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Original Article

Data-Driven Approach to Defining the Emergency Department Frequent Attender Using a Cohort of 10 Years

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Aims: To identify, based on the measure of resource utilization, the number of visits per calendar year that defines the emergency department (ED) frequent attender; and examine for significant trends in patient characteristics and outcomes which may support the use of our definition.

Materials and Methods: We conducted a retrospective observational study of electronic clinical records of all ED visits over a 10-year period from January 2005 to December 2014 to an urban tertiary general hospital. We defined the ED frequent attender based on the number of ED attendances per calendar year which would yield a patient group representing more than 20% of all patient visits. Chi-square tests were conducted on each categorical factor individually to assess if they were independent of time, and the Student's t-test was used to assess continuous variables on their association with being a frequent attender.

Results: 1.381 million attendance records were analyzed. Patients who attended three or more times per year accounted for about 22.1% of all attendances and were defined as frequent attenders. They were associated with higher triage acuity, complex chronic illnesses, greater 30-day mortality for patients with three to six visits, and increased markers of resource utilization, such as ambulance use (15.5% vs. 11.6%), time to disposition (180 vs. 155 minutes), admissions rate (47.4% vs. 30.7%) and inpatient length of stay (6 days vs. 4 days). All p values were statistically significant ($p < 0.001$).

Conclusion: We have demonstrated a data-driven approach to defining an ED frequent attender. Frequent attenders are associated with increased resource utilization, more complex illness and may be associated with greater 30-day mortality rates.

Key words: *emergency department, frequent attenders, emergency department resource utilization, mortality*

Introduction

Emergency department (ED) crowding affects access to healthcare and leads to poorer patient outcomes.[1,2] Frequent users to the ED contribute to crowding, and there has been increasing body of research done to identify the ED frequent attender (FA), with their associated characteristics and outcomes.

Studies related to ED FAs utilize different cut-off values, ranging from 2 visits to 12 visits, for defining a FA.[3,4] Cut-off values used are often arbitrary, except for a study which defined a FA based on the number of visits that would yield a patient group representing 25% of all ED visits, which was a level deemed significant administratively and warranting expenditure of resources for intervention.[5] There remains a need to create a widely accepted definition for FAs that is pragmatic and grounded on data.[6,7]

Most studies regarding ED FAs study data over a 1 to 2-year period, and there have been no studies

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which demonstrate any significant differences in patient characteristics, visit characteristics and clinical outcomes between the FA and non-FA.[8]

Based on a primary data set stretching over a 10-year duration, we aim to identify, based on the measure of resource utilization, the number of visits per calendar year that defines the FA within our population. We also aim to examine the patient characteristics, visit characteristics and clinical outcomes for significant trends which may support the use of our definition for a FA.

We postulate that, when defined by a resource utilization measure of the ED FA group representing 20% or more of all ED visits, there are significant differences between FAs and non-FAs in terms of patient characteristics, visit characteristics and clinical outcomes.

Methods

Study Design

We conducted a retrospective observational study of electronic clinical records of all ED visits over a 10-year period from January 2005 to December 2014 to an urban tertiary general hospital. Institutional Review Board approval was obtained for this study.

Study Settings and Population

Singapore is a city state with a population of 5.6 million[9] living in an urban setting. Singapore General Hospital (SGH) is the largest public hospital in Singapore, with 1,600 inpatient beds. The Department of Emergency Medicine at SGH receives more than 140,000 patients annually. SGH is part of the SingHealth Regional Health System which serves a patient population of more than 1.1 million patients.

Study Protocol

The data was generated from the Integrated Healthcare Information System (IHIS), which compiles data from several hospital databases. Patient identification, attendance identification, and admission identification were masked to ensure that records could not be identified outside the database, while maintaining the ability to identify the same patient over repeated attendances within the database.

Attendances records from the ED registration database formed the backbone of the study database including date and time upon the ED registration, consultation, and disposition, as well as mode of arrival, triage class, vital signs readings, and diagnosis at the ED. Patients' personal data, such as age, gender, ethnic group and postal codes, were pooled from the SGH patient health records database, each patient possibly having multiple ED visits.

Upon attendance to the ED, patients are triaged and accorded a Patient Acuity Category Score (PACS), which corresponds to the severity and acuity of the patients' presenting condition. The PACS is a four-level triage scale (P1, P2, P3 and P4) used in Singapore, with the sickest patients accorded P1 and patients with non-emergency conditions to P4.

Time to consultation was defined as the period from patient registration after arrival at the ED, to the time when consultation was commenced by a physician. Time to disposition was defined as the period from time consultation commenced, to the time when a disposition decision was made.

Admission data and discharge time stamps were also included in the study database. Admission diagnosis was evaluated according to the *International Classification of Diseases: Ninth Revision* (ICD-9). Death records were added into the study database from the SingHealth death registry, and were tagged to all attendance entries of the departed patient. The 30-day mortality rate reflected death from all causes within 30 days of the index ED visit.

Data Analysis

The SAP (SAP SE, Walldorf, Germany) relational database management system was used to calculate some variables in the provided dataset, such as "Length of stay," "Time to consultation," and "Attendance this year." Further data preparation and analyses were performed using R v3.2.3 (R Foundation, Vienna, Austria).

The difference in demographic profile and characteristics between non-FAs and FAs were considered over the entire 2005–2014 period. Chi-square-tests were conducted on each categorical factor individually to assess if they were independent of time (across the three periods), and the Student's t-test was used to assess continuous variables on their association with being a FA. All demographic profile and attendance characteristic factors available were found to reject the null hypothesis that they were independent to time at the 95% significance level (p value of 0.05).

Results

There were 1.383 million attendance records spanning over the period of January 1, 2005 to December 31, 2014. One thousand, seven hundred and fifteen records (or 0.001%) were removed from the dataset as they were either dead on arrival (DOA, 1,681 records) or lacked basic demographic data such as age and gender (34 records). There were no other exclusion criteria.

The remaining 1.381 million attendance records spanning over 2005–2014 were used for this study. To view the changes in the profile of attendance to SGH ED before and after 2012, the analysis range was divided into 3 period blocks: 2005–2008 (4 years), 2009–2012 (4 years), and 2013–2014 (2 years).

General Characteristics

The aging profile of ED attendances was broadly consistent with the aging of the Singapore population.[9] The proportion of ED attenders aged 65 years old and older increased from 25.1% to 27.6% over the three periods, as did the proportion of those who were of the age from 45 to 64 years, increasing from 28.9% to 30.8% over the same period. Despite the previously noted drop in Department of Emergency Medicine at Singapore General Hospital (SGH-ED) attendance post-2012, the age groups of "65 to 85" and "85 & above" continued to increase in 2013–2014.

However, the share of attendances of younger patients declined, as those between 25 to 44 years old declined from 28.7% to 28.4%, and those below 25 years declined from 17.3% to 13.2%. There was a shift in the gender mix of attendance, as the female share of attendance increased from 44.7% (2005–2008) to 47.5% (2013–2014). This was likely related to the aging profile of the attendance, as females had a longer life expectancy to men.[9]

Defining the ED FA and Assessing Their Characteristics

Resource Utilization by ED FAs

Repeat attenders utilized a disproportionate amount of resources with their attendances. From a resource utilization perspective, one-time attenders (within the calendar year) accounted for 58.6% of all attendances, and two-time attenders accounted for 19.3% (Fig. 1). Cumulatively, attenders who attended three or more times accounted for about 22.1% of all ED attendances. As the patients visiting three or more times per calendar year constituted more than 20% of all ED attendances, we defined our ED FA as such.

Based on the above definition, although FAs only make up 7% of all unique patients visiting the

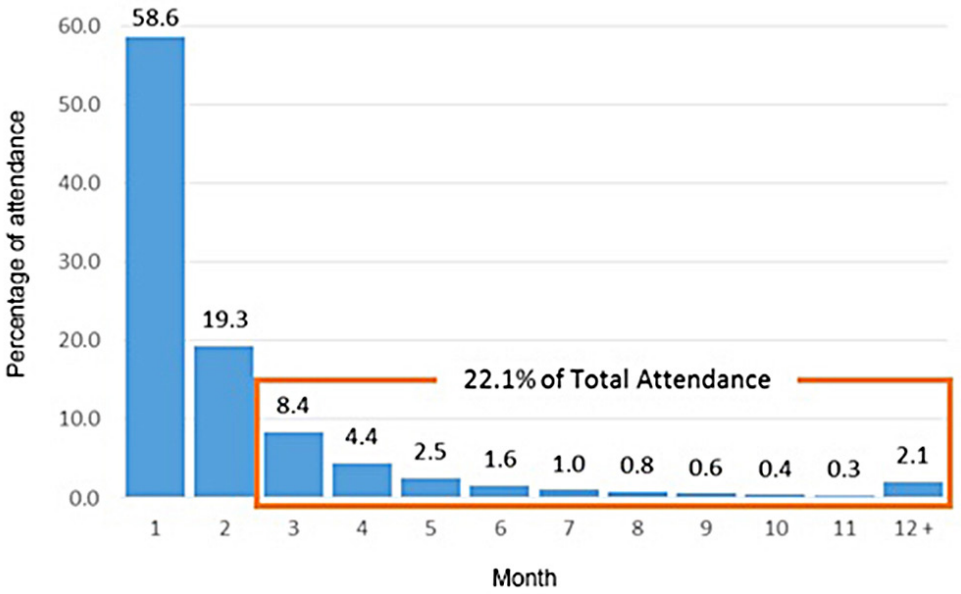

Fig. 1. Share of Department of Emergency Medicine at Singapore General Hospital (SGH-ED) attendance by number of visits in a calendar year.

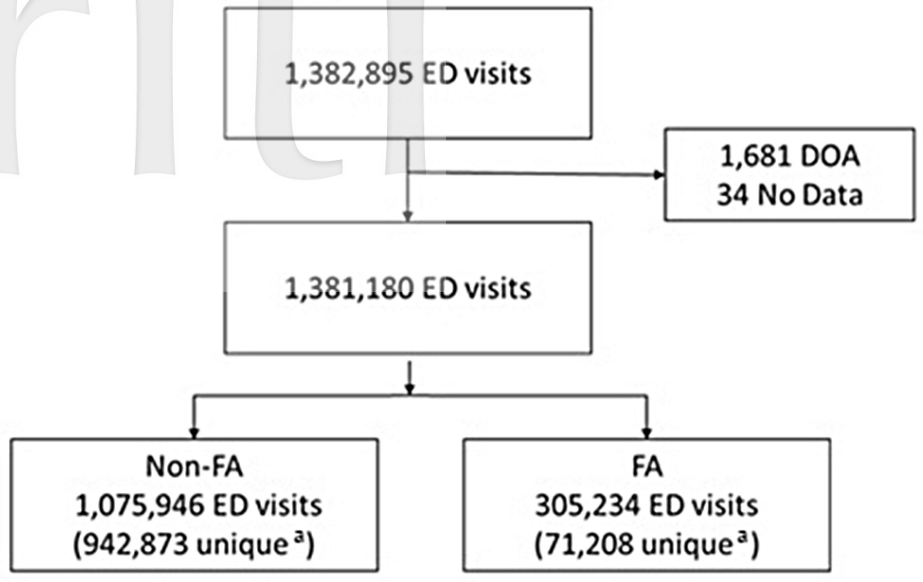

Fig. 2. Data selection for 2005–2014.
DOA: dead on arrival; ED: emergency medicine; FA: frequent attender.
[a]Unique patient with the calendar year.

Table 1. Average per year FA3 attendance by period, 2005–2014

	2005–2008 (n = 518,878)	2009–2012 (n = 578,381)	2013–2014 (n = 283,921)
Average per year			
Total attendance	129,720	144,595	141,961
FA attendance	28,549	32,187	31,146
FA share of attendance	22.0	22.3	21.9
Average per year			
Unique attendance	95,479	105,907	104,268
Unique FA attendance	6,633	7,501	7,337
FA Share of attendance	6.9	7.1	7.0

FA: frequent attender.

ED, they accounted for 22.1% (305,234 ED visits) of all ED attendance over 2005–2014 (Fig. 2). The proportion of FAs attendance to total attendance remained stable at around 22% through the three period blocks. Similarly, the proportion of unique FAs to overall unique attenders remained relatively constant at about 7% each year over these periods (Table 1).

Characteristics of an ED FA

Patient Characteristics

Over the period 2005–2014, FAs had a higher proportion of attendances who were "≥ 65" (36.3%), compared to non-FAs (22.6%), suggesting that FAs have a disproportionate higher share of older patients.

FAs also had a disproportionally higher share of male patients at 58.6%, compared to 52.9% among non-FAs. In terms of ethnic groups, "Malay" (15.6%) and "Indian" (22.6%) ethnicities had higher shares among the FAs, compared to non-FAs (11.7% and 12.2%, respectively). They also have higher triage acuity, with 54.3% of their attendances being P1 and P2 cases, compared to 40.9% among non-FAs.

Visit Characteristics

FAs tend to utilize ambulance services more frequently (15.5%), compared to non-FAs (11.6%). The median time from consultation to disposition from ED

Table 2. Characteristics of non-FAs vs. FAs attendances, 2005–2014

	Non-FA (n = 1,075,953)	FA (n = 305,261)	*p* values
Patient characteristics			
Gender			< 0.001
Female	47.1	41.4	
Male	52.9	58.6	
Age			< 0.001
Less than 65	77.5	63.7	
≥ 65	22.5	36.3	
Ethnicity			< 0.001
Chinese	66.0	57.0	
Malay	11.7	15.6	
Indian	12.2	22.6	
Others	10.0	4.8	
Triage priority			< 0.001
P1	7.7	11.5	
P2	33.2	42.8	
P3/P4	59.1	45.7	
Visit characteristics			
Distance to SGH-ED			< 0.001
0 to < 5 km	26.1	27.9	
5 to < 10 km	25.9	21.3	
10 to < 15 km	27.9	24.6	
15 km or more	20.1	16.1	
Transport			< 0.001
Ambulance	11.6	15.5	
Day of attendance			< 0.001
Monday	16.4	16.8	
Tuesday	14.5	14.6	
Wednesday	14.0	14.2	
Thursday	13.9	13.9	
Friday	13.7	13.4	
Saturday	13.8	12.7	
Sunday	13.8	14.5	
Time of attendance			< 0.001
0000–0559 hr	10.2	11.3	
0600–1159 hr	26.3	26.3	
1200–1759 hr	36.7	33.6	
1800–2359 hr	26.8	28.8	
FA with 3–6 visits	—	76.6	—
FA with 7 or more visits	—	23.4	—

Table 2. Characteristics of non-FAs vs. FAs attendances, 2005–2014 (Continued)

	Non-FA (n = 1,075,953)	FA (n = 305,261)	*p* values
Outcome characteristics			
Median time to disposition[a] (min)	155.0	180.0	< 0.001
ED diagnosis			< 0.001
Infectious diseases	7.7	7.9	
Neoplasms	1.3	2.4	
Immunity disorders	2.5	5.4	
Blood diseases	0.8	0.9	
Mental disorders	1.0	1.6	
Nervous diseases	6.9	3.8	
Circulatory diseases	6.9	8.4	
Respiratory diseases	8.3	13.1	
Digestive diseases	8.0	8.5	
Genitourinary diseases	4.0	5.1	
Pregnancy related	0.4	0.2	
Skin diseases	4.2	4.2	
Musculoskeletal	5.8	6.3	
General symptoms	23.1	24.3	
Injury and poisoning	19.2	8.0	
ED observation ward	3.7	2.7	< 0.001
Admission			
Admitted	30.7	47.4	< 0.001
Median length of stay (day)	4.0	6.0	< 0.001
30-day mortality	1.8	2.9	< 0.001

FA: frequent attender; SGH-ED: Department of Emergency Medicine at Singapore General Hospital.
[a]Time to disposition is calculated at the time from consultation to disposition.

was 180 mins for FAs, compared to 155 mins for non-FAs. This may suggest that FAs had more complex illnesses to be attended for before they were discharged from the ED.

Outcome Characteristics

FAs were more likely to be admitted (47.4%) than non-FAs (30.7%), and among those admitted, the median length of stay among FAs was longer at 6 days, compared to 4 days among non-FAs. There was also higher proportion of FA patients with "Neoplasms," "Immunity disorders," and "Respiratory diseases," compared to non-FAs. Conversely, there were lower proportions of "Nervous diseases" and "Injury and poisoning" among FAs.

The 30-day mortality rate, defined as the death of the patient within 30 days of registration of an ED attendance, was presented by the numbered visits with in the calendar year (Fig. 3). It showed that among all ED attendances (not limited to FAs) that the 30-day mortality rate increased from 1.4% in the first visit to 4.9% at the third visit, and remained at or above 5% until the after the sixth visit, suggesting that repeat attenders have a higher 30-day mortality risk over the third to sixth visit.

We conclude that FAs have different patient, visit and outcome characteristics, when compared to non FAs. There may exist a subset of FAs which may be termed as super attenders, for patients with seven or more visits per calendar year to the ED.

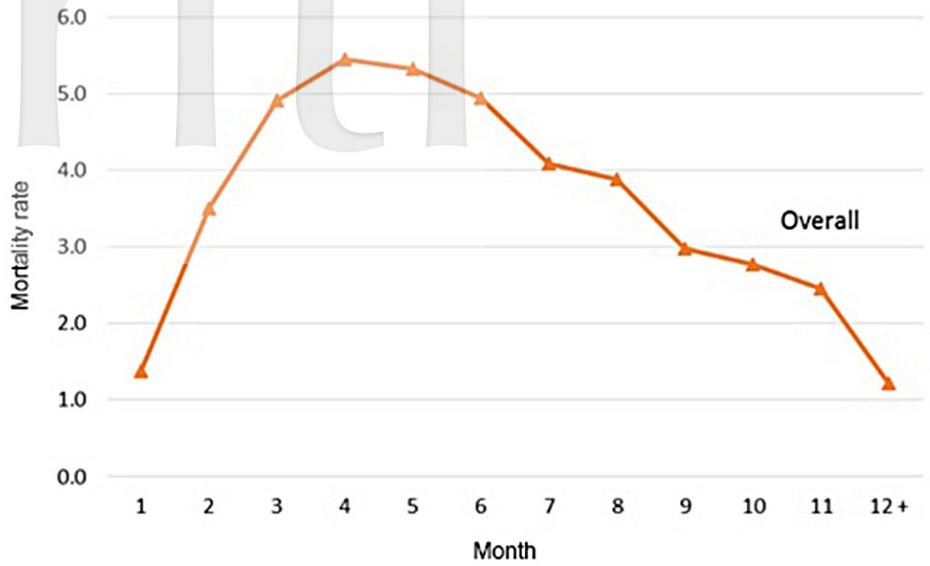

Fig. 3. Thirty-day mortality rates by the numbered visit for all attendances.

Factors Associated with 30-Day Mortality for ED FAs

Non-diagnosis related factors with the highest adjusted odds ratios associated with 30-day mortality (Table 3) were: Transport "Ambulance" 2.69 (95% confidence interval [CI] = 2.61–2.77), Age "≥ 65" 2.04 (95% CI = 1.98–2.10), "Attend previous year" 1.27 (95% CI = 1.23–1.31), and Gender "Male" 1.22 (95% CI = 1.18–1.25). Factors associated with lower odds of 30-day mortality were: "Triage P3/P4" 0.18 (95% CI = 0.16–0.19), "Triage P2" 0.49 (95% CI = 0.47–0.50), and "7 or more visits" 0.33 (95% CI = 0.31–0.36).

In terms of diagnosis-related factors, "Neoplasms disorders" 6.80 (95% CI = 6.43–7.19) exhibited the highest adjusted odds ratio of 30-day mortality among the diagnoses. Conversely, "Pregnancy related" had the lowest adjusted odds ratio at 0.16 (95% CI = 0.05–0.37), along with "Nervous diseases" 0.34 (95% CI = 0.30–0.40), "Injury and poisoning" 0.39 (95% CI = 0.36–0.43), and "Mental disorders" 0.40 (95% CI = 0.28–0.54). Further, attendances whom were admitted to the ED Observation Ward also reflected low odds of mortality 0.21 (95% CI = 0.16–0.27).

Discussion

Deriving the cut-off for the number of ED attendances over a year, based on resources utilized, and correlating the identified group of ED attenders with clinically relevant outcomes, is the pragmatic approach toward defining the ED FA.

There are studies done in other countries which show that patients with 4 or more ED visits over a year account for 20–30% of total patient attendances.[5,10] In contrast to the population settings of other countries and cities, the urban and compact setting of Singapore allows for efficient integration with primary health care.

Due to a flat rate per visit ED fee, which is adjusted and pegged to be above what it costs for a patient to receive primary care by a family physician, there is a financial disincentive to discourage inappropriate ED attendances which may be better managed within the community. Social causes found to be associated with frequent ED attendance,[10-13] such as substance abuse/addiction, homelessness and poverty, also occur less commonly in Singapore compared to other population settings.

There are limited studies across countries which attempt to define their population's FA based on a resource utilization model.[8] We postulate that the number of visits per year to the ED that defines an ED's FA may differ across countries and population settings. No study so far has shown any threshold number of ED visits per year for a FA at which striking differences in resources, demographics or clinical importance is observed.[8] We look forward to studies from other centers which may confirm or disprove

Table 3. Univariate and multivariate analysis of factors associated with 30-day mortality

	Univariate		Multivariate	
	OR	95% CI	Adjusted OR	95% CI
Gender				
Female	1.00			
Male	1.08	(1.06–1.11)	1.22	(1.18–1.25)
Age				
Less than 65	1.00			
≥ 65	6.22	(6.06–6.37)	2.04	(1.98–2.10)
Ethnicity				
Chinese	1.00			
Malay	0.66	(0.63–0.68)	0.92	(0.87–0.96)
Indian	0.37	(0.35–0.39)	0.66	(0.62–0.70)
Others	0.27	(0.25–0.28)	0.66	(0.61–0.71)
Distance to SGH-ED				
0 to < 5 km	1.00			
5 to < 10 km	0.97	(0.94–1.00)	1.20	(1.15–1.25)
10 to < 15 km	0.98	(0.95–1.01)	1.22	(1.14–1.31)
15 km or more	0.87	(0.84–0.9)	1.25	(1.15–1.35)
Transport				
Ambulance	7.01	(6.85–7.18)	2.69	(2.61–2.77)
Day of attendance				
Monday	0.97	(0.93–1.02)	1.03	(0.98–1.08)
Tuesday	0.96	(0.92–1.01)	1.00	(0.95–1.05)
Wednesday	0.98	(0.94–1.03)	1.01	(0.96–1.07)
Thursday	0.97	(0.93–1.01)	0.98	(0.93–1.03)
Friday	1.00			
Saturday	1.00	(0.95–1.04)	1.00	(0.95–1.05)
Sunday	1.00	(0.96–1.04)	1.04	(0.98–1.09)
Time of attendance				
00:00–05:59 hrs	1.00			
06:00–11:59 hrs	1.14	(1.09–1.19)	1.13	(1.07–1.19)
12:00–17:59 hrs	1.16	(1.11–1.21)	1.19	(1.13–1.25)
18:00–23:59 hrs	1.16	(1.11–1.21)	1.14	(1.08–1.20)
Triage priority				
P1	1.00			
P2	0.31	(0.30–0.32)	0.49	(0.47–0.50)
P3/P4	0.02	(0.02–0.02)	0.18	(0.16–0.19)
Attend previous year	2.14	(2.09–2.19)	1.27	(1.23–1.31)
FA	1.62	(1.58–1.66)	—	—
3–6 visits	1.93	(1.88–1.98)	0.76	(0.74–0.79)
7 or more visits	0.64	(0.60–0.68)	0.33	(0.31–0.36)

Table 3. Univariate and multivariate analysis of factors associated with 30-day mortality (Continued)

	Univariate		Multivariate	
	OR	95% CI	Adjusted OR	95% CI
Time to consultation	0.98	(0.98–0.98)	1.00	(1.00–1.00)
Time to disposition	1.00	(1.00–1.00)	1.00	(1.00–1.00)
ED diagnosis				
Infectious diseases	1.00			
Neoplasms	12.23	(11.67–12.81)	6.80	(6.43–7.19)
Immunity disorders	1.52	(1.44–1.61)	0.76	(0.71–0.81)
Blood diseases	1.40	(1.27–1.54)	0.99	(0.88–1.10)
Mental disorders	0.14	(0.11–0.18)	0.40	(0.28–0.54)
Nervous diseases	0.10	(0.09–0.12)	0.34	(0.30–0.40)
Circulatory diseases	1.21	(1.15–1.27)	0.53	(0.50–0.56)
Respiratory diseases	1.14	(1.08–1.19)	0.95	(0.90–1.01)
Digestive diseases	0.60	(0.57–0.64)	0.75	(0.70–0.80)
Genitourinary diseases	0.65	(0.61–0.70)	0.91	(0.84–0.99)
Pregnancy related	0.03	(0.01–0.07)	0.16	(0.05–0.37)
Skin diseases	0.28	(0.26–0.31)	0.63	(0.56–0.70)
Musculoskeletal diseases	0.12	(0.10–0.13)	0.49	(0.41–0.57)
Congenital	0.72	(0.29–1.48)	1.42	(0.54–3.09)
Symptoms	0.46	(0.44–0.48)	0.74	(0.70–0.78)
Injury and poisoning	0.14	(0.13–0.15)	0.39	(0.36–0.43)
ED observation ward	0.11	(0.09–0.13)	0.21	(0.16–0.27)

CI: confidence interval; OR: odds ratio; SGH-ED: Department of Emergency Medicine at Singapore General Hospital.

our findings that the defined FA, based on a resource utilization model, has patient characteristics, visit characteristics and clinical outcomes that differ from the non-FA.

FAs contribute disproportionately to the total number of visits to the ED. If attendances among FAs could be reduced to two attendances within a calendar year, this could free up 11.8% of the ED resources to attend to other ED cases. FAs are associated with other markers of increased resource utilization, such as ambulance use, time to disposition at ED, admissions rate from ED and inpatient length of stay. They are also associated with higher triage acuity, more complex chronic illnesses and greater 30-day mortality risk, corroborating findings from prior studies.[3,14-17]

The 30-day mortality risk for FAs decreases significantly from the seventh ED attendance onwards, with the 30-day mortality risk becoming lower than that for the non-FAs by the ninth ED attendance. This group of super attenders with seven or more visits within a calendar year (5.2% of all ED attendances) may have different baseline patient and visit characteristics compared to FAs who have three to six ED attendances over a calendar year (16.9% of all ED attendances).

Similar to prior studies related to ED FAs,[18,19] the elderly consistently make up a significant proportion of FAs. As the general population ages in developed countries, the elderly would continue to make up a greater proportion of FAs, and there is a need to further evaluate the characteristics of the elderly FA.

Limitation

Due to its retrospective nature, we were unable to collect data not included within the primary study data set. We were not privy to the sub-details of each unique patient visit, and thus could not determine the appropriateness or necessity of each ED visit. We are unable to determine if the visits were related to underlying disease burden, health seeking behavior or social circumstances.

As the purpose of the study was to define the ED FA and examine their associated characteristics, we did not attempt to establish the specific reasons for ED attendance or examine the reasons for the multiple outcomes assessed within the study. Establishing the causes for the poorer outcomes within the FA group is important, and it is the subject of a further study by the authors.

As the study was conducted within a single center, we were unable to reference visits that each unique patient may have made to other EDs within the country and study findings could have under estimated the burden of FAs for SGH. However, this study remains relevant, as it pragmatically examines the issue of FAs from the institution's point of view.

We were unable to draw mortality data from the national death registry for purposes of the study. Mortality rate after inclusion of national death data may have been higher, but the study remains generalizable in view of the large sample size, coupled with small physical geography and large area of coverage by SingHealth.

Conclusion

In conclusion, we have demonstrated a data-driven approach to defining an ED FA within our patient population, and demonstrated significant differences in patient and visit characteristics, and clinical outcomes between the FA and non-FA.

This study illustrates the need to develop targeted interventions towards ED FAs, to improve patient outcomes and encourage a more efficient use of finite ED resources.

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