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Here one year, gone the next? Investigating duration and predictors of ongoing frequent emergency department attendance, a retrospective study in Australia.

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Abstract

Objectives: Patients are presenting to Emergency Departments (EDs) with increasing complexity at rates beyond population growth and ageing. Intervention studies target patients with 12 months or less of frequent attendance (FA). However, since most of these patients do not remain FA, these interventions may not be well targeted. This paper quantifies temporary and ongoing FA and contrasts risk factors for each group.

Design: A retrospective population-based study using 10 years of longitudinal data.

Setting: An Australian health district including metropolitan, regional and rural EDs.

Participants: 332,100 residents visited any ED during the study period, of which 8,577 were FA (seven or more visits within 12 months).

Main outcome measure: Logistic regression modelling was used to identify risk factors for temporary (one year) and ongoing FA among adults and children. Ongoing FA were further split into repeat (two years) and persistent (three or more years).

Results: Of the 8,577 FA, 80.1% were identified as temporary, and 19.9% as ongoing (12.9% repeat, 7.1% persistent). Among adults, ongoing FA were more likely than temporary FA to be young (age 25 to 44), of Aboriginal or Torres Strait Islander background, have a partner, be from high socio-economic areas, or be admitted following ED presentation. Ongoing FAs had higher-rates of non-injury presentations, in particular substance-related (OR=3.0, 95% CI 1.7 to 5.3) and psychiatric illness (OR=3.5, 95% CI 2.5 to 4.9). Among children, ongoing FAs were more likely than temporary FAs to be female, aged 5-15, with higher likelihood of

admission (OR=3.0, 95% CI 1.2 to 7.4) and rates of neurological conditions (OR=2.3, 95% CI 1.2 to 4.4).

Conclusions: This study highlights that most FA are temporary, raising concerns about the value of intervention studies which target the entire FA cohort. Future intervention studies should focus on ongoing FA or include controls.

Article summary

Strengths and limitations of this study:

- Our unique, longitudinal study reports on long-term patterns of attendance to all emergency departments within a single health district by frequent attenders over 10 years.
- We considered long-term frequent attendance patterns which allowed for patients discontinuing frequent attendance and resuming later on.
- We contrasted socio-demographic and risk factors for temporary versus ongoing frequent attendance and for both adults and children.
- We included metropolitan, regional and rural EDs in Australia, however findings from one healthcare setting may not be generalisable to other settings.

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Data statement: Additional materials are available in the supplementary appendix, the dataset was extracted from the Illawarra Health Information Platform.

Competing interests: The authors declare that they have no competing interests.

INTRODUCTION

Background

Emergency Department (ED) frequent attenders (FA) are a complex and vulnerable patient group.[1-4] Compared to non-frequent ED attenders, they have higher rates of morbidity and mortality,[5] mental health issues,[5-7] substance use problems,[6,8] and chronic diseases,[8-10] and are more likely to be homeless[11] and of low socio-economic status.[12] By definition, this group accounts for a disproportionate share of ED visits. They are also more likely to attend multiple EDs to address their unmet health needs.[8]

Interventions are primarily aimed at reducing ED visits,[13-17] and improving social and clinical outcomes.[13,16,18] The most commonly studied intervention is case management. [13,10,16,18] Other interventions include establishment of care plans with patient input,[19] and providing case notes from previous ED visits.[20] Case management in some cases reduced ED costs and improved social and clinical outcomes, but in many studies had no impact, or increased ED and primary care utilisation.[13]The limited number of studies with control groups has contributed to a lack of evidence on effective interventions, as before-and-after studies fail to account for the high likelihood of FAs becoming infrequent without intervention.[1]

Relevance

Few studies have investigated long-term use patterns among ED attenders across multiple facilities.[21] Most studies report data from a single year,[22-28] or a small number of years,[11,16] or from a small number of facilities,[9,29,30] with ongoing visit patterns given little consideration.[1] Multi-site studies of more than 2-3 years are scarce.[1,21,31,32] The need for research into long-term utilisation patterns among FA has been identified, in particular understanding predictors

of ongoing use,[21] and analysis by age group and frequency of visit, to distinguish meaningful sub-groups for intervention.[1,33]

Research addressing these knowledge gaps will assist with identifying and distinguishing the characteristics of ongoing FAs from those with temporary frequent ED use. This information will assist in planning appropriate support or interventions for the temporary and ongoing subgroups of FA.

Objectives

The aim of this study was to contrast the attributes and risk factors of temporary FA, with ongoing FA. The ongoing FA were further subdivided into repeat FA, who met the frequent attendance threshold twice, and persistent FA, who met the threshold in three or more periods.

METHODS

Study design and setting

A retrospective population-based study was carried out using longitudinal data from an Australian regional health service, the Illawarra Shoalhaven Local Health District (ISLHD). The district services almost 390,000 residents in a 250 kilometre long coastal catchment area, covering rural, regional and metropolitan areas.[34] Five of the eight public hospitals within the district have an ED, the largest being one of the busiest adult and paediatric emergency departments in the state of New South Wales.[35]

Selection of participants

This negligible risk study accessed data from the Illawarra Health Information Platform (IHIP). IHIP is a non-identifiable databank established by the ISLHD and the University of

Wollongong for research, planning and evaluation purposes. IHIP holds a unique record number for every person who has accessed any ISLHD service since the late 1980s. Ethical approval was received to establish the IHIP non-identifiable databank and for the associated data linkage protocols.

Emergency Department data were analysed for all individuals who attended any of the district's EDs at least once between 1 July 2005 and 30 June 2015. Non-residents of the district's catchment area were excluded.

Patient and Public Involvement

Previous studies by the authors on patient's reasons for attending ED,[36] and other literature on patient perspectives in the ED,[37] shaped the research questions, including a focus on understanding long-term use patterns rather than individual visits. The retrospective study was designed to inform future interventions and research. While patients weren't directly involved in the design or conduct of this study, a steering group which includes a patient advisor will contribute to research translation and dissemination activities. Dissemination to patients will also occur through the health district's Community Partnership Council and other established patient advisory committees.

Outcomes

Historically, frequent ED use has been defined as three to 12 visits per year,[5] while highly frequent use has been defined as four to 20 visits per year.[7,38] Because of this variation, Locker et al proposed that more than four ED visits per year was a non-random event, and suggested this become a standard threshold for defining frequent ED attendance. [6] This study uses a more recently proposed definition based on a divergence of patient characteristics, where non-FA present 1-6 times in a year, and FA 7 or more times in a year.[39]

A 12-month window was used to count ED visits following a first (or index) ED visit, a patient-based timeline not defined by calendar year.[39,40] Subsequent 12 month windows commenced at the next ED visit after each 12-month window.

Duration of frequent ED attendance was measured by the number of 12-month windows each patient had frequent ED use. Sub-groups of FAs were identified to provide insight into the varying needs of this complex and heterogeneous patient group. Temporary FA were defined as those who met the FA threshold once during the study period, and ongoing FA were looked at in two groups - repeat FA who met the threshold twice, and persistent FA on more than two occasions.

Measurements

Demographic characteristics such as age, sex, preferred language, and marital status were analysed according to the first ED visit in the study period. Private hospital insurance status and Aboriginal and Torres Strait Islander status were analysed according to the most recent visit to the ED,[41] due to a higher proportion of missing data in the early study years. Triage category was averaged over all visits with an average of 4 to 5 considered low urgency. The proportion of all ED visits resulting in a hospital admission was calculated for each person.

Socioeconomic status was based on Index of Relative Socio-economic Disadvantage (IRSD) information.[42] Each Australian postal area has an ISRD score and ranking. For the purposes of this study, the rankings which were summarised as deciles were reduced to quintiles, with low ranks representing the most disadvantaged.

Patient diagnosis was recorded on discharge from the ED. Between 2009 and 2012 each ED within the regional health service transitioned from ICD-9-CM diagnosis coding to SNOMED recording of diagnosis. For this study, diagnoses according to ICD-9-CM coding and SNOMED were therefore mapped to ICD-10-AM[43] and then aggregated to Major Diagnostic Blocks (MDB) using the Independent Hospital Pricing Authority's Urgency

Related Group software v1.4.4.[44] Frequent ED attenders were primarily analysed according to their most common MDB to reduce the likelihood of bias from with missing data (such as during system transition and for patients who did not wait), but also described based on whether they ever had a diagnosis in each MDB.

Data analysis

Associations between categorical variables were evaluated using Pearson's Chi Square Test. Multivariate logistic regression models were used to compare characteristics of non-FA with FA and subgroups, and results summarised as odds ratios (OR) and 95% confidence intervals (CI). Demographic, diagnosis (MDB), and visit characteristics were included in regression models. The proportion of missing data was generally low, ranging from <1% for items such as sex, Aboriginal or Torres Strait Islander status, socioeconomic status and triage category, to 5.3% for preferred language, 10.8% for hospital insurance and 11.4% for marital status. Those without an assigned MDB due to; no recorded diagnosis (7.5%), a diagnosis code not recognised by the grouper (3.9%) or patients who did not wait (3.5%), were excluded from analysis by diagnosis. Planned return visits accounted for 3.1% of all ED visits, and these were excluded from all analyses. Sensitivity analyses were carried out with an alternative threshold for frequent ED attendance of four visits per year, and including planned return visits. Statistical significance was set at 5%. All statistical analysis was conducted using SAS version 9.4.[45]

RESULTS

A total of 1,199,633 ED visits by 332,100 individuals were recorded across the 10-year study period (Table 1). Of residents who attended the ED, 2.6% (n=8 577) met the threshold for frequent attendance (attended 7 or more times within a 12-month window).

Among FA, most (n=6866, 80.1%) met the attendance threshold only once (temporary FA) (Figure 1). A further 12.9% (n= 1104) met the threshold twice (repeat FA), while only 7.1% (n=607) met the threshold on 3 or more occasions (persistent FA). Over the 10 years, these 607 persistent FA made 38,338 ED visits. A similar pattern of predominantly temporary FA was observed in each age group (Figure 1).

A sensitivity analysis including planned return visits, indicated similar patterns of long term ED use. For example, 81.4% of FAs were temporary FA when planned return visits were included. When the threshold of FA was reduced to four visits in 12-months, 75.6% of individuals were temporary FA.

Demographic and visit characteristics

Compared to non-FA, FA were more likely to be: male, older (aged 65 or over), Aboriginal or Torres Strait Islander, have no partner, from non-English speaking backgrounds, un-insured (publically insured only patients), and resident in lower socio-economic areas (Table 1). Compared to the other groups of FA, persistent FA were young to middle aged adults, female, Aboriginal or Torres Strait Islander, had no partner, were from lower socioeconomic areas, un-insured (publically insured only patients) and not admitted (Table 1). During the ten year study period FA had an average of 21.0 ED visits, compared to 3.2 for non-FA, with more FA admitted to hospital.

Diagnostic profile

The most common diagnoses among FA were digestive, respiratory, circulatory, single site major injury and psychiatric illness (Supplementary Material Table 1), however diagnostic profile differed by age and length of frequent attendance.

Among the youngest FA, aged 0-4 years, respiratory illness was the most common diagnosis across all groups FA (Table 2). Among children aged 5-15 years, injury and

digestive system illnesses were the two most common diagnoses in all sub-groups, with injury being the most common diagnosis among temporary FA and digestive system illness among the persistent FA. Children also presented with psychiatric illness, which was the most common diagnosis for 9.3% of temporary FA, 14.3% of repeat FA and 12.7% of persistent FA.

While injury and digestive system illness were also common among older teenagers and young adults (16-24 and 25-44 years), there were increasing numbers of patients visiting ED primarily for psychiatric illness, particularly among repeat FA aged 25-44 years and persistent FA (Table 2).

Among adults aged 45-64 years, the most common diagnoses were circulatory, digestive and respiratory illnesses. Among older adults 65 years and above, circulatory followed by respiratory system illnesses were most common, with the exception of persistent FA who had more respiratory illness than circulatory illness. In the older age groups, aged 75 years and above, digestive system and urological system illness were common among all FA groups.

Analysis of all diagnoses reported in the study period (rather than most common) shows that from the age of 25 years, ED visits relating to single site major injuries were common among temporary and repeat FA, while persistent FA had higher proportions of respiratory, musculoskeletal, neurological and psychiatric visits (Table 2). Among ongoing FA aged 5-15, 16-24 and 25-44, more than half presented with a psychiatric diagnosis at least once during the study period.

Predictors of frequent attendance

Multivariate logistic regression models were fit to assess the likelihood of being a FA, based on socio-demographic and visit characteristics and diagnoses for those aged 16 and over (Table 3) and those aged under 16 (Table 4). Consistent with the findings of the earlier descriptive analysis, being an adult FA was associated with being: male; older; Aboriginal or

Torres Strait Islander; un-insured (publically insured only patients); socio-economically disadvantaged presenting with higher urgency; and less likely to be admitted or have a partner (Table 3). Compared to the reference category (single site major injury), FA was associated with all diagnostic groups, with the highest odds of psychiatric illness (OR=6.7, 95% CI 5.9 to 7.6) and alcohol/drug related disorders (OR=6.7, 95% CI 5.1 to 8.7) (Table 3).

Among children aged under 16, FA were more likely to be older (age 5 to 15) and similarly to adult FA, were more likely to be Aboriginal or Torres Strait Islander, un-insured (publically insured only patients); socio-economically disadvantaged; and present with higher urgency (OR=2.5, 95% CI 2.2 to 2.8). However they were not more likely to be male; and were no less likely to be admitted than non-FA (Table 4).

Compared to the reference category (single site major injury), FA children aged under 16 were more likely to present with digestive illness, endocrine, nutritional and metabolic system illness, neurological system illness, and respiratory illness. As with adults, the highest risk of FA was presenters with psychiatric illness (OR=7.8, 95% CI 5.9 to 10.2) (Table 4).

Predictors of frequent attendance by duration

Models fitted separately for each FA sub-group (temporary FA, repeat FA and persistent FA compared to non-FA) led to different demographic risk factors. While temporary and repeat adult FA were more likely to be male, after adjusting for other characteristics, sex was not a risk factor for persistent FA (OR=1.0, 95% CI 0.9 to 1.2) (Table 3). Persistent adult FA were also more likely to be in the middle age groups, aged 25-64 years, whereas those aged 65 and over were more at risk for temporary and repeat FA. Among those aged under 16, ongoing FA (repeat and persistent) were more likely to be female and aged 5 to 15, neither of which were risk factors for temporary FA (Table 4).

Demographic and clinical risk factors for adult FA were in many cases magnified among repeat and persistent FA (Table 3). For example, Aboriginal or Torres Strait Islander

background was a larger risk factor for those with long periods of FA (temporary FA OR=1.9, 95% CI 1.6 to 2.2 and persistent FA OR=3.1, 95% CI 2.2 to 4.2) and having a partner was less likely among longer duration FA (temporary FA OR=0.7, 95% CI 0.7 to 0.8 and persistent FA OR=0.4, 95% CI 0.3 to 0.5).

Alcohol and drug-related disorders were much more prominent among longer-duration FA (temporary FA OR=5.2, 95% CI 3.8 to 7.1 compared to persistent FA OR=26.5, 95% CI 12.3 to 57.2), as were neurological illness (temporary FA OR=1.7, 95% CI 1.5 to 2.0 compared to persistent FA OR=10.1, 95% CI 5.6 to 18.1), and psychiatric illness (temporary FA OR=5.0, 95% CI 4.3 to 5.8 compared to persistent FA OR=25.5, 95% CI 14.6 to 44.5) (Table 3).

Risk factors for temporary versus ongoing frequent attendance

Risk factors for ongoing FA (repeat and persistent) were modelled in comparison to temporary FA, rather than non-FA. This confirmed the earlier findings that ongoing FA are younger (aged 25-64) and more likely to be Aboriginal or Torres Strait Islander, but less likely to have a partner, be admitted, or be from high socio-economic areas (Figure 2, left image). Substance-related visits, psychiatric illness, endocrine/nutritional/metabolic illness and neurological illness were again more likely for ongoing FA. Among children aged under 16, ongoing FA were more likely than temporary FA to be female, aged 5-15, and present with neurological illness (Figure 2, right image).

DISCUSSION

This investigation of 10 years of longitudinal ED data has provided a novel perspective on the risk factors by duration of FA, for both adults and children. Investigation of visits to all EDs in the region found the majority of frequent ED attenders are temporary, and only

approximately 20% remain as FA in any of up to nine subsequent years. Persistent FA only accounted for 7.1% of FA.

The estimate that 80.1% of FA are temporary is slightly higher than other shorter-term studies carried out in the US,[1, 33,43,46] Sweden[3] and New Zealand,[47] where estimates varied between 58 and 72%. Definitions of temporary FA differ slightly across studies, including: the threshold number of visits for FA; whether the period of FA is patient-based (using an index visit) or calendar based; whether another period of FA immediately follows the first FA period or is during the study period. We considered any periods of FA across the entire study period to be inclusive of patients who re-established frequent attendance patterns.[48] Systematic reviews show that internationally, intervention studies have been targeting the entire FA cohort.[13,14] However, differences in profile and risk factors for ongoing FA compared to temporary FA, and for adults and children, demonstrate a need to consider different types of interventions. In particular, the cohort of persistent FA may receive more benefit from case management, and increased continuity of primary care provider[49] than temporary FA. Young adults with ongoing FA related to substance disorders and psychiatric illness may benefit from additional services outside the ED, while among children, older females with neurological conditions (predominantly seizure-related and headaches) could benefit from pathways which reduce the likelihood of admission and result in reduced length of hospital stay.[50]

Our research has shown a complex relationship between ED attendance and hospital admission. Multivariate analysis showed frequent ED attendance was inversely associated with hospital admission, and duration of frequent ED attendance was not associated with hospital admission among adults, suggesting some FA may be treated and/or managed in a different setting.

Limitations

The inclusion of any patients whose with frequent attendance for any 12 month period during the 10 year study period enabled patients to be grouped according to long-term patterns of frequent attendance, however some temporary and repeat FA may have been classified differently had all participants had equal follow up time.

Data quality, data consistency and the amount of missing information (in particular diagnosis) improved over time, which may impact descriptive and modelling results. The effect of missing diagnoses was minimised by modelling a patient's most common diagnostic block over all visits. While hospital insurance and preferred language were imputed using recent data, having a partner was considered more likely to change over the study period so missing cases were excluded from models.

Social variables that may increase the risk FA, such as use of primary care services, homelessness or isolation, were not routinely collected. Other factors that may be predictive of FA, such as patient satisfaction with treatment, and having a regular source of care[51] were not collected.

We did not link to data on deaths outside hospital and therefore did not explore reasons for patients discontinuing frequent attendance, however this is an area of potential future research. We included metropolitan, regional and rural EDs in Australia, however findings from one healthcare setting may not be generalisable to other settings.

Conclusions

This study has provided a unique, longitudinal perspective on ED FA, contrasting the demographic and diagnostic profile of temporary, repeat and persistent FA. The distinction between temporary and ongoing FA cohorts should be used when describing FA, and to inform appropriate interventions and better direct health resources.

Author contributions

LL carried out analysis, interpretation, and drafted the manuscript, VWW and KL assisted with interpretation of the data and assisted with drafting and reviewing the manuscript, RZ, JM, TC, and WT contributed to interpretation of the data and reviewed the manuscript, KE was responsible for the study conception and contributed to interpretation of the data and reviewed the manuscript.

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Table 1. Characteristics of ED patients, 12-month windows, and visits* by length of frequent attendance

	Frequent Attenders (FA)				Non-frequent ED attenders	ED attenders
	Temporary	Repeat	Persistent	*All*		
Patients	(N=6,866)	(N=1,104)	(N=607)	*(N=8,577)*	(N=323,523)	(N=332,100)
Age group (%) †‡						
0-4	10.4	5.7	2.3	*9.2*	13.4	13.3
5-15	9.0	8.9	9.1	*9.0*	12.6	12.5
16-24	11.5	12.5	12.4	*11.7*	12.6	12.6
25-44	20.2	24.3	34.9	*21.8*	22.6	22.6
45-64	18.8	21.9	23.7	*19.6*	20.2	20.2
65-74	12.4	12.6	8.7	*12.2*	8.6	8.7
75+	17.8	14.1	8.9	*16.7*	10.1	10.2
Sex (%)†‡						
Male	53.8	51.5	46.8	*53.0*	51.3	51.3
Female	46.2	48.6	53.2	*47.0*	48.8	48.7
Indigenous (%)§‡**						
Aboriginal or Torres Strait Islander origin	7.4	10.6	12.5	*8.2*	3.3	3.4
Neither Aboriginal nor Torres Strait Islander origin	92.6	89.4	87.5	*91.8*	96.8	96.6
Partner†‡** (persons aged 16 and over)						
Yes	45.1	39.0	30.2	*43.2*	53.8	53.5
No	54.9	61.0	69.8	*56.8*	46.2	46.5
Private hospital insurance (%)§‡**						
Yes	17.3	16.1	11.7	*16.8*	32.0	31.6
No	82.7	83.9	88.3	*83.3*	68.0	68.4
Preferred language (%)†‡**						
English	78.9	82.2	82.1	*79.6*	87.7	87.5
Other	21.1	17.8	17.9	*20.4*	12.3	12.5
Socio-economic status†‡**						
Quintile 1 (low)	30.0	32.8	34.4	*30.7*	22.2	22.4
Quintile 2	26.6	24.6	25.0	*26.3*	22.8	22.9
Quintile 3	32.8	35.6	34.6	*33.3*	40.4	40.2
Quintile 4	5.7	4.1	4.1	*5.4*	7.6	7.5
Quintile 5 (high)	4.8	2.9	1.8	*4.4*	7.0	7.0
Visits	(N=108,858)	(N=32,643)	(N=38,338)	*(N=179,839)*	(N=1,019,794)	(N=1,199,633)
Visits in study period (mean)	15.9	29.6	63.2	*21.0*	3.2	3.6
Visits per 12-month window (with 1+ visit) (mean)	4.2	5.8	9.5	*5.1*	1.7	1.8
Admitted (%)‡**						
Yes	37.0	38.0	33.5	*36.4*	30.8	31.6
No	63.0	62.0	66.5	*63.6*	69.2	68.4
Triage category‡**						
1 (highest urgency)	0.5	0.5	0.5	*0.5*	0.5	0.5
2	7.7	8.3	7.7	*7.8*	6.7	6.9
3	30.0	30.3	28.8	*29.9*	28.0	28.3
4	45.1	45.7	46.6	*45.8*	50.7	49.9
5 (lowest urgency)	16.7	15.3	16.4	*16.7*	14.2	14.5

* Excludes planned return visits

† As reported at earliest ED visit in study period

‡ χ^2 test for patient type (temporary FA, repeat FA, ongoing FA) by: age $\chi^2_{12} = 164.5$ ($p<.0001$), sex $\chi^2_2 = 12.2$ ($p=0.002$) , Indigenous $\chi^2_2 = 29.1$ ($p<.0001$), Partner $\chi^2_2 = 43.8$ ($p<.0001$), Hospital insurance $\chi^2_2 = 10.8$ ($p=0.045$) Preferred language $\chi^2_2 = 8.6$ ($p=0.014$), Socio-economic status $\chi^2_8 = 34.6$ ($p<.0001$), Admitted $\chi^2_2 = 196.7$ ($p<.0001$), Triage category $\chi^2_8 = 76.0$ ($p<.0001$). Excludes unknown, missing, and not-stated.

§ As reported at most recent ED visit in study period. This is the recommended approach for Indigenous status (Randall et al 2013) and was required for hospital insurance due to incomplete early data at two facilities.

** Percentage missing, unknown, not stated - Partner 11.5%, Indigenous status (at last ED visit) 0.9%, Socio-economic status 0.0%, Hospital insurance (at last ED visit) 10.8%, Preferred language 5.3%, Admitted 0.0%, Triage category 0.2%

Table 2. Diagnostic profile of ED frequent attender patients* by duration of frequent attendance and age group

	Temporary frequent attender (frequent attender in one 12-month period)								Repeat frequent attender (frequent attender in two 12-month periods)								Persistent frequent attender (frequent attender in three or more 12-month periods)							
	Age group†								Age group								Age group							
% of patients	0-4	5-15	16-24	25-44	45-64	65-74	75+	All	0-4	5-15	16-24	25-44	45-64	65-74	75+	All	0-4	5-15	16-24	25-44	45-64	65-74	75+	All
N persons	711	615	791	1387	1291	850	1221	6866	63	98	138	268	242	139	156	1104	14	55	75	212	144	53	54	607
Most common Major Diagnostic Block																								
Alcohol/drug abuse and alcohol/drug induced mental disorders	0.0	0.0	1.0	2.0	1.6	0.0	0.0	0.8	0.0	0.0	‡	2.6	2.9	0.0	0.0	1.4	0.0	0.0	‡	2.8	4.2	‡	0.0	2.3
Circulatory system illness	‡	1.3	3.5	5.5	17.5	24.4	23.7	12.2	0.0	5.1	‡	4.5	15.3	25.2	32.7	13.0	0.0	‡	‡	7.6	18.1	28.3	14.8	11.5
Digestive system illness	12.2	18.5	21.4	15.9	14.4	12.0	13.6	15.2	14.3	22.5	26.8	15.7	19.4	13.8	9.6	17.6	‡	36.4	26.7	18.4	16.7	15.1	14.8	19.9
Endocrine, nutritional and metabolic system illness	‡	0.8	0.9	1.1	0.7	1.1	1.2	0.9	‡	‡	‡	‡	2.1	‡	‡	1.4	0.0	‡	‡	‡	‡	0.0	0.0	1.3
Illness of skin, subcutaneous tissue, breast	2.0	4.7	5.6	7.1	5.4	3.3	2.9	4.7	‡	‡	5.1	5.6	2.9	‡	‡	3.4	0.0	‡	‡	4.3	‡	0.0	‡	2.6
Injury, single site, major	14.5	31.7	20.0	13.4	6.3	3.9	6.2	12.1	‡	21.4	7.3	12.7	2.1	‡	5.8	7.7	‡	21.8	‡	7.6	3.5	0.0	‡	6.9
Musculoskeletal/connective tissue system illness	0.7	2.9	3.0	6.0	5.3	5.4	4.2	4.3	0.0	‡	5.1	9.3	6.6	5.0	‡	5.3	0.0	‡	8.0	9.4	5.6	0.0	‡	6.1
Neurological system illness	4.6	3.6	3.5	5.6	5.3	5.9	7.0	5.3	9.5	7.1	5.1	6.3	8.7	5.8	3.9	6.5	‡	9.1	8.0	11.3	13.2	‡	11.1	10.4
Psychiatric illness	0.0	9.3	11.3	13.1	5.9	1.4	1.0	6.2	‡	14.3	21.0	25.0	10.7	‡	‡	12.9	0.0	12.7	29.3	26.4	10.4	‡	0.0	16.6
Respiratory system illness	44.0	6.0	4.6	4.0	14.3	18.4	17.1	14.4	47.6	‡	5.1	4.9	14.5	21.6	19.9	13.6	0.0	0.0	‡	2.4	16.7	34.0	22.2	11.2
Urological system illness	1.1	1.3	2.5	2.5	4.7	10.6	13.3	5.6	0.0	6.1	‡	‡	3.3	10.1	16.7	5.3	0.0	0.0	‡	‡	‡	9.4	14.8	3.2
Other MDBs	20.0	19.8	22.8	23.9	18.7	13.8	10.0	18.3	19.1	15.3	18.1	11.2	11.6	7.9	7.7	12.1	‡	10.9	‡	8.0	6.9	7.6	11.1	7.9
Major Diagnostic Block during study period																								
Alcohol/drug abuse and alcohol/drug induced mental disorders	0.0	8.5	10.5	11.8	7.3	1.5	0.7	6.0	0.0	10.2	17.4	26.1	16.5	0.0	‡	13.2	0.0	16.4	24.0	31.6	18.8	‡	‡	20.4
Circulatory system illness	4.1	22.4	29.6	35.3	58.9	69.5	71.5	45.4	7.9	40.8	31.9	49.6	65.7	89.9	81.4	57.3	‡	58.2	53.3	65.6	82.6	90.6	85.2	70.2
Digestive system illness	63.4	65.5	58.7	54.2	57.0	61.5	59.9	59.1	85.7	79.6	79.7	70.9	71.9	79.9	74.4	75.5	89.9	96.4	85.3	85.9	85.4	88.7	74.1	86.0
Endocrine, nutritional and metabolic system illness	6.5	6.0	3.5	7.9	16.9	20.4	19.0	12.3	12.7	10.2	10.9	13.1	24.4	23.7	30.1	18.8	7.1	12.7	17.3	20.3	24.7	45.3	29.6	25.4
Illness of skin, subcutaneous tissue, breast	38.1	36.3	36.8	36.0	33.4	29.5	26.6	33.4	46.0	46.9	44.2	46.6	37.2	44.6	33.3	42.1	28.9	56.4	56.0	49.5	46.5	30.2	44.4	47.9
Injury, single site, major	62.6	82.3	66.4	57.7	48.8	42.2	50.8	56.6	69.8	87.8	74.6	71.3	61.2	46.8	55.8	65.6	57.4	90.9	81.3	38.4	22.7	6.3	7.3	76.9
Musculoskeletal/connective tissue system illness	15.3	48.1	42.4	44.7	44.6	43.8	41.4	41.0	27.0	66.3	56.5	59.0	57.9	59.0	55.1	56.7	46.7	89.1	73.3	71.7	79.2	69.8	66.7	73.8

* Excludes planned return visits
† Age group defined at first visit in first period of frequent attendance
‡ Cell suppressed, n ≤ 5

Neurological system illness	18.1	27.8	30.7	32.3	36.6	44.2	52.5	36.3	23.8	37.8	52.9	55.6	56.2	64.0	64.1	54.3	‡	58.2	70.7	74.1	75.0	83.0	68.5	71.7
Psychiatric illness	1.4	31.1	36.0	36.3	23.0	15.4	14.2	23.2	‡	54.1	58.7	62.7	36.0	18.7	21.2	40.9	0.0	67.3	68.0	71.2	52.1	28.3	16.7	55.7
Respiratory system illness	83.5	39.5	34.6	32.6	50.0	58.6	61.6	50.4	92.1	53.1	46.4	48.5	66.5	71.9	76.3	62.0	100.0	78.2	65.3	64.2	77.1	83.0	85.2	73.0
Urological system illness	11.1	17.7	21.0	17.9	27.3	40.4	47.4	27.3	14.3	32.7	27.5	24.3	42.6	65.5	60.3	39.1	‡	49.1	45.3	31.6	42.4	58.5	72.2	43.2

Table 3. Logistic regression predicting frequent attendance (FA): non-frequent vs i) all FA, ii) temporary FA, iii) repeat FA, iv) persistent FA. Persons aged 16 or over

	Non-frequent vs all frequent attenders[9]		Non-frequent vs *temporary* frequent attenders[10]		Non-frequent vs *repeat* frequent attenders[11]		Non-frequent vs *persistent* frequent attenders[12]	
Variable	**OR**	**(95% CI)**	**OR**	**(95% CI)**	**OR**	**(95% CI)**	**OR**	**(95% CI)**
Sex								
Male	1.2	(1.2,1.3)	1.3	(1.2,1.3)	1.3	(1.1,1.5)	1.0	(0.9,1.2)
Female (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Age group								
16-24 (reference)	1.0	-	1.0	-	1.0	-	1.0	-
25-44	1.1	(1.0,1.2)	1.0	(0.9,1.1)	1.2	(1.0,1.5)	1.9	(1.4.2.6)
45-64	1.1	(1.0,1.2)	1.0	(0.9,1.2)	1.4	(1.1,1.8)	1.7	(1.2,2.4)
65-74	1.5	(1.3,1.6)	1.4	(1.3,1.6)	1.6	(1.2,2.1)	1.3	(0.9,2.0)
75+	1.6	(1.4,1.7)	1.6	(1.4,1.8)	1.4	(1.1,1.9)	0.9	(0.6,1.3)
Partner								
Yes	0.7	(0.6,0.7)	0.7	(0.7,0.8)	0.6	(0.5,0.7)	0.4	(0.3,0.5)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Uninsured (no private hospital insurance)[13]								
Yes	2.0	(1.9,2.2)	1.9	(1.8,2.1)	2.5	(2.0,3.1)	2.3	(1.7,3.0)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Aboriginal or Torres Strait Islander								
Yes	2.1	(1.9,2.4)	1.9	(1.6,2.2)	2.5	(1.8,3.3)	3.1	(2.2.4.3)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
High average triage (1-3)								
Yes	3.3	(3.1,3.6)	3.2	(3.0,3.5)	3.7	(3.1,4.6)	3.3	(2.5,4.2)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Preferred language non-English**								
Yes	1.2	(1.1,1.4)	1.2	(1.1,1.4)	1.2	(0.9,1.6)	0.8	(0.5,1.4)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Proportion of visits admitted	0.7	(0.7,0.8)	0.7	(0.7,0.8)	0.6	(0.5,0.8)	0.6	(0.5,0.9)
Socio-economic status								
Quintile 1 (low)	1.5	(1.4,1.6)	1.5	(1.4,1.6)	1.4	(1.2,1.7)	1.4	(1.1,1.7)
Quintile 2	1.1	(1.0,1.2)	1.2	(1.1,1.3)	1.0	(0.8,1.2)	0.8	(0.6,1.1)
Quintile 3 (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Quintile 4	0.8	(0.7,0.9)	0.8	(0.7,1.0)	0.6	(0.4,0.9)	0.6	(0.4,1.0)
Quintile 5 (high)	0.7	(0.6,0.8)	0.8	(0.6,0.9)	0.5	(0.3,0.8)	0.4	(0.2,0.8)
Major Diagnostic Block[14]								
Alcohol/drug abuse and alcohol/drug induced mental disorders	6.7	(5.1,8.7)	5.2	(3.8,7.1)	11.1	(5.9,20.8)	26.5	(12.3,57.2)
Circulatory system illness	2.0	(1.8,2.3)	1.8	(1.6,2.1)	3.0	(2.1, 4.3)	5.6	(3.1, 9.9)
Digestive system illness	2.8	(2.5,3.2)	2.5	(2.2,2.8)	4.3	(3.0, 6.1)	8.5	(4.9, 14.7)
Endocrine, nutritional and metabolic system illness	2.5	(1.9,3.3)	2.0	(1.5,2.8)	4.9	(2.6, 9.3)	8.6	(3.3,22.4)
Illness of skin, subcutaneous tissue, breast	3.2	(2.7,3.7)	3.1	(2.6,3.6)	3.7	(2.3, 5.9)	3.9	(1.8 ,8.5)
Injury, single site, major (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Musculoskeletal/connective tissue system illness	1.8	(1.5,2.0)	1.5	(1.3,1.8)	2.8	(1.9, 4.3)	5.8	(3.1, 10.7)
Neurological system illness	2.1	(1.8,2.4)	1.7	(1.5,2.0)	3.2	(2.1, 4.8)	10.1	(5.6,18.1)
Psychiatric illness	6.7	(5.9,7.6)	5.0	(4.3,5.8)	13.8	(9.7,19.8)	25.5	(14.6,44.5)
Respiratory system illness	3.3	(2.9,3.7)	2.8	(2.5,3.2)	5.1	(3.5, 7.3)	9.4	(5.3,16.8)
Urological system illness	3.1	(2.7,3.6)	2.9	(2.5,3.4)	4.0	(2.6, 6.2)	5.1	(2.5,10.4)
Other	1.3	(1.1,1.5)	1.3	(1.1,1.4)	1.5	(1.0, 2.2)	1.3	(0.7, 2.4)

CI, Confidence Interval
OR, Odds Ratio

[9] n=211,447, χ^2_{26} = 4829.6 (p<.0001), R^2 = 8.5% (McFadden)
[10] n=210,198, χ^2_{26} = 3395.2 (p<.0001), R^2 = 7.1% (McFadden)
[11] n=206,440, χ^2_{26} = 1010.8 (p<.0001), R^2 = 9.5% (McFadden)
[12] n=206,097, χ^2_{26} = 836.5 (p<.0001), R^2 = 9.5% (McFadden)
[13] Missing values imputed with patient's most recent non-missing value.
[14] Most frequent MDB over all visits. Excludes missing diagnoses and those unable to be mapped to an MDB. All MDBs which included less than five ongoing, repeat or temporary frequent attenders was included with "Other MDB" in a category labelled 'Other'.

Table 4. Logistic regression predicting frequent attendance (FA): non-frequent vs i) all FA, ii) temporary FA, iii) repeat FA, iv) persistent FA. Persons aged under 16

	Non-frequent vs all frequent attenders[15]		Non-frequent vs *temporary* frequent attenders[16]		Non-frequent vs *repeat* frequent attenders[17]		Non-frequent vs *persistent* frequent attenders[18]	
Variable	**OR**	**(95% CI)**	**OR**	**(95% CI)**	**OR**	**(95% CI)**	**OR**	**(95% CI)**
Sex								
Male	0.9	(0.8,1.0)	1.0	(0.9,1.1)	0.6	(0.4,0.8)	0.4	(0.2,0.7)
Female (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Age group								
0-4 (reference)	1.0	-	1.0	-	1.0	-	1.0	-
5-15	1.3	(1.2,1.5)	1.2	(1.1,1.3)	2.0	(1.4,2.9)	4.7	(2.5,8.7)
Uninsured (no private hospital insurance)[19]								
Yes	1.9	(1.7,2.2)	1.9	(1.6,2.2)	1.9	(1.2,2.9)	3.6	(1.5,8.4)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Aboriginal or Torres Strait Islander								
Yes	1.5	(1.2,1.8)	1.4	(1.2,1.7)	1.9	(1.3,3.0)	1.5	(0.7.3.3)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
High average triage (1-3)								
Yes	2.5	(2.2,2.8)	2.4	(2.1,2.7)	3.0	(2.0,4.5)	3.9	(2.1,7.3)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Proportion of visits admitted	0.9	(0.8,1.1)	0.9	(0.7,1.1)	1.2	(0.7,2.0)	1.2	(0.5,2.6)
Socio-economic status								
Quintile 1 (low)	1.7	(1.5,2.0)	1.7	(1.4,1.9)	1.8	(1.2,2.7)	3.4	(1.7,6.7)
Quintile 2	1.7	(1.5,1.9)	1.7	(1.4,1.9)	1.6	(1.1,2.5)	3.5	(1.8,6.9)
Quintile 3 (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Quintile 4	1.1	(0.9,1.4)	1.2	(0.9,1.5)	0.4	(0.1,1.2)	1.6	(0.5,5.6)
Quintile 5 (high)	0.9	(0.7,1.2)	0.9	(0.7,1.3)	0.4	(0.1,1.3)	1.1	(0.2,4.8)
Major Diagnostic Block[20]								
Circulatory system illness	1.3	(0.8,2.1)	1.0	(0.5,1.8)	3.6	(1.4, 9.5)	1.2	(0.2, 9.3)
Digestive system illness	1.6	(1.3,1.9)	1.4	(1.2,1.7)	2.1	(1.3, 3.6)	3.2	(1.6, 6.4)
Endocrine, nutritional and metabolic system illness	2.1	(1.2,3.8)	1.6	(0.8,3.2)	5.0	(1.5, 16.8)	6.3	(1.4,29.2)
Illness of skin, subcutaneous tissue, breast	0.9	(0.6,1.2)	0.9	(0.7,1.3)	0.7	(0.2, 2.2)	0.5	(0.1 ,3.7)
Injury, single site, major (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Musculoskeletal/connective tissue system illness	0.6	(0.4,0.9)	0.7	(0.4,1.0)	0.3	(0.0, 2.0)	0.5	(0.1, 4.0)
Neurological system illness	2.4	(1.9,3.2)	2.1	(1.5,2.8)	4.5	(2.3, 8.8)	4.9	(1.9,12.4)
Psychiatric illness	7.8	(5.9,10.2)	6.9	(5.1,9.4)	13.4	(7.0,25.8)	9.8	(3.8,25.2)
Respiratory system illness	2.1	(1.8,2.4)	2.1	(1.8,2.4)	2.3	(1.4, 3.9)	1.2	(0.5, 3.2)
Other	0.8	(0.7,0.9)	0.8	(0.6,0.9)	0.9	(0.5, 1.5)	0.5	(0.2, 1.3)

CI, Confidence Interval
OR, Odds Ratio

[15] n=82,344, χ^2_{19} = 1076.2 (p<.0001), R^2 = 6.5% (McFadden)
[16] n=82,115, χ^2_{19} = 801.9 (p<.0001), R^2 = 5.3% (McFadden)
[17] n=80,958, χ^2_{19} = 232.4 (p<.0001), R^2 = 7.9% (McFadden)
[18] n=80,867, χ^2_{19} = 129.8 (p<.0001), R^2 = 10.9% (McFadden)
[19] Missing values imputed with patient's most recent non-missing value.
[20] Most frequent MDB over all visits. Excludes missing diagnoses and those unable to be mapped to an MDB. All MDBs which included less than five ongoing, repeat or temporary frequent attenders was included with "Other MDB" in a category labelled 'Other'.

Figure captions

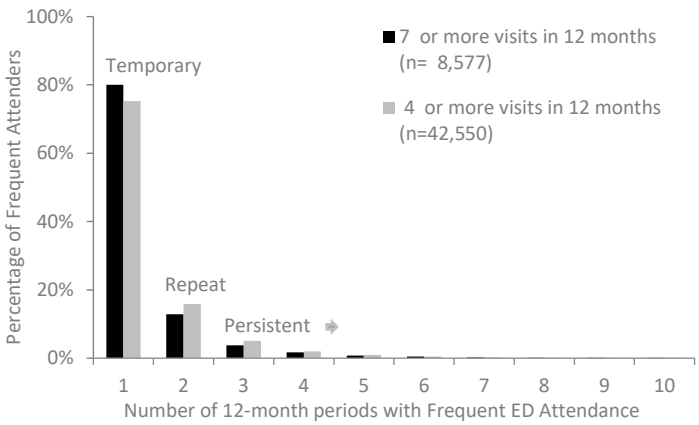
Figure 1.

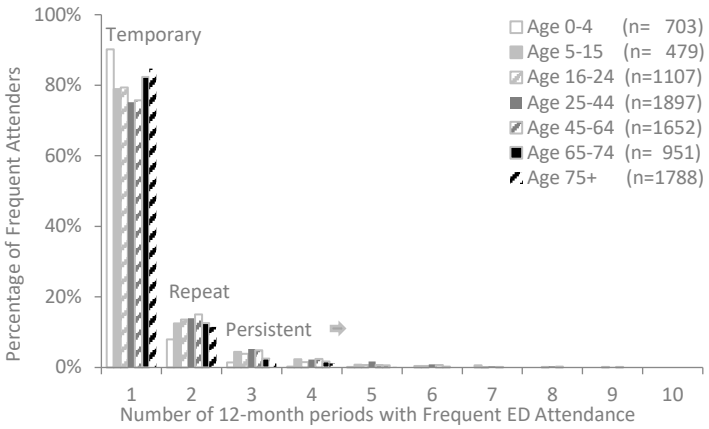
Number of 12-month periods where the frequent attendance threshold was met by frequently attending residents. *Left*: All residents with 7 or more visits in 12 months and all residents with 4 or more visits in 12 months. *Right*: all residents with 7 or more visits in 12 months by age group. Excludes planned return visits.

.**Figure 2.**

Logistic regression model predicting ongoing vs temporary frequent attendance. *Left*: Persons aged 16 and over (n=5,803). *Right*: Persons aged under 16 (n=1,546).

Note: Reference categories for persons aged 16 and over - Age: 16-24, SEIFA: Quintile 3, Major Diagnostic Block: Single Site Major Injury. Reference categories for persons aged under 16 - Age: 0-4, SEIFA: Quintile 3, Major Diagnostic Block: Single Site Major Injury.





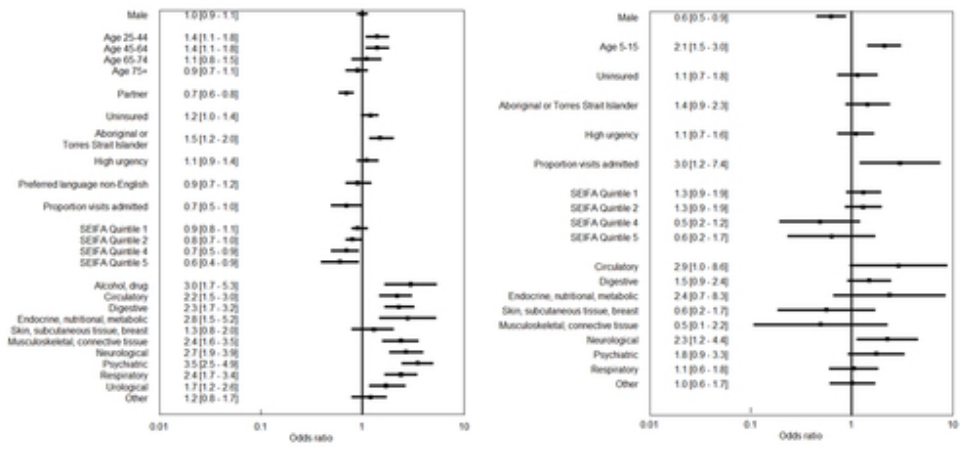


Figure 2. Logistic regression model predicting ongoing vs temporary frequent attendance. Left: Persons aged 16 and over (n=5,803). Right: Persons aged under 16 (n=1,546). Reference categories for adults: Age: 16-24, SEIFA: Quintile 3, Major Diagnostic Block: Single Site Major Injury and for children: age: 0-4, SEIFA: Quintile 3, Major Diagnostic Block: Single Site Major Injury

43x20mm (300 x 300 DPI)

Supplementary Material for Here one year, gone the next? Investigating duration and predictors of ongoing frequent emergency department attendance, a retrospective study in Australia.

Table 1. Diagnostic profile of all ED frequent attenders[1] by age group

	Age group[2]							
% of frequent attenders	**0-4**	**5-15**	**16-24**	**25-44**	**45-64**	**65-74**	**75+**	**All**
	N persons							
	788	768	1004	1867	1677	1042	1431	8577
Most common Major Diagnostic Block								
Alcohol/drug abuse and alcohol/drug induced mental disorders	0.0	0.0	1.0	2.2	2.0	0.1	0.0	1.0
Circulatory system illness	0.4	1.8	3.6	5.6	17.2	24.7	24.3	12.3
Digestive system illness	12.4	20.3	22.5	16.2	15.3	12.7	13.2	15.9
Endocrine, nutritional and metabolic system illness	0.6	1.0	1.2	1.1	0.9	1.1	1.0	1.0
Illness of skin, subcutaneous tissue, breast	1.9	4.2	5.2	6.6	4.8	3.0	2.7	4.3
Injury, single site, major	13.6	29.7	17.1	12.6	5.4	3.6	6.2	11.2
Musculoskeletal/connective tissue system illness	0.6	2.6	3.7	6.9	5.5	5.1	3.8	4.6
Neurological system illness	5.2	4.4	4.1	6.4	6.5	5.7	6.8	5.8
Psychiatric illness	0.1	10.2	13.9	16.3	7.0	1.5	1.0	7.8
Respiratory system illness	44.4	5.3	4.5	3.9	14.5	19.6	17.6	14.1
Urological system illness	1.0	1.8	2.4	2.1	4.2	10.5	13.7	5.4
Other MDBs	19.7	18.6	20.8	20.3	16.6	12.7	9.8	16.7
Major Diagnostic Block during study period								
Alcohol/drug abuse and alcohol/drug induced mental disorders	0.0	9.2	12.5	16.1	9.6	1.4	0.8	8.0
Circulatory system illness	4.6	27.3	31.7	40.8	61.9	73.3	73.1	48.7
Digestive system illness	65.7	69.5	63.6	60.2	61.6	65.4	62.0	63.1
Endocrine, nutritional and metabolic system illness	7.0	7.0	5.6	10.0	19.5	22.1	20.6	14.0
Illness of skin, subcutaneous tissue, breast	38.8	39.1	39.2	39.1	35.1	32.6	28.0	35.5
Injury, single site, major	63.3	83.6	68.6	62.6	52.7	43.5	51.8	59.2
Musculoskeletal/connective tissue system illness	16.6	53.4	46.6	49.8	49.5	47.1	43.9	45.3
Neurological system illness	18.8	31.3	36.8	40.4	42.7	48.9	55.2	41.1
Psychiatric illness	1.7	36.6	41.5	44.1	27.4	16.5	15.0	27.8
Respiratory system illness	84.5	44.0	38.6	38.5	54.7	61.6	64.1	53.7
Urological system illness	11.6	21.9	23.7	20.4	30.8	44.6	49.8	30.0

[1] Excludes planned return visits
[2] Age group at first visit in first period of frequent attendance.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	7
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	n.a.
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8
Bias	9	Describe any efforts to address potential sources of bias	9
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9
		(*b*) Describe any methods used to examine subgroups and interactions	8-9
		(*c*) Explain how missing data were addressed	8
		(*d*) If applicable, explain how loss to follow-up was addressed	n.a.
		(*e*) Describe any sensitivity analyses	9
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9-10
		(b) Give reasons for non-participation at each stage	n.a.
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10-11
		(b) Indicate number of participants with missing data for each variable of interest	8
		(c) Summarise follow-up time (eg, average and total amount)	9-10
Outcome data	15*	Report numbers of outcome events or summary measures over time	9-10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-11
		(*b*) Report category boundaries when continuous variables were categorized	8, In tables
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11-13
Discussion			
Key results	18	Summarise key results with reference to study objectives	13-14
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	3

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Here one year, gone the next? Investigating persistence of frequent emergency department attendance, a retrospective study in Australia.

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Secondary Subject Heading:	Epidemiology, Health services research, Health policy
Keywords:	emergency department, repeat use, longitudinal study, persistent, social determinants of health

Here one year, gone the next? Investigating persistence of frequent emergency department attendance, a retrospective study in Australia.

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Abstract

Objectives: Patients are presenting to Emergency Departments (EDs) with increasing complexity at rates beyond population growth and ageing. Intervention studies target patients with 12 months or less of frequent attendance. However, these interventions are not well targeted since most patients do not remain frequent attenders. This paper quantifies temporary and ongoing frequent attendance and contrasts risk factors for each group.

Design: Retrospective population-based study using 10 years of longitudinal data.

Setting: An Australian geographic region that includes metropolitan and rural EDs.

Participants: 332,100 residents visited any ED during the study period, of which 8,577 were frequent attenders (seven or more visits within 12 months).

Main outcome measure: Risk factors for temporary (one year) and ongoing frequent attenders were identified using logistic regression models for adults and children. Ongoing frequent attenders were further split into repeat (two years) and persistent (three or more years).

Results: Of 8,577 frequent attenders, 80.1% were temporary and 19.9% ongoing (12.9% repeat, 7.1% persistent). Among adults, ongoing were more likely than temporary frequent attenders to be young (age 25-44), of Aboriginal or Torres Strait Islander background, have no partner, be from lower socio-economic areas, and less likely to be admitted. Ongoing frequent attenders had higher-rates of non-injury presentations, in particular substance-related (OR=3.0, 95% CI 1.7 to 5.3) and psychiatric illness (OR=3.5, 95% CI 2.5 to 4.9). In comparison, children who were ongoing were more likely than temporary frequent attenders

to be female, aged 5-15, with higher likelihood of admission (OR=3.0, 95% CI 1.2 to 7.4) and rates of neurological conditions (OR=2.3, 95% CI 1.2 to 4.4).

Conclusions: Intervention studies that target the entire frequent attender cohort are inevitably unsuccessful because most frequent attenders are temporary. Future intervention studies should distinguish between temporary and ongoing frequent attenders, develop specific interventions for each group, and include rigorous evaluation.

Article summary

Strengths and limitations of this study:

- Our unique, longitudinal data platform has enabled this study on long-term patterns of attendance to all emergency departments within a single geographic region by frequent attenders over 10 years.
- We considered long-term frequent attendance patterns which allowed for patients discontinuing frequent attendance and resuming later on.
- We contrasted socio-demographic and risk factors for temporary versus ongoing frequent attendance and for both adults and children.
- We included metropolitan, regional and rural EDs in Australia, however findings from one healthcare setting may not be generalisable to other settings.

Funding and support: The authors acknowledge the Illawarra Health Information Platform (IHIP) research partnership established between the Illawarra Shoalhaven Local Health District (ISLHD) and the University of Wollongong, with ISLHD providing funding support and the data used in this study, and the NSW Ministry of Health who authorised the data release.

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Data statement: This study accessed data from the Illawarra Health Information Platform (IHIP) non-identifiable databank, which was established by the Illawarra Shoalhaven Local Health District (ISLHD) and the University of Wollongong in NSW, Australia, for research, planning and evaluation purposes. The study used deidentified participant data from 1 July 2005 to 30 June 2015. The Centre for Health Research Illawarra Shoalhaven Population and the NSW Ministry of Health approved unit record data access. Additional materials are available in the supplementary appendix.

Competing interests: The authors declare that they have no competing interests.

INTRODUCTION

Background

Emergency Department (ED) frequent attenders are a complex and vulnerable patient group.[1-4] Compared to non-frequent ED attenders, they have higher rates of morbidity and mortality,[5] mental health issues,[5-7] substance use problems,[6,8] and chronic diseases,[8-10] and are more likely to be homeless[11] and of low socio-economic status.[12] By definition, this group accounts for a disproportionate share of ED visits. They are also more likely to attend multiple EDs to address their unmet health needs.[8]

Interventions are primarily aimed at reducing ED visits,[13-17] and improving social and clinical outcomes.[13,16,18] The most commonly studied intervention is case management.[13,10,16,18] Other interventions include establishment of care plans with patient input,[19] and providing case notes from previous ED visits.[20] Case management in some cases reduced ED costs and improved social and clinical outcomes, but in many studies had no impact, or increased ED and primary care utilisation.[13] The limited number of studies with control groups has contributed to a lack of evidence on effective interventions, as before-and-after studies fail to account for the high likelihood of frequent attenders becoming infrequent without intervention.[1]

Relevance

Few studies have investigated long-term use patterns among ED attenders across multiple facilities.[21] Most studies report data from a single year,[22-28] or a small number of years,[11,16] or from a small number of facilities,[9,29,30] with ongoing visit patterns given little consideration.[1] Multi-site studies of more than 2-3 years are scarce.[1,21,31,32] The need for research into long-term utilisation patterns among frequent attenders has been identified, in particular

understanding predictors of ongoing use,[21] and analysis by age group and frequency of visit, to distinguish meaningful sub-groups for intervention.[1,33]

Research addressing these knowledge gaps will assist with identifying and distinguishing the characteristics of ongoing frequent attenders from those with temporary frequent ED use. This information will assist in planning appropriate support or interventions for the temporary and ongoing subgroups of frequent attenders.

Objectives

The aim of this study was to contrast the attributes and risk factors of temporary frequent attenders, with ongoing frequent attenders. The ongoing frequent attenders were further subdivided into repeat frequent attenders, who met the frequent attendance threshold twice, and persistent frequent attenders, who met the threshold in three or more periods.

METHODS

Study design and setting

A retrospective population-based study was carried out using longitudinal data from an Australian regional health service, the Illawarra Shoalhaven Local Health District (ISLHD). The district services almost 390,000 residents in a 250 kilometre long coastal catchment area, covering rural, regional and metropolitan areas.[34] Five of the eight public hospitals within the district have an ED, the largest being one of the busiest adult and paediatric emergency departments in the state of New South Wales.[35]

Selection of participants

This negligible risk study accessed data from the Illawarra Health Information Platform (IHIP). IHIP is a non-identifiable databank established by the ISLHD and the University of

Wollongong for research, planning and evaluation purposes. IHIP holds a unique record number for every person who has accessed any ISLHD service since the late 1980s. Ethical approval was received to establish the IHIP non-identifiable databank and for the associated data linkage protocols.

Emergency Department data were analysed for all individuals who attended any of the district's EDs at least once between 1 July 2005 and 30 June 2015. Non-residents of the district's catchment area were excluded.

Patient and Public Involvement

Previous studies by the authors on patient's reasons for attending ED,[36] and other literature on patient perspectives in the ED,[37] shaped the research questions, including a focus on understanding long-term use patterns rather than individual visits. The retrospective study was designed to inform future interventions and research. While patients were not directly involved in the design or conduct of this study, a steering group that includes a patient advisor will contribute to research translation and dissemination activities. Dissemination to patients will also occur through the health district's Community Partnership Council and other established patient advisory committees.

Outcomes

The primary outcome of the study was an estimate of the proportion of frequent attenders for whom frequent attendance is a temporary phenomenon (occurring only once during the study period). A secondary outcome was to identify and contrast risk factors for temporary and ongoing frequent attendance to highlight characteristics associated with a continuing frequent ED use.

Measurements

Historically, frequent ED use has been defined as three to 12 visits per year,[5] while highly frequent use has been defined as four to 20 visits per year.[7,38] Because of this variation, Locker et al proposed that more than four ED visits per year was a non-random event, and suggested this become a standard threshold for defining frequent ED attendance.[6] This study uses a more recently proposed definition based on a divergence of patient characteristics, where non-frequent attenders present 1-6 times in a year, and frequent attenders 7 or more times in a year.[39] A sub-group of highly frequent attenders, [39] who made 18 or more visits to EDs in any 12-month period, were also investigated.

A 12-month window was used to count ED visits following a first (or index) ED visit, a patient-based timeline not defined by calendar year.[39,40] Subsequent 12 month windows commenced at the next ED visit after each 12-month window. Consequently, a subsequent period of frequent attendance was not constrained to immediate following a first period.

Duration of frequent ED attendance was measured by the number of 12-month windows each patient had frequent ED use. Sub-groups of frequent attenders were identified to provide insight into the varying needs of this complex and heterogeneous patient group. Temporary frequent attenders were defined as those who met the frequent attendance threshold once during the study period, and ongoing frequent attenders were looked at in two groups - repeat frequent attenders who met the threshold twice, and persistent frequent attenders, who met the threshold three or more times.

Demographic characteristics such as age, sex, preferred language, and marital status were analysed according to the first ED visit in the study period. Private hospital insurance status and Aboriginal and Torres Strait Islander status were analysed according to the most recent visit to the ED,[41] due to a higher proportion of missing data in the early study years. Triage

category was averaged over all visits with an average of 4 to 5 considered low urgency. The proportion of all ED visits resulting in a hospital admission was calculated for each person.

Socioeconomic status was based on Index of Relative Socio-economic Disadvantage (IRSD) information.[42] Each Australian postal area has an ISRD score and ranking. For the purposes of this study, the rankings which were summarised as deciles were reduced to quintiles, with low ranks representing the most disadvantaged.

Patient diagnosis was recorded on discharge from the ED. Between 2009 and 2012 each ED within the regional health service transitioned from ICD-9-CM diagnosis coding to SNOMED recording of diagnosis. For this study, diagnoses according to ICD-9-CM coding and SNOMED were therefore mapped to ICD-10-AM[43] and then aggregated to Major Diagnostic Blocks (MDB) using the Independent Hospital Pricing Authority's Urgency Related Group software v1.4.4.[44] Frequent ED attenders were primarily analysed according to their most common MDB to reduce the likelihood of bias from with missing data (such as during system transition and for patients who did not wait), but also described based on whether they ever had a diagnosis in each MDB.

Data analysis

Associations between categorical variables were evaluated using Pearson's Chi Square Test. Multivariate logistic regression models were used to compare characteristics of non-frequent attenders with frequent attenders and subgroups, and results summarised as odds ratios (OR) and 95% confidence intervals (CI). Demographic, diagnosis (MDB), and visit characteristics were included in regression models. The proportion of missing data was generally low, ranging from <1% for items such as sex, Aboriginal or Torres Strait Islander status, socioeconomic status and triage category, to 5.3% for preferred language, 10.8% for hospital insurance and 11.4% for marital status. Those without an assigned MDB due to; no recorded diagnosis (7.5%), a diagnosis code not recognised by the grouper (3.9%) or patients who did

not wait (3.5%), were excluded from analysis by diagnosis. Planned return visits accounted for 3.1% of all ED visits, and these were excluded from all analyses. Sensitivity analyses were carried out with an alternative threshold for frequent ED attendance of four visits per year, and including planned return visits. Statistical significance was set at 5%. All statistical analysis was conducted using SAS version 9.4.[45]

RESULTS

A total of 1,199,633 ED visits by 332,100 individuals were recorded across the 10-year study period (Table 1). Of residents who attended the ED, 2.6% (n=8 577) met the threshold for frequent attendance (attended seven or more times within a 12-month window).

Among frequent attenders, most (n=6866, 80.1%) met the attendance threshold only once (temporary frequent attenders) (Figure 1). A further 12.9% (n= 1104) met the threshold twice (repeat frequent attenders), while only 7.1% (n=607) met the threshold on three or more occasions (persistent frequent attenders). Over the 10 years, these 607 persistent frequent attenders made 38,338 ED visits. A similar pattern of predominantly temporary frequent attendance was observed in each age group (Figure 1).

A sensitivity analysis including planned return visits indicated similar patterns of long term ED use. For example, 81.4% of frequent attenders were temporary frequent attenders when planned return visits were included. When the threshold of frequent attendance was reduced to four visits in 12-months, 75.6% of individuals were temporary frequent attenders.

Demographic and visit characteristics

Compared to non- frequent attenders, frequent attenders were more likely to be male, older (aged 65 or over), Aboriginal or Torres Strait Islander, have no partner, from non-English speaking backgrounds, un-insured (publically insured only patients), and resident in lower socio-economic areas (Table 1). Compared to the other groups of frequent attenders,

persistent frequent attenders were young to middle aged adults, female, Aboriginal or Torres Strait Islander, had no partner, were from lower socioeconomic areas, un-insured (publically insured only patients) and not admitted (Table 1). During the ten-year study period, frequent attenders had an average of 21.0 ED visits, compared to 3.2 for non- frequent attenders, with more frequent attenders admitted to hospital.

Diagnostic profile

The most common diagnoses among frequent attenders were digestive, respiratory, circulatory, single site major injury and psychiatric illness (Supplementary Material Table 1), however diagnostic profile differed by age and length of frequent attendance.

Among the youngest frequent attenders, aged 0-4 years, respiratory illness was the most common diagnosis across all groups' frequent attenders (Table 2). Among children aged 5-15 years, injury and digestive system illnesses were the two most common diagnoses in all sub-groups, with injury being the most common diagnosis among temporary frequent attenders and digestive system illness among the persistent frequent attenders. Children also presented with psychiatric illness, which was the most common diagnosis for 9.3% of temporary frequent attenders, 14.3% of repeat frequent attenders and 12.7% of persistent frequent attenders.

While injury and digestive system illness were also common among older teenagers and young adults (16-24 and 25-44 years), there were increasing numbers of patients visiting ED primarily for psychiatric illness, particularly among repeat frequent attenders aged 25-44 years and persistent frequent attenders (Table 2).

Among adults aged 45-64 years, the most common diagnoses were circulatory, digestive and respiratory illnesses. Among older adults 65 years and above, circulatory followed by respiratory system illnesses were most common, with the exception of persistent frequent attenders who had more respiratory illness than circulatory illness. In the older age groups,

aged 75 years and above, digestive system and urological system illness were common among all frequent attender groups.

Analysis of all diagnoses reported in the study period (rather than most common) shows that from the age of 25 years, ED visits relating to single site major injuries were common among temporary and repeat frequent attenders, while persistent frequent attenders had higher proportions of respiratory, musculoskeletal, neurological and psychiatric visits (Table 2). Among ongoing frequent attenders aged 5-15, 16-24 and 25-44, more than half presented with a psychiatric diagnosis at least once during the study period.

Risk factors associated with frequent attendance

Multivariate logistic regression models were fit to assess the likelihood of being a frequent attenders, based on socio-demographic and visit characteristics and diagnoses for those aged 16 and over (Table 3) and those aged under 16 (Table 4). Consistent with the findings of the earlier descriptive analysis, being an adult frequent attender was associated with being: male; older; Aboriginal or Torres Strait Islander; un-insured (publically insured only patients); socio-economically disadvantaged; presenting with higher urgency; lower likelihood of admission; and less likely to have a partner (Table 3). Compared to the reference category (single site major injury), frequent attendance was associated with all diagnostic groups, with the highest odds of psychiatric illness (OR=6.7, 95% CI 5.9 to 7.6) and alcohol/drug related disorders (OR=6.7, 95% CI 5.1 to 8.7) (Table 3).

Among children aged under 16, frequent attenders were more likely to be older (age 5 to 15) and similarly to adult frequent attenders, were more likely to be Aboriginal or Torres Strait Islander, un-insured (publically insured only patients); socio-economically disadvantaged; and present with higher urgency (OR=2.5, 95% CI 2.2 to 2.8). However, they were not more likely to be male; and were no less likely to be admitted than non- frequent attenders (Table 4).

Compared to the reference category (single site major injury), frequently attending children aged under 16 were more likely to present with digestive illness, endocrine, nutritional and metabolic system illness, neurological system illness, and respiratory illness. As with adults, the highest risk of frequent attendance was presenters with psychiatric illness (OR=7.8, 95% CI 5.9 to 10.2) (Table 4).

Risk factors associated with frequent attendance by duration

Models fitted separately for each frequent attendance sub-group (temporary frequent attenders, repeat frequent attenders and persistent frequent attenders compared to non-frequent attenders) led to different demographic risk factors. While temporary and repeat adult frequent attenders were more likely to be male, after adjusting for other characteristics, sex was not a risk factor for persistent frequent attenders (OR=1.0, 95% CI 0.9 to 1.2) (Table 3). Persistent adult frequent attenders were also more likely to be in the middle age groups, aged 25-64 years, whereas those aged 65 and over were more at risk for temporary and repeat frequent attendance. Among those aged under 16, ongoing frequent attenders (repeat and persistent) were more likely to be female and aged 5 to 15, neither of which were risk factors for temporary frequent attendance (Table 4).

Demographic and clinical risk factors for adult frequent attendance were in many cases magnified among repeat and persistent frequent attenders (Table 3). For example, Aboriginal or Torres Strait Islander background was a larger risk factor for those with long periods of frequent attendance (temporary frequent attenders OR=1.9, 95% CI 1.6 to 2.2 and persistent frequent attenders OR=3.1, 95% CI 2.2 to 4.2) and having a partner was less likely among longer duration frequent attenders (temporary frequent attenders OR=0.7, 95% CI 0.7 to 0.8 and persistent frequent attenders OR=0.4, 95% CI 0.3 to 0.5).

Alcohol and drug-related disorders were much more prominent among longer-duration frequent attenders (temporary frequent attenders OR=5.2, 95% CI 3.8 to 7.1 compared to

persistent frequent attenders OR=26.5, 95% CI 12.3 to 57.2), as were neurological illness (temporary frequent attenders OR=1.7, 95% CI 1.5 to 2.0 compared to persistent frequent attenders OR=10.1, 95% CI 5.6 to 18.1), and psychiatric illness (temporary frequent attenders OR=5.0, 95% CI 4.3 to 5.8 compared to persistent frequent attenders OR=25.5, 95% CI 14.6 to 44.5) (Table 3).

Risk factors for temporary versus ongoing frequent attendance

Risk factors for ongoing frequent attenders (repeat and persistent) were modelled in comparison to temporary frequent attenders, rather than non-frequent attenders. This confirmed the earlier findings that ongoing frequent attenders are younger (aged 25-64) and more likely to be Aboriginal or Torres Strait Islander, but less likely to have a partner, be admitted, or be from high socio-economic areas (Figure 2, left image). Substance-related visits, psychiatric illness, endocrine/nutritional/metabolic illness and neurological illness were again more likely for ongoing frequent attenders. Among children aged under 16, ongoing frequent attenders were more likely than temporary frequent attenders to be female, aged 5-15, and present with neurological illness (Figure 2, right image). Highly frequent users (18 or more visits in any 12-month period) were more likely to be ongoing frequent attenders. Among those who only met the lower frequent attendance threshold (7-17 visits in a 12-month period), 5.1% were persistent frequent attenders. In contrast, of patients who met the highly frequent threshold at least once (18 or more visits in any 12-month period), 45.5% were persistent frequent attenders.

DISCUSSION

This investigation of 10 years of longitudinal ED data has provided a novel perspective on the risk factors by duration of frequent attenders, for both adults and children. Investigation of visits to all EDs in the region found the majority of frequent ED attenders are temporary

and only approximately 20% remain as frequent attenders in any of up to nine subsequent years. Persistent frequent attenders only accounted for 7.1% of frequent attenders.

The estimate that 80.1% of frequent attenders are temporary is slightly higher than other shorter-term studies carried out in the US,[1, 33,43,46] Sweden[3] and New Zealand,[47] where estimates varied between 58 and 72%. Definitions of temporary frequent attenders differ slightly across studies, including: the threshold number of visits for frequent attenders; whether the period of frequent attendance is patient-based (using an index visit) or calendar based; whether another period of frequent attendance immediately follows the first frequent attendance period or is during the study period. We considered any periods of frequent attendance across the entire study period, to be inclusive of patients who re-established frequent attendance patterns.[48]

Systematic reviews show that internationally, intervention studies have been targeting the entire frequent attender cohort.[13,14] However, differences in profile and risk factors for ongoing frequent attenders compared to temporary frequent attenders, and for adults and children, demonstrate a need to consider different types of interventions. In particular, the cohort of persistent frequent attenders may receive more benefit from case management, and increased continuity of primary care provider[49] than temporary frequent attenders. Young adults with ongoing frequent attendance related to substance disorders and psychiatric illness may benefit from additional services outside the ED, while among children, older females with neurological conditions (predominantly seizure-related and headaches) could benefit from pathways which reduce the likelihood of admission and result in reduced length of hospital stay.[50]

Our research has shown a complex relationship between ED attendance and hospital admission. Multivariate analysis showed frequent ED attendance was inversely associated with hospital admission, and duration of frequent ED attendance was not associated with

hospital admission among adults, suggesting some frequent attenders may be treated and/or managed in a different setting. Highly frequent users do not use other health care services proportionally more than (low volume) frequent users,[39] suggesting highly frequent attenders may use ED's as a main source of care. It is therefore possible that the persistent frequent attender cohort, of which almost half were highly frequent attenders, also use the ED as a main source of care.

The heterogeneity of frequent attenders has contributed to ineffective policy development, with interventions needing to target specific sub-groups.[5] Similar to evidence in the literature, we identified three vulnerable patient groups at high risk of frequent attendance; those in situations of socioeconomic distress (e.g. low income, homelessness, social isolation);[8,9,11,21,51] those living with mental health and substance use problems;[8,21,39,47] and the elderly.[5,52] The first two of these groups are more likely to be ongoing frequent attenders, while the latter, elderly group tend to be temporary frequent attenders. Due to the ongoing nature of frequent ED attendance by those with socioeconomic and mental health issues, or both, it is imperative to find cost-effective alternatives. Temporary older frequent attenders are driving increases in ED utilisation and changing the clinical profile of EDs.[53,54,55,56] This group are multimorbid, with complex, ongoing health care needs, and required improved identification and management of those at risk of return.[52,54,57,58] To date, hospital-based interventions for these elderly patients have had little effect on ED use, potentially due to their typically short-term nature. However, a systematic review found that interventions in outpatient and primary care/home settings (including geriatric assessment and management and case management) have reduced ED use among this patient cohort.[59]

Our research has shown a complex relationship between ED attendance and hospital admission and found longitudinal ED data investigating ongoing frequent use identifies additional and inflated risk factors. In accordance with the recommendations of Pines et al,[33]

the authors future research agenda includes using data in model development and testing for predicting patients who are at risk of becoming and/or remaining frequent attenders. This will improve generalisability of existing predictive models, which are mostly from the U.S.,[46,60,61] often have small samples,[11,60] focus on a specific patient sub-group (e.g. Medicaid users,[46] or using inconsistent thresholds for frequent attendance (3, 4 or 10 visits in a year).[11,60,61]

Limitations

The inclusion of any patients whose with frequent attendance for any 12 month period during the 10 year study period enabled patients to be grouped according to long-term patterns of frequent attendance, however some temporary and repeat frequent attenders may have been classified differently had all participants had equal follow up time.

Data quality, data consistency and the amount of missing information (in particular diagnosis) improved over time, which may impact descriptive and modelling results. The effect of missing diagnoses was minimised by modelling a patient's most common diagnostic block over all visits. While hospital insurance and preferred language were imputed using recent data, having a partner was considered more likely to change over the study period so missing cases were excluded from models.

Social variables that may increase the risk of frequent attendance, such as use of primary care services, homelessness or isolation, are not routinely collected. Other factors that may be predictive of frequent attendance, such as patient satisfaction with treatment, and having a regular source of care[62] were not collected.

We could not link to data on deaths outside of the public hospital system and therefore could not explore reasons for patients discontinuing frequent attendance, however this is an area of potential future research. Finally, while we included data from metropolitan and rural EDs in one region in Australia, this may not be generalisable to other settings.

Conclusions

This study has provided a unique, longitudinal perspective on ED frequent attenders, contrasting the demographic and diagnostic profile of temporary, repeat and persistent frequent attenders. The distinction between temporary and ongoing frequently attending cohorts should be used when describing frequent attenders, and to inform appropriate interventions and better direct health resources.

Author contributions

LL carried out analysis, interpretation, and drafted the manuscript, VWW and KL assisted with interpretation of the data and assisted with drafting and reviewing the manuscript, RZ, JM, TC, and WT contributed to interpretation of the data and reviewed the manuscript, KE was responsible for the study conception and contributed to interpretation of the data and reviewed the manuscript.

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Table 1. Characteristics of ED patients, 12-month windows, and visits* by length of frequent attendance

	Frequent Attenders				Non-frequent ED attenders	ED attenders
	Temporary	Repeat	Persistent	*All*		
Patients	(N=6,866)	(N=1,104)	(N=607)	*(N=8,577)*	(N=323,523)	(N=332,100)
Age group (%) †‡						
0-4	10.4	5.7	2.3	*9.2*	13.4	13.3
5-15	9.0	8.9	9.1	*9.0*	12.6	12.5
16-24	11.5	12.5	12.4	*11.7*	12.6	12.6
25-44	20.2	24.3	34.9	*21.8*	22.6	22.6
45-64	18.8	21.9	23.7	*19.6*	20.2	20.2
65-74	12.4	12.6	8.7	*12.2*	8.6	8.7
75+	17.8	14.1	8.9	*16.7*	10.1	10.2
Sex (%)†‡						
Male	53.8	51.5	46.8	*53.0*	51.3	51.3
Female	46.2	48.6	53.2	*47.0*	48.8	48.7
Indigenous (%)§‡**						
Aboriginal or Torres Strait Islander origin	7.4	10.6	12.5	*8.2*	3.3	3.4
Neither Aboriginal nor Torres Strait Islander origin	92.6	89.4	87.5	*91.8*	96.8	96.6
Partner†‡** (persons aged 16 and over)						
Yes	45.1	39.0	30.2	*43.2*	53.8	53.5
No	54.9	61.0	69.8	*56.8*	46.2	46.5
Private hospital insurance (%)§‡**						
Yes	17.3	16.1	11.7	*16.8*	32.0	31.6
No	82.7	83.9	88.3	*83.3*	68.0	68.4
Preferred language (%)†‡**						
English	78.9	82.2	82.1	*79.6*	87.7	87.5
Other	21.1	17.8	17.9	*20.4*	12.3	12.5
Socio-economic status†‡**						
Quintile 1 (low)	30.0	32.8	34.4	*30.7*	22.2	22.4
Quintile 2	26.6	24.6	25.0	*26.3*	22.8	22.9
Quintile 3	32.8	35.6	34.6	*33.3*	40.4	40.2
Quintile 4	5.7	4.1	4.1	*5.4*	7.6	7.5
Quintile 5 (high)	4.8	2.9	1.8	*4.4*	7.0	7.0
Visits	(N=108,858)	(N=32,643)	(N=38,338)	*(N=179,839)*	(N=1,019,794)	(N=1,199,633)
Visits in study period (mean)	15.9	29.6	63.2	*21.0*	3.2	3.6
Visits per 12-month window (with 1+ visit) (mean)	4.2	5.8	9.5	*5.1*	1.7	1.8
Admitted (%)‡**						
Yes	37.0	38.0	33.5	*36.4*	30.8	31.6
No	63.0	62.0	66.5	*63.6*	69.2	68.4
Triage category‡**						
1 (highest urgency)	0.5	0.5	0.5	*0.5*	0.5	0.5
2	7.7	8.3	7.7	*7.8*	6.7	6.9
3	30.0	30.3	28.8	*29.9*	28.0	28.3
4	45.1	45.7	46.6	*45.8*	50.7	49.9
5 (lowest urgency)	16.7	15.3	16.4	*16.7*	14.2	14.5

* Excludes planned return visits

† As reported at earliest ED visit in study period

‡ χ^2 test for patient type (temporary frequent attender, repeat frequent attender, ongoing frequent attender by: age $\chi^2_{12} = 164.5$ (p<.0001), sex $\chi^2_2 = 12.2$ (p=0.002) , Indigenous $\chi^2_2 = 29.1$ (p<.0001), Partner $\chi^2_2 = 43.8$ (p<.0001), Hospital insurance $\chi^2_2 = 10.8$ (p=0.045) Preferred language $\chi^2_2 = 8.6$ (p=0.014), Socio-economic status $\chi^2_8 = 34.6$ (p<.0001), Admitted $\chi^2_2 = 196.7$ (p<.0001), Triage category $\chi^2_8 = 76.0$ (p<.0001). Excludes unknown, missing, and not-stated.

§ As reported at most recent ED visit in study period. This is the recommended approach for Indigenous status (Randall et al 2013) and was required for hospital insurance due to incomplete early data at two facilities.

** Percentage missing, unknown, not stated - Partner 11.5%, Indigenous status (at last ED visit) 0.9%, Socio-economic status 0.0%, Hospital insurance (at last ED visit) 10.8%, Preferred language 5.3%, Admitted 0.0%, Triage category 0.2%

Table 2. Diagnostic profile of ED frequent attender patients* by duration of frequent attendance and age group

	Temporary frequent attender (frequent attender in one 12-month period)								Repeat frequent attender (frequent attender in two 12-month periods)								Persistent frequent attender (frequent attender in three or more 12-month periods)							
	Age group†								Age group								Age group							
% of patients	0-4	5-15	16-24	25-44	45-64	65-74	75+	All	0-4	5-15	16-24	25-44	45-64	65-74	75+	All	0-4	5-15	16-24	25-44	45-64	65-74	75+	All
N persons	711	615	791	1387	1291	850	1221	6866	63	98	138	268	242	139	156	1104	14	55	75	212	144	53	54	607
Most common Major Diagnostic Block																								
Alcohol/drug abuse and alcohol/drug induced mental disorders	0.0	0.0	1.0	2.0	1.6	0.0	0.0	0.8	0.0	0.0	‡	2.6	2.9	0.0	0.0	1.4	0.0	0.0	‡	2.8	4.2	‡	0.0	2.3
Circulatory system illness	‡	1.3	3.5	5.5	17.5	24.4	23.7	12.2	0.0	5.1	‡	4.5	15.3	25.2	32.7	13.0	0.0	‡	‡	7.6	18.1	28.3	14.8	11.5
Digestive system illness	12.2	18.5	21.4	15.9	14.4	12.0	13.6	15.2	14.3	22.5	26.8	15.7	19.4	13.8	9.6	17.6	‡	36.4	26.7	18.4	16.7	15.1	14.8	19.9
Endocrine, nutritional and metabolic system illness	‡	0.8	0.9	1.1	0.7	1.1	1.2	0.9	‡	‡	‡	‡	2.1	‡	‡	1.4	0.0	‡	‡	‡	‡	0.0	0.0	1.3
Illness of skin, subcutaneous tissue, breast	2.0	4.7	5.6	7.1	5.4	3.3	2.9	4.7	‡	‡	5.1	5.6	2.9	‡	‡	3.4	0.0	‡	‡	4.3	‡	0.0	‡	2.6
Injury, single site, major	14.5	31.7	20.0	13.4	6.3	3.9	6.2	12.1	‡	21.4	7.3	12.7	2.1	‡	5.8	7.7	‡	21.8	‡	7.6	3.5	0.0	‡	6.9
Musculoskeletal/connective tissue system illness	0.7	2.9	3.0	6.0	5.3	5.4	4.2	4.3	0.0	‡	5.1	9.3	6.6	5.0	‡	5.3	0.0	‡	8.0	9.4	5.6	0.0	‡	6.1
Neurological system illness	4.6	3.6	3.5	5.6	5.3	5.9	7.0	5.3	9.5	7.1	5.1	6.3	8.7	5.8	3.9	6.5	‡	9.1	8.0	11.3	13.2	‡	11.1	10.4
Psychiatric illness	0.0	9.3	11.3	13.1	5.9	1.4	1.0	6.2	‡	14.3	21.0	25.0	10.7	‡	‡	12.9	0.0	12.7	29.3	26.4	10.4	‡	0.0	16.6
Respiratory system illness	44.0	6.0	4.6	4.0	14.3	18.4	17.1	14.4	47.6	‡	5.1	4.9	14.5	21.6	19.9	13.6	0.0	0.0	‡	2.4	16.7	34.0	22.2	11.2
Urological system illness	1.1	1.3	2.5	2.5	4.7	10.6	13.3	5.6	0.0	6.1	‡	‡	3.3	10.1	16.7	5.3	0.0	0.0	‡	‡	‡	9.4	14.8	3.2
Other MDBs	20.0	19.8	22.8	23.9	18.7	13.8	10.0	18.3	19.1	15.3	18.1	11.2	11.6	7.9	7.7	12.1	‡	10.9	‡	8.0	6.9	7.6	11.1	7.9
Major Diagnostic Block during study period																								
Alcohol/drug abuse and alcohol/drug induced mental disorders	0.0	8.5	10.5	11.8	7.3	1.5	0.7	6.0	0.0	10.2	17.4	26.1	16.5	0.0	‡	13.2	0.0	16.4	24.0	31.6	18.8	‡	‡	20.4
Circulatory system illness	4.1	22.4	29.6	35.3	58.9	69.5	71.5	45.4	7.9	40.8	31.9	49.6	65.7	89.9	81.4	57.3	‡	58.2	53.3	65.6	82.6	90.6	85.2	70.2
Digestive system illness	63.4	65.5	58.7	54.2	57.0	61.5	59.9	59.1	85.7	79.6	79.7	70.9	71.9	79.9	74.4	75.5	89.9	96.4	85.3	85.9	85.4	88.7	74.1	86.0
Endocrine, nutritional and metabolic system illness	6.5	6.0	3.5	7.9	16.9	20.4	19.0	12.3	12.7	10.2	10.9	13.1	24.4	23.7	30.1	18.8	7.1	12.7	17.3	20.3	24.7	45.3	29.6	25.4
Illness of skin, subcutaneous tissue, breast	38.1	36.3	36.8	36.0	33.4	29.5	26.6	33.4	46.0	46.9	44.2	46.6	37.2	44.6	33.3	42.1	28.9	56.4	56.0	49.5	46.5	30.2	44.4	47.9
Injury, single site, major	62.6	82.3	66.4	57.7	48.8	42.2	50.8	56.6	69.8	87.8	74.6	71.3	61.2	46.8	55.8	65.6	57.4	90.9	81.3	38.4	22.7	6.3	7.3	76.9
Musculoskeletal/connective tissue system illness	15.3	48.1	42.4	44.7	44.6	43.8	41.4	41.0	27.0	66.3	56.5	59.0	57.9	59.0	55.1	56.7	46.7	89.1	73.3	71.7	79.2	69.8	66.7	73.8

* Excludes planned return visits
† Age group defined at first visit in first period of frequent attendance
‡ Cell suppressed, n ≤ 5

Neurological system illness	18.1	27.8	30.7	32.3	36.6	44.2	52.5	36.3	23.8	37.8	52.9	55.6	56.2	64.0	64.1	54.3	‡	58.2	70.7	74.1	75.0	83.0	68.5	71.7
Psychiatric illness	1.4	31.1	36.0	36.3	23.0	15.4	14.2	23.2	‡	54.1	58.7	62.7	36.0	18.7	21.2	40.9	0.0	67.3	68.0	71.2	52.1	28.3	16.7	55.7
Respiratory system illness	83.5	39.5	34.6	32.6	50.0	58.6	61.6	50.4	92.1	53.1	46.4	48.5	66.5	71.9	76.3	62.0	100.0	78.2	65.3	64.2	77.1	83.0	85.2	73.0
Urological system illness	11.1	17.7	21.0	17.9	27.3	40.4	47.4	27.3	14.3	32.7	27.5	24.3	42.6	65.5	60.3	39.1	‡	49.1	45.3	31.6	42.4	58.5	72.2	43.2

Table 3. Logistic regression modelling characteristics associated with frequent attendance: non-frequent vs i) all frequent attenders, ii) temporary frequent attenders, iii) repeat frequent attenders, iv) persistent frequent attenders. Persons aged 16 or over

	Non-frequent vs all frequent attenders[9]		Non-frequent vs *temporary* frequent attenders[10]		Non-frequent vs *repeat* frequent attenders[11]		Non-frequent vs *persistent* frequent attenders[12]	
Variable	**OR**	**(95% CI)**	**OR**	**(95% CI)**	**OR**	**(95% CI)**	**OR**	**(95% CI)**
Sex								
Male	1.2	(1.2,1.3)	1.3	(1.2,1.3)	1.3	(1.1,1.5)	1.0	(0.9,1.2)
Female (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Age group								
16-24 (reference)	1.0	-	1.0	-	1.0	-	1.0	-
25-44	1.1	(1.0,1.2)	1.0	(0.9,1.1)	1.2	(1.0,1.5)	1.9	(1.4.2.6)
45-64	1.1	(1.0,1.2)	1.0	(0.9,1.2)	1.4	(1.1,1.8)	1.7	(1.2,2.4)
65-74	1.5	(1.3,1.6)	1.4	(1.3,1.6)	1.6	(1.2,2.1)	1.3	(0.9,2.0)
75+	1.6	(1.4,1.7)	1.6	(1.4,1.8)	1.4	(1.1,1.9)	0.9	(0.6,1.3)
Partner								
Yes	0.7	(0.6,0.7)	0.7	(0.7,0.8)	0.6	(0.5,0.7)	0.4	(0.3,0.5)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Uninsured (no private hospital insurance)[13]								
Yes	2.0	(1.9,2.2)	1.9	(1.8,2.1)	2.5	(2.0,3.1)	2.3	(1.7,3.0)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Aboriginal or Torres Strait Islander								
Yes	2.1	(1.9,2.4)	1.9	(1.6,2.2)	2.5	(1.8,3.3)	3.1	(2.2.4.3)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
High average triage (1-3)								
Yes	3.3	(3.1,3.6)	3.2	(3.0,3.5)	3.7	(3.1,4.6)	3.3	(2.5,4.2)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Preferred language non-English**								
Yes	1.2	(1.1,1.4)	1.2	(1.1,1.4)	1.2	(0.9,1.6)	0.8	(0.5,1.4)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Proportion of visits admitted	0.7	(0.7,0.8)	0.7	(0.7,0.8)	0.6	(0.5,0.8)	0.6	(0.5,0.9)
Socio-economic status								
Quintile 1 (low)	1.5	(1.4,1.6)	1.5	(1.4,1.6)	1.4	(1.2,1.7)	1.4	(1.1,1.7)
Quintile 2	1.1	(1.0,1.2)	1.2	(1.1,1.3)	1.0	(0.8,1.2)	0.8	(0.6,1.1)
Quintile 3 (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Quintile 4	0.8	(0.7,0.9)	0.8	(0.7,1.0)	0.6	(0.4,0.9)	0.6	(0.4,1.0)
Quintile 5 (high)	0.7	(0.6,0.8)	0.8	(0.6,0.9)	0.5	(0.3,0.8)	0.4	(0.2,0.8)
Major Diagnostic Block[14]								
Alcohol/drug abuse and alcohol/drug induced mental disorders	6.7	(5.1,8.7)	5.2	(3.8,7.1)	11.1	(5.9,20.8)	26.5	(12.3,57.2)
Circulatory system illness	2.0	(1.8,2.3)	1.8	(1.6,2.1)	3.0	(2.1, 4.3)	5.6	(3.1, 9.9)
Digestive system illness	2.8	(2.5,3.2)	2.5	(2.2,2.8)	4.3	(3.0, 6.1)	8.5	(4.9, 14.7)
Endocrine, nutritional and metabolic system illness	2.5	(1.9,3.3)	2.0	(1.5,2.8)	4.9	(2.6, 9.3)	8.6	(3.3,22.4)
Illness of skin, subcutaneous tissue, breast	3.2	(2.7,3.7)	3.1	(2.6,3.6)	3.7	(2.3, 5.9)	3.9	(1.8 ,8.5)
Injury, single site, major (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Musculoskeletal/connective tissue system illness	1.8	(1.5,2.0)	1.5	(1.3,1.8)	2.8	(1.9, 4.3)	5.8	(3.1, 10.7)
Neurological system illness	2.1	(1.8,2.4)	1.7	(1.5,2.0)	3.2	(2.1, 4.8)	10.1	(5.6,18.1)
Psychiatric illness	6.7	(5.9,7.6)	5.0	(4.3,5.8)	13.8	(9.7,19.8)	25.5	(14.6,44.5)
Respiratory system illness	3.3	(2.9,3.7)	2.8	(2.5,3.2)	5.1	(3.5, 7.3)	9.4	(5.3,16.8)
Urological system illness	3.1	(2.7,3.6)	2.9	(2.5,3.4)	4.0	(2.6, 6.2)	5.1	(2.5,10.4)
Other	1.3	(1.1,1.5)	1.3	(1.1,1.4)	1.5	(1.0, 2.2)	1.3	(0.7, 2.4)

CI, Confidence Interval
OR, Odds Ratio

[9] n=211,447, χ^2_{26} = 4829.6 (p<.0001), R^2 = 8.5% (McFadden)
[10] n=210,198, χ^2_{26} = 3395.2 (p<.0001), R^2 = 7.1% (McFadden)
[11] n=206,440, χ^2_{26} = 1010.8 (p<.0001), R^2 = 9.5% (McFadden)
[12] n=206,097, χ^2_{26} = 836.5 (p<.0001), R^2 = 9.5% (McFadden)
[13] Missing values imputed with patient's most recent non-missing value.
[14] Most frequent MDB over all visits. Excludes missing diagnoses and those unable to be mapped to an MDB. All MDBs which included less than five ongoing, repeat or temporary frequent attenders was included with "Other MDB" in a category labelled 'Other'.

Table 4. Logistic regression modelling characteristics associated with frequent attendance: non-frequent vs i) all frequent attenders, ii) temporary frequent attenders, iii) repeat frequent attenders, iv) persistent frequent attenders. Persons aged under 16

	Non-frequent vs all frequent attenders[15]		Non-frequent vs *temporary* frequent attenders[16]		Non-frequent vs *repeat* frequent attenders[17]		Non-frequent vs *persistent* frequent attenders[18]	
Variable	**OR**	**(95% CI)**	**OR**	**(95% CI)**	**OR**	**(95% CI)**	**OR**	**(95% CI)**
Sex								
Male	0.9	(0.8,1.0)	1.0	(0.9,1.1)	0.6	(0.4,0.8)	0.4	(0.2,0.7)
Female (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Age group								
0-4 (reference)	1.0	-	1.0	-	1.0	-	1.0	-
5-15	1.3	(1.2,1.5)	1.2	(1.1,1.3)	2.0	(1.4,2.9)	4.7	(2.5,8.7)
Uninsured (no private hospital insurance)[19]								
Yes	1.9	(1.7,2.2)	1.9	(1.6,2.2)	1.9	(1.2,2.9)	3.6	(1.5,8.4)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Aboriginal or Torres Strait Islander								
Yes	1.5	(1.2,1.8)	1.4	(1.2,1.7)	1.9	(1.3,3.0)	1.5	(0.7.3.3)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
High average triage (1-3)								
Yes	2.5	(2.2,2.8)	2.4	(2.1,2.7)	3.0	(2.0,4.5)	3.9	(2.1,7.3)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Proportion of visits admitted	0.9	(0.8,1.1)	0.9	(0.7,1.1)	1.2	(0.7,2.0)	1.2	(0.5,2.6)
Socio-economic status								
Quintile 1 (low)	1.7	(1.5,2.0)	1.7	(1.4,1.9)	1.8	(1.2,2.7)	3.4	(1.7,6.7)
Quintile 2	1.7	(1.5,1.9)	1.7	(1.4,1.9)	1.6	(1.1,2.5)	3.5	(1.8,6.9)
Quintile 3 (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Quintile 4	1.1	(0.9,1.4)	1.2	(0.9,1.5)	0.4	(0.1,1.2)	1.6	(0.5,5.6)
Quintile 5 (high)	0.9	(0.7,1.2)	0.9	(0.7,1.3)	0.4	(0.1,1.3)	1.1	(0.2,4.8)
Major Diagnostic Block[20]								
Circulatory system illness	1.3	(0.8,2.1)	1.0	(0.5,1.8)	3.6	(1.4, 9.5)	1.2	(0.2, 9.3)
Digestive system illness	1.6	(1.3,1.9)	1.4	(1.2,1.7)	2.1	(1.3, 3.6)	3.2	(1.6, 6.4)
Endocrine, nutritional and metabolic system illness	2.1	(1.2,3.8)	1.6	(0.8,3.2)	5.0	(1.5, 16.8)	6.3	(1.4,29.2)
Illness of skin, subcutaneous tissue, breast	0.9	(0.6,1.2)	0.9	(0.7,1.3)	0.7	(0.2, 2.2)	0.5	(0.1 ,3.7)
Injury, single site, major (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Musculoskeletal/connective tissue system illness	0.6	(0.4,0.9)	0.7	(0.4,1.0)	0.3	(0.0, 2.0)	0.5	(0.1, 4.0)
Neurological system illness	2.4	(1.9,3.2)	2.1	(1.5,2.8)	4.5	(2.3, 8.8)	4.9	(1.9,12.4)
Psychiatric illness	7.8	(5.9,10.2)	6.9	(5.1,9.4)	13.4	(7.0,25.8)	9.8	(3.8,25.2)
Respiratory system illness	2.1	(1.8,2.4)	2.1	(1.8,2.4)	2.3	(1.4, 3.9)	1.2	(0.5, 3.2)
Other	0.8	(0.7,0.9)	0.8	(0.6,0.9)	0.9	(0.5, 1.5)	0.5	(0.2, 1.3)

CI, Confidence Interval
OR, Odds Ratio

[15] n=82,344, χ^2_{19} = 1076.2 (p<.0001), R^2 = 6.5% (McFadden)
[16] n=82,115, χ^2_{19} = 801.9 (p<.0001), R^2 = 5.3% (McFadden)
[17] n=80,958, χ^2_{19} = 232.4 (p<.0001), R^2 = 7.9% (McFadden)
[18] n=80,867, χ^2_{19} = 129.8 (p<.0001), R^2 = 10.9% (McFadden)
[19] Missing values imputed with patient's most recent non-missing value.
[20] Most frequent MDB over all visits. Excludes missing diagnoses and those unable to be mapped to an MDB. All MDBs which included less than five ongoing, repeat or temporary frequent attenders was included with "Other MDB" in a category labelled 'Other'.

Figure captions

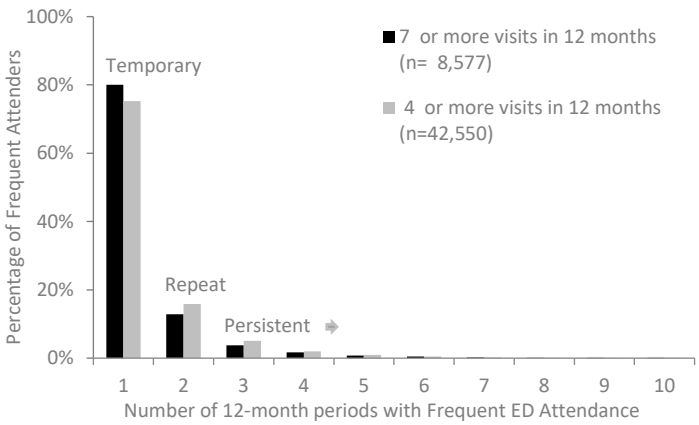
Figure 1.

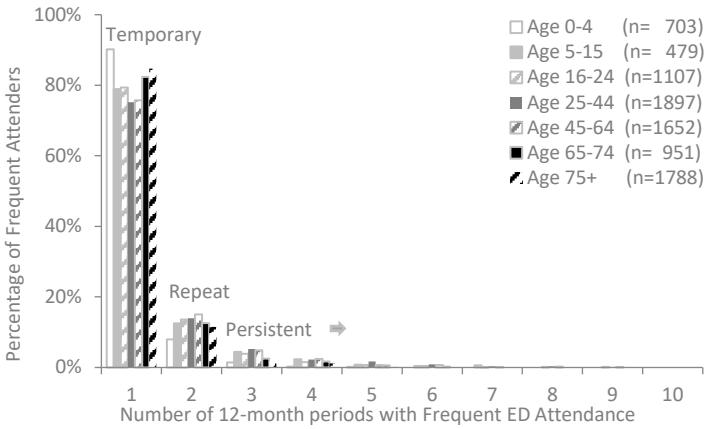
Number of 12-month periods where the frequent attendance threshold was met by frequently attending residents. *Left*: All residents with 7 or more visits in 12 months and all residents with 4 or more visits in 12 months. *Right*: all residents with 7 or more visits in 12 months by age group. Excludes planned return visits.

Figure 2.

Logistic regression model identifying characteristics associated with ongoing vs temporary frequent attendance. *Left*: Persons aged 16 and over (n=5,803). *Right*: Persons aged under 16 (n=1,546).

Note: Reference categories for persons aged 16 and over - Age: 16-24, SEIFA: Quintile 3, Major Diagnostic Block: Single Site Major Injury. Reference categories for persons aged under 16 - Age: 0-4, SEIFA: Quintile 3, Major Diagnostic Block: Single Site Major Injury.





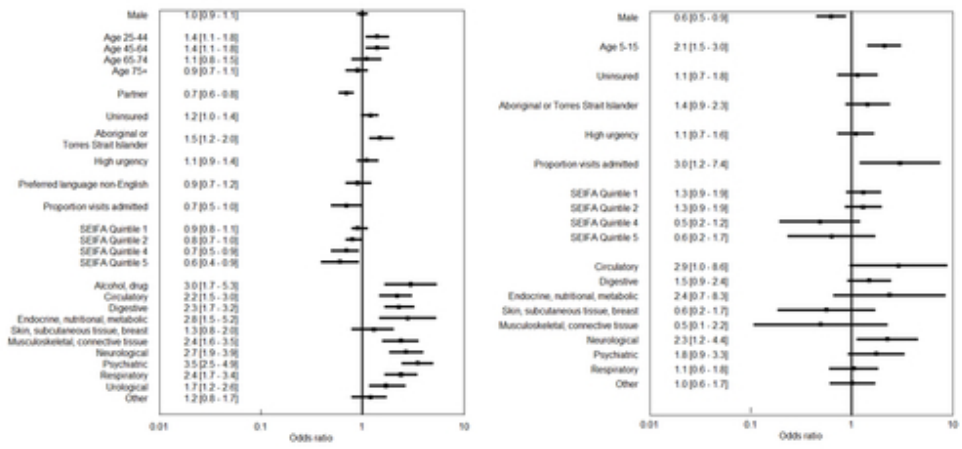


Figure 2. Logistic regression model identifying characteristics associted with ongoing vs temporary frequent attendance. Left: Persons aged 16 and over (n=5,803). Right: Persons aged under 16 (n=1,546). Reference categories for adults: Age: 16-24, SEIFA: Quintile 3, Major Diagnostic Block: Single Site Major Injury and for children: age: 0-4, SEIFA: Quintile 3, Major Diagnostic Block: Single Site Major Injury

43x20mm (300 x 300 DPI)

Supplementary Material for Here one year, gone the next? Investigating duration and predictors of ongoing frequent emergency department attendance, a retrospective study in Australia.

Table 1. Diagnostic profile of all ED frequent attenders[1] by age group

	Age group[2]							
% of frequent attenders	**0-4**	**5-15**	**16-24**	**25-44**	**45-64**	**65-74**	**75+**	**All**
	N persons							
	788	768	1004	1867	1677	1042	1431	8577
Most common Major Diagnostic Block								
Alcohol/drug abuse and alcohol/drug induced mental disorders	0.0	0.0	1.0	2.2	2.0	0.1	0.0	1.0
Circulatory system illness	0.4	1.8	3.6	5.6	17.2	24.7	24.3	12.3
Digestive system illness	12.4	20.3	22.5	16.2	15.3	12.7	13.2	15.9
Endocrine, nutritional and metabolic system illness	0.6	1.0	1.2	1.1	0.9	1.1	1.0	1.0
Illness of skin, subcutaneous tissue, breast	1.9	4.2	5.2	6.6	4.8	3.0	2.7	4.3
Injury, single site, major	13.6	29.7	17.1	12.6	5.4	3.6	6.2	11.2
Musculoskeletal/connective tissue system illness	0.6	2.6	3.7	6.9	5.5	5.1	3.8	4.6
Neurological system illness	5.2	4.4	4.1	6.4	6.5	5.7	6.8	5.8
Psychiatric illness	0.1	10.2	13.9	16.3	7.0	1.5	1.0	7.8
Respiratory system illness	44.4	5.3	4.5	3.9	14.5	19.6	17.6	14.1
Urological system illness	1.0	1.8	2.4	2.1	4.2	10.5	13.7	5.4
Other MDBs	19.7	18.6	20.8	20.3	16.6	12.7	9.8	16.7
Major Diagnostic Block during study period								
Alcohol/drug abuse and alcohol/drug induced mental disorders	0.0	9.2	12.5	16.1	9.6	1.4	0.8	8.0
Circulatory system illness	4.6	27.3	31.7	40.8	61.9	73.3	73.1	48.7
Digestive system illness	65.7	69.5	63.6	60.2	61.6	65.4	62.0	63.1
Endocrine, nutritional and metabolic system illness	7.0	7.0	5.6	10.0	19.5	22.1	20.6	14.0
Illness of skin, subcutaneous tissue, breast	38.8	39.1	39.2	39.1	35.1	32.6	28.0	35.5
Injury, single site, major	63.3	83.6	68.6	62.6	52.7	43.5	51.8	59.2
Musculoskeletal/connective tissue system illness	16.6	53.4	46.6	49.8	49.5	47.1	43.9	45.3
Neurological system illness	18.8	31.3	36.8	40.4	42.7	48.9	55.2	41.1
Psychiatric illness	1.7	36.6	41.5	44.1	27.4	16.5	15.0	27.8
Respiratory system illness	84.5	44.0	38.6	38.5	54.7	61.6	64.1	53.7
Urological system illness	11.6	21.9	23.7	20.4	30.8	44.6	49.8	30.0

[1] Excludes planned return visits
[2] Age group at first visit in first period of frequent attendance.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6-7
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	n.a.
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8-9
Bias	9	Describe any efforts to address potential sources of bias	9-10
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9-10
		(*b*) Describe any methods used to examine subgroups and interactions	8-9
		(*c*) Explain how missing data were addressed	9-10
		(*d*) If applicable, explain how loss to follow-up was addressed	n.a.
		(*e*) Describe any sensitivity analyses	10
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	10
		(b) Give reasons for non-participation at each stage	n.a.
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10-12
		(b) Indicate number of participants with missing data for each variable of interest	9-10
		(c) Summarise follow-up time (eg, average and total amount)	7-8
Outcome data	15*	Report numbers of outcome events or summary measures over time	10-11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-14
		(*b*) Report category boundaries when continuous variables were categorized	8-9, In tables
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11-14
Discussion			
Key results	18	Summarise key results with reference to study objectives	14-17
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17
Generalisability	21	Discuss the generalisability (external validity) of the study results	17
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	3

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Here one year, gone the next? Investigating persistence of frequent emergency department attendance, a retrospective study in Australia.

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Keywords:	emergency department, repeat use, longitudinal study, persistent, social determinants of health

Here one year, gone the next? Investigating persistence of frequent emergency department attendance, a retrospective study in Australia.

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Keywords: emergency department; repeat use; longitudinal study; persistent; social determinants of health;

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Abstract

Objectives: Patients are presenting to Emergency Departments (EDs) with increasing complexity at rates beyond population growth and ageing. Intervention studies target patients with 12 months or less of frequent attendance. However, these interventions are not well targeted since most patients do not remain frequent attenders. This paper quantifies temporary and ongoing frequent attendance and contrasts risk factors for each group.

Design: Retrospective population-based study using 10 years of longitudinal data.

Setting: An Australian geographic region that includes metropolitan and rural EDs.

Participants: 332,100 residents visited any ED during the study period, of which 8,577 were frequent attenders (seven or more visits within 12 months).

Main outcome measure: Risk factors for temporary (one year) and ongoing frequent attenders were identified using logistic regression models for adults and children. Ongoing frequent attenders were further split into repeat (two years) and persistent (three or more years).

Results: Of 8,577 frequent attenders, 80.1% were temporary and 19.9% ongoing (12.9% repeat, 7.1% persistent). Among adults, ongoing were more likely than temporary frequent attenders to be young to middle aged (age 25-64), , and less likely to be from a high socio economic area or be admitted. Ongoing frequent attenders had higher-rates of non-injury presentations, in particular substance-related (OR=2.5, 99% CI 1.1 to5.6) and psychiatric illness (OR=2.9, 99% CI 1.8 to4.6). In comparison, children who were ongoing were more

likely than temporary frequent attenders to be aged 5-15, and were not more likely to be admitted (OR=2.7, 99% CI 0.7 to10.9).

Conclusions: Intervention studies that target the entire frequent attender cohort are inevitably unsuccessful because most frequent attenders are temporary. Future intervention studies should distinguish between temporary and ongoing frequent attenders, develop specific interventions for each group, and include rigorous evaluation.

Article summary

Strengths and limitations of this study:

- Our unique, longitudinal data platform has enabled this study on long-term patterns of attendance to all emergency departments within a single geographic region by frequent attenders over 10 years.
- We considered long-term frequent attendance patterns which allowed for patients discontinuing frequent attendance and resuming later on.
- We contrasted socio-demographic and risk factors for temporary versus ongoing frequent attendance and for both adults and children.
- We included metropolitan, regional and rural EDs in Australia, however findings from one healthcare setting may not be generalisable to other settings.

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Data statement: This study accessed data from the Illawarra Health Information Platform (IHIP) non-identifiable databank, which was established by the Illawarra Shoalhaven Local Health District (ISLHD) and the University of Wollongong in NSW, Australia, for research, planning and evaluation purposes. The study used deidentified participant data from 1 July 2005 to 30 June 2015. The Centre for Health Research Illawarra Shoalhaven Population and the NSW Ministry of Health approved unit record data access. Additional materials are available in the supplementary appendix.

Competing interests: The authors declare that they have no competing interests.

INTRODUCTION

Background

Emergency Department (ED) frequent attenders are a complex and vulnerable patient group.[1-4] Compared to non-frequent ED attenders, they have higher rates of morbidity and mortality,[5] mental health issues,[5-7] substance use problems,[6,8] and chronic diseases,[8-10] and are more likely to be homeless[11] and of low socio-economic status.[12] By definition, this group accounts for a disproportionate share of ED visits. They are also more likely to attend multiple EDs to address their unmet health needs.[8]

Interventions are primarily aimed at reducing ED visits,[13-17] and improving social and clinical outcomes.[13,16,18] The most commonly studied intervention is case management.[13,10,16,18] Other interventions include establishment of care plans with patient input,[19] and providing case notes from previous ED visits.[20] Case management in some cases reduced ED costs and improved social and clinical outcomes, but in many studies had no impact, or increased ED and primary care utilisation.[13] The limited number of studies with control groups has contributed to a lack of evidence on effective interventions, as before-and-after studies fail to account for the high likelihood of frequent attenders becoming infrequent without intervention.[1]

Relevance

Few studies have investigated long-term use patterns among ED attenders across multiple facilities.[21] Most studies report data from a single year,[22-28] or a small number of years,[11,16] or from a small number of facilities,[9,29,30] with ongoing visit patterns given little consideration.[1] Multi-site studies of more than 2-3 years are scarce.[1,21,31,32] The need for research into long-term utilisation patterns among frequent attenders has been identified, in particular

understanding predictors of ongoing use,[21] and analysis by age group and frequency of visit, to distinguish meaningful sub-groups for intervention.[1,33]

Research addressing these knowledge gaps will assist with identifying and distinguishing the characteristics of ongoing frequent attenders from those with temporary frequent ED use. This information will assist in planning appropriate support or interventions for the temporary and ongoing subgroups of frequent attenders.

Objectives

The aim of this study was to contrast the attributes and risk factors of temporary frequent attenders, with ongoing frequent attenders. The ongoing frequent attenders were further subdivided into repeat frequent attenders, who met the frequent attendance threshold twice, and persistent frequent attenders, who met the threshold in three or more periods.

METHODS

Study design and setting

A retrospective population-based study was carried out using longitudinal data from an Australian regional health service, the Illawarra Shoalhaven Local Health District (ISLHD). The district services almost 390,000 residents in a 250 kilometre long coastal catchment area, covering rural, regional and metropolitan areas.[34] Five of the eight public hospitals within the district have an ED, the largest being one of the busiest adult and paediatric emergency departments in the state of New South Wales.[35]

Selection of participants

This negligible risk study accessed data from the Illawarra Health Information Platform (IHIP). IHIP is a non-identifiable databank established by the ISLHD and the University of

Wollongong for research, planning and evaluation purposes. IHIP holds a unique record number for every person who has accessed any ISLHD service since the late 1980s. Emergency Department data were analysed for all individuals who attended any of the district's EDs at least once between 1 July 2005 and 30 June 2015. Non-residents of the district's catchment area were excluded.

Ethical approval

The study involved the use of existing non-identifiable data sourced from ISLHD routine administrative data and accessed from IHIP. Ethical approval for establishment of IHIP's non-identifiable databank, including the ISLHD administrative data, was obtained from the University of Wollongong and Illawarra Shoalhaven Local Health District's Health and Medical Human Research Ethics Committee (HREC) on 14 November 2016 (Ethics number: 2016/306). The CHRISP Executive Steering Committee also approved this study. This committee includes senior representatives of both institutions including the Chief Executive and Director of Research at ISLHD, and the Deputy Vice-Chancellor Research at UOW. The committee, as the institutional review board, deemed the study exempt from ethical review, as it was negligible risk, involved only routinely collected non-identifiable data that had already been approved by the HREC, and were already stored in IHIP, used only unlinked data, and did not require any further approvals (e.g. specific ethics approval from the Aboriginal Health & Medical Research Council). This study was completed in accordance with the National Statement on Ethical Research 2007 (updated 2018, The National Health and Medical Research Council, the Australian Research Council and Universities Australia) and the Helsinki Declaration (as revised in 2013).

Patient and Public Involvement

Previous studies by the authors on patient's reasons for attending ED,[36] and other literature on patient perspectives in the ED,[37] shaped the research questions, including a focus on

understanding long-term use patterns rather than individual visits. The retrospective study was designed to inform future interventions and research. While patients were not directly involved in the design or conduct of this study, a steering group that includes a patient advisor will contribute to research translation and dissemination activities. Dissemination to patients will also occur through the health district's Community Partnership Council and other established patient advisory committees.

Outcomes

The primary outcome of the study was an estimate of the proportion of frequent attenders for whom frequent attendance is a temporary phenomenon (occurring only once during the study period). A secondary outcome was to identify and contrast risk factors for temporary and ongoing frequent attendance to highlight characteristics associated with a continuing frequent ED use.

Measurements

Historically, frequent ED use has been defined as three to 12 visits per year,[5] while highly frequent use has been defined as four to 20 visits per year.[7,38] Because of this variation, Locker et al proposed that more than four ED visits per year was a non-random event, and suggested this become a standard threshold for defining frequent ED attendance.[6] This study uses a more recently proposed definition based on a divergence of patient characteristics, where non-frequent attenders present 1-6 times in a year, and frequent attenders 7 or more times in a year.[39] A sub-group of highly frequent attenders, [39] who made 18 or more visits to EDs in any 12-month period, were also investigated.

A 12-month window was used to count ED visits following a first (or index) ED visit, a patient-based timeline not defined by calendar year.[39,40] Subsequent 12 month windows

commenced at the next ED visit after each 12-month window. Consequently, a subsequent period of frequent attendance was not constrained to immediate following a first period.

Duration of frequent ED attendance was measured by the number of 12-month windows each patient had frequent ED use. Sub-groups of frequent attenders were identified to provide insight into the varying needs of this complex and heterogeneous patient group. Temporary frequent attenders were defined as those who met the frequent attendance threshold once during the study period, and ongoing frequent attenders were looked at in two groups - repeat frequent attenders who met the threshold twice, and persistent frequent attenders, who met the threshold three or more times.

Demographic characteristics such as age, sex, preferred language, and marital status were analysed according to the first ED visit in the study period. Private hospital insurance status and Aboriginal and Torres Strait Islander status were analysed according to the most recent visit to the ED,[41] due to a higher proportion of missing data in the early study years. Triage category was averaged over all visits with an average of 4 to 5 considered low urgency. The proportion of all ED visits resulting in a hospital admission was calculated for each person.

Socioeconomic status was based on Index of Relative Socio-economic Disadvantage (IRSD) information.[42] Each Australian postal area has an ISRD score and ranking. For the purposes of this study, the rankings which were summarised as deciles were reduced to quintiles, with low ranks representing the most disadvantaged.

Patient diagnosis was recorded on discharge from the ED. Between 2009 and 2012 each ED within the regional health service transitioned from ICD-9-CM diagnosis coding to SNOMED recording of diagnosis. For this study, diagnoses according to ICD-9-CM coding and SNOMED were therefore mapped to ICD-10-AM[43] and then aggregated to Major Diagnostic Blocks (MDB) using the Independent Hospital Pricing Authority's Urgency Related Group software v1.4.4.[44] Frequent ED attenders were primarily analysed according to

their most common MDB to reduce the likelihood of bias from with missing data (such as during system transition and for patients who did not wait), but also described based on whether they ever had a diagnosis in each MDB.

Data analysis

Associations between categorical variables were evaluated using Pearson's Chi Square Test. Multivariate mixed logistic regression models with crossed random effects to control for attendance at one or more ED's were used to identify factors associated with frequent attendance among persistent, repeat and ongoing groups, each compared with non-frequent attenders. Results were summarised as odds ratios (OR) and confidence intervals (CI) presented with alpha of 5% adjusted for multiple comparisons via Bonferroni correction according to the number of model parameters estimated in each model. This resulted in odds ratios with 99.8% confidence intervals for models relating to adults, and 99.6% relating to children (where less model parameters were used). Demographic, diagnosis (MDB), and visit characteristics were included in regression models. The proportion of missing data was generally low, ranging from <1% for items such as sex, Aboriginal or Torres Strait Islander status, socioeconomic status and triage category, to 5.3% for preferred language, 10.8% for hospital insurance and 11.4% for marital status. Those without an assigned MDB due to; no recorded diagnosis (7.5%), a diagnosis code not recognised by the grouper (3.9%) or patients who did not wait (3.5%), were excluded from analysis by diagnosis. Planned return visits accounted for 3.1% of all ED visits, and these were excluded from all analyses. Sensitivity analyses were carried out with an alternative threshold for frequent ED attendance of four visits per year, and including planned return visits. Statistical significance was set at 5%. All statistical analysis was conducted using SAS version 9.4.[45] Multilevel logistic models with crossed random effects were fit using PROC GLIMMIX with model fit, discrimination and

calibration assessed using Chi-squared/ degrees of freedom, Area Under the Curve (AUC) and Hosmer-Lemeshow chi-square respectively.

RESULTS

A total of 1,199,633 ED visits by 332,100 individuals were recorded across the 10-year study period (Table 1). Of residents who attended the ED, 2.6% (n=8 577) met the threshold for frequent attendance (attended seven or more times within a 12-month window).

Among frequent attenders, most (n=6866, 80.1%) met the attendance threshold only once (temporary frequent attenders) (Figure 1). A further 12.9% (n= 1104) met the threshold twice (repeat frequent attenders), while only 7.1% (n=607) met the threshold on three or more occasions (persistent frequent attenders). Over the 10 years, these 607 persistent frequent attenders made 38,338 ED visits. A similar pattern of predominantly temporary frequent attendance was observed in each age group (Figure 1).

A sensitivity analysis including planned return visits indicated similar patterns of long term ED use. For example, 81.4% of frequent attenders were temporary frequent attenders when planned return visits were included. When the threshold of frequent attendance was reduced to four visits in 12-months, 75.6% of individuals were temporary frequent attenders.

Demographic and visit characteristics

Compared to non- frequent attenders, frequent attenders were more likely to be male, older (aged 65 or over), Aboriginal or Torres Strait Islander, have no partner, from non-English speaking backgrounds, un-insured (publically insured only patients), and resident in lower socio-economic areas (Table 1). Compared to the other groups of frequent attenders, persistent frequent attenders were young to middle aged adults, female, Aboriginal or Torres Strait Islander, had no partner, were from lower socioeconomic areas, un-insured (publically insured only patients) and not admitted (Table 1). During the ten-year study period, frequent

attenders had an average of 21.0 ED visits, compared to 3.2 for non- frequent attenders, with more frequent attenders admitted to hospital.

Diagnostic profile

The most common diagnoses among frequent attenders were digestive, respiratory, circulatory, single site major injury and psychiatric illness (Supplementary Material Table 1), however diagnostic profile differed by age and length of frequent attendance.

Among the youngest frequent attenders, aged 0-4 years, respiratory illness was the most common diagnosis across all groups' frequent attenders (Table 2). Among children aged 5-15 years, injury and digestive system illnesses were the two most common diagnoses in all sub-groups, with injury being the most common diagnosis among temporary frequent attenders and digestive system illness among the persistent frequent attenders. Children also presented with psychiatric illness, which was the most common diagnosis for 9.3% of temporary frequent attenders, 14.3% of repeat frequent attenders and 12.7% of persistent frequent attenders.

While injury and digestive system illness were also common among older teenagers and young adults (16-24 and 25-44 years), there were increasing numbers of patients visiting ED primarily for psychiatric illness, particularly among repeat frequent attenders aged 25-44 years and persistent frequent attenders (Table 2).

Among adults aged 45-64 years, the most common diagnoses were circulatory, digestive and respiratory illnesses. Among older adults 65 years and above, circulatory followed by respiratory system illnesses were most common, with the exception of persistent frequent attenders who had more respiratory illness than circulatory illness. In the older age groups, aged 75 years and above, digestive system and urological system illness were common among all frequent attender groups.

Analysis of all diagnoses reported in the study period (rather than most common) shows that from the age of 25 years, ED visits relating to single site major injuries were common among temporary and repeat frequent attenders, while persistent frequent attenders had higher proportions of respiratory, musculoskeletal, neurological and psychiatric visits (Table 2). Among ongoing frequent attenders aged 5-15, 16-24 and 25-44, more than half presented with a psychiatric diagnosis at least once during the study period.

Risk factors associated with frequent attendance

Multivariate multilevel logistic regression models with crossed random effects were fit to assess the likelihood of being a frequent attenders, based on socio-demographic and visit characteristics and diagnoses for those aged 16 and over (Table 3) and those aged under 16 (Table 4). Consistent with the findings of the earlier descriptive analysis, being an adult frequent attender was associated with being: male; older; Aboriginal or Torres Strait Islander; un-insured (publically insured only patients); socio-economically disadvantaged; presenting with higher urgency; lower likelihood of admission; and less likely to have a partner (Table 3). Compared to the reference category (single site major injury), frequent attendance was associated with all diagnostic groups, with the highest odds of psychiatric illness (OR=6.2, 99% CI 5.1 to 7.5) and alcohol/drug related disorders (OR=6.4, 99% CI 4.3 to 9.7) (Table 3).

Among children aged under 16, frequent attenders were more likely to be older (age 5 to 15) and similarly to adult frequent attenders, were more likely to be Aboriginal or Torres Strait Islander, un-insured (publically insured only patients); socio-economically disadvantaged; and present with higher urgency (OR=2.3, 99% CI 1.9 to 2.9). However, they were not more likely to be male; and were no less likely to be admitted than non- frequent attenders (Table 4).

Compared to the reference category (single site major injury), frequently attending children aged under 16 were more likely to present with digestive illness, neurological system

illness, and respiratory illness. As with adults, the highest risk of frequent attendance was presenters with psychiatric illness (OR=6.7, 99% CI 4.1 to 11.1) (Table 4).

Risk factors associated with frequent attendance by duration

Models fitted separately for each frequent attendance sub-group (temporary frequent attenders compared to non-frequent, repeat frequent attenders compared to non-frequent and persistent frequent attenders compared to non-frequent attenders) led to different demographic risk factors. While temporary adult frequent attenders were more likely to be male, after adjusting for other characteristics, sex was not a risk factor for repeat (OR=1.2, 99% CI 1.1 to 1.3) or persistent frequent attenders (OR=1.0, 99% CI 0.7 to 1.2) (Table 3). Persistent adult frequent attenders were also more likely to be in the middle age groups, aged 25-44 years. Among those aged under 16, repeat frequent attenders were more likely to be female and aged 5 to 15 (OR=0.6, 99% CI 0.3 to 1.0), which was the same OR for persistent attenders (OR=0.6, 99%CI 0.2 to 1.4), though not statistically significant after adjustment for multiple comparisons (Table 4).

Demographic and clinical risk factors for adult frequent attendance were in many cases magnified among repeat and persistent frequent attenders (Table 3). For example, Aboriginal or Torres Strait Islander background was a larger risk factor for those with long periods of frequent attendance (temporary frequent attenders OR=1.9, 99% CI 1.5 to 2.3 and persistent frequent attenders OR=2.6, 99% CI 1.6 to 4.2) and having a partner was less likely among longer duration frequent attenders (temporary frequent attenders OR=0.7, 99% CI 0.7 to 0.8 and persistent frequent attenders OR=0.5, 95% CI 0.4 to 0.7).

Alcohol and drug-related disorders were much more prominent among longer-duration frequent attenders (temporary frequent attenders OR=5.1, 99% CI 3.2 to 8.2 compared to persistent frequent attenders OR=17.9, 99% CI 6.2 to 51.5), as were neurological illness (temporary frequent attenders OR=1.8, 99% CI 1.4 to 2.3 compared to persistent frequent

attenders OR=6.8, 99% CI 3.3 to 13.7), and psychiatric illness (temporary frequent attenders OR=4.8, 99% CI 3.8 to6.0 compared to persistent frequent attenders OR=13.7, 99% CI 7.1 to 26.5) (Table 3).

Risk factors for temporary versus ongoing frequent attendance

Risk factors for the ongoing frequent attender group (repeat and persistent combined) were modelled in comparison to temporary frequent attendersa. This confirmed the earlier findings that ongoing frequent attenders are younger (aged 25-64) but less likely to have be admitted, or be from high socio-economic areas (Figure 2, left image). Substance-related visits, psychiatric illness, and neurological illness were again more likely for ongoing frequent attenders. Among children aged under 16, ongoing frequent attenders were more likely than temporary frequent attenders to be aged 5-15 (Figure 2, right image). Highly frequent users (18 or more visits in any 12-month period) were more likely to be ongoing frequent attenders. Among those who only met the lower frequent attendance threshold (7-17 visits in a 12-month period), 5.1% were persistent frequent attenders. In contrast, of patients who met the highly frequent threshold at least once (18 or more visits in any 12-month period), 45.5% were persistent frequent attenders.

DISCUSSION

This investigation of 10 years of longitudinal ED data has provided a novel perspective on the risk factors by duration of frequent attenders, for both adults and children. Investigation of visits to all EDs in the region found the majority of frequent ED attenders are temporary and only approximately 20% remain as frequent attenders in any of up to nine subsequent years. Persistent frequent attenders only accounted for 7.1% of frequent attenders.

The estimate that 80.1% of frequent attenders are temporary is slightly higher than other shorter-term studies carried out in the US,[1, 33,43,46] Sweden[3] and New Zealand,[47] where

estimates varied between 58 and 72%. Definitions of temporary frequent attenders differ slightly across studies, including: the threshold number of visits for frequent attenders; whether the period of frequent attendance is patient-based (using an index visit) or calendar based; whether another period of frequent attendance immediately follows the first frequent attendance period or is during the study period. We considered any periods of frequent attendance across the entire study period, to be inclusive of patients who re-established frequent attendance patterns.[48]

Systematic reviews show that internationally, intervention studies have been targeting the entire frequent attender cohort.[13,14] However, differences in profile and risk factors for ongoing frequent attenders compared to temporary frequent attenders, and for adults and children, demonstrate a need to consider different types of interventions. In particular, the cohort of persistent frequent attenders may receive more benefit from case management, and increased continuity of primary care provider[49] than temporary frequent attenders. Young adults with ongoing frequent attendance related to substance disorders and psychiatric illness may benefit from additional services outside the ED, while among children, older females with neurological conditions (predominantly seizure-related and headaches) could benefit from pathways which reduce the likelihood of admission and result in reduced length of hospital stay.[50]

Our research has shown a complex relationship between ED attendance and hospital admission. Multivariate analysis showed frequent ED attendance was inversely associated with hospital admission, and duration of frequent ED attendance was not associated with hospital admission among adults, suggesting some frequent attenders may be treated and/or managed in a different setting. Highly frequent users do not use other health care services proportionally more than (low volume) frequent users,[39] suggesting highly frequent attenders may use ED's as a main source of care. It is therefore possible that the persistent frequent

attender cohort, of which almost half were highly frequent attenders, also use the ED as a main source of care.

The heterogeneity of frequent attenders has contributed to ineffective policy development, with interventions needing to target specific sub-groups.[5] Similar to evidence in the literature, we identified three vulnerable patient groups at high risk of frequent attendance; those in situations of socioeconomic distress (e.g. low income, homelessness, social isolation);[8,9,11,21,51] those living with mental health and substance use problems;[8,21,39,47] and the elderly.[5,52] The first two of these groups are more likely to be ongoing frequent attenders, while the latter, elderly group tend to be temporary frequent attenders. Due to the ongoing nature of frequent ED attendance by those with socioeconomic and mental health issues, or both, it is imperative to find cost-effective alternatives. Temporary older frequent attenders are driving increases in ED utilisation and changing the clinical profile of EDs.[53,54,55,56] This group are multimorbid, with complex, ongoing health care needs, and required improved identification and management of those at risk of return.[52,54,57,58] To date, hospital-based interventions for these elderly patients have had little effect on ED use, potentially due to their typically short-term nature. However, a systematic review found that interventions in outpatient and primary care/home settings (including geriatric assessment and management and case management) have reduced ED use among this patient cohort.[59]

Our research has shown a complex relationship between ED attendance and hospital admission and found longitudinal ED data investigating ongoing frequent use identifies additional and inflated risk factors. In accordance with the recommendations of Pines et al,[33] the authors future research agenda includes using data in model development and testing for predicting patients who are at risk of becoming and/or remaining frequent attenders. This will improve generalisability of existing predictive models, which are mostly from the U.S.,[46,60,61]

often have small samples,[11,60] focus on a specific patient sub-group (e.g. Medicaid users,[46] or using inconsistent thresholds for frequent attendance (3, 4 or 10 visits in a year).[11,60,61]

Limitations

The inclusion of any patients whose with frequent attendance for any 12 month period during the 10 year study period enabled patients to be grouped according to long-term patterns of frequent attendance, however some temporary and repeat frequent attenders may have been classified differently had all participants had equal follow up time.

Logistic regression models identifying factors associated with frequent attendance used both characteristics of the person (e.g. socio-demographics) and their presentations to ED (diagnosis, urgency) throughout the study period, therefore there is confounding between the independent and dependent variables. When developing models to predict future frequent attendance, these would need to use only characteristics prior to a period of frequent attendance. Data quality, data consistency and the amount of missing information (in particular diagnosis) improved over time, which may impact descriptive and modelling results. The effect of missing diagnoses was minimised by modelling a patient's most common diagnostic block over all visits. While hospital insurance and preferred language were imputed using recent data, having a partner was considered more likely to change over the study period so missing cases were excluded from models.

Social variables that may increase the risk of frequent attendance, such as use of primary care services, homelessness or isolation, are not routinely collected. Other factors that may be predictive of frequent attendance, such as patient satisfaction with treatment, and having a regular source of care[62] were not collected.

We could not link to data on deaths outside of the public hospital system and therefore could not explore reasons for patients discontinuing frequent attendance, however

this is an area of potential future research. Finally, while we included data from metropolitan and rural EDs in one region in Australia, this may not be generalisable to other settings.

Conclusions

This study has provided a unique, longitudinal perspective on ED frequent attenders, contrasting the demographic and diagnostic profile of temporary, repeat and persistent frequent attenders. The distinction between temporary and ongoing frequently attending cohorts should be used when describing frequent attenders, and to inform appropriate interventions and better direct health resources.

Author contributions

LL carried out analysis, interpretation, and drafted the manuscript, VWW and KL assisted with interpretation of the data and assisted with drafting and reviewing the manuscript, RZ, JM, TC, and WT contributed to interpretation of the data and reviewed the manuscript, KE was responsible for the study conception and contributed to interpretation of the data and reviewed the manuscript.

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Table 1. Characteristics of ED patients, 12-month windows, and visits* by length of frequent attendance

	Frequent Attenders				Non-frequent ED attenders	ED attenders
	Temporary	Repeat	Persistent	*All*		
Patients	(N=6,866)	(N=1,104)	(N=607)	*(N=8,577)*	(N=323,523)	(N=332,100)
Age group (%) †‡						
0-4	10.4	5.7	2.3	*9.2*	13.4	13.3
5-15	9.0	8.9	9.1	*9.0*	12.6	12.5
16-24	11.5	12.5	12.4	*11.7*	12.6	12.6
25-44	20.2	24.3	34.9	*21.8*	22.6	22.6
45-64	18.8	21.9	23.7	*19.6*	20.2	20.2
65-74	12.4	12.6	8.7	*12.2*	8.6	8.7
75+	17.8	14.1	8.9	*16.7*	10.1	10.2
Sex (%)†‡						
Male	53.8	51.5	46.8	*53.0*	51.3	51.3
Female	46.2	48.6	53.2	*47.0*	48.8	48.7
Indigenous (%)§‡**						
Aboriginal or Torres Strait Islander origin	7.4	10.6	12.5	*8.2*	3.3	3.4
Neither Aboriginal nor Torres Strait Islander origin	92.6	89.4	87.5	*91.8*	96.8	96.6
Partner†‡** (persons aged 16 and over)						
Yes	45.1	39.0	30.2	*43.2*	53.8	53.5
No	54.9	61.0	69.8	*56.8*	46.2	46.5
Private hospital insurance (%)§‡**						
Yes	17.3	16.1	11.7	*16.8*	32.0	31.6
No	82.7	83.9	88.3	*83.3*	68.0	68.4
Preferred language (%)†‡**						
English	78.9	82.2	82.1	*79.6*	87.7	87.5
Other	21.1	17.8	17.9	*20.4*	12.3	12.5
Socio-economic status†‡**						
Quintile 1 (low)	30.0	32.8	34.4	*30.7*	22.2	22.4
Quintile 2	26.6	24.6	25.0	*26.3*	22.8	22.9
Quintile 3	32.8	35.6	34.6	*33.3*	40.4	40.2
Quintile 4	5.7	4.1	4.1	*5.4*	7.6	7.5
Quintile 5 (high)	4.8	2.9	1.8	*4.4*	7.0	7.0
Visits	(N=108,858)	(N=32,643)	(N=38,338)	*(N=179,839)*	(N=1,019,794)	(N=1,199,633)
Visits in study period (mean)	15.9	29.6	63.2	*21.0*	3.2	3.6
Visits per 12-month window (with 1+ visit) (mean)	4.2	5.8	9.5	*5.1*	1.7	1.8
Admitted (%)‡**						
Yes	37.0	38.0	33.5	*36.4*	30.8	31.6
No	63.0	62.0	66.5	*63.6*	69.2	68.4
Triage category‡**						
1 (highest urgency)	0.5	0.5	0.5	*0.5*	0.5	0.5
2	7.7	8.3	7.7	*7.8*	6.7	6.9
3	30.0	30.3	28.8	*29.9*	28.0	28.3
4	45.1	45.7	46.6	*45.8*	50.7	49.9
5 (lowest urgency)	16.7	15.3	16.4	*16.7*	14.2	14.5

* Excludes planned return visits

† As reported at earliest ED visit in study period

‡ χ^2 test for patient type (temporary frequent attender, repeat frequent attender, ongoing frequent attender by: age $\chi^2_{12} = 164.5$ ($p<.0001$), sex $\chi^2_2 = 12.2$ ($p=0.002$) , Indigenous $\chi^2_2 = 29.1$ ($p<.0001$), Partner $\chi^2_2 = 43.8$ ($p<.0001$), Hospital insurance $\chi^2_2 = 10.8$ ($p=0.045$) Preferred language $\chi^2_2 = 8.6$ ($p=0.014$), Socio-economic status $\chi^2_8 = 34.6$ ($p<.0001$), Admitted $\chi^2_2 = 196.7$ ($p<.0001$), Triage category $\chi^2_8 = 76.0$ ($p<.0001$). Excludes unknown, missing, and not-stated.

§ As reported at most recent ED visit in study period. This is the recommended approach for Indigenous status (Randall et al 2013) and was required for hospital insurance due to incomplete early data at two facilities.

** Percentage missing, unknown, not stated - Partner 11.5%, Indigenous status (at last ED visit) 0.9%, Socio-economic status 0.0%, Hospital insurance (at last ED visit) 10.8%, Preferred language 5.3%, Admitted 0.0%, Triage category 0.2%

Table 2. Diagnostic profile of ED frequent attender patients* by duration of frequent attendance and age group

	Temporary frequent attender (frequent attender in one 12-month period)								Repeat frequent attender (frequent attender in two 12-month periods)								Persistent frequent attender (frequent attender in three or more 12-month periods)							
	Age group†								Age group								Age group							
% of patients	0-4	5-15	16-24	25-44	45-64	65-74	75+	All	0-4	5-15	16-24	25-44	45-64	65-74	75+	All	0-4	5-15	16-24	25-44	45-64	65-74	75+	All
N persons	711	615	791	1387	1291	850	1221	6866	63	98	138	268	242	139	156	1104	14	55	75	212	144	53	54	607
Most common Major Diagnostic Block																								
Alcohol/drug abuse and alcohol/drug induced mental disorders	0.0	0.0	1.0	2.0	1.6	0.0	0.0	0.8	0.0	0.0	‡	2.6	2.9	0.0	0.0	1.4	0.0	0.0	‡	2.8	4.2	‡	0.0	2.3
Circulatory system illness	‡	1.3	3.5	5.5	17.5	24.4	23.7	12.2	0.0	5.1	‡	4.5	15.3	25.2	32.7	13.0	0.0	‡	‡	7.6	18.1	28.3	14.8	11.5
Digestive system illness	12.2	18.5	21.4	15.9	14.4	12.0	13.6	15.2	14.3	22.5	26.8	15.7	19.4	13.8	9.6	17.6	‡	36.4	26.7	18.4	16.7	15.1	14.8	19.9
Endocrine, nutritional and metabolic system illness	‡	0.8	0.9	1.1	0.7	1.1	1.2	0.9	‡	‡	‡	‡	2.1	‡	‡	1.4	0.0	‡	‡	‡	‡	0.0	0.0	1.3
Illness of skin, subcutaneous tissue, breast	2.0	4.7	5.6	7.1	5.4	3.3	2.9	4.7	‡	‡	5.1	5.6	2.9	‡	‡	3.4	0.0	‡	‡	4.3	‡	0.0	‡	2.6
Injury, single site, major	14.5	31.7	20.0	13.4	6.3	3.9	6.2	12.1	‡	21.4	7.3	12.7	2.1	‡	5.8	7.7	‡	21.8	‡	7.6	3.5	0.0	‡	6.9
Musculoskeletal/connective tissue system illness	0.7	2.9	3.0	6.0	5.3	5.4	4.2	4.3	0.0	‡	5.1	9.3	6.6	5.0	‡	5.3	0.0	‡	8.0	9.4	5.6	0.0	‡	6.1
Neurological system illness	4.6	3.6	3.5	5.6	5.3	5.9	7.0	5.3	9.5	7.1	5.1	6.3	8.7	5.8	3.9	6.5	‡	9.1	8.0	11.3	13.2	‡	11.1	10.4
Psychiatric illness	0.0	9.3	11.3	13.1	5.9	1.4	1.0	6.2	‡	14.3	21.0	25.0	10.7	‡	‡	12.9	0.0	12.7	29.3	26.4	10.4	‡	0.0	16.6
Respiratory system illness	44.0	6.0	4.6	4.0	14.3	18.4	17.1	14.4	47.6	‡	5.1	4.9	14.5	21.6	19.9	13.6	0.0	0.0	‡	2.4	16.7	34.0	22.2	11.2
Urological system illness	1.1	1.3	2.5	2.5	4.7	10.6	13.3	5.6	0.0	6.1	‡	‡	3.3	10.1	16.7	5.3	0.0	0.0	‡	‡	‡	9.4	14.8	3.2
Other MDBs	20.0	19.8	22.8	23.9	18.7	13.8	10.0	18.3	19.1	15.3	18.1	11.2	11.6	7.9	7.7	12.1	‡	10.9	‡	8.0	6.9	7.6	11.1	7.9
Major Diagnostic Block during study period																								
Alcohol/drug abuse and alcohol/drug induced mental disorders	0.0	8.5	10.5	11.8	7.3	1.5	0.7	6.0	0.0	10.2	17.4	26.1	16.5	0.0	‡	13.2	0.0	16.4	24.0	31.6	18.8	‡	‡	20.4
Circulatory system illness	4.1	22.4	29.6	35.3	58.9	69.5	71.5	45.4	7.9	40.8	31.9	49.6	65.7	89.9	81.4	57.3	‡	58.2	53.3	65.6	82.6	90.6	85.2	70.2
Digestive system illness	63.4	65.5	58.7	54.2	57.0	61.5	59.9	59.1	85.7	79.6	79.7	70.9	71.9	79.9	74.4	75.5	92.9	96.4	85.3	85.9	85.4	88.7	74.1	86.0
Endocrine, nutritional and metabolic system illness	6.5	6.0	3.5	7.9	16.9	20.4	19.0	12.3	12.7	10.2	10.9	13.1	24.4	23.7	30.1	18.8	7.1	12.7	17.3	20.3	24.7	45.3	29.6	25.4
Illness of skin, subcutaneous tissue, breast	38.1	36.3	36.8	36.0	33.4	29.5	26.6	33.4	46.0	46.9	44.2	46.6	37.2	44.6	33.3	42.1	28.9	56.4	56.0	49.5	46.5	30.2	44.4	47.9
Injury, single site, major	62.6	82.3	66.4	57.7	48.8	42.2	50.8	56.6	69.8	87.8	74.6	71.3	61.2	46.8	55.8	65.6	71.4	90.9	81.3	38.4	22.7	6.3	7.3	76.9
Musculoskeletal/connective tissue system illness	15.3	48.1	42.4	44.7	44.6	43.8	41.4	41.0	27.0	66.3	56.5	59.0	57.9	59.0	55.1	56.7	78.7	89.1	73.3	71.7	79.2	69.8	66.7	73.8

* Excludes planned return visits
† Age group defined at first visit in first period of frequent attendance
‡ Cell suppressed, n ≤ 5

Neurological system illness	18.1	27.8	30.7	32.3	36.6	44.2	52.5	36.3	23.8	37.8	52.9	55.6	56.2	64.0	64.1	54.3	‡	58.2	70.7	74.1	75.0	83.0	68.5	71.7
Psychiatric illness	1.4	31.1	36.0	36.3	23.0	15.4	14.2	23.2	‡	54.1	58.7	62.7	36.0	18.7	21.2	40.9	0.0	67.3	68.0	71.2	52.1	28.3	16.7	55.7
Respiratory system illness	83.5	39.5	34.6	32.6	50.0	58.6	61.6	50.4	92.1	53.1	46.4	48.5	66.5	71.9	76.3	62.0	100.0	78.2	65.3	64.2	77.1	83.0	85.2	73.0
Urological system illness	11.1	17.7	21.0	17.9	27.3	40.4	47.4	27.3	14.3	32.7	27.5	24.3	42.6	65.5	60.3	39.1	‡	49.1	45.3	31.6	42.4	58.5	72.2	43.2

Table 3. Logistic regression modelling characteristics associated with frequent attendance: non-frequent vs i) all frequent attenders, ii) temporary frequent attenders, iii) repeat frequent attenders, iv) persistent frequent attenders. Persons aged 16 or over

	Non-frequent vs all frequent attenders[9]		Non-frequent vs *temporary* frequent attenders[10]		Non-frequent vs *repeat* frequent attenders[11]		Non-frequent vs *persistent* frequent attenders[12]	
Variable	**OR**	**(CI)**	**OR**	**(CI)**	**OR**	**(CI)**	**OR**	**(CI)**
Sex								
Male	1.2	(1.1,1.3)	1.2	(1.1,1.3)	1.2	(1.0,1.5)	0.9	(0.7,1.2)
Female (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Age group								
16-24 (reference)	1.0	-	1.0	-	1.0	-	1.0	-
25-44	1.2	(1.0,1.3)	1.1	(1.0,1.3)	1.6	(1.1,2.3)	1.9	(1.2.3.0)
45-64	1.4	(1.2,1.6)	1.3	(1.1,1.5)	2.0	(1.3,2.9)	2.4	(1.5,3.9)
65-74	1.8	(1.5,2.1)	1.6	(1.4,2.0)	2.2	(1.4,3.4)	2.1	(1.1,3.8)
75+	2.1	(1.8,2.5)	2.1	(1.7,2.4)	2.3	(1.5,3.6)	1.6	(0.9,2.9)
Partner								
Yes	0.7	(0.6,0.8)	0.7	(0.7,0.8)	0.6	(0.5,0.8)	0.5	(0.4,0.7)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Uninsured (no private hospital insurance)[13]								
Yes	1.7	(1.6,1.9)	1.7	(1.5,1.9)	1.8	(1.3,2.4)	1.9	(1.2,2.8)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Aboriginal or Torres Strait Islander								
Yes	2.0	(1.7,2.4)	1.9	(1.5,2.3)	2.5	(1.7,3.7)	2.6	(1.6.4.2)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
High average triage (1-3)								
Yes	2.1	(1.9,2.3)	2.0	(1.8,2.3)	2.4	(1.8,3.2)	1.9	(1.3,2.7)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Preferred language non-English**								
Yes	1.1	(0.9,1.4)	1.2	(0.9,1.4)	1.2	(0.7,2.0)	0.7	(0.3,1.8)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Proportion of visits admitted	0.7	(0.6,0.8)	0.7	(0.6,0.9)	0.6	(0.4,0.9)	0.5	(0.3,0.9)
Socio-economic status								
Quintile 1 (low)	1.4	(1.2,1.5)	1.4	(1.2,1.5)	1.3	(1.0,1.7)	1.4	(1.0,2.0)
Quintile 2	0.9	(0.8,1.0)	0.9	(0.8,1.1)	0.9	(0.6,1.2)	0.8	(0.5,1.3)
Quintile 3 (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Quintile 4	0.6	(0.5,0.8)	0.7	(0.6,0.9)	0.5	(0.3,0.8)	0.5	(0.2,1.1)
Quintile 5 (high)	0.6	(0.5,0.7)	0.7	(0.5,0.8)	0.4	(0.2,0.7)	0.3	(0.1,0.8)
Major Diagnostic Block[14]								
Alcohol/drug abuse and alcohol/drug induced mental disorders	6.4	(4.3,9.7)	5.1	(3.2,8.2)	11.2	(4.4,28.3)	17.9	(6.2,51.5)
Circulatory system illness	2.3	(1.9,2.7)	2.0	(1.7,2.5)	3.4	(2.0, 5.5)	4.0	(2.0, 8.0)
Digestive system illness	2.8	(2.4,3.3)	2.5	(2.1,3.0)	4.3	(2.7, 7.0)	5.6	(2.9,10.6)
Endocrine, nutritional and metabolic system illness	2.8	(1.9,4.2)	2.4	(1.5,3.7)	4.8	(1.8, 13.1)	6.5	(1.7,24.4)
Illness of skin, subcutaneous tissue, breast	2.9	(2.4,3.7)	2.9	(2.2,3.6)	3.6	(1.9, 7.0)	2.7	(1.0,7.3)
Injury, single site, major (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Musculoskeletal/connective tissue system illness	1.7	(1.4,2.1)	1.5	(1.2,1.9)	2.6	(1.5, 4.7)	3.1	(1.4,6.7)
Neurological system illness	2.2	(1.8,2.7)	1.8	(1.4,2.3)	3.2	(1.8, 5.8)	6.8	(3.3,13.7)
Psychiatric illness	6.2	(5.1,7.5)	4.8	(3.8,6.0)	12.5	(7.6,20.5)	13.7	(7.1,26.5)
Respiratory system illness	3.3	(2.8,4.0)	3.0	(2.4,3.6)	5.1	(3.1, 8.5)	5.6	(2.8,11.4)
Urological system illness	3.2	(2.6,3.9)	3.0	(2.4,3.8)	4.3	(2.3, 7.8)	3.4	(1.3,8.6)
Other	1.7	(1.4,1.9)	1.6	(1.4,2.0)	1.8	(1.1, 3.0)	1.3	(0.6,2.8)

CI, 99.8% Confidence Interval (α adjusted for multiple comparisons, 1-α/m = 1-0.05/26 = 0.998)
OR, Odds Ratio

[9] n=211,447, AUC=0.82, Hosmer-Lemeshow χ^2 =1,867 (p<0.0001), Generalized Chi-Square / DF = 0.90,
[10] n=210,198, AUC=0.80, Hosmer-Lemeshow χ^2 =1,461 (p<0.0001), Generalized Chi-Square / DF = 0.90,
[11] N=206,440, AUC=0.87, Hosmer-Lemeshow χ^2 =877 (p<0.0001), Generalized Chi-Square / DF =0.79,
[12] N=206,097, AUC=0.89, Hosmer-Lemeshow χ^2 =678 (p<0.0001), Generalized Chi-Square / DF =0.89,
[13] Missing values imputed with patient's most recent non-missing value.
[14] Most frequent MDB over all visits. Excludes missing diagnoses and those unable to be mapped to an MDB. All MDBs which included less than five ongoing, repeat or temporary frequent attenders was included with "Other MDB" in a category labelled 'Other'.

Table 4. Logistic regression modelling characteristics associated with frequent attendance: non-frequent vs i) all frequent attenders, ii) temporary frequent attenders, iii) repeat frequent attenders, iv) persistent frequent attenders. Persons aged under 16

	Non-frequent vs all frequent attenders[15]		Non-frequent vs *temporary* frequent attenders[16]		Non-frequent vs *repeat* frequent attenders[17]		Non-frequent vs *persistent* frequent attenders[18]	
Variable	**OR**	**(CI)**	**OR**	**(CI)**	**OR**	**(CI)**	**OR**	**(CI)**
Sex								
Male	0.9	(0.8,1.1)	1.0	(0.8,1.2)	0.6	(0.3,1.0)	0.6	(0.2,1.4)
Female (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Age group								
0-4 (reference)	1.0	-	1.0	-	1.0	-	1.0	-
5-15	1.0	(0.8,1.2)	1.0	(0.8,1.1)	1.4	(0.8,2.4)	1.3	(0.5,3.1)
Uninsured (no private hospital insurance)[19]								
Yes	1.8	(1.4,2.2)	1.8	(1.4,2.2)	1.7	(0.8,3.4)	2.3	(0.7,7.9)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Aboriginal or Torres Strait Islander								
Yes	1.7	(1.3,2.2)	1.7	(1.3,2.2)	1.4	(0.6,3.2)	1.8	(0.5.6.3)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
High average triage (1-3)								
Yes	2.3	(1.9,2.9)	2.3	(1.8,2.8)	2.5	(1.2,4.9)	4.7	(1.1,19.1)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Proportion of visits admitted	0.9	(0.7,1.3)	0.9	(0.6,1.3)	1.3	(0.5,3.5)	1.6	(0.3,8.2)
Socio-economic status								
Quintile 1 (low)	1.7	(1.4,2.0)	1.6	(1.3,2.0)	2.1	(1.2,3.6)	2.3	(0.9,5.8)
Quintile 2-5 (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Major Diagnostic Block[20]								
Digestive system illness	1.7	(1.3,2.2)	1.6	(1.2,2.1)	2.3	(1.0, 5.2)	6.0	(1.4, 24.7)
Injury, single site, major (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Neurological system illness	2.7	(1.8,4.1)	2.4	(1.5,3.9)	5.0	(1.7, 14.4)	7.6	(1.2,48.1)
Psychiatric illness	6.7	(4.1,11.1)	6.1	(3.5,10.6)	8.6	(2.4,31.2)	34.7	(6.3,190.6)
Respiratory system illness	2.4	(1.8,3.0)	2.4	(1.9,3.0)	2.7	(1.3, 5.9)	2.0	(0.4, 10.2)
Other	0.9	(0.7,1.1)	0.9	(0.7,1.2)	1.2	(0.5, 2.7)	1.4	(0.3, 6.5)

CI, Confidence Interval
OR, Odds Ratio

[15] n=82,344, AUC=0.83, Hosmer-Lemeshow = 456 (p<0.0001), Generalized Chi-Square / DF = 0.87
[16] n=82,115, AUC=0.82, Hosmer-Lemeshow = 415 (p<0.0001), Generalized Chi-Square / DF =0.85
[17] N=80,958, AUC=0.87, Hosmer-Lemeshow = 158 (p<0.0001), Generalized Chi-Square / DF =0.88
[18] n=80,867, AUC=0.93, Hosmer-Lemeshow = 64 (p<0.0001), Generalized Chi-Square / DF =0.64
[19] Missing values imputed with patient's most recent non-missing value.
[20] Most frequent MDB over all visits. Excludes missing diagnoses and those unable to be mapped to an MDB. All MDBs which included less than five ongoing, repeat or temporary frequent attenders was included with "Other MDB" in a category labelled 'Other'.

Figure captions

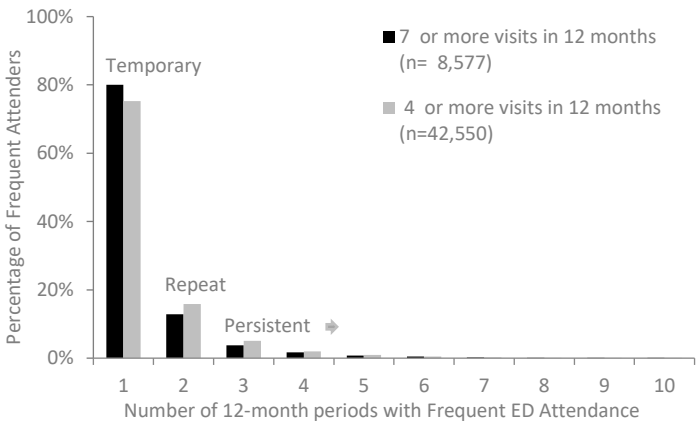
Figure 1.

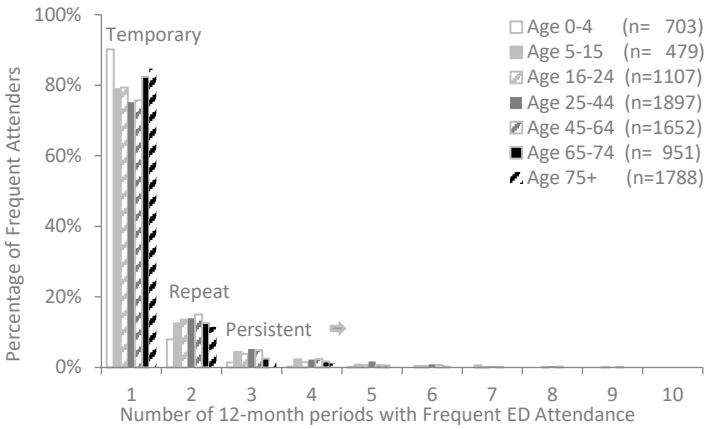
Number of 12-month periods where the frequent attendance threshold was met by frequently attending residents. *Left*: All residents with 7 or more visits in 12 months and all residents with 4 or more visits in 12 months. *Right*: all residents with 7 or more visits in 12 months by age group. Excludes planned return visits.

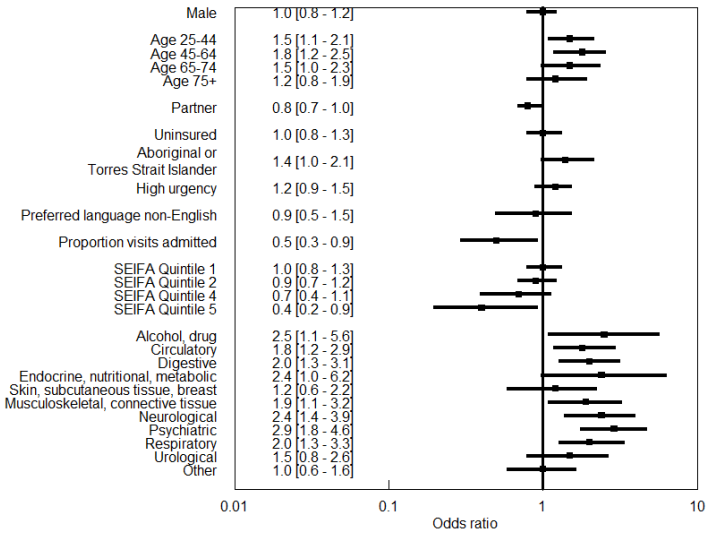
Figure 2.

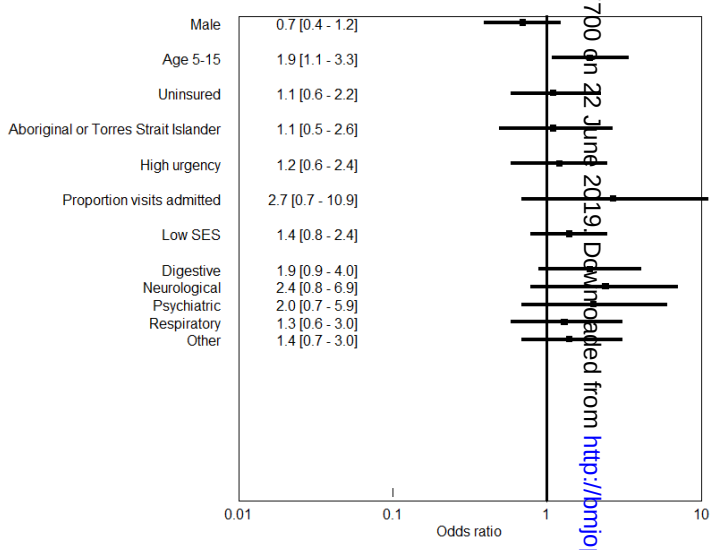
Logistic regression model identifying characteristics associated with ongoing vs temporary frequent attendance. *Left*: Persons aged 16 and over (n=5,803). *Right*: Persons aged under 16 (n=1,546).

Note: Reference categories for persons aged 16 and over - Age: 16-24, SEIFA: Quintile 3, Major Diagnostic Block: Single Site Major Injury. Reference categories for persons aged under 16 - Age: 0-4, SEIFA: Quintile 2-5, Major Diagnostic Block: Single Site Major Injury.









Supplementary Material for Here one year, gone the next? Investigating duration and predictors of ongoing frequent emergency department attendance, a retrospective study in Australia.

Table 1. Diagnostic profile of all ED frequent attenders[1] by age group

	Age group[2]							
% of frequent attenders	**0-4**	**5-15**	**16-24**	**25-44**	**45-64**	**65-74**	**75+**	**All**
	N persons							
	788	768	1004	1867	1677	1042	1431	8577
Most common Major Diagnostic Block								
Alcohol/drug abuse and alcohol/drug induced mental disorders	0.0	0.0	1.0	2.2	2.0	0.1	0.0	1.0
Circulatory system illness	0.4	1.8	3.6	5.6	17.2	24.7	24.3	12.3
Digestive system illness	12.4	20.3	22.5	16.2	15.3	12.7	13.2	15.9
Endocrine, nutritional and metabolic system illness	0.6	1.0	1.2	1.1	0.9	1.1	1.0	1.0
Illness of skin, subcutaneous tissue, breast	1.9	4.2	5.2	6.6	4.8	3.0	2.7	4.3
Injury, single site, major	13.6	29.7	17.1	12.6	5.4	3.6	6.2	11.2
Musculoskeletal/connective tissue system illness	0.6	2.6	3.7	6.9	5.5	5.1	3.8	4.6
Neurological system illness	5.2	4.4	4.1	6.4	6.5	5.7	6.8	5.8
Psychiatric illness	0.1	10.2	13.9	16.3	7.0	1.5	1.0	7.8
Respiratory system illness	44.4	5.3	4.5	3.9	14.5	19.6	17.6	14.1
Urological system illness	1.0	1.8	2.4	2.1	4.2	10.5	13.7	5.4
Other MDBs	19.7	18.6	20.8	20.3	16.6	12.7	9.8	16.7
Major Diagnostic Block during study period								
Alcohol/drug abuse and alcohol/drug induced mental disorders	0.0	9.2	12.5	16.1	9.6	1.4	0.8	8.0
Circulatory system illness	4.6	27.3	31.7	40.8	61.9	73.3	73.1	48.7
Digestive system illness	65.7	69.5	63.6	60.2	61.6	65.4	62.0	63.1
Endocrine, nutritional and metabolic system illness	7.0	7.0	5.6	10.0	19.5	22.1	20.6	14.0
Illness of skin, subcutaneous tissue, breast	38.8	39.1	39.2	39.1	35.1	32.6	28.0	35.5
Injury, single site, major	63.3	83.6	68.6	62.6	52.7	43.5	51.8	59.2
Musculoskeletal/connective tissue system illness	16.6	53.4	46.6	49.8	49.5	47.1	43.9	45.3
Neurological system illness	18.8	31.3	36.8	40.4	42.7	48.9	55.2	41.1
Psychiatric illness	1.7	36.6	41.5	44.1	27.4	16.5	15.0	27.8
Respiratory system illness	84.5	44.0	38.6	38.5	54.7	61.6	64.1	53.7
Urological system illness	11.6	21.9	23.7	20.4	30.8	44.6	49.8	30.0

[1] Excludes planned return visits
[2] Age group at first visit in first period of frequent attendance.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6-7
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	n.a.
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8-9
Bias	9	Describe any efforts to address potential sources of bias	9-10
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9-10
		(*b*) Describe any methods used to examine subgroups and interactions	8-9
		(*c*) Explain how missing data were addressed	9-10
		(*d*) If applicable, explain how loss to follow-up was addressed	n.a.
		(*e*) Describe any sensitivity analyses	10
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	10
		(b) Give reasons for non-participation at each stage	n.a.
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10-12
		(b) Indicate number of participants with missing data for each variable of interest	9-10
		(c) Summarise follow-up time (eg, average and total amount)	7-8
Outcome data	15*	Report numbers of outcome events or summary measures over time	10-11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-14
		(*b*) Report category boundaries when continuous variables were categorized	8-9, In tables
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11-14
Discussion			
Key results	18	Summarise key results with reference to study objectives	14-17
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17
Generalisability	21	Discuss the generalisability (external validity) of the study results	17
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	3

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Here one year, gone the next? Investigating persistence of frequent emergency department attendance, a retrospective study in Australia.

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Primary Subject Heading:	Emergency medicine
Secondary Subject Heading:	Epidemiology, Health services research, Health policy
Keywords:	emergency department, repeat use, longitudinal study, persistent, social determinants of health

Here one year, gone the next? Investigating persistence of frequent emergency department attendance, a retrospective study in Australia.

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Keywords: emergency department; repeat use; longitudinal study; persistent; social determinants of health;

Word count: Manuscript: 4,112. Abstract: 272.

Abstract

Objectives: Patients are presenting to Emergency Departments (EDs) with increasing complexity at rates beyond population growth and ageing. Intervention studies target patients with 12 months or less of frequent attendance. However, these interventions are not well targeted since most patients do not remain frequent attenders. This paper quantifies temporary and ongoing frequent attendance and contrasts risk factors for each group.

Design: Retrospective population-based study using 10 years of longitudinal data.

Setting: An Australian geographic region that includes metropolitan and rural EDs.

Participants: 332,100 residents visited any ED during the study period.

Main outcome measure: Frequent attendance was defined as seven or more visits to any ED in the region within a 12-month period. Temporary frequent attendance was defined as meeting this threshold only once, and ongoing more than once. Risk factors for temporary and ongoing frequent attenders were identified using logistic regression models for adults and children.

Results: Of 8,577 frequent attenders, 80.1% were temporary and 19.9% ongoing (12.9% repeat, 7.1% persistent). Among adults, ongoing were more likely than temporary frequent attenders to be young to middle aged (age 25-64), and less likely to be from a high socio-economic area or be admitted. Ongoing frequent attenders had higher-rates of non-injury presentations, in particular substance-related (OR=2.5, 99% CI 1.1 to 5.6) and psychiatric illness (OR=2.9, 99% CI 1.8 to 4.6). In comparison, children who were ongoing were more

likely than temporary frequent attenders to be aged 5-15, and were not more likely to be admitted (OR=2.7, 99% CI 0.7 to 10.9).

Conclusions: Future intervention studies should distinguish between temporary and ongoing frequent attenders, develop specific interventions for each group, and include rigorous evaluation.

Article summary

Strengths and limitations of this study:

- Our unique, longitudinal data platform has enabled this study on long-term patterns of attendance to all emergency departments within a single geographic region by frequent attenders over 10 years.
- We considered long-term frequent attendance patterns, which allowed for patients discontinuing frequent attendance and resuming later on.
- We contrasted socio-demographic and risk factors for temporary versus ongoing frequent attendance and for both adults and children.
- We included metropolitan, regional and rural EDs in Australia, however findings from one healthcare setting may not be generalisable to other settings.

Funding and support: The authors acknowledge the Illawarra Health Information Platform (IHIP) research partnership established between the Illawarra Shoalhaven Local Health District (ISLHD) and the University of Wollongong, with ISLHD providing funding support and the data used in this study, and the NSW Ministry of Health who authorised the data release.

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Data statement: This study accessed data from the Illawarra Health Information Platform (IHIP) non-identifiable databank, established by the Illawarra Shoalhaven Local Health District (ISLHD) and the University of Wollongong in NSW, Australia, for research, planning and evaluation purposes. The study used deidentified participant data from 1 July 2005 to 30 June 2015. The Centre for Health Research Illawarra Shoalhaven Population and the NSW Ministry of Health approved unit record data access. Additional materials are available in the supplementary appendix.

Competing interests: The authors declare that they have no competing interests.

INTRODUCTION

Background

Emergency Department (ED) frequent attenders are a complex and vulnerable patient group.[1-4] Compared to non-frequent ED attenders, they have higher rates of morbidity and mortality,[5] mental health issues,[5-7] substance use problems,[6,8] and chronic diseases,[8-10] and are more likely to be homeless[11] and of low socio-economic status.[12] By definition, this group accounts for a disproportionate share of ED visits. They are also more likely to attend multiple EDs to address their unmet health needs.[8]

Interventions are primarily aimed at reducing ED visits,[13-17] and improving social and clinical outcomes.[13,16,18] The most commonly studied intervention is case management.[13,10,16,18] Other interventions include establishment of care plans with patient input,[19] and providing case notes from previous ED visits.[20] Case management in some cases reduced ED costs and improved social and clinical outcomes, but in many studies had no impact, or increased ED and primary care utilisation.[13] The limited number of studies with control groups has contributed to a lack of evidence on effective interventions, as before-and-after studies fail to account for the high likelihood of frequent attenders becoming infrequent without intervention.[1]

Relevance

Few studies have investigated long-term use patterns among ED attenders across multiple facilities.[21] Most studies report data from a single year,[22-28] or a small number of years,[11,16] or from a small number of facilities,[9,29,30] with ongoing visit patterns given little consideration.[1] Multi-site studies of more than 2-3 years are scarce.[1,21,31,32] The need for research into long-term utilisation patterns among frequent attenders has been identified, in particular

understanding predictors of ongoing use,[21] and analysis by age group and frequency of visit, to distinguish meaningful sub-groups for intervention.[1,33]

Research addressing these knowledge gaps will assist with identifying and distinguishing the characteristics of ongoing frequent attenders from those with temporary frequent ED use. This information will assist in planning appropriate support or interventions for the temporary and ongoing subgroups of frequent attenders.

Objectives

The aim of this study was to contrast the attributes and risk factors of temporary frequent attenders, with ongoing frequent attenders. The ongoing frequent attenders were further subdivided into repeat frequent attenders, who met the frequent attendance threshold twice, and persistent frequent attenders, who met the threshold in three or more periods.

METHODS

Study design and setting

A retrospective population-based study was carried out using longitudinal data from an Australian regional health service, the Illawarra Shoalhaven Local Health District (ISLHD). The district services almost 390,000 residents in a 250 kilometre long coastal catchment area, covering rural, regional and metropolitan areas.[34] Five of the eight public hospitals within the district have an ED, the largest being one of the busiest adult and paediatric emergency departments in the state of New South Wales.[35]

Selection of participants

This negligible risk study accessed data from the Illawarra Health Information Platform (IHIP). IHIP is a non-identifiable databank established by the ISLHD and the University of

Wollongong for research, planning and evaluation purposes. IHIP holds a unique record number for every person who has accessed any ISLHD service since the late 1980s. Emergency Department data were analysed for all individuals who attended any of the district's EDs at least once between 1 July 2005 and 30 June 2015. Non-residents of the district's catchment area were excluded.

Ethical approval

The study involved the use of existing non-identifiable data sourced from ISLHD routine administrative data and accessed from IHIP. Ethical approval for establishment of IHIP's non-identifiable databank, including the ISLHD administrative data, was obtained from the University of Wollongong and Illawarra Shoalhaven Local Health District's Health and Medical Human Research Ethics Committee (HREC) on 14 November 2016 (Ethics number: 2016/306). The CHRISP Executive Steering Committee also approved this study. This committee includes senior representatives of both institutions including the Chief Executive and Director of Research at ISLHD, and the Deputy Vice-Chancellor Research at UOW. The committee, as the institutional review board, deemed the study exempt from ethical review, as it was negligible risk, involved only routinely collected non-identifiable data that had already been approved by the HREC, and were already stored in IHIP, used only unlinked data, and did not require any further approvals (e.g. specific ethics approval from the Aboriginal Health & Medical Research Council). This study was completed in accordance with the National Statement on Ethical Research 2007 (updated 2018, The National Health and Medical Research Council, the Australian Research Council and Universities Australia) and the Helsinki Declaration (as revised in 2013).

Patient and Public Involvement

Previous studies by the authors on patient's reasons for attending ED,[36] and other literature on patient perspectives in the ED,[37] shaped the research questions, including a focus on

understanding long-term use patterns rather than individual visits. The retrospective study was designed to inform future interventions and research. While patients were not directly involved in the design or conduct of this study, a steering group that includes a patient advisor will contribute to research translation and dissemination activities. Dissemination to patients will also occur through the health district's Community Partnership Council and other established patient advisory committees.

Outcomes

The primary outcome of the study was an estimate of the proportion of frequent attenders for whom frequent attendance is a temporary phenomenon (occurring only once during the study period). A secondary outcome was to identify and contrast risk factors for temporary and ongoing frequent attendance to highlight characteristics associated with a continuing frequent ED use.

Measurements

Historically, frequent ED use has been defined as three to 12 visits per year,[5] while highly frequent use has been defined as four to 20 visits per year.[7,38] Because of this variation, Locker et al proposed that more than four ED visits per year was a non-random event, and suggested this become a standard threshold for defining frequent ED attendance.[6] This study uses a more recently proposed definition based on a divergence of patient characteristics, where non-frequent attenders present 1-6 times in a year, and frequent attenders 7 or more times in a year.[39] A sub-group of highly frequent attenders, [39] who made 18 or more visits to EDs in any 12-month period, were also investigated.

A 12-month window was used to count ED visits following a first (or index) ED visit, a patient-based timeline not defined by calendar year.[39,40] Subsequent 12 month windows

commenced at the next ED visit after each 12-month window. Consequently, a subsequent period of frequent attendance was not constrained to immediate following a first period.

Duration of frequent ED attendance was measured by the number of 12-month windows each patient had frequent ED use. Sub-groups of frequent attenders were identified to provide insight into the varying needs of this complex and heterogeneous patient group. Temporary frequent attenders were defined as those who met the frequent attendance threshold once during the study period, and ongoing frequent attenders were looked at in two groups - repeat frequent attenders who met the threshold twice, and persistent frequent attenders, who met the threshold three or more times.

Demographic characteristics such as age, sex, preferred language, and marital status were analysed according to the first ED visit in the study period. Private hospital insurance status and Aboriginal and Torres Strait Islander status were analysed according to the most recent visit to the ED,[41] due to a higher proportion of missing data in the early study years. Triage category was averaged over all visits with an average of 4 to 5 considered low urgency. The proportion of all ED visits resulting in a hospital admission was calculated for each person.

Socioeconomic status was based on Index of Relative Socio-economic Disadvantage (IRSD) information.[42] Each Australian postal area has an ISRD score and ranking. For the purposes of this study, the rankings which were summarised as deciles were reduced to quintiles, with low ranks representing the most disadvantaged.

Patient diagnosis was recorded on discharge from the ED. Between 2009 and 2012 each ED within the regional health service transitioned from ICD-9-CM diagnosis coding to SNOMED recording of diagnosis. For this study, diagnoses according to ICD-9-CM coding and SNOMED were therefore mapped to ICD-10-AM[43] and then aggregated to Major Diagnostic Blocks (MDB) using the Independent Hospital Pricing Authority's Urgency Related Group software v1.4.4.[44] Frequent ED attenders were primarily analysed according to

their most common MDB to reduce the likelihood of bias from with missing data (such as during system transition and for patients who did not wait), but also described based on whether they ever had a diagnosis in each MDB.

Data analysis

Associations between categorical variables were evaluated using Pearson's Chi Square Test. Multivariate mixed logistic regression models with crossed random effects to control for attendance at one or more ED's were used to identify factors associated with frequent attendance among persistent, repeat and ongoing groups, each compared with non-frequent attenders. Results were summarised as odds ratios (OR) and confidence intervals (CI) presented with alpha of 5% adjusted for multiple comparisons via Bonferroni correction according to the number of model parameters estimated in each model. This resulted in odds ratios with 99.8% confidence intervals for models relating to adults, and 99.6% relating to children (where less model parameters were used). Demographic, diagnosis (MDB), and visit characteristics were included in regression models. The proportion of missing data was generally low, ranging from <1% for items such as sex, Aboriginal or Torres Strait Islander status, socioeconomic status and triage category, to 5.3% for preferred language, 10.8% for hospital insurance and 11.4% for marital status. Those without an assigned MDB due to; no recorded diagnosis (7.5%), a diagnosis code not recognised by the grouper (3.9%) or patients who did not wait (3.5%), were excluded from analysis by diagnosis. Planned return visits accounted for 3.1% of all ED visits, and these were excluded from all analyses. Sensitivity analyses were carried out with an alternative threshold for frequent ED attendance of four visits per year, and including planned return visits. Statistical significance was set at 5%. All statistical analysis was conducted using SAS version 9.4.[45] Multilevel logistic models with crossed random effects were fit using PROC GLIMMIX with model fit, discrimination and

calibration assessed using Chi-squared/ degrees of freedom, Area Under the Curve (AUC) and Hosmer-Lemeshow chi-square respectively.

RESULTS

A total of 1,199,633 ED visits by 332,100 individuals were recorded across the 10-year study period (Table 1). Of residents who attended the ED, 2.6% (n=8 577) met the threshold for frequent attendance (attended seven or more times within a 12-month window).

Among frequent attenders, most (n=6866, 80.1%) met the attendance threshold only once (temporary frequent attenders) (Figure 1). A further 12.9% (n= 1104) met the threshold twice (repeat frequent attenders), while only 7.1% (n=607) met the threshold on three or more occasions (persistent frequent attenders). Over the 10 years, these 607 persistent frequent attenders made 38,338 ED visits. A similar pattern of predominantly temporary frequent attendance was observed in each age group (Figure 1).

A sensitivity analysis including planned return visits indicated similar patterns of long term ED use. For example, 81.4% of frequent attenders were temporary frequent attenders when planned return visits were included. When the threshold of frequent attendance was reduced to four visits in 12-months, 75.6% of individuals were temporary frequent attenders.

Demographic and visit characteristics

Compared to non- frequent attenders, frequent attenders were more likely to be male, older (aged 65 or over), Aboriginal or Torres Strait Islander, have no partner, from non-English speaking backgrounds, un-insured (publically insured only patients), and resident in lower socio-economic areas (Table 1). Compared to the other groups of frequent attenders, persistent frequent attenders were young to middle aged adults, female, Aboriginal or Torres Strait Islander, had no partner, were from lower socioeconomic areas, un-insured (publically insured only patients) and not admitted (Table 1). During the ten-year study period, frequent

attenders had an average of 21.0 ED visits, compared to 3.2 for non- frequent attenders, with more frequent attenders admitted to hospital.

Diagnostic profile

The most common diagnoses among frequent attenders were digestive, respiratory, circulatory, single site major injury and psychiatric illness (Supplementary Material Table 1), however diagnostic profile differed by age and length of frequent attendance.

Among the youngest frequent attenders, aged 0-4 years, respiratory illness was the most common diagnosis across all groups' frequent attenders (Table 2). Among children aged 5-15 years, injury and digestive system illnesses were the two most common diagnoses in all sub-groups, with injury being the most common diagnosis among temporary frequent attenders and digestive system illness among the persistent frequent attenders. Children also presented with psychiatric illness, which was the most common diagnosis for 9.3% of temporary frequent attenders, 14.3% of repeat frequent attenders and 12.7% of persistent frequent attenders.

While injury and digestive system illness were also common among older teenagers and young adults (16-24 and 25-44 years), there were increasing numbers of patients visiting ED primarily for psychiatric illness, particularly among repeat frequent attenders aged 25-44 years and persistent frequent attenders (Table 2).

Among adults aged 45-64 years, the most common diagnoses were circulatory, digestive and respiratory illnesses. Among older adults 65 years and above, circulatory followed by respiratory system illnesses were most common, with the exception of persistent frequent attenders who had more respiratory illness than circulatory illness. In the older age groups, aged 75 years and above, digestive system and urological system illness were common among all frequent attender groups.

Analysis of all diagnoses reported in the study period (rather than most common) shows that from the age of 25 years, ED visits relating to single site major injuries were common among temporary and repeat frequent attenders, while persistent frequent attenders had higher proportions of respiratory, musculoskeletal, neurological and psychiatric visits (Table 2). Among ongoing frequent attenders aged 5-15, 16-24 and 25-44, more than half presented with a psychiatric diagnosis at least once during the study period.

Risk factors associated with frequent attendance

Multivariate multilevel logistic regression models with crossed random effects were fit to assess the likelihood of being a frequent attenders, based on socio-demographic and visit characteristics and diagnoses for those aged 16 and over (Table 3) and those aged under 16 (Table 4). Consistent with the findings of the earlier descriptive analysis, being an adult frequent attender was associated with being: male; older; Aboriginal or Torres Strait Islander; un-insured (publically insured only patients); socio-economically disadvantaged; presenting with higher urgency; lower likelihood of admission; and less likely to have a partner (Table 3). Compared to the reference category (single site major injury), frequent attendance was associated with all diagnostic groups, with the highest odds of psychiatric illness (OR=6.2, 99% CI 5.1 to 7.5) and alcohol/drug related disorders (OR=6.4, 99% CI 4.3 to 9.7) (Table 3).

Among children aged under 16, frequent attenders were more likely to be older (age 5 to 15) and similarly to adult frequent attenders, were more likely to be Aboriginal or Torres Strait Islander, un-insured (publically insured only patients); socio-economically disadvantaged; and present with higher urgency (OR=2.3, 99% CI 1.9 to 2.9). However, they were not more likely to be male; and were no less likely to be admitted than non- frequent attenders (Table 4).

Compared to the reference category (single site major injury), frequently attending children aged under 16 were more likely to present with digestive illness, neurological system

illness, and respiratory illness. As with adults, the highest risk of frequent attendance was presenters with psychiatric illness (OR=6.7, 99% CI 4.1 to 11.1) (Table 4).

Risk factors associated with frequent attendance by duration

Models fitted separately for each frequent attendance sub-group (temporary frequent attenders compared to non-frequent, repeat frequent attenders compared to non-frequent and persistent frequent attenders compared to non-frequent attenders) led to different demographic risk factors. While temporary adult frequent attenders were more likely to be male, after adjusting for other characteristics, sex was not a risk factor for repeat (OR=1.2, 99% CI 1.1 to 1.3) or persistent frequent attenders (OR=1.0, 99% CI 0.7 to 1.2) (Table 3). Persistent adult frequent attenders were also more likely to be in the middle age groups, aged 25-44 years. Among those aged under 16, repeat frequent attenders were more likely to be female and aged 5 to 15 (OR=0.6, 99% CI 0.3 to 1.0), which was the same OR for persistent attenders (OR=0.6, 99%CI 0.2 to 1.4), though not statistically significant after adjustment for multiple comparisons (Table 4).

Demographic and clinical risk factors for adult frequent attendance were in many cases magnified among repeat and persistent frequent attenders (Table 3). For example, Aboriginal or Torres Strait Islander background was a larger risk factor for those with long periods of frequent attendance (temporary frequent attenders OR=1.9, 99% CI 1.5 to 2.3 and persistent frequent attenders OR=2.6, 99% CI 1.6 to 4.2) and having a partner was less likely among longer duration frequent attenders (temporary frequent attenders OR=0.7, 99% CI 0.7 to 0.8 and persistent frequent attenders OR=0.5, 95% CI 0.4 to 0.7).

Alcohol and drug-related disorders were much more prominent among longer-duration frequent attenders (temporary frequent attenders OR=5.1, 99% CI 3.2 to 8.2 compared to persistent frequent attenders OR=17.9, 99% CI 6.2 to 51.5), as were neurological illness (temporary frequent attenders OR=1.8, 99% CI 1.4 to 2.3 compared to persistent frequent

attenders OR=6.8, 99% CI 3.3 to 13.7), and psychiatric illness (temporary frequent attenders OR=4.8, 99% CI 3.8 to6.0 compared to persistent frequent attenders OR=13.7, 99% CI 7.1 to 26.5) (Table 3).

Risk factors for temporary versus ongoing frequent attendance

Risk factors for the ongoing frequent attender group (repeat and persistent combined) were modelled in comparison to temporary frequent attenders. This confirmed the earlier findings that ongoing frequent attenders are younger (aged 25-64) but less likely to have be admitted, or be from high socio-economic areas (Figure 2, left image). Substance-related visits, psychiatric illness, and neurological illness were again more likely for ongoing frequent attenders. Among children aged under 16, ongoing frequent attenders were more likely than temporary frequent attenders to be aged 5-15 (Figure 2, right image). Highly frequent users (18 or more visits in any 12-month period) were more likely to be ongoing frequent attenders. Among those who only met the lower frequent attendance threshold (7-17 visits in a 12-month period), 5.1% were persistent frequent attenders. In contrast, of patients who met the highly frequent threshold at least once (18 or more visits in any 12-month period), 45.5% were persistent frequent attenders.

DISCUSSION

This investigation of 10 years of longitudinal ED data has provided a novel perspective on the risk factors by duration of frequent attenders, for both adults and children. Investigation of visits to all EDs in the region found the majority of frequent ED attenders are temporary and only approximately 20% remain as frequent attenders in any of up to nine subsequent years. Persistent frequent attenders only accounted for 7.1% of frequent attenders. This did not vary when the threshold was reduced from seven down to four visits in 12 months, or when planned return visits were included in the analyses.

The estimate that 80.1% of frequent attenders are temporary is slightly higher than other shorter-term studies carried out in the US,[1, 33,43,46] Sweden[3] and New Zealand,[47] where estimates varied between 58 and 72%. Definitions of temporary frequent attenders differ slightly across studies, including: the threshold number of visits for frequent attenders; whether the period of frequent attendance is patient-based (using an index visit) or calendar based; whether another period of frequent attendance immediately follows the first frequent attendance period or is during the study period. We considered any periods of frequent attendance across the entire study period, to be inclusive of patients who re-established frequent attendance patterns.[48]

Systematic reviews show that internationally, intervention studies have been targeting the entire frequent attender cohort.[13,14] However, differences in profile and risk factors for ongoing frequent attenders compared to temporary frequent attenders, and for adults and children, demonstrate a need to consider different types of interventions. In particular, the cohort of persistent frequent attenders may receive more benefit from case management, and increased continuity of primary care provider[49] than temporary frequent attenders. Young adults with ongoing frequent attendance related to substance disorders and psychiatric illness may benefit from additional services outside the ED, while among children, older females with neurological conditions (predominantly seizure-related and headaches) could benefit from pathways which reduce the likelihood of admission and result in reduced length of hospital stay.[50]

Our research has shown a complex relationship between ED attendance and hospital admission. Multivariate analysis showed frequent ED attendance was inversely associated with hospital admission, and duration of frequent ED attendance was not associated with hospital admission among adults, suggesting some frequent attenders may be treated and/or managed in a different setting. Highly frequent users do not use other health care services

proportionally more than (low volume) frequent users,[39] suggesting highly frequent attenders may use ED's as a main source of care. It is therefore possible that the persistent frequent attender cohort, of which almost half were highly frequent attenders, also use the ED as a main source of care.

The heterogeneity of frequent attenders has contributed to ineffective policy development, with interventions needing to target specific sub-groups.[5] Similar to evidence in the literature, we identified three vulnerable patient groups at high risk of frequent attendance; those in situations of socioeconomic distress (e.g. low income, homelessness, social isolation);[8,9,11,21,51] those living with mental health and substance use problems;[8,21,39,47] and the elderly.[5,52] The first two of these groups are more likely to be ongoing frequent attenders, while the latter, elderly group tend to be temporary frequent attenders. Due to the ongoing nature of frequent ED attendance by those with socioeconomic and mental health issues, or both, it is imperative to find cost-effective alternatives. Temporary older frequent attenders are driving increases in ED utilisation and changing the clinical profile of EDs.[53,54,55,56] This group are multimorbid, with complex, ongoing health care needs, and required improved identification and management of those at risk of return.[52,54,57,58] To date, hospital-based interventions for these elderly patients have had little effect on ED use, potentially due to their typically short-term nature. However, a systematic review found that interventions in outpatient and primary care/home settings (including geriatric assessment and management and case management) have reduced ED use among this patient cohort.[59]

Our research has shown a complex relationship between ED attendance and hospital admission and found longitudinal ED data investigating ongoing frequent use identifies additional and inflated risk factors. In accordance with the recommendations of Pines et al,[33] the authors future research agenda includes using data in model development and testing for predicting patients who are at risk of becoming and/or remaining frequent attenders. This will

improve generalisability of existing predictive models, which are mostly from the U.S.,[46,60,61] often have small samples,[11,60] focus on a specific patient sub-group (e.g. Medicaid users,[46] or using inconsistent thresholds for frequent attendance (3, 4 or 10 visits in a year).[11,60,61]

Limitations

The inclusion of any patients whose with frequent attendance for any 12 month period during the 10 year study period enabled patients to be grouped according to long-term patterns of frequent attendance, however some temporary and repeat frequent attenders may have been classified differently had all participants had equal follow up time.

Logistic regression models identifying factors associated with frequent attendance used both characteristics of the person (e.g. socio-demographics) and their presentations to ED (diagnosis, urgency) throughout the study period, therefore there is confounding between the independent and dependent variables. When developing models to predict future frequent attendance, these would need to use only characteristics prior to a period of frequent attendance. Data quality, data consistency and the amount of missing information (in particular diagnosis) improved over time, which may impact descriptive and modelling results. The effect of missing diagnoses was minimised by modelling a patient's most common diagnostic block over all visits. While hospital insurance and preferred language were imputed using recent data, having a partner was considered more likely to change over the study period so missing cases were excluded from models.

Social variables that may increase the risk of frequent attendance, such as use of primary care services, homelessness or isolation, are not routinely collected. Other factors that may be predictive of frequent attendance, such as patient satisfaction with treatment, and having a regular source of care[62] were not collected.

We could not link to data on deaths outside of the public hospital system and therefore could not explore reasons for patients discontinuing frequent attendance, however

this is an area of potential future research. Finally, while we included data from metropolitan and rural EDs in one region in Australia, this may not be generalisable to other settings.

Conclusions

This study has provided a unique, longitudinal perspective on ED frequent attenders, contrasting the demographic and diagnostic profile of temporary, repeat and persistent frequent attenders. The distinction between temporary and ongoing frequently attending cohorts should be used when describing frequent attenders, and to inform appropriate interventions and better direct health resources.

Author contributions

LL carried out analysis, interpretation, and drafted the manuscript, VWW and KL assisted with interpretation of the data and assisted with drafting and reviewing the manuscript, RZ, JM, TC, and WT contributed to interpretation of the data and reviewed the manuscript, KE was responsible for the study conception and contributed to interpretation of the data and reviewed the manuscript.

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Table 1. Characteristics of ED patients, 12-month windows, and visits* by length of frequent attendance

	Frequent Attenders				Non-frequent ED attenders	ED attenders
	Temporary	Repeat	Persistent	*All*		
Patients	(N=6,866)	(N=1,104)	(N=607)	*(N=8,577)*	(N=323,523)	(N=332,100)
Age group (% of patients) †‡						
0-4	10.4	5.7	2.3	*9.2*	13.4	13.3
5-15	9.0	8.9	9.1	*9.0*	12.6	12.5
16-24	11.5	12.5	12.4	*11.7*	12.6	12.6
25-44	20.2	24.3	34.9	*21.8*	22.6	22.6
45-64	18.8	21.9	23.7	*19.6*	20.2	20.2
65-74	12.4	12.6	8.7	*12.2*	8.6	8.7
75+	17.8	14.1	8.9	*16.7*	10.1	10.2
Sex (% of patients)†‡						
Male	53.8	51.5	46.8	*53.0*	51.3	51.3
Female	46.2	48.6	53.2	*47.0*	48.8	48.7
Indigenous (% of patients)§‡**						
Aboriginal or Torres Strait Islander origin	7.4	10.6	12.5	*8.2*	3.3	3.4
Neither Aboriginal nor Torres Strait Islander origin	92.6	89.4	87.5	*91.8*	96.8	96.6
Partner†‡** (% of patients, persons aged						
Yes	45.1	39.0	30.2	*43.2*	53.8	53.5
No	54.9	61.0	69.8	*56.8*	46.2	46.5
Private hospital insurance (% of						
Yes	17.3	16.1	11.7	*16.8*	32.0	31.6
No	82.7	83.9	88.3	*83.3*	68.0	68.4
Preferred language (% of patients)†‡**						
English	78.9	82.2	82.1	*79.6*	87.7	87.5
Other	21.1	17.8	17.9	*20.4*	12.3	12.5
Socio-economic status†‡** (% of						
Quintile 1 (low)	30.0	32.8	34.4	*30.7*	22.2	22.4
Quintile 2	26.6	24.6	25.0	*26.3*	22.8	22.9
Quintile 3	32.8	35.6	34.6	*33.3*	40.4	40.2
Quintile 4	5.7	4.1	4.1	*5.4*	7.6	7.5
Quintile 5 (high)	4.8	2.9	1.8	*4.4*	7.0	7.0
Visits	(N=108,858)	(N=32,643)	(N=38,338)	*(N=179,839)*	(N=1,019,794)	(N=1,199,633)
Visits in study period (mean visits)	15.9	29.6	63.2	*21.0*	3.2	3.6
Visits per 12-month window (with 1+ visit) (mean visits)	4.2	5.8	9.5	*5.1*	1.7	1.8
Admitted (% of visits)‡**						
Yes	37.0	38.0	33.5	*36.4*	30.8	31.6
No	63.0	62.0	66.5	*63.6*	69.2	68.4
Triage category‡** (% of visits)						
1 (highest urgency)	0.5	0.5	0.5	*0.5*	0.5	0.5
2	7.7	8.3	7.7	*7.8*	6.7	6.9
3	30.0	30.3	28.8	*29.9*	28.0	28.3
4	45.1	45.7	46.6	*45.8*	50.7	49.9
5 (lowest urgency)	16.7	15.3	16.4	*16.7*	14.2	14.5

* Excludes planned return visits

† As reported at earliest ED visit in study period

‡ χ^2 test for patient type (temporary frequent attender, repeat frequent attender, ongoing frequent attender by: age $\chi^2_{12} = 164.5$ (p<.0001), sex $\chi^2_2 = 12.2$ (p=0.002) , Indigenous $\chi^2_2 = 29.1$ (p<.0001), Partner $\chi^2_2 = 43.8$ (p<.0001), Hospital insurance $\chi^2_2 = 10.8$ (p=0.045) Preferred language $\chi^2_2 = 8.6$ (p=0.014), Socio-economic status $\chi^2_8 = 34.6$ (p<.0001), Admitted $\chi^2_2 = 196.7$ (p<.0001), Triage category $\chi^2_8 = 76.0$ (p<.0001). Excludes unknown, missing, and not-stated.

§ As reported at most recent ED visit in study period. This is the recommended approach for Indigenous status (Randall et al 2013) and was required for hospital insurance due to incomplete early data at two facilities.

** Percentage missing, unknown, not stated - Partner 11.5%, Indigenous status (at last ED visit) 0.9%, Socio-economic status 0.0%, Hospital insurance (at last ED visit) 10.8%, Preferred language 5.3%, Admitted 0.0%, Triage category 0.2%

Table 2. Diagnostic profile of ED frequent attender patients* by duration of frequent attendance and age group (% of patients)

	Temporary frequent attender (frequent attender in one 12-month period)								Repeat frequent attender (frequent attender in two 12-month periods)								Persistent frequent attender (frequent attender in three or more 12-month periods)							
	Age group†								Age group								Age group							
% of patients	0-4	5-15	16-24	25-44	45-64	65-74	75+	All	0-4	5-15	16-24	25-44	45-64	65-74	75+	All	0-4	5-15	16-24	25-44	45-64	65-74	75+	All
N persons	711	615	791	1387	1291	850	1221	6866	63	98	138	268	242	139	156	1104	14	55	75	212	144	53	54	607
Most common Major Diagnostic Block																								
Alcohol/drug abuse and alcohol/drug induced mental disorders	0.0	0.0	1.0	2.0	1.6	0.0	0.0	0.8	0.0	0.0	‡	2.6	2.9	0.0	0.0	1.4	0.0	0.0	‡	2.8	4.2	‡	0.0	2.3
Circulatory system illness	‡	1.3	3.5	5.5	17.5	24.4	23.7	12.2	0.0	5.1	‡	4.5	15.3	25.2	32.7	13.0	0.0	‡	‡	7.6	18.1	28.3	14.8	11.5
Digestive system illness	12.2	18.5	21.4	15.9	14.4	12.0	13.6	15.2	14.3	22.5	26.8	15.7	19.4	13.8	9.6	17.6	‡	36.4	26.7	18.4	16.7	15.1	14.8	19.9
Endocrine, nutritional and metabolic system illness	‡	0.8	0.9	1.1	0.7	1.1	1.2	0.9	‡	‡	‡	‡	2.1	‡	‡	1.4	0.0	‡	‡	‡	‡	0.0	0.0	1.3
Illness of skin, subcutaneous tissue, breast	2.0	4.7	5.6	7.1	5.4	3.3	2.9	4.7	‡	‡	5.1	5.6	2.9	‡	‡	3.4	0.0	‡	‡	4.3	‡	0.0	‡	2.6
Injury, single site, major	14.5	31.7	20.0	13.4	6.3	3.9	6.2	12.1	‡	21.4	7.3	12.7	2.1	‡	5.8	7.7	‡	21.8	‡	7.6	3.5	0.0	‡	6.9
Musculoskeletal/connective tissue system illness	0.7	2.9	3.0	6.0	5.3	5.4	4.2	4.3	0.0	‡	5.1	9.3	6.6	5.0	‡	5.3	0.0	‡	8.0	9.4	5.6	0.0	‡	6.1
Neurological system illness	4.6	3.6	3.5	5.6	5.3	5.9	7.0	5.3	9.5	7.1	5.1	6.3	8.7	5.8	3.9	6.5	‡	9.1	8.0	11.3	13.2	‡	11.1	10.4
Psychiatric illness	0.0	9.3	11.3	13.1	5.9	1.4	1.0	6.2	‡	14.3	21.0	25.0	10.7	‡	‡	12.9	0.0	12.7	29.3	26.4	10.4	‡	0.0	16.6
Respiratory system illness	44.0	6.0	4.6	4.0	14.3	18.4	17.1	14.4	47.6	‡	5.1	4.9	14.5	21.6	19.9	13.6	0.0	0.0	‡	2.4	16.7	34.0	22.2	11.2
Urological system illness	1.1	1.3	2.5	2.5	4.7	10.6	13.3	5.6	0.0	6.1	‡	‡	3.3	10.1	16.7	5.3	0.0	0.0	‡	‡	‡	9.4	14.8	3.2
Other MDBs	20.0	19.8	22.8	23.9	18.7	13.8	10.0	18.3	19.1	15.3	18.1	11.2	11.6	7.9	7.7	12.1	‡	10.9	‡	8.0	6.9	7.6	11.1	7.9
Major Diagnostic Block during study period																								
Alcohol/drug abuse and alcohol/drug induced mental disorders	0.0	8.5	10.5	11.8	7.3	1.5	0.7	6.0	0.0	10.2	17.4	26.1	16.5	0.0	‡	13.2	0.0	16.4	24.0	31.6	18.8	‡	‡	20.4
Circulatory system illness	4.1	22.4	29.6	35.3	58.9	69.5	71.5	45.4	7.9	40.8	31.9	49.6	65.7	89.9	81.4	57.3	‡	58.2	53.3	65.6	82.6	90.6	85.2	70.2
Digestive system illness	63.4	65.5	58.7	54.2	57.0	61.5	59.9	59.1	85.7	79.6	79.7	70.9	71.9	79.9	74.4	75.5	92.9	96.4	85.3	85.9	85.4	88.7	74.1	86.0
Endocrine, nutritional and metabolic system illness	6.5	6.0	3.5	7.9	16.9	20.4	19.0	12.3	12.7	10.2	10.9	13.1	24.4	23.7	30.1	18.8	7.1	12.7	17.3	20.3	24.7	45.3	29.6	25.4
Illness of skin, subcutaneous tissue, breast	38.1	36.3	36.8	36.0	33.4	29.5	26.6	33.4	46.0	46.9	44.2	46.6	37.2	44.6	33.3	42.1	28.9	56.4	56.0	49.5	46.5	30.2	44.4	47.9
Injury, single site, major	62.6	82.3	66.4	57.7	48.8	42.2	50.8	56.6	69.8	87.8	74.6	71.3	61.2	46.8	55.8	65.6	57.4	90.9	81.3	38.4	22.7	6.3	7.3	76.9
Musculoskeletal/connective tissue system illness	15.3	48.1	42.4	44.7	44.6	43.8	41.4	41.0	27.0	66.3	56.5	59.0	57.9	59.0	55.1	56.7	35.7	89.1	73.3	71.7	79.2	69.8	66.7	73.8

* Excludes planned return visits
† Age group defined at first visit in first period of frequent attendance
‡ Cell suppressed, n ≤ 5

Neurological system illness	18.1	27.8	30.7	32.3	36.6	44.2	52.5	36.3	23.8	37.8	52.9	55.6	56.2	64.0	64.1	54.3	‡	58.2	70.7	74.1	75.0	83.0	68.5	71.7
Psychiatric illness	1.4	31.1	36.0	36.3	23.0	15.4	14.2	23.2	‡	54.1	58.7	62.7	36.0	18.7	21.2	40.9	0.0	67.3	68.0	71.2	52.1	28.3	16.7	55.7
Respiratory system illness	83.5	39.5	34.6	32.6	50.0	58.6	61.6	50.4	92.1	53.1	46.4	48.5	66.5	71.9	76.3	62.0	100.0	78.2	65.3	64.2	77.1	83.0	85.2	73.0
Urological system illness	11.1	17.7	21.0	17.9	27.3	40.4	47.4	27.3	14.3	32.7	27.5	24.3	42.6	65.5	60.3	39.1	‡	49.1	45.3	31.6	42.4	58.5	72.2	43.2

Table 3. Logistic regression modelling characteristics associated with frequent attendance: non-frequent vs i) all frequent attenders, ii) temporary frequent attenders, iii) repeat frequent attenders, iv) persistent frequent attenders. Persons aged 16 or over

	Non-frequent vs all frequent attenders[9]		Non-frequent vs *temporary* frequent attenders[10]		Non-frequent vs *repeat* frequent attenders[11]		Non-frequent vs *persistent* frequent attenders[12]	
Variable	**OR**	**(CI)**	**OR**	**(CI)**	**OR**	**(CI)**	**OR**	**(CI)**
Sex								
Male	1.2	(1.1,1.3)	1.2	(1.1,1.3)	1.2	(1.0,1.5)	0.9	(0.7,1.2)
Female (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Age group								
16-24 (reference)	1.0	-	1.0	-	1.0	-	1.0	-
25-44	1.2	(1.0,1.3)	1.1	(1.0,1.3)	1.6	(1.1,2.3)	1.9	(1.2.3.0)
45-64	1.4	(1.2,1.6)	1.3	(1.1,1.5)	2.0	(1.3,2.9)	2.4	(1.5,3.9)
65-74	1.8	(1.5,2.1)	1.6	(1.4,2.0)	2.2	(1.4,3.4)	2.1	(1.1,3.8)
75+	2.1	(1.8,2.5)	2.1	(1.7,2.4)	2.3	(1.5,3.6)	1.6	(0.9,2.9)
Partner								
Yes	0.7	(0.6,0.8)	0.7	(0.7,0.8)	0.6	(0.5,0.8)	0.5	(0.4,0.7)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Uninsured (no private hospital insurance)[13]								
Yes	1.7	(1.6,1.9)	1.7	(1.5,1.9)	1.8	(1.3,2.4)	1.9	(1.2,2.8)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Aboriginal or Torres Strait Islander								
Yes	2.0	(1.7,2.4)	1.9	(1.5,2.3)	2.5	(1.7,3.7)	2.6	(1.6.4.2)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
High average triage (1-3)								
Yes	2.1	(1.9,2.3)	2.0	(1.8,2.3)	2.4	(1.8,3.2)	1.9	(1.3,2.7)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Preferred language non-English**								
Yes	1.1	(0.9,1.4)	1.2	(0.9,1.4)	1.2	(0.7,2.0)	0.7	(0.3,1.8)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Proportion of visits admitted	0.7	(0.6,0.8)	0.7	(0.6,0.9)	0.6	(0.4,0.9)	0.5	(0.3,0.9)
Socio-economic status								
Quintile 1 (low)	1.4	(1.2,1.5)	1.4	(1.2,1.5)	1.3	(1.0,1.7)	1.4	(1.0,2.0)
Quintile 2	0.9	(0.8,1.0)	0.9	(0.8,1.1)	0.9	(0.6,1.2)	0.8	(0.5,1.3)
Quintile 3 (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Quintile 4	0.6	(0.5,0.8)	0.7	(0.6,0.9)	0.5	(0.3,0.8)	0.5	(0.2,1.1)
Quintile 5 (high)	0.6	(0.5,0.7)	0.7	(0.5,0.8)	0.4	(0.2,0.7)	0.3	(0.1,0.8)
Major Diagnostic Block[14]								
Alcohol/drug abuse and alcohol/drug induced mental disorders	6.4	(4.3,9.7)	5.1	(3.2,8.2)	11.2	(4.4,28.3)	17.9	(6.2,51.5)
Circulatory system illness	2.3	(1.9,2.7)	2.0	(1.7,2.5)	3.4	(2.0, 5.5)	4.0	(2.0, 8.0)
Digestive system illness	2.8	(2.4,3.3)	2.5	(2.1,3.0)	4.3	(2.7, 7.0)	5.6	(2.9,10.6)
Endocrine, nutritional and metabolic system illness	2.8	(1.9,4.2)	2.4	(1.5,3.7)	4.8	(1.8, 13.1)	6.5	(1.7,24.4)
Illness of skin, subcutaneous tissue, breast	2.9	(2.4,3.7)	2.9	(2.2,3.6)	3.6	(1.9, 7.0)	2.7	(1.0,7.3)
Injury, single site, major (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Musculoskeletal/connective tissue system illness	1.7	(1.4,2.1)	1.5	(1.2,1.9)	2.6	(1.5, 4.7)	3.1	(1.4,6.7)
Neurological system illness	2.2	(1.8,2.7)	1.8	(1.4,2.3)	3.2	(1.8, 5.8)	6.8	(3.3,13.7)
Psychiatric illness	6.2	(5.1,7.5)	4.8	(3.8,6.0)	12.5	(7.6,20.5)	13.7	(7.1,26.5)
Respiratory system illness	3.3	(2.8,4.0)	3.0	(2.4,3.6)	5.1	(3.1, 8.5)	5.6	(2.8,11.4)
Urological system illness	3.2	(2.6,3.9)	3.0	(2.4,3.8)	4.3	(2.3, 7.8)	3.4	(1.3,8.6)
Other	1.7	(1.4,1.9)	1.6	(1.4,2.0)	1.8	(1.1, 3.0)	1.3	(0.6,2.8)

CI, 99.8% Confidence Interval (α adjusted for multiple comparisons, 1-α/m = 1-0.05/26 = 0.998)
OR, Odds Ratio

[9] n=211,447, AUC=0.82, Hosmer-Lemeshow χ^2 =1,867 (p<0.0001), Generalized Chi-Square / DF = 0.90,
[10] n=210,198, AUC=0.80, Hosmer-Lemeshow χ^2 =1,461 (p<0.0001), Generalized Chi-Square / DF = 0.90,
[11] N=206,440, AUC=0.87, Hosmer-Lemeshow χ^2 =877 (p<0.0001), Generalized Chi-Square / DF =0.79,
[12] N=206,097, AUC=0.89, Hosmer-Lemeshow χ^2 =678 (p<0.0001), Generalized Chi-Square / DF =0.89,
[13] Missing values imputed with patient's most recent non-missing value.
[14] Most frequent MDB over all visits. Excludes missing diagnoses and those unable to be mapped to an MDB. All MDBs which included less than five ongoing, repeat or temporary frequent attenders was included with "Other MDB" in a category labelled 'Other'.

Table 4. Logistic regression modelling characteristics associated with frequent attendance: non-frequent vs i) all frequent attenders, ii) temporary frequent attenders, iii) repeat frequent attenders, iv) persistent frequent attenders. Persons aged under 16

	Non-frequent vs all frequent attenders[15]		Non-frequent vs *temporary* frequent attenders[16]		Non-frequent vs *repeat* frequent attenders[17]		Non-frequent vs *persistent* frequent attenders[18]	
Variable	**OR**	**(CI)**	**OR**	**(CI)**	**OR**	**(CI)**	**OR**	**(CI)**
Sex								
Male	0.9	(0.8,1.1)	1.0	(0.8,1.2)	0.6	(0.3,1.0)	0.6	(0.2,1.4)
Female (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Age group								
0-4 (reference)	1.0	-	1.0	-	1.0	-	1.0	-
5-15	1.0	(0.8,1.2)	1.0	(0.8,1.1)	1.4	(0.8,2.4)	1.3	(0.5,3.1)
Uninsured (no private hospital insurance)[19]								
Yes	1.8	(1.4,2.2)	1.8	(1.4,2.2)	1.7	(0.8,3.4)	2.3	(0.7,7.9)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Aboriginal or Torres Strait Islander								
Yes	1.7	(1.3,2.2)	1.7	(1.3,2.2)	1.4	(0.6,3.2)	1.8	(0.5.6.3)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
High average triage (1-3)								
Yes	2.3	(1.9,2.9)	2.3	(1.8,2.8)	2.5	(1.2,4.9)	4.7	(1.1,19.1)
No (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Proportion of visits admitted	0.9	(0.7,1.3)	0.9	(0.6,1.3)	1.3	(0.5,3.5)	1.6	(0.3,8.2)
Socio-economic status								
Quintile 1 (low)	1.7	(1.4,2.0)	1.6	(1.3,2.0)	2.1	(1.2,3.6)	2.3	(0.9,5.8)
Quintile 2-5 (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Major Diagnostic Block[20]								
Digestive system illness	1.7	(1.3,2.2)	1.6	(1.2,2.1)	2.3	(1.0, 5.2)	6.0	(1.4, 24.7)
Injury, single site, major (reference)	1.0	-	1.0	-	1.0	-	1.0	-
Neurological system illness	2.7	(1.8,4.1)	2.4	(1.5,3.9)	5.0	(1.7, 14.4)	7.6	(1.2,48.1)
Psychiatric illness	6.7	(4.1,11.1)	6.1	(3.5,10.6)	8.6	(2.4,31.2)	34.7	(6.3,190.6)
Respiratory system illness	2.4	(1.8,3.0)	2.4	(1.9,3.0)	2.7	(1.3, 5.9)	2.0	(0.4, 10.2)
Other	0.9	(0.7,1.1)	0.9	(0.7,1.2)	1.2	(0.5, 2.7)	1.4	(0.3, 6.5)

CI, Confidence Interval (α adjusted for multiple comparisons, 1-α/m = 1-0.05/26 = 0.998)
OR, Odds Ratio

[15] n=82,344, AUC=0.83, Hosmer-Lemeshow = 456 (p<0.0001), Generalized Chi-Square / DF = 0.87
[16] n=82,115, AUC=0.82, Hosmer-Lemeshow = 415 (p<0.0001), Generalized Chi-Square / DF =0.85
[17] N=80,958, AUC=0.87, Hosmer-Lemeshow = 158 (p<0.0001), Generalized Chi-Square / DF =0.88
[18] n=80,867, AUC=0.93, Hosmer-Lemeshow = 64 (p<0.0001), Generalized Chi-Square / DF =0.64
[19] Missing values imputed with patient's most recent non-missing value.
[20] Most frequent MDB over all visits. Excludes missing diagnoses and those unable to be mapped to an MDB. All MDBs which included less than five ongoing, repeat or temporary frequent attenders was included with "Other MDB" in a category labelled 'Other'.

Figure captions

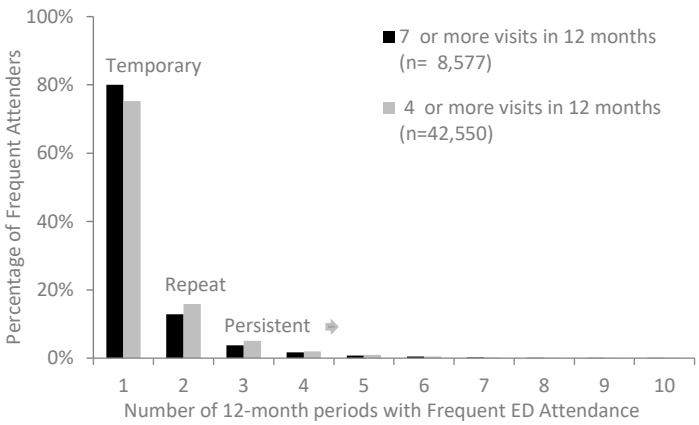
Figure 1.

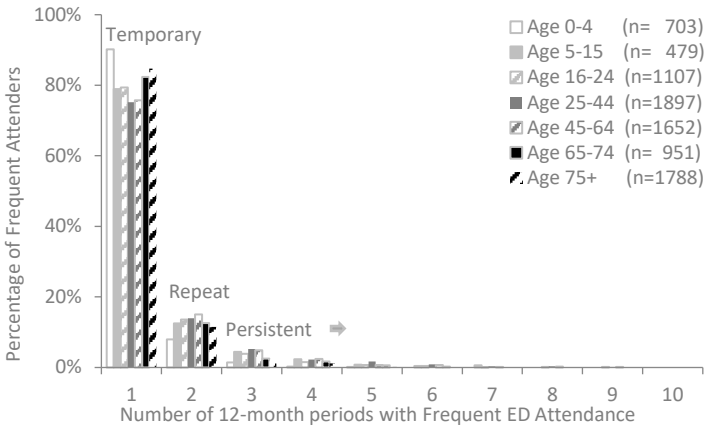
Number of 12-month periods where the frequent attendance threshold was met by frequently attending residents. *Left*: All residents with 7 or more visits in 12 months and all residents with 4 or more visits in 12 months. *Right*: all residents with 7 or more visits in 12 months by age group. Excludes planned return visits.

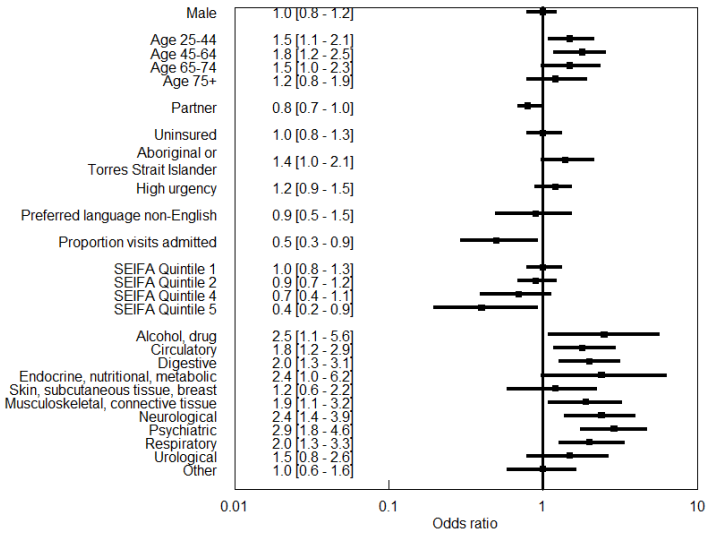
Figure 2.

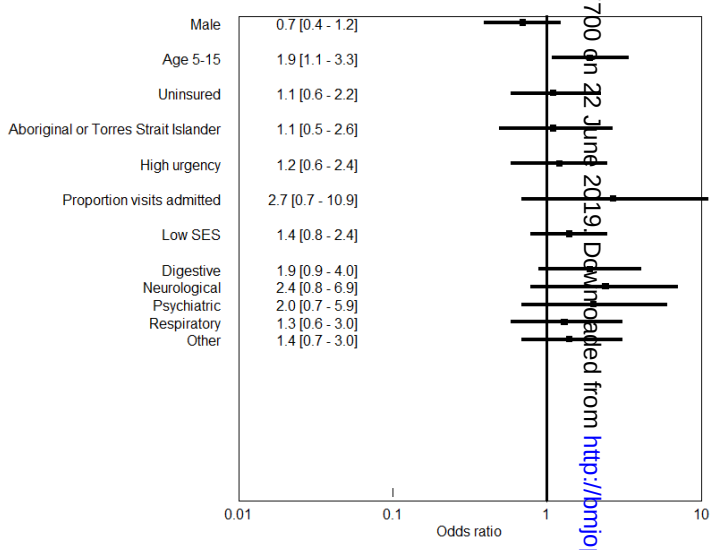
Logistic regression model identifying characteristics associated with ongoing vs temporary frequent attendance. *Left*: Persons aged 16 and over (n=5,803). *Right*: Persons aged under 16 (n=1,546).

Note: Reference categories for persons aged 16 and over - Age: 16-24, SEIFA: Quintile 3, Major Diagnostic Block: Single Site Major Injury. Reference categories for persons aged under 16 - Age: 0-4, SEIFA: Quintile 2-5, Major Diagnostic Block: Single Site Major Injury.









Supplementary Material for Here one year, gone the next? Investigating duration and predictors of ongoing frequent emergency department attendance, a retrospective study in Australia.

Table 1. Diagnostic profile of all ED frequent attenders[1] by age group

	Age group[2]							
% of frequent attenders	**0-4**	**5-15**	**16-24**	**25-44**	**45-64**	**65-74**	**75+**	**All**
	N persons							
	788	768	1004	1867	1677	1042	1431	8577
Most common Major Diagnostic Block								
Alcohol/drug abuse and alcohol/drug induced mental disorders	0.0	0.0	1.0	2.2	2.0	0.1	0.0	1.0
Circulatory system illness	0.4	1.8	3.6	5.6	17.2	24.7	24.3	12.3
Digestive system illness	12.4	20.3	22.5	16.2	15.3	12.7	13.2	15.9
Endocrine, nutritional and metabolic system illness	0.6	1.0	1.2	1.1	0.9	1.1	1.0	1.0
Illness of skin, subcutaneous tissue, breast	1.9	4.2	5.2	6.6	4.8	3.0	2.7	4.3
Injury, single site, major	13.6	29.7	17.1	12.6	5.4	3.6	6.2	11.2
Musculoskeletal/connective tissue system illness	0.6	2.6	3.7	6.9	5.5	5.1	3.8	4.6
Neurological system illness	5.2	4.4	4.1	6.4	6.5	5.7	6.8	5.8
Psychiatric illness	0.1	10.2	13.9	16.3	7.0	1.5	1.0	7.8
Respiratory system illness	44.4	5.3	4.5	3.9	14.5	19.6	17.6	14.1
Urological system illness	1.0	1.8	2.4	2.1	4.2	10.5	13.7	5.4
Other MDBs	19.7	18.6	20.8	20.3	16.6	12.7	9.8	16.7
Major Diagnostic Block during study period								
Alcohol/drug abuse and alcohol/drug induced mental disorders	0.0	9.2	12.5	16.1	9.6	1.4	0.8	8.0
Circulatory system illness	4.6	27.3	31.7	40.8	61.9	73.3	73.1	48.7
Digestive system illness	65.7	69.5	63.6	60.2	61.6	65.4	62.0	63.1
Endocrine, nutritional and metabolic system illness	7.0	7.0	5.6	10.0	19.5	22.1	20.6	14.0
Illness of skin, subcutaneous tissue, breast	38.8	39.1	39.2	39.1	35.1	32.6	28.0	35.5
Injury, single site, major	63.3	83.6	68.6	62.6	52.7	43.5	51.8	59.2
Musculoskeletal/connective tissue system illness	16.6	53.4	46.6	49.8	49.5	47.1	43.9	45.3
Neurological system illness	18.8	31.3	36.8	40.4	42.7	48.9	55.2	41.1
Psychiatric illness	1.7	36.6	41.5	44.1	27.4	16.5	15.0	27.8
Respiratory system illness	84.5	44.0	38.6	38.5	54.7	61.6	64.1	53.7
Urological system illness	11.6	21.9	23.7	20.4	30.8	44.6	49.8	30.0

[1] Excludes planned return visits
[2] Age group at first visit in first period of frequent attendance.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6-7
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	n.a.
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8-9
Bias	9	Describe any efforts to address potential sources of bias	9-10
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9-10
		(*b*) Describe any methods used to examine subgroups and interactions	8-9
		(*c*) Explain how missing data were addressed	9-10
		(*d*) If applicable, explain how loss to follow-up was addressed	n.a.
		(*e*) Describe any sensitivity analyses	10
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	10
		(b) Give reasons for non-participation at each stage	n.a.
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10-12
		(b) Indicate number of participants with missing data for each variable of interest	9-10
		(c) Summarise follow-up time (eg, average and total amount)	7-8
Outcome data	15*	Report numbers of outcome events or summary measures over time	10-11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-14
		(*b*) Report category boundaries when continuous variables were categorized	8-9, In tables
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11-14
Discussion			
Key results	18	Summarise key results with reference to study objectives	14-17
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17
Generalisability	21	Discuss the generalisability (external validity) of the study results	17
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	3

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.