trend, Wald test).

Table 5 presents the mean and median bed days by Charlson Comorbidity Index categories, and Table 6 presents the absolute number of bed days. Overall, the number of bed days among those with a Charlson Comorbidity Index of 1, 2 or 3 or more increased by 9.6% or 58,289 bed days from 2012 to 2019. The proportion of bed days among patients with a Charlson Comorbidity Index of 1 increased 2.8% from 2012 to 2019, however this increased 13.4% and 13.5% among those with an Index score of 2 or 3 or more, respectively. Although not presented, patients with no comorbidity (Charlson Comorbidity Index = 0) had a 15.7% decrease in absolute bed days from 2012 to 2019.

An increasing Charlson Comorbidity Index was associated with greater bed days in the univariate model ($p < 0.001$) and this association was maintained when adjusted for sex, age at admission, year of admission and country of birth ($p < 0.001$) (Figure 7). For example, compared with a patient with a Charlson Comorbidity Index of zero, a patient with Charlson Comorbidity Index of 3 would need 0.76 extra bed days (coefficient=0.76, 95% CI 0.75-0.76), or 0.62 extra bed days after adjustment for other risk factors (coefficient=0.62, 95% CI 0.62-0.63) (Table 7).

Table 5 - Bed days by Charlson Comorbidity Index, South Australia 2012-2020

	2012	2013	2014	2015	2016	2017	2018	2019	2020
Bed days	1,352,868	1,348,016	1,330,061	1,296,743	1,278,623	1,258,528	1,293,790	1,293,953	1,200,809
Charlson Index Mean (SD)									
0	4.9 (20.4)	4.9 (22.7)	4.8 (19.2)	4.7 (17.1)	4.5 (17.3)	4.4 (11.9)	4.6 (13.0)	4.5 (11.3)	4.4 (8.7)
1	7.0 (13.7)	6.8 (19.7)	6.6 (19.1)	6.3 (12.7)	6.0 (15.3)	6.0 (15.5)	6.1 (14.8)	6.0 (11.2)	5.8 (9.1)
2	8.1 (28.1)	7.5 (20.8)	7.3 (20.8)	7.0 (12.9)	6.5 (10.8)	6.4 (10.9)	6.6 (11.9)	6.4 (11.3)	6.1 (9.5)
3+	11.2 (18.0)	10.6 (15.0)	10.2 (15.5)	9.8 (14.0)	9.7 (18.1)	9.4 (12.8)	9.7 (14.4)	9.6 (14.4)	9.3 (12.7)
Overall	6.1 (20.3)	6.1 (21.4)	6.0 (19.0)	5.8 (15.8)	5.6 (16.6)	5.5 (12.7)	5.7 (13.5)	5.6 (11.8)	5.4 (9.6)
Charlson Index Median (IQR)									
0	2 (1,5)	2 (1,4)	2 (1,4)	2 (1,4)	2 (1,4)	2 (1,4)	2 (1,4)	2 (1,4)	2 (1,4)
1	4 (2,8)	3 (1,7)	3 (1,7)	3 (1,7)	3 (1,7)	3 (1,7)	3 (1,7)	3 (1,7)	3 (1,7)
2	4 (2,9)	4 (1,8)	4 (1,8)	4 (1,8)	3 (1,7)	3 (1,8)	3 (1,8)	3 (1,7)	3 (1,7)
3+	7 (3,14)	6 (3,13)	6 (3,12)	6 (3,12)	6 (3,12)	6 (3,12)	6 (3,12)	6 (3,12)	6 (3,11)
Overall	3 (1,6)	3 (1,6)	3 (1,6)	3 (1,6)	2 (1,6)	3 (1,6)	3 (1,6)	2 (1,6)	2 (1,6)

Note: Inpatient bed days exclude day cases. Day cases are defined by the same admission and discharge dates (before midnight) [10]

Table 6 - Bed days (number) by Charlson Comorbidity Index among patients with at least one comorbidity, South Australia 2012-2019

	2012	2013	2014	2015	2016	2017	2018	2019	Change (2012-2019)	% Change (2012-2019)
Charlson Index										
1	215,455	235,425	236,328	229,729	227,076	228,508	223,595	221,483	6,028	2.8
2	145,933	154,016	149,882	153,588	151,410	154,672	163,499	165,421	19,488	13.4
≥3	243,037	268,392	271,041	263,746	260,845	262,184	276,239	275,810	32,773	13.5
Total	604,425	657,833	657,251	647,063	639,331	645,364	663,333	662,714	58,289	9.6

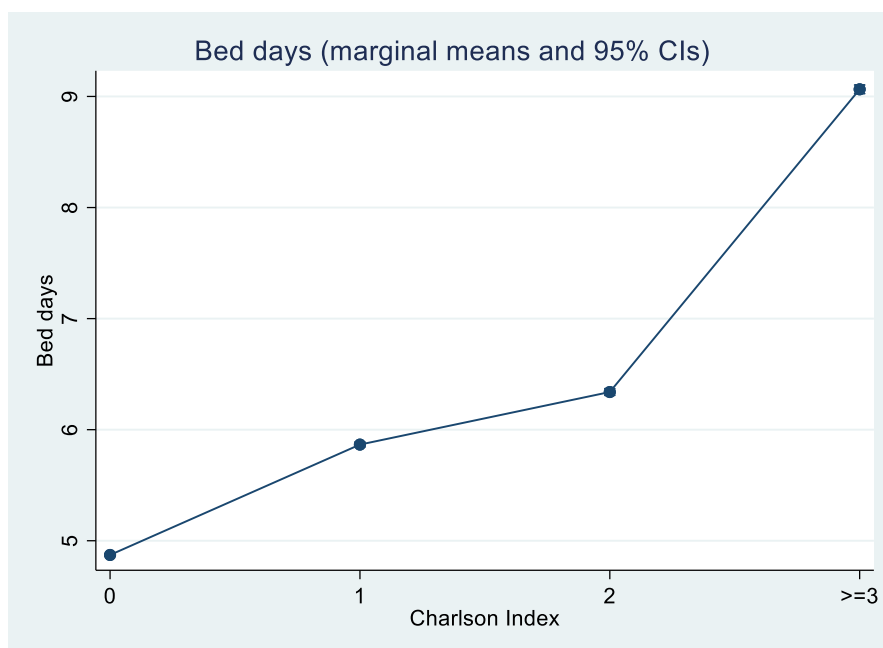
Note: Inpatient bed days exclude day cases. Day cases are defined by the same admission and discharge dates (before midnight) [10].

Table 7 - Association between the bed days and the Charlson Comorbidity Index, South Australia 2012-2020

Bed days	Univariate model coefficient (95% CI)	Multivariable model coefficient (95% CI)
Charlson Index		
0	0	0
1	0.30 (0.30 - 0.31)	0.19 (0.18 - 0.19)
2	0.38 (0.38 - 0.39)	0.26 (0.26 - 0.27)
≥3	0.76 (0.75 - 0.76)	0.62 (0.62 - 0.63)
Sex		
Male		0
Female		-0.08 (-0.08 - -0.08)
Indeterminate		-0.36 (-1.50 - 0.79)
Age at admission		0.01 (0.01 - 0.01)
Year at admission		
2012		0
2013		-0.01 (-0.02 - -0.01)
2014		-0.04 (-0.05 - -0.03)
2015		-0.08 (-0.08 - -0.07)
2016		-0.11 (-0.11 - -0.10)
2017		-0.13 (-0.13 - -0.12)
2018		-0.10 (-0.11 - -0.09)
2019		-0.12 (-0.12 - -0.11)
2020		-0.15 (-0.15 - -0.14)
Country of birth		
Other		0
Australia		0.02 (0.02 - 0.03)

Results are from two generalised linear models, and $p < 0.001$ for linear trend for Charlson Comorbidity Index (the higher of Charlson Comorbidity Index, the longer length of stay, Wald test) for both univariate model and multivariable models

Figure 7 - Bed days (mean) by the Charlson Comorbidity Index, South Australia 2012-2020



Note: results are derived from a generalised multivariable linear model (adjusted for sex, age at admission, admission year and country of birth, $p < 0.001$ for linear trend, Wald test).

Long Stay Patients

Further investigation was warranted into long stay patients. For the purpose of this study, they were classified as having stayed 14 days or longer, or 30 days or longer. Between 2012 and 2019, the absolute number of patients who stayed 14 days or longer remained stable (21,907 in 2012 to 21,248 in 2019), however this actually represented a decrease as a proportion of all patients (9.9% in 2012 to 9.2% in 2019). Between 2012 and 2019, the absolute number of patients who stayed 30 days or longer decreased from 6062 in 2012 to 5291 in 2019, representing a decrease as a proportion of all patients from 2.7% to 2.3% (Table 8).

Table 8 – Number and proportion (of all patients) of long stay patients, South Australia 2012-2020

	2012	2013	2014	2015	2016	2017	2018	2019	2020
All patients	222,279	220,548	221,937	225,002	228,982	228,930	228,138	231,616	221,155
≥14 day stay									
number	21,907	22,005	21,871	21,212	20,908	20,945	21,465	21,248	20,137
%	9.9	10.0	9.9	9.4	9.1	9.2	9.4	9.2	9.1
≥30 day stay									
number	6,062	6,127	6,050	5,683	5,235	4,857	5,421	5,291	4,858
%	2.7	2.8	2.7	2.5	2.3	2.1	2.4	2.3	2.2

When factoring in the Charlson Comorbidity Index of long stay patients, Table 9 shows that over 40% of patients who stayed 14 days or more had a Charlson Comorbidity Index of 0. This decreased from 45.3% in 2012 to 41.0% in 2019. The proportion of long stay (14 or more days) patients with a Charlson Comorbidity Index of 2 increased from 12.0% in 2012 to 13.9% in 2019, and those with a Charlson Comorbidity Index of 3 or more increased from 25.0% to 27.9%. Similarly, over 40% of patients who stayed 30 days or more had a Charlson Comorbidity Index of 0, and this decreased from 45.6% in 2012 to 42.8% in 2019. The redistribution of these patients tended to be in those with a Charlson Comorbidity Index of 3 or more, as the proportion of these patients who stayed 30 days or more increased from 25.1% in 2012 to 28.4% in 2019 (Table 9).

Table 10 presents the comorbidity groups of long stay (≥14 days) patients. The proportion of long stay patients (≥14 days) from the comorbidity group of diabetes with end organ damage increased 6.2% from 10.0% in 2012 to 16.1% in 2019 ($p < 0.001$). Similarly, the proportion of long stay patients from the comorbidity group of diabetes with chronic complications increased from 11.4% in 2012 to 14.9% in 2019 ($p < 0.001$). Other comorbidity groups which had a significant increase over time included mild liver disease and chronic obstructive pulmonary disease.

The same outcomes were observed among patients who stayed ≥30 days (Table 11). The proportion of long stay patients (≥30 days) from the comorbidity group of diabetes with end organ damage increased 5.3% from 9.8% in 2012 to 15.2% in 2019 ($p < 0.001$). Similarly, the proportion of long stay patients from the comorbidity group of diabetes with chronic complications increased from 11.4% in 2012 to 15.1% in 2019 ($p < 0.001$). Other comorbidity groups which had a significant increase over time included mild liver disease, chronic obstructive pulmonary disease and renal disease.

Table 9 - Distribution of Charlson Comorbidity Index among long stay patients, South Australia 2012-2020

	2012	2013	2014	2015	2016	2017	2018	2019	2020
Bed days ≥14									
Charlson Comorbidity Index	number								
0	9,915	9,143	9,173	8,839	8,556	8,476	8,835	8,704	8,461
1	3,903	4,049	4,058	3,875	3,843	3,845	3,750	3,675	3,451
2	2,617	2,897	2,827	2,824	2,753	2,868	2,885	2,946	2,612
≥3	5,472	5,916	5,813	5,674	5,756	5,756	5,995	5,923	5,613
Total	21,907	22,005	21,871	21,212	20,908	20,945	21,465	21,248	20,137
Charlson Comorbidity Index	Proportion (%)								
0	45.3	41.6	41.9	41.7	40.9	40.5	41.2	41.0	42.0
1	17.8	18.4	18.6	18.3	18.4	18.4	17.5	17.3	17.1
2	12.0	13.2	12.9	13.3	13.2	13.7	13.4	13.9	13.0
≥3	25.0	26.9	26.6	26.8	27.5	27.5	27.9	27.9	27.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Bed days ≥30									
Charlson Comorbidity Index	number								
0	2,764	2,612	2,589	2,337	2,183	2,034	2,274	2,264	2,168
1	1,016	1,012	1,069	1,041	917	835	882	852	709
2	759	773	712	739	654	600	696	672	595
≥3	1,523	1,730	1,680	1,566	1,481	1,388	1,569	1,503	1,386
Total	6,062	6,127	6,050	5,683	5,235	4,857	5,421	5,291	4,858
Charlson Comorbidity Index	Proportion (%)								
0	45.6	42.6	42.8	41.1	41.7	41.9	42.0	42.8	44.6
1	16.8	16.5	17.7	18.3	17.5	17.2	16.3	16.1	14.6
2	12.5	12.6	11.8	13.0	12.5	12.4	12.8	12.7	12.3
≥3	25.1	28.2	27.8	27.6	28.3	28.6	28.9	28.4	28.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 10 - Percentage of comorbidity groups among hospitalised long stay (≥ 14 days) patients in South Australia, 2012-2020

	2012	2013	2014	2015	2016	2017	2018	2019	2020	Change (2019-2012)	p-value *
Number of patients stayed ≥ 14 days	21,907	22,005	21,871	21,212	20,908	20,945	21,465	21,248	20,137	-659	
	Proportion (%)										
Myocardial infarction	2.9	2.8	2.7	2.9	2.7	2.5	2.4	2.4	2.6	-0.5	0.001
Congestive heart failure	9.3	9.2	9.7	9.2	9.5	9.7	9.1	9.7	9.4	0.5	0.095
Peripheral vascular disease	2.9	2.6	2.2	2.1	2.2	2.2	2.4	2.3	2.3	-0.7	<0.001
Cerebrovascular disease	9.7	9.7	9.6	9.9	9.9	8.7	8.4	8.5	8.8	-1.2	<0.001
Dementia	7.8	8.0	6.7	6.4	6.5	7.2	7.3	7.7	7.4	-0.1	0.735
Chronic obstructive pulmonary disease	6.2	7.3	6.7	6.6	7.1	8.1	8.1	8.0	7.0	1.7	<0.001
Rheumatic disease	0.8	1.0	1.0	0.9	0.9	0.9	1.0	1.0	0.8	0.2	0.057
Peptic ulcer disease	0.8	0.6	0.5	0.6	0.5	0.6	0.6	0.6	0.7	-0.2	0.051
Mild liver disease	2.2	3.2	3.7	4.6	4.7	4.4	4.0	4.2	4.4	2.0	<0.001
Diabetes with chronic complication	11.4	15.1	15.4	15.6	16.4	15.9	15.4	14.9	15.6	3.5	<0.001
Diabetes with end organ damage	10.0	12.6	13.3	13.7	15.4	15.9	15.8	16.1	16.3	6.2	<0.001
Hemiplegia/paraplegia	6.3	6.4	6.1	6.1	5.7	5.1	5.5	5.5	5.5	-0.9	<0.001
Renal disease	8.1	9.6	9.4	8.9	8.3	8.9	9.2	8.9	9.6	0.8	0.003
Any malignancy/lymphoma/leukaemia	12.6	12.5	12.7	12.5	12.5	12.8	12.8	12.9	12.4	0.2	0.498
Moderate or severe liver disease	1.4	1.3	1.0	1.4	1.3	1.4	1.2	1.2	1.4	-0.1	0.239
Metastatic solid cancer	6.3	6.1	6.4	6.3	6.2	6.4	6.6	6.5	6.2	0.2	0.418
AIDS/HIV	0.11	0.14	0.09	0.16	0.13	0.08	0.08	0.05	0.06	-0.06	0.025

* p values are derived from chi square test to compare the proportion of disease between 2012 and 2019 for each disease group.

Table 11 - Percentage of comorbidity groups among hospitalised long stay (≥ 30 days) patients in South Australia, 2012-2020

	2012	2013	2014	2015	2016	2017	2018	2019	2020	Change (2019-2012)	p-value *
Number of patients stayed ≥ 30 days	6,062	6,127	6,050	5,683	5,235	4,857	5,421	5,291	4,858	-771	
	Proportion (%)										
Myocardial infarction	2.2	2.2	2.4	2.5	2.3	2.5	2.0	2.0	2.1	-0.1	0.66
Congestive heart failure	8.1	8.4	8.9	8.4	8.4	8.7	8.2	8.1	8.3	0.0	0.93
Peripheral vascular disease	3.3	2.8	2.3	2.3	2.5	2.3	2.6	2.5	2.3	-0.8	0.01
Cerebrovascular disease	12.9	13.2	12.3	14.0	12.6	11.5	10.9	11.4	10.7	-1.5	0.02
Dementia	9.0	8.9	8.2	8.2	7.1	8.0	8.7	9.3	8.5	0.3	0.63
Chronic obstructive pulmonary disease	4.4	5.0	4.8	4.9	5.5	6.4	6.8	6.4	5.5	2.0	<0.001
Rheumatic disease	0.9	1.0	1.1	1.0	0.9	0.9	1.0	1.2	1.0	0.3	0.14
Peptic ulcer disease	0.8	0.7	0.5	0.6	0.7	0.7	0.6	0.9	1.0	0.1	0.73
Mild liver disease	1.8	3.7	4.5	5.1	5.2	4.3	4.9	4.7	4.6	2.9	<0.001
Diabetes with chronic complication	11.4	14.7	15.4	15.6	16.9	14.5	15.3	15.1	15.9	3.7	<0.001
Diabetes with end organ damage	9.8	12.8	12.6	14.2	15.6	15.1	15.1	15.2	15.9	5.3	<0.001
Hemiplegia/paraplegia	9.6	10.0	9.3	9.7	8.5	8.4	8.5	8.9	8.4	-0.7	0.23
Renal disease	7.4	9.5	8.3	7.9	8.2	9.0	8.1	8.3	8.7	1.0	0.06
Any malignancy/lymphoma/leukaemia	11.0	10.6	11.4	10.1	10.7	12.0	12.0	10.8	11.2	-0.3	0.65
Moderate or severe liver disease	1.4	1.5	1.1	1.4	1.6	1.6	1.5	1.4	1.6	0.0	0.97
Metastatic solid cancer	4.8	4.6	5.5	4.7	4.8	4.6	5.2	5.0	4.5	0.2	0.62
AIDS/HIV	0.12	0.16	0.08	0.32	0.13	0.04	0.02	0.08	0.06	-0.04	0.5

* p values are derived from chi square test to compare the proportion of disease between 2012 and 2019 for each disease group.

Conclusion

This study examined the trends in people admitted to hospital in South Australia from 2012 to 2020, considering any changes in comorbidity due to chronic disease over this time period.

The Charlson Comorbidity Index increased significantly over the study period, independent of age at admission.

There was a significant increase in comorbidity over time, with the number of comorbidities at admission increasing from 4.1 in 2012 to 5.8 in 2019. Diabetes (both with chronic complications and end organ damage) were the most prevalent comorbidities among all hospital patients across the study period, and both significantly increased from 2012 to 2019 by 4.4% and 4.6% respectively.

The overall increased comorbidity led to an absolute increase in the number of bed days for those people, the highest in those with a Charlson Comorbidity Index of 2 and 3 – an increase of 13.4% and 13.5% from 2012 to 2019.

Diabetes appeared to be an important contributor to the change in comorbidity over time. Given South Australia's ageing population, high rates of diabetes (compared with Australia) and the increase in risk factors associated with diabetes such as overweight and obesity, prevention efforts must focus on the reduction of such comorbidities to manage the increasing burden on the hospital system.

There are a number of strengths and limitations of this study. All admissions to South Australian public hospitals were included in the study, and a standard evidence based approach was used to estimate comorbidity. Limitations include being an administrative dataset which may have incorrectly recorded comorbidity, although it is likely that would more likely lead to an undercount of conditions. The study was unable to examine patterns of comorbidity on emergency department presentations due to limitations in the data available for analysis, but this would be an important next step as data become available.

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