Original Article

PROCEEDINGS OF SINGAPORE HEALTHCARE

Frequent attenders at the emergency department: an analysis of characteristics and utilisation trends

Proceedings of Singapore Healthcare
2018, Vol. 27(1) 12–19

DOI: 10.1177/2010105817715271
journals.sagepub.com/home/psh
SAGE

Joanna Shi-En Chan[1], Aung Soe Tin[2], Wai Leng Chow[2], Ling Tiah[3], Mohan Tiru[3] and Chien Earn Lee[4]

Abstract

Background: Frequent attenders (FAs) place a disproportionate burden on emergency department (ED) resources.
Objectives: Our study aimed to describe characteristics of ED visits by FAs to our hospital so as to identify potential strategies to better manage ED demand.
Methods: This was a retrospective observational study. All visits to the ED from 1 January 2011 to 31 December 2011 were included. FAs were defined as patients with ⩾5 visits to the ED over the study period. They were further stratified by visit frequency.
Results: FAs showed a bimodal age distribution, with visits by FAs aged 16–25 years old and the elderly aged 66 years and above accounting for the largest proportion of ED visits relative to the number of visits by their non-FA counterparts. Using the age group of 26–45 years as reference, the odds ratio (OR) of FAs being 16–25 years old was 3.037 (95% confidence interval (CI) 2.708–3.407, $p < 0.001$). Above the age of 65, the OR of FAs falling into a given age group increased for every additional decade of life, up to 3.118 (2.495–3.898, $p < 0.001$) for the age group of 86 and above. FAs were more likely to be male. Diagnoses which accounted for a higher percentage of visits with increasing visit frequency were asthma, chronic obstructive pulmonary disease, upper respiratory tract infection and headache.
Conclusions: FAs include the high-acuity chronic sick as well as young adults with low-acuity complaints. Disease optimisation programmes, case management, robust community-based healthcare and public education are possible avenues to optimise ED resources in an ageing society.

Keywords

Frequent attenders, emergency department, public health, health systems, Singapore

Introduction

Frequent attenders (FAs) at the emergency department (ED) have come under scrutiny worldwide. This is due to the disproportionate burden they place on ED resources.[1–6] The characteristics of FAs are known to vary according to setting and context.[2] Studies in the United Kingdom (UK), the United States of America (USA) and Australia have associated frequent ED attendance with social issues. These are homelessness, drug use, psychiatric conditions and poor access to primary care.[4–11] Elsewhere, in the USA, Canada and Sweden, FAs are heavy users of primary care.[12–14] Many FAs have a high disease burden and do not use the ED inappropriately.[7,15–20]

Singapore is a small urbanised city-state with a population of 5.54 million in 2015.[21] There are six public general hospitals with a 24-hour ED that are easily accessible. At the ED of these hospitals, patients pay a flat fee in the range S$103–115. Specialised investigations such as computed tomography scans incur a separate charge. An individual's inability to pay upfront or insurance status does not restrict ED access. The ED is also not limited to patients who are referred by an

[1]Emergency Medicine Residency, Singapore Health Services, Singapore
[2]Health Services Research, Eastern Health Alliance, Tampines Plaza, Singapore
[3]Accident and Emergency Department, Changi General Hospital, Singapore
[4]Chief Executive's Office, Changi General Hospital, Singapore

Corresponding author:
Joanna Shi-En Chan, Department of Emergency Medicine, Singapore General Hospital, Outram Road, Singapore 169608, Singapore.
Email: joanna.chan@mohh.com.sg

institution or primary care provider. More than 70% of visits to the ED are made by patients who choose to come to the ED as the first stop for their respective conditions. In 2016, there were 1,008,718 attendances to public hospital EDs.[22]

There have been two studies on the profile of FAs to different tertiary hospitals in Singapore. Paul et al. defined FAs as patients with ⩾5 visits in 12 months including an index visit,[23] using data from 2005–2007. This study found that patients with the highest rates of re-attendance were those with chronic diseases. There was also a high repeat attendance rate for patients with infections and trauma.[23] Boh et al. conducted a case-control study of FAs and non-FAs with data from 2010–2011.[24] This study defined FAs as making ⩾4 visits in 12 months including an index visit. The majority of FAs had more than four chronic diseases and were older than 60 years. The total cost of visits by FAs was found to be four times the cost of visits by non-FAs. While Singapore has easy access to primary care, and a low occurrence of ED usage due to social causes, frequent attendance continues to be an expensive problem.[24]

In our study, we aimed to further analyse the characteristics and utilisation trends of the FAs at the ED. This was in order to identify potential strategies to better manage ED demand. Based on the bimodal age distribution of FAs in previous local studies, we postulated that the FAs in our study would comprise two main groups: elderly patients with chronic diseases; young patients with lower acuity complaints.

Methods

Study design and setting

This was a retrospective observational study evaluating ED attendance at the Changi General Hospital (CGH) from 1 January 2011 to 31 December 2011. CGH is a 1000-bed acute hospital located in the east of Singapore serving a population of about 1.4 million people, with about 150,000 ED visits annually.[25] Institutional Review Board approval was obtained for the study.

Study population

We included all visits within the study period completed with a documented ED diagnosis and disposition plan. We excluded patients who cancelled their registration without being seen, and those who left the ED before the consultation was completed. We also excluded all visits by patients who had died in the ED; as such patients had their visit patterns interrupted by death and did not contribute to data precision and model construction. Prison inmates were excluded as well, because they could not be representative of voluntary attendance to the ED.

FAs were defined as patients who had ⩾5 visits to the ED in the year studied. Definitions of frequent attendance in the literature vary from 3 to 20 visits a year.[2–5] In our study we chose the definition of '⩾5 visits to the ED in one year' based on a UK study,[26] which calculated that this most appropriately identifies the group of patients who frequently attend due to non-random events. In order to better identify different subgroups of FAs with differing characteristics and needs, FAs were further stratified by the number of visits: 5–10 visits, 11–20 visits or ⩾21 visits a year.

Data variables

Data was extracted from the ED electronic registry. The variables included age, gender, race, triage acuity, referral source, discharge diagnosis, and disposition. Patients aged 66 years and above were defined as being elderly. For patients with more than one ED visit, their age at the first ED visit was taken as the age of the patients in the analysis.

Triage acuity was classified using the Patient Acuity Category Scale: P1 referred to critically ill patients requiring immediate attention; P2 referred to patients with urgent or painful conditions requiring attention within 30–60 min; P3 referred to patients with minor emergencies or non-urgent conditions; and P4 referred to non-emergencies.

Referral sources were classified into either 'self' referred or 'non-self' referred. Self-referrals were visits by patients to the ED without a referral and not conveyed by ambulances. Non-self-referrals were ED visits by patients who had been referred by government polyclinics, private practitioners, community hospitals, nursing homes, the military and the police. All visits conveyed by ambulance were considered non-self-referrals.

Diagnoses were coded according to International Classification of Diseases Ninth Revision (ICD-9) by the attending physician for every individual visit to the ED. Unique diagnoses were then re-categorised into groups of conditions for meaningful analysis.

Data analysis

Patients with missing data were not excluded from the study but were omitted from data analysis if the missing variable made it impossible to include them in a calculation.

Data was analysed using Microsoft Excel software. Categorical data was presented as frequency (percentage) and numerical data was presented as mean (standard deviation). Potential factors that were significant in univariate models were put into the logistics regression model to determine the statistically significant association with frequent visits. The data generated was presented as odds ratio (OR), associated with its 95% confidence interval (CI). A two-tailed p-value <0.05 was considered statistically significant. Statistical data analysis was performed with SPSS statistical software, version 19.0 (IBM Corp, Armonk, NY).

Results

In 2011, 109,383 patients were responsible for 163,190 visits to the ED (Figure 1). Using our definition, FAs represented 3.0% of all patients and accounted for 14.6% of total visits. There were two instances of missing data: an attendance by a female non-FA patient of unknown age, and a unique non-FA patient of unknown gender. The largest group of FAs was the group which made 5–10 visits per year. The highest number of visits by a single patient was 82 visits in the year studied.

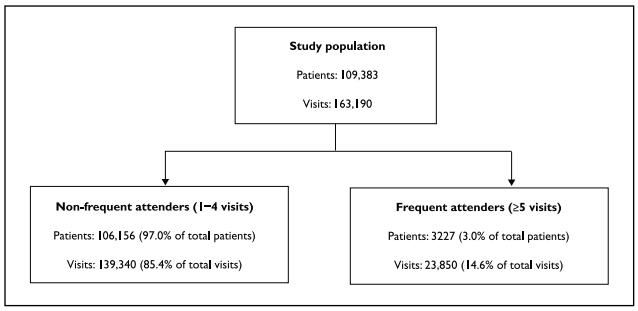

Figure 1. Breakdown of study population.

Table 1. Demographic and A&E utilisation profile of non-frequent attenders (non-FAs) vs. frequent attenders (FAs).

	Visit frequency	
	Non-FAs	FAs
Triage acuity of visits (*N* = 163,190)	*n* (%)	*n* (%)
P1	11,901 (8.5)	1919 (8.1)
P2	52,083 (37.4)	5221 (21.9)
P3	75,317 (54.1)	16,700 (70.0)
P4	39 (0.0)	10 (0.0)
Gender of visits	(%)	(%)
F	57,134 (41.0)	6384 (26.8)
M	82,206 (59.0)	17,466 (73.2)
Age category of visits	(%)	(%)
Below 16	5203 (3.7)	88 (0.4)
16–25	32,949 (23.6)	10,664 (44.7)
26–35	27,317 (19.6)	2780 (11.7)
36–45	17,854 (12.8)	1909 (8.0)
46–55	18,186 (13.1)	2591 (10.9)
56–65	15,325 (11.0)	1928 (8.1)
66–75	9538 (6.8)	1430 (6.0)
76–85	8940 (6.4)	1732 (7.3)
86 and above	4027 (2.9)	728 (3.0)

Low acuity P3 visits accounted for 70.0% of visits by FAs, as opposed to 54.1% of visits by non-FAs; while the percentage of P1 visits remained similar across both groups (Table 1).

Demographics

The proportion of FAs was more than that of non-FAs in two age groups: 16–25 years and 76 years and above (Table 1). FAs who were aged 16–25 years represented 5.4% of all ED unique visitors, but accounted for 24.5% of all ED visits.

Among FAs, a higher percentage of visits by males than by females were of P3 triage acuity (74.1% vs. 58.9%, respectively). Visits by young adult males outnumbered visits by young adult females by more than ten to one (Figure 2).

Self-referral, visit outcomes and discharge diagnosis

Seventy per cent of visits by non-FAs, and 84.9% of visits by FAs, were self-referred. Among FAs who were self-referred, 50.4% of visits were by FAs aged 16–25 years old while the FAs with non-self-referred visits tended to be older with the peak age category 76–85 years old (Figure 3). The proportion of P3 visits which were self-referred was similarly high in both non-FA and FA groups (93.0% vs. 94.6%, respectively). P1 visits accounted for a higher proportion of non-self-referred visits (22.6% and 35.4% for non-FAs and FAs, respectively) compared to self-referred visits (2.4% and 3.2% for non-FAs and FAs, respectively). Ambulance cases made up a higher percentage of non-self-referred visits by FAs (Table 2). Of these ambulance cases, FAs were more likely to be triaged to P3 (6.8% vs. 17.5%, respectively, for non-FAs vs. FAs), whereas the proportion who were triaged to P1 was similar (45.5% and 43.8%, respectively, for non-FAs vs. FAs).

A higher percentage of all visits by FAs compared to non-FAs resulted in discharge without specialist follow-up (63.9% vs. 49.6%, respectively). Discharge with specialist follow-up was given for 30.1% of P3 visits by non-FAs vs. 19.5% of P3 visits by FAs. There were similar rates of admission across all triage categories by non-FAs and FAs (0.4% of P3 visits by non-FAs vs. 0.3% of P3 visits by FAs, 30.8% of P2 visits by non-FAs vs. 39.5% of P2 visits by FAs and 89.2% of P1 visits by non-FAs vs. 91.2% of P1 visits by FAs). Higher rates of discharge were found among visits by younger patients.

Diagnoses which accounted for a higher percentage of visits with increasing visit frequency were asthma, chronic obstructive pulmonary disease (COPD), upper respiratory tract infection (URTI) and headache (Table 3).

Asthma accounted for half as many visits among FAs (911 visits) as non-FAs (1885 visits) despite the former being a much smaller group. Asthma was the second most common diagnosis after URTI in the group of young adults with very high frequency (≥21) visits.

COPD/bronchiectasis accounted for 3.6% of visits by elderly male non-FAs but 12.8% of visits by elderly male FAs. It was the most common diagnosis for male and female elderly with >11 visits a year. COPD accounted for 36.8% of all visits by elderly males with ≥21 visits.

URTI/pharyngitis was the top diagnosis for both non-FAs and FAs (17.7% vs. 31.3%) aged 16–25 regardless of gender. The only groups of patients for whom URTI was not in the top 10 diagnoses were elderly non-FA patients and elderly FAs with ≥21 visits.

Headache was in the top 10 diagnoses for young males with 11–20 visits and middle-aged females with ≥21 visits.

Psychiatric conditions displayed a trend to be more common with increased visit frequency, but overall accounted for small visit numbers, comprising 1.0% of total visits by FAs.

Multivariate regression

A multivariate regression was performed, showing that unique FAs were significantly more likely to be male and non-Chinese (Table 4). Using the age group of 26–35 years as the reference, the OR of FAs being 16–25 years old was 3.037 (95% CI 2.708–3.407). Above the age of 65, the OR of FAs falling into a given age group increased for every additional decade of life. The OR of FAs being aged 66–75 was 1.939 (95% CI 1.635–2.300, $p < 0.001$), and the OR increased to 2.926 (95% CI 2.489–3.441, $p < 0.001$) for the age group

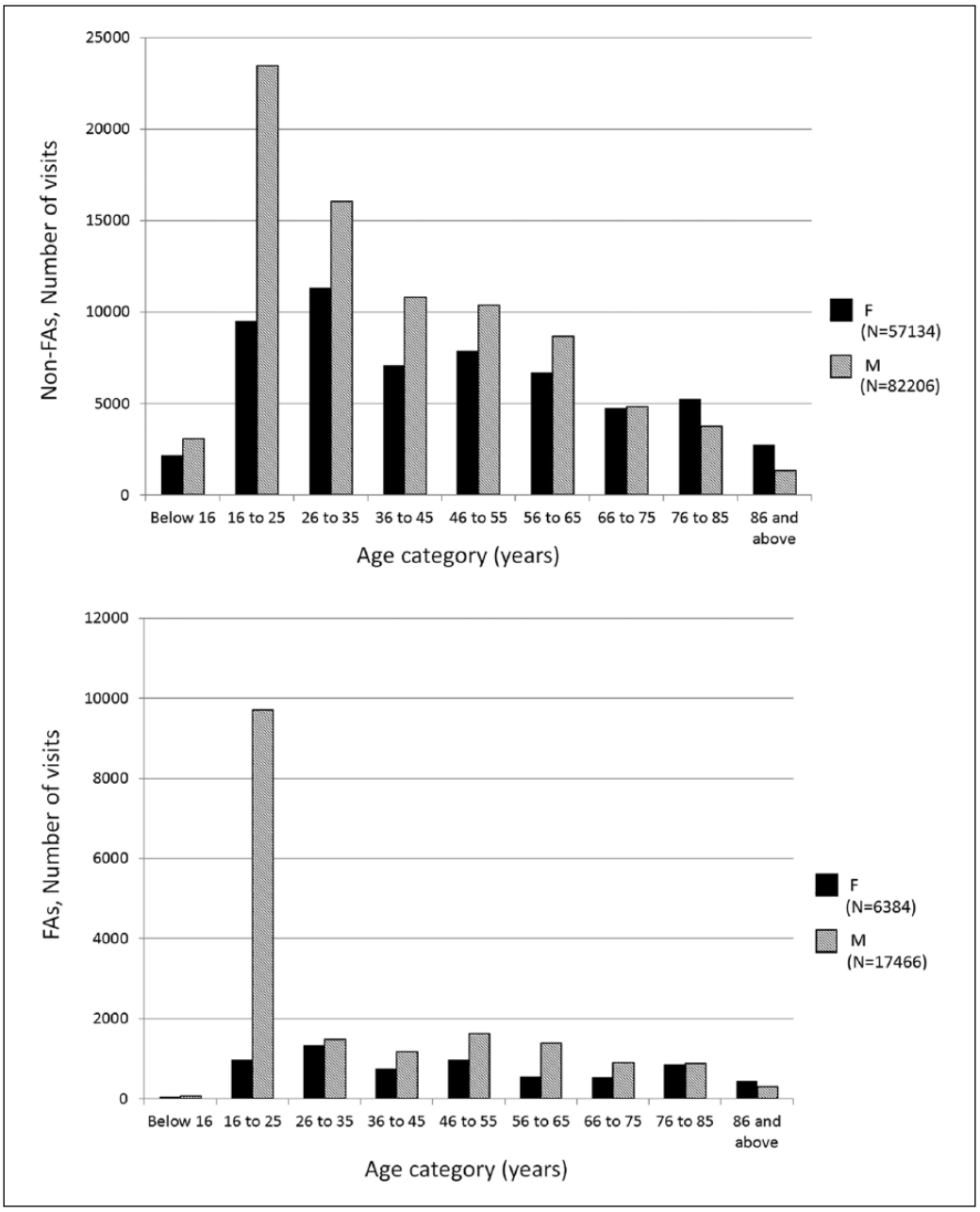

Figure 2. Gender distribution by age category, in non-frequent attenders (non-FAs) compared to frequent attenders (FAs).

75–85, and to 3.118 (95% CI 2.495–3.898, $p < 0.001$) for the age group of 86 and above. When the regression was performed using ED visits as the unit of analysis, the significant variables did not differ.

Discussion

Among the FAs in our study population, a bimodal age distribution was demonstrated. Those aged 16–25 years accounted for the largest proportion of ED visits relative to the number of visits by their non-FA counterparts in the same age category, followed by those by the elderly aged 66 and above. FAs were more likely to be male than female, although the gender distinction was less apparent among elderly FAs.

We found that every increase in 10 years above the age of 65 markedly increased the odds of frequent attendance. These elderly FAs also tended to be referred to the ED instead of being self-referred. In addition, non-self-referred FAs were of higher acuity compared to self-referred FAs. This seemed to support the hypothesis that there is a group of FAs comprising the elderly sick with acute conditions and comorbidities requiring treatment at the ED. Likewise, Boh et al. found that frequent attendance was associated with more comorbidities and higher triage acuity.[24] In their study, 55% of visits by FAs, with a median age of 63 years, were deemed unsuitable for diversion to primary care based on the five criteria which determined appropriate use of the ED.[24] We need to address the needs of these elderly FAs, with an eye to prevention and early detection. This requires us to strengthen the links between the institution and the community Measures that are being explored by our institution include services for vulnerable ED-discharged patients such as

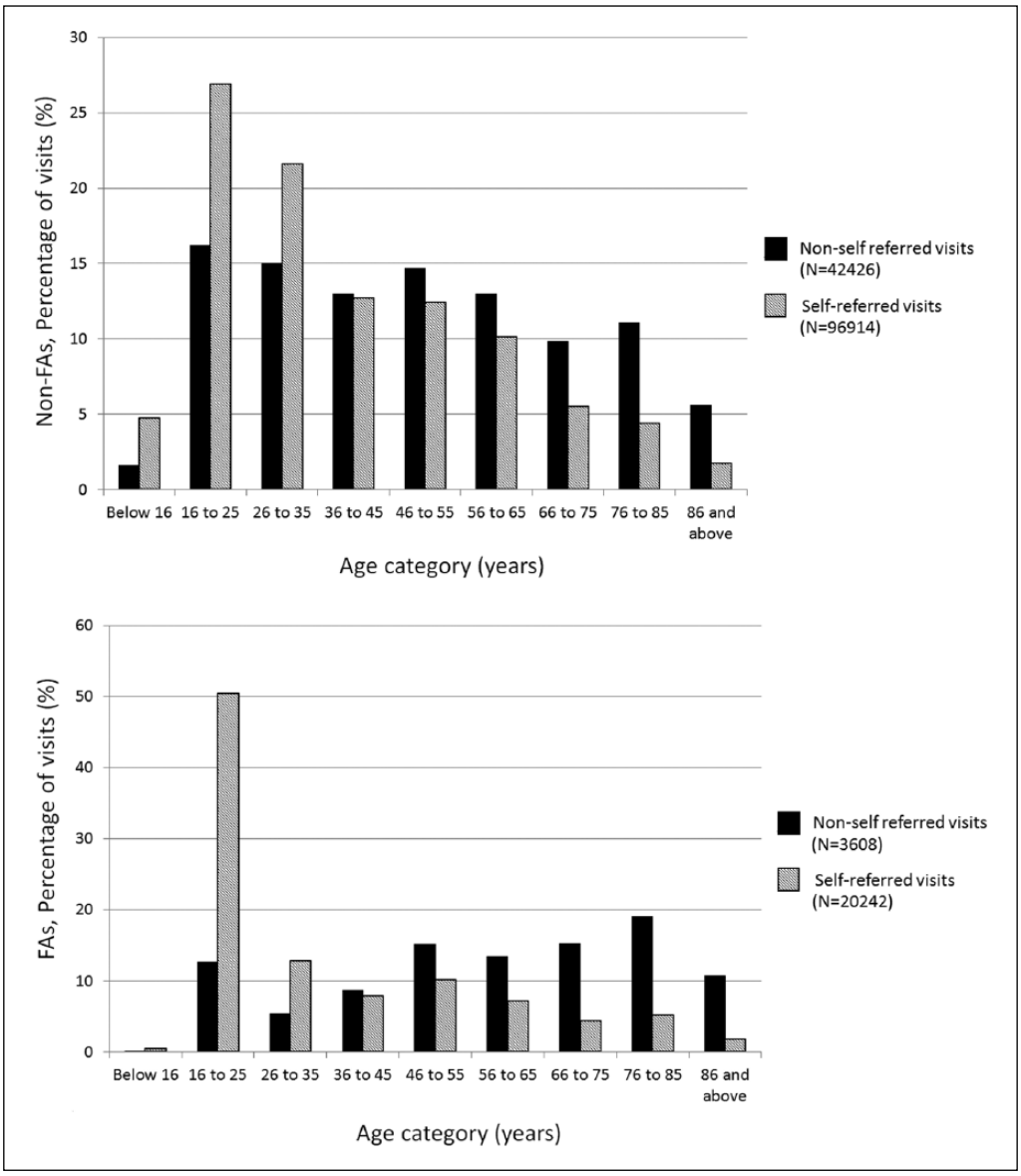

Figure 3. Non-self-referred vs. self-referred visits by age category, in non-frequent attenders (non-FAs) compared to frequent attenders (FAs).

Table 2. Sources of referral for non-self-referred visits.

Referral source	Visits by non-self-referred patients	
	Visits by non-FAs (*N* = 42,426), *n* (%)	Visits by FAs (*N* = 3,608), *n* (%)
Polyclinic	7743 (18.3)	359 (10.0)
Private practitioner or private hospital	11,279 (26.6)	206 (5.7)
Restructured hospital, public hospital specialist clinic or ED referral	414 (1.0)	57 (1.6)
Community hospital, VWO or nursing home	9 (0.0)	0 (0)
Military	1686 (4.0)	158 (4.4)
Police or prison (excludes current inmates)	1757 (4.1)	104 (2.9)
Ambulance cases	19,538 (46.1)	2724 (75.5)

ED = emergency department; FA = frequent attender; VWO = voluntary welfare organisation.

telephone follow-ups and home visits by multi-disciplinary teams. Also, collaboration with community leaders has resulted in a programme that trains volunteers to care for the elderly in their respective neighbourhoods.

A large proportion in the non-self-referred group of FAs arrived by ambulance. The percentage of ambulance cases triaged as P1 was similar in both non-FA and FA groups, suggesting a constant proportion of truly sick patients in both

Table 3. Diagnoses for which an increasing percentage of visits correlated with increasing category of visit frequency.

	Percentage of all visits which this specific diagnosis accounts for in each visit frequency category				
	Non-FA		FA		
Primary diagnosis	1 visit	2–4 visits	5–10 visits	11–20 visits	⩾21 visits
URTI/pharyngitis	6.4	10.8	18.5	24.5	21.0
Asthma	1.1	1.8	3.0	5.0	9.5
COPD/bronchiectasis	0.3	0.8	1.4	2.7	5.8
Headache	0.7	1.1	1.7	2.6	2.3

COPD = chronic obstructive pulmonary disease; FA = frequent attender; URTI = upper respiratory tract infection.
Note: The four conditions were identified by listing the diagnoses which clearly accounted for a higher percentage of visits among FAs compared to non-FAs.

Table 4. Multivariate regression showing factors associated with frequent visits (unit of analysis – unique patients).

Characteristic	Odds ratio (95% CI)	*p* value
Gender		
Female	Reference	
Male	1.631 (1.508–1.764)	<0.001
Ethnicity		
Chinese	Reference	
Malay	1.841 (1.693–2.003)	<0.001
Indian	1.849 (1.656–2.066)	<0.001
Others	1.258 (1.116–1.417)	<0.001
Age (years)		
26–35	Reference	
Below 16	0.188 (0.114–0.310)	<0.001
16–25	3.037 (2.708–3.407)	<0.001
36–45	0.986 (0.840–1.156)	0.858
46–55	1.359 (1.172–1.576)	<0.001
56–65	1.381 (1.180–1.617)	<0.001
66–75	1.939 (1.635–2.300)	<0.001
76–85	2.926 (2.489–3.441)	<0.001
86 and above	3.118 (2.495–3.898)	<0.001

groups. The proportion of ambulance cases triaged as P3, however, was higher for the FAs. While this might imply an unnecessary use of pre-hospital and ED services by some FAs, we postulate that it could also be a reflection of patients or caregivers perceiving a low-acuity complaint as urgent and serious enough to warrant an ED visit and transport by the ambulance. Such patients and families would benefit from targeted engagement with healthcare providers, both in the institution and the community for medical treatment and caregiver education.

One striking finding of our study was that a young adult patient demographic was noted to pay excessive visits to the ED for low acuity, self-limiting illnesses. While frequent ED use has been associated with younger patients in Ireland, France and New Zealand,[2] the reasons for this may vary according to different locations and health insurance systems. Taiwan shares some similarities to Singapore in that it is a relatively small country with easy access to hospitals, and patients are free to visit the ED without prior referral. Patients have universal health insurance under a co-payment scheme. A 2003 Taiwanese study linked high ED use to low-acuity complaints and high usage of primary care and outpatient clinic services.[20] Eighty-seven per cent of frequent users of the ED cited perceived severity of the problem as the reason that they chose to visit the ED. The leading diagnosis among frequent ED users in Taiwan was cancer, and the author noted that hospice care then in Taiwan was underdeveloped to cater to this population. In a subsequent study that analysed the 2004 data from a national health insurance database, another possible reason cited for inappropriate ED use was the fact that people who work office hours may have difficulty accessing primary care not available on weekends and evenings.[27]

In our local setting, self-perceived severity of illness may indeed explain some of the low-acuity visits by young adult patients to the ED. This is currently being evaluated in a qualitative study. Office-hour constraints for young working adults are similarly applicable in our setting. Information about primary care facilities that operate after office hours and during weekends should be disseminated to create awareness about alternative avenues of medical care.

The preponderance of males in the age category of 16–25 years old in our study was more exaggerated than in the Taiwanese studies, and may be the result of young male army conscripts seeking treatment at the ED. High rates of re-attendance by young male FAs were also observed locally in the study by Paul et al.,[23] with the gender difference most apparent in FAs <25 years. The Boh et al. study showed that FAs who were older, female and with multiple comorbidities were less likely to make inappropriate visits.[24] Considering their small numbers, young adult patients seemed to be responsible for a disproportionate number of P3 attendances. Interventions could be targeted at this group to decrease avoidable ED attendance. To this end, our institution has introduced the GP-First initiative, a campaign which seeks to patients to visit a partnering primary care provider first for low acuity complaints. If the primary care provider deems it necessary to refer the patient to the ED, a subsidy of S$50 will be implemented at ED registration.

Other patient subgroups we found to contribute to the driving force behind higher frequency of repeat attendances were those with asthma and COPD, as well as patients with headache. This is in keeping with previous studies in which frequent attendance was associated with respiratory diseases and painful conditions.[4,10,16,19,28]

Our study corroborates the importance of disease optimisation for asthma and COPD. A recent local study found that FAs with multiple exacerbations of asthma were more likely to be males with social issues, financial difficulties and

substance abusers.[29] With the high numbers of asthmatic patients visiting our ED in both the FA and non-FA population, it may be worthwhile to work with our respiratory and primary care colleagues to revive the Singapore National Asthma Program to optimise a system of identifying poorly controlled asthmatics, improving self-management strategies, and redirecting their usage patterns back to primary providers.[30] A similar disease optimisation programme for COPD patients could be explored. For example, the fourth visit to ED in a year could raise a flag for follow up by a multidisciplinary case management team.

Attendance to the ED for URTI and other low-acuity conditions is high among non-FAs and FAs both during and outside office hours. This ED visit pattern may be a reflection of the fact that the majority of our patients are self-referred without a first "triage" by a primary care doctor. The general public may have the misconception that ED is a convenient "one-stop" facility with expedited specialist care. This is despite an existing policy which fixes ED fees higher than the expected fee of a primary care physician to disincentivise inappropriate use of the ED.[24]

Many methods have been advocated internationally to prevent inappropriate ED use,[31] including public education, prehospital diversion, patient financial incentives to influence choice of care siting and triaging out inappropriate attendees. These have met with varying success, and some raise questions of patient safety and poor patient satisfaction.[32] Patient safety is of utmost importance, as a delay in treatment for time-sensitive conditions such as acute coronary syndromes or cerebrovascular accident could be catastrophic.

Another method that has been suggested is siting primary care physicians in the ED . This provides an alternative option for patients with non-urgent conditions at the ED. There is literature to suggest that this model is safe and cost-effective,[33,34] and it is supported in a position statement by the College of Emergency Medicine, UK.[35]

It is also likely that primary care services are currently perceived by the public as suboptimal at managing expectation and demand for health treatment. This requires modification to reduce the burden on acute hospitals.

Scope for further research includes studying the effects of ED and non-ED based interventions, and the degree to which suboptimal primary care management of diseases leads to frequent ED use.[36] Such studies would be in line with the Ministry of Health's move to decentralise health care from hospitals, developing regional health systems in which a general hospital collaborates with step-down facilities and primary providers to reduce hospitalisations, and emphasising preventive medicine.

Limitations

The main limitations of our study stemmed from issues inherent in retrospective studies. Firstly, while the data for patient demographics and triage status were objective, it was less clear-cut for diagnoses. Although diagnoses were coded according to ICD-9, the attending physicians might enter a generic code (e.g. 'general symptoms') and then provide the diagnosis as free text. As such, individual diagnoses had to be re-categorised into groups of conditions for meaningful analysis. This resulted in a less precise representation of the diagnoses.

Secondly, it was unfortunate that the ED registration system coded all ambulance cases as non-self-referrals, without capturing further information about who called for the ambulances. This would have enabled further stratification of referral sources to better target potential interventions to influence referral patterns.

Thirdly, other relevant characteristics of patients that may influence health-seeking behaviour include comorbidities, social circumstances and occupation. Because we did not review individual medical records to extract this information, we could not further profile the FAs. However, a currently ongoing qualitative study evaluating the health-seeking behaviour of patients at ED may add valuable insights.

Lastly, we did not analyse the costs of medical care incurred per visit and potential savings if self-referred FAs with low-acuity triage status had sought treatment first at primary care. The cost-effectiveness analysis provides an important dimension to the evaluation of the issue.

Conclusions

Among FAs at the ED in our study, the patients who accounted for a larger percentage of the ED visits relative to their non-FA counterparts were the elderly with chronic illnesses requiring frequent hospital care and the younger group with low-acuity complaints. Common diagnoses associated with visits by FAs included asthma and COPD. Disease optimisation and case management programmes for these specific conditions may help to reduce their visits to the ED. Public education efforts to reduce inappropriate ED visits for low-acuity complaints, in tandem with the development of robust community-based healthcare, may be the way forward to optimise ED resources in an ageing society.

Acknowledgements

We would like to thank Ms Carmen Kam from the Clinical Trials Research Unit for assisting with the multivariate regression.

Declaration of Conflicting Interests

The authors declare that there are no conflicts of interest.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

References

1. Cook LJ, Knight S, Junkins EP, et al. Repeat patients to the emergency department in a statewide database. *Acad Emerg Med* 2004; 11: 256–263.
2. La Calle E and Rabin E. Frequent users of emergency departments: the myths, the data, and the policy implications. *Ann Emerg Med* 2010; 56: 42–48.
3. Ruger JP, Richter CJ, Spitznagel EL, et al. Analysis of costs, length of stay, and utilization of emergency department services by frequent users: implications for health policy. *Acad Emerg Med* 2004; 11: 1311–1317.

4. Sandoval E, Smith S, Walter J, et al. A comparison of frequent and infrequent visitors to an urban emergency department. *J Emerg Med* 2010; 38(2):115–121.
5. Hunt KA, Weber EJ and Showstack JA. Characteristics of frequent users of emergency departments. *Ann Emerg Med* 2006; 48: 1–8.
6. Markham D and Graudins A. Characteristics of frequent emergency department presenters to an Australian emergency medicine network. *BMC Emerg Med* 2011; 11: 21.
7. Mandelberg JH, Kuhn RE and Kohn MA. Epidemiologic analysis of an urban, public emergency department's frequent users. *Acad Emerg Med* 2000; 7: 637–646.
8. Kne T, Young R and Spillane L. Frequent ED users: patterns of use over time. *Am J Emerg Med* 1998; 16: 648–652.
9. Byrne M, Murphy AW, Plunkett PK, et al. Frequent attenders to an emergency department: a study of primary health care use, medical profile, and psychosocial characteristics. *Ann Emerg Med* 2003; 41: 309–318.
10. Kennedy D and Ardagh M. Frequent attenders at Christchurch Hospital's Emergency Department: a 4-year study of attendance patterns. *N Z Med J* 2004; 117: U871.
11. Dent AW, Phillips GA, Chenhall AJ, et al. The heaviest repeat users of an inner city emergency department are not general practice patients. *Emerg Med* 2003; 15: 322–329.
12. Hansagi H, Olsson M, Sjöberg S, et al. Frequent use of the hospital emergency department is indicative of high use of other health care services. *Ann Emerg Med* 2001; 37: 561–567.
13. Ovens HJ and Chan BT. Heavy users of emergency services: a population-based review. *Can Med Assoc J* 2001; 165: 1049–1050.
14. Chan BT and Ovens HJ. Frequent users of emergency departments. Do they also use family physicians' services? *Can Fam Physician* 2002; 48: 1654–1660.
15. Salazar A, Bardes I, Juan A, et al. High mortality rates from medical problems of frequent emergency department users at a university hospital tertiary care centre. *Eur J Emerg Med* 2005; 12: 2–5.
16. Lucas RH and Sanford SM. An analysis of frequent users of emergency care at an urban university hospital. *Ann Emerg Med* 1998; 32: 563–568.
17. Bieler G, Paroz S, Faouzi M, et al. Social and medical vulnerability factors of emergency department frequent users in a universal health insurance system. *Acad Emerg Med* 2012; 19: 63–68.
18. Sun BC, Burstin HR and Brennan TA. Predictors and outcomes of frequent emergency department users. *Acad Emerg Med* 2003; 10: 320–328.
19. Miller JB, Brauer E, Rao H, et al. The most frequent ED patients carry insurance and a significant burden of disease. *Am J Emerg Med* 2013; 31: 16–19.
20. Huang JA, Tsai WC, Chen YC, et al. Factors associated with frequent use of emergency services in a medical center. *J Formos Med Assoc* 2003; 102: 222–228.
21. Department of Statistics Singapore. Population trends, 2016. Report, Department of Statistics, Ministry of Trade & Industry, Republic of Singapore, September 2016.
22. Ministry of Health Singapore. Admissions and outpatient attendances, www.moh.gov.sg/content/moh_web/home/statistics/Health_Facts_Singapore/Admissions_and_Outpatient_Attendances.html (2016, accessed 6 June 2017).
23. Paul P, Heng BH, Seow E, et al. Predictors of frequent attenders of emergency department at an acute general hospital in Singapore. *Emerg Med J* 2010; 27: 843–848.
24. Boh C, Li H, Finkelstein E, et al. Factors contributing to inappropriate visits of frequent attenders and their economic effects at an emergency department in Singapore. *Acad Emerg Med* 2015; 22: 1025–1033.
25. Ministry of Health Singapore. Healthcare institution statistics, www.moh.gov.sg/content/moh_web/home/statistics/healthcare_institutionstatistics.html (2014, accessed 24 May 2016).
26. Locker TE, Baston S, Mason SM, et al. Defining frequent use of an urban emergency department. *Emerg Med J* 2007; 24: 398–401.
27. Huang JA, Weng RH, Lai CS, et al. Exploring medical utilization patterns of emergency department users. *J Formos Med Assoc* 2008; 107: 119–128.
28. Milbrett P and Halm M. Characteristics and predictors of frequent utilization of emergency services. *J Emerg Nurs* 2009; 35: 191–113.
29. Lim SF, Wah W, Pasupathi Y, et al. Frequent attenders to the ED: patients who present with repeated asthma exacerbations. *Am J Emerg Med* 2014; 32: 895–899.
30. Chong PN, Tan NC and Lim TK. Impact of the Singapore National Asthma Program (SNAP) on preventer–reliever prescription ratio in polyclinics. *Ann Acad Med Singapore* 2008; 37: 114–117.
31. Morgan SR, Chang AM, Alqatari M, et al. Non-emergency department interventions to reduce ED utilization: a systematic review. *Acad Emerg Med* 2013; 20: 969–985.
32. Uscher-Pines L, Pines J, Kellermann A, et al. Emergency department visits for nonurgent conditions: systematic literature review. *Am J Manag Care* 2013; 19: 47–59.
33. Van der Straten LM, van Stel HF, Spee FJM, et al. Safety and efficiency of triaging low urgent self-referred patients to a general practitioner at an acute care post: an observational study. *Emerg Med J* 2012; 29: 877–881.
34. Bosmans JE, Boeke AJ, van Randwijck-Jacobze ME, et al. Addition of a general practitioner to the accident and emergency department: a cost-effective innovation in emergency care. *Emerg Med J* 2012; 29: 192–196.
35. The College of Emergency Medicine. The College of Emergency Medicine welcomes new report into the relationship between primary care and EDs, https://secure.rcem.ac.uk/code/document.asp?ID=5262 (2010, accessed 6 June 2017).
36. Pines JM, Asplin BR, Kaji AH, et al. Frequent users of emergency department services: gaps in knowledge and a proposed research agenda. *Acad Emerg Med* 2011; 18: e64–e69.