American Journal of Emergency Medicine 34 (2016) 459–463

Contents lists available at ScienceDirect

American Journal of Emergency Medicine

journal homepage: www.elsevier.com/locate/ajem

Original Contribution

The prehospital and hospital costs of emergency care for frequent ED patients☆,☆☆

Robert G. Solberg [a,*], Brandy L. Edwards, MD [b], Jeffrey P. Chidester [a], Debra G. Perina, MD [b], William J. Brady, MD [b], Michael D. Williams, MD [b]

[a] University of Virginia School of Medicine
[b] University of Virginia Health System

ARTICLE INFO

Article history:
Received 12 October 2015
Received in revised form 23 November 2015
Accepted 24 November 2015

ABSTRACT

Introduction: Frequent emergency department (ED) use has been identified as a cause of ED overcrowding and increasing health care costs. Studies have examined the expense of frequent patients (FPs) to hospitals but have not added the cost Emergency Medical Services (EMS) to estimate the total cost of this pattern of care.
Methods: Data on 2012 ED visits to a rural Level I Trauma Center and public safety net hospital were collected through a deidentified patient database. Transport data and 2012 Medicare Reimbursement Schedules were used to estimate the cost of EMS transport. Health information, outcomes, and costs were compared to find differences between the FP and non-FP group.
Results: This study identified 1242 FPs who visited the ED 5 or more times in 2012. Frequent patients comprised 3.25% of ED patients but accounted for 17% of ED visits and 13.7% of hospital costs. Frequent patients had higher rates of chronic disease, severity scores, and mortality. Frequent patients arrived more often via ambulance and accounted for 32% of total transports at an estimated cost of $2.5-$3.2 million. Hospital costs attributable to FPs were $29.1 million, bringing the total cost of emergency care to $31.6-$32.3 million, approximately $25,000 per patient.
Conclusions: This study demonstrates that the inclusion of a prehospital cost estimate adds approximately 10% to the cost of care for the FP population. In addition to improving care for a sick population of patients, programs that reduce frequent EMS and ED use have the potential to produce a favorable cost benefit to communities and health systems.

1. Introduction

Frequent emergency department (ED) use has been identified as a cause of ED overcrowding [1] and increasing health care costs [2]. This pattern of ED visitation accounts for a disproportionate utilization of resources and produces a financial and operational burden to appropriate patient care delivery. The issue of frequent ED use is a public health matter of significant concern, worthy of additional inquiry.

Studies estimate that frequent patients (FPs) comprise 1% to 10% of ED populations and account for 10% to 34% of ED visits [3–5]. Increase in the number of FPs and FP visits is outpacing that of overall ED visits; Martin et al [6] reported an 83% increase in FP visits from 1999 to 2009, with US ED visits increasing just 30% in the same period. Expansion of insurance coverage under the Affordable Care Act is likely to further increase ED use [7,8], and expanding coverage to the uninsured was previously shown to increase this pattern of ED visitation [9].

As the number of ED visits from the FP population has increased, so has the expense of emergency care. The mean Medicare expenditure per patient on ED care in 2003 was $698 (inflation-adjusted), which doubled to $1390 for 2012 [10,11]. Traditionally quoted as 2% of national health care costs, Lee et al [12] estimated that ED costs may be closer to 10% because national surveys underestimate the cost of ED care. Patients who visit the ED frequently also use Emergency Medical Services (EMS) at an increased rate, and reimbursements for both ED and EMS care transport are generally poor [2,13]. To our knowledge, no peer-reviewed studies have added EMS cost to the cost of hospital care to estimate the total cost of emergency care for this population.

The literature has recognized FPs as a medically complex group, more likely to have multiple comorbid conditions, psychiatric diagnoses, and substance abuse problems [14–17]. The FP group has increased rates of hospital admissions and mortality [18]. Frequent patients also use non-ED health care and community services more frequently than the general population [19,20].

☆ Funding sources: none.
☆☆ Presentations: American Public Health Association Annual Meeting, November 2, 2015, Chicago, IL.
* Corresponding author at: University of Virginia School of Medicine, PO Box 800793, Charlottesville, VA, 22908. Tel.: +1 443 243 8645.
E-mail addresses: rgs5jz@virginia.edu (R.G. Solberg), ble4n@hscmail.mcc.virginia.edu (B.L. Edwards), jpc5hr@virginia.edu (J.P. Chidester), dgp3a@hscmail.mcc.virginia.edu (D.G. Perina), wb4z@hscmail.mcc.virginia.edu (W.J. Brady), mdw9g@hscmail.mcc.virginia.edu (M.D. Williams).

http://dx.doi.org/10.1016/j.ajem.2015.11.066
0735-6757/

Collectively, existing data suggest that FPs are ill patients in whom intensive interventions can improve health outcomes and reduce the cost of care. The goals of this study are to characterize frequent ED use at our institution, quantify the hospital costs of treating FPs, and determine the total cost of this care by adding an estimate of EMS cost to direct single-institution costs. Our hypothesis is that prehospital costs contribute significantly to the overall cost of emergency care, and we hope these data will serve as an aligned financial incentive for communities and health systems to explore innovative approaches to intervention with the FP population.

2. Methods

Data regarding ED use at a Level I Trauma Center and public safety net hospital were gathered using our institution's Clinical Data Repository (CDR), a deidentified patient database maintained by the Biomedical Informatics Division of the School of Medicine [21]. Data were collected under Institutional Review Board approval for all ED visits in 2012 and included patient demographics, visit level information, health information, outcomes, and financial data (see footnotes for additional information on CDR categories).

Various definitions of FPs have been used in previous studies, ranging from 3 to 20 visits per year. We defined FPs as having ≥5 visits per year based on previous research that defined this value as the threshold for chance visitation to the ED [22]. Another study sets the threshold at 7 visits for frequent patients based on clinical significance; however, using this threshold would miss a large population of patients for whom interventions could be very important [23].

An EMS cost estimate was calculated for each visit using 2012 Medicare Reimbursement Schedule formulas. Transport distance, which figures significantly into reimbursement and affects cost, was estimated based on the location of the EMS Agency because the actual dispatch location was not available. Two estimates of transport costs are reported, the first using Medicare Basic Life Support (BLS) ground transportation rates and the second using Advanced Life Support (ALS) ground transportation rates, as the level of provider was not available from our database. Transports by agencies with air and ground units, as well as transports where the agency was unknown, were not included in the estimate, as the transport distance could not be estimated.

Hospital costs were collected from the CDR, which downloads this information from the Medical Center's Billing Office. The CDR data include the hospital costs for each visit along with hospital charges, physician charges, and reimbursements.

Statistical analysis of patient and visit level characteristics of FPs and non-FPs was performed using Pearson χ^2 for categorical variables and Wilcoxon rank sum or Student t test for continuous variables, as appropriate. Continuous variables are presented as means with standard deviations or medians with interquartile ranges (IQRs).

3. Results

In 2012, 59,629 visits were made to our institution's ED by 38,213 patients. Of these, 1242 patients were identified as FPs. Frequent patients accounted for 3.25% of the ED patient population and 17% (10,167) of the total ED visits. Demographically, the FP group was older on average, was more likely to be publically insured or uninsured, and had a lower median institutional pay scale rating (Table 1). Frequent patients had higher average age-adjusted Charlson severity score, higher prevalence of chronic disease, higher rates of mortality within 30 days of discharge, and higher 1-year mortality (Table 2).

The median number of visits for the FP group was 6 visits (IQR, 5-8; range, 5-84) and median number of admissions was 3 (range, 0-19) per patient compared with 1 visit (IQR, 1-1) and 0 admission in the non-FP ($P < .0001$). Frequent patients were significantly more likely to arrive by ambulance and accounted for 32% of the total EMS transports. Frequent patients also accounted for 2109 admissions, or 16.6% of the total admissions from the ED. Visits were similar between the 2 groups with regard to triage acuity, length of stay, rate of admission, and disposition (Table 3).

Table 1
Patient demographics

	Non-FPs (n = 36,971)	FPs (n = 1242)	*P* value
Mean age	38.53 ± 23.582	42.99 ± 20.417	<.0001
Median age	36 (20-56)	43 (27-56)	<.0001
Race			
White	25,372 (68.6%)	724 (58.3%)	<.0001
Black	8447 (22.8%)	481 (38.7%)	<.0001
Other	3037 (8.2%)	34 (2.7%)	<.0001
Unknown	98 (0.2%)	3 (0.2%)	<.0001
Ethnicity (Hispanic)	1816 (4.9%)	37 (3.0%)	.0018
Sex (male)	17,586 (47.6%)	558 (44.9%)	.0669
Payor			
Medicare	9637 (26.1%)	407 (32.8%)	<.0001
Self-pay	6494 (17.6%)	341 (27.4%)	<.0001
Medicaid	1570 (4.2%)	127 (10.2%)	<.0001
Medicaid HMO	5185 (14%)	195 (15.7%)	.0948
Median pay scale	4 (1-7)	1 (1-3)	<.0001

Total hospital costs for FPs in 2012 were $29.1 million: $23.7 million in inpatient costs and $5.4 million in ED costs. For comparison, non-FPs accounted to for $182.7 million in total costs: $155.7 million in inpatient and $27.0 million in ED costs, respectively. In percentages, FPs accounted for 13.7% of overall hospital costs, 13.1% of inpatient costs, and 16.7% of ED costs, respectively. Frequent patients had a higher median hospital cost per visit ($1285.53 vs $525.25, $P < .0001$) and a higher median annual cost ($9730 vs $671, $P < .0001$) than non-FPs (Table 4).

A total of 21,518 visits arrived by EMS transport, with FPs accounting for 6953 (32%) of transports. Total transport-associated EMS cost estimates were $12.1 million using BLS transport rates and $14.9 million using ALS transport rates, with $2.5 million (BLS) and $3.2 million (ALS) attributable to FPs (Table 4). Adding BLS transport estimates to total hospital cost, the group of 1242 FPs accounted for $31.6 million in total cost, or an average of $25,461 per patient. The same calculation for non-FPs yields $192.3 million, or $5202 per patient.

4. Discussion

Using our definition of FPs, 3.25% of ED patients accounted for 17% of ED visits, 17% of ED-to-hospital admissions, and 14% of total hospital costs, supporting previous research that identifies FPs as a small group

Table 2
Comorbidity and mortality information

	Non-FPs (n = 36,971)	FPs (n = 1242)	*P* value
Mean Charlson severity score	1.62 ± 2.729	3.62 ± 4.15	<.0001
Median Charlson severity score	0 (0-0)	2 (0-6)	<.0001
Death within 30 d	776 (2.1%)	44 (3.5%)	.0006
Death within 90 d	1030 (2.8%)	68 (5.5%)	<.0001
Death within 1 y	1473 (4.0%)	112 (9.0%)	<.0001
Comorbidities			
Hypertension	11,359 (30.7%)	726 (58.5%)	<.0001
Peripheral vascular disease	3174 (8.6%)	255 (20.5%)	<.0001
Chronic obstructive pulmonary disease	7368 (19.9%)	614 (49.4%)	<.0001
Congestive heart failure	2870 (7.8%)	278 (22.4%)	<.0001
Diabetes mellitus	5566 (15.1%)	404 (32.5%)	<.0001
Mental disorders	9026 (24.4%)	783 (63.0%)	<.0001
Depression	7490 (20.3%)	697 (56.1%)	<.0001
Psychoses	4997 (13.5%)	539 (43.4%)	<.0001
Renal failure	2348 (6.4%)	215 (17.3%)	<.0001
Substance abuse (all)	4859 (13.1%)	562 (45.2%)	<.0001
Alcohol abuse	3760 (10.2%)	431 (34.7%)	<.0001
Drug abuse	2297 (6.2%)	381 (20.7%)	<.0001
Coagulopathy	2267 (6.1%)	232 (18.7%)	<.0001

Table 3
Visit information

	Non-FPs (n = 36,971)	FPs (n = 1242)	*P* value
Total number of visits	49,462	10,167	
Mean number of visits	1.38 ± 0.691	8.19 ± 6.779	<.0001
Median number of visits	1 (1-1)	6 (5-8)	<.0001
Mean number of admissions	0.29 ± 0.56	1.7 ± 2.22	<.0001
Mean admission/visit ratio	0.21 ± 0.36	0.23 ± 0.27	.0129
Arrival by ambulance	14,565 (29.4%)	6953 (68.4%)	<.0001
Arrival by ambulance then discharged	7179 (49.3%)	1710 (24.6%)	<.0001
Triage acuity			
Emergent	6415 (12.9%)	1348 (13.3%)	.6912
Urgent	24,915 (50.4%)	5229 (51.4%)	
Immediate	476 (1.0%)	99 (1.0%)	
Less urgent	13,107 (26.5%)	2691 (26.5%)	
Nonurgent	2687 (5.4%)	576 (5.7%)	
Unknown	1862 (3.8%)	224 (2.2%)	
ED disposition			
Admitted	12,496 (25.2%)	2540 (25.0%)	.4714
Deceased	41 (0.1%)	11 (0.1%)	
Discharged	34,494 (69.7%)	7226 (71.1%)	
Left against medical advice	152 (0.3%)	37 (0.4%)	
Left before being discharged	1210 (2.4%)	275 (2.7%)	
Other	1221 (2.5%)	115 (1.1%)	
Mean length of stay	1.12 (4.32)	1.19 (2.04)	.611
Median length of stay	0 (0-0.33)	0.33 (0-1.6)	<.0001

of patients that account for a large percentage of resource utilization and cost. Our data largely support previous information about demographic and insurance status of the FP group, except that 27% of FPs in our study were identified as self-pay, higher than quoted in previous studies [24,25]. Frequent patients had higher illness severity scores, higher mortality, and higher rates of chronic disease. The difference in severity between the groups was comparable to previous data that used Charlson severity score [14] or admission rate [5,19] (as a surrogate for severity), adding to the growing body of evidence suggesting that these patients carry a substantial disease burden and are not typically "abusing" the ED [26]. Frequent patients in our study were transported via EMS 68% of the time and accounted for 32% of total transports, adding EMS utilization to the increased demand on resources needed to facilitate this pattern of ED use. Our estimate of $2.5-$3.2 million dollars adds approximately 10% to the cost of emergency care for this group.

Previous reports on cost of the care of FPs vary by definition of frequent use but generally mirror use statistics. A 2001 study by Ruger and colleagues [26] found that 9.5% of costs were attributable to patients with ≥6 visits and 33.7% of costs were from patients with ≥3. Similarly, Ondler and colleagues [24] found that annual charges are much greater per patient in the FP group. We found that just more than 1200 FPs accounted for $29 million in hospital costs with a median annual hospital cost of $9730 per patient. As a group, FPs averaged more than $25,000 per patient annually when EMS cost estimates were included, although this figure is skewed by the highest frequency patients. These figures support the notion that interventions aimed at reducing patterns of frequent ED use have the potential to greatly affect the cost of emergency care.

Table 4
Financial information

	Non-FPs (n = 36,971)	FPs (n = 1242)	*P* value
Total hospital cost	$182,748,465	$29,073,762	
Total ED cost	$27,027,789	$5,407,155	
Total inpatient cost	$155,720,676	$23,666,607	
Median hospital cost/visit	$525 (247-2354)	$1286 (464-3868)	<.0001
Median annual cost/patient	$671 (290-3233)	$9730 (3172-28200)	<.0001
Total BLS cost estimate	$9,579,186	$2,527,843	
Total ALS cost estimate	$11,645,865	$3,204,360	
Mean BLS cost/patient	$259 ± $469	$2035 ± $3228	<.0001
Median BLS cost/patient	0 (0-561.42)	$1122 (0-2807)	<.0001
Mean ALS cost/patient	$315 ± $557	$2580 ± $4199	<.0001
Median ALS cost/patient	0 (0-796)	$1592 (0-3464)	<.0001

Morganti and colleagues [2] estimated that 55% of emergency services went unreimbursed nationwide, representing a significant operating loss for hospitals. For public safety net hospitals such as our own institution, this loss is partially offset by disproportionate share hospital funds. This funding, however, is expected to decrease substantially under provision of the Affordable Care Act. With Medicaid expansion, funding for EMS and ED visits will fall under Medicaid Managed Care Organizations. Regardless, frequent ED and EMS use by all except privately insured patients will continue to be a significant government health care expenditure and public health concern.

Studies of EMS use show patterns of cost and use comparable to that of EDs [13,27,28]. Depending on definition, 0.2%-23% of EMS patients are frequent users, accounting for 1.4%-40% of transports [29]. Our data fall within these figures, with FPs accounting for 32% of EMS transports. The percentage of FP visits arriving by EMS (68%) transport was more dramatic in our study than previously reported [30,31], possibly because of our hospital's less urban location and area billing practices (see footnotes for further explanation). Our estimate of EMS utilization, as well as others, underestimates the actual burden on the EMS system, as Castillo and colleagues point out that community-wide approaches identify 28% more FPs and 65% more super FPs (≥20 visits) than single-hospital approaches [32]. Most (70%) FPs and almost all (97%) of super FPs (≥20 visits) visit multiple hospitals [33]. This is certainly the case in our hospital's catchment area.

To our knowledge, this study is the first to include an estimate of FP EMS costs in overall health care costs. In addition to adding to the overall health care cost attributable to FPs, reimbursement rates of EMS transport are even lower than those of ED care. Hall et al (2015) [13] found that high-frequency EMS users in San Francisco accounted for 17.4% of total EMS charges, with reimbursement rates of just 27%. A review of Baltimore City EMS reimbursement showed that reimbursement for transport of uninsured patients averages just 3% of costs [34]. Uninsured patients comprised 27.4% of our FP population. The same study estimated that transport calls cost the Fire and EMS system an average of $762, whereas reimbursements average $377.

Of EMS transports that are reimbursed, a majority of payments come from Medicare and Medicaid. Medicare payment currently accounts for approximately 35% of EMS reimbursements nationwide, with total payments estimated at $5.3 billion in 2011 [35]. In line with other studies, 58% of our FP population was insured publicly (32% by Medicare), and the proportion of FPs covered by Medicare was greater than for the non-FP population. With the heavy EMS use observed in our study, care of FPs represents a significant area of expense and a source of potential savings for local agencies and public insurance programs alike. Our situation is likely common to many suburban and rural EDs, underscoring the impact of this pattern of use.

A goal of this study was to add EMS cost to hospital cost to demonstrate an aligned financial incentive for coordinated development of intervention programs for FPs that improve outcomes and reduce costs to communities, hospitals, and the public. A recent review of interventions targeting the FP population [36] found several studies demonstrating the ability of intervention programs to reduce frequency of visits and health care costs, improve social situations, and increase patient and physician satisfaction. EMS has been described as a valuable tool for identifying frequent patients and has proven effective when combined with case management based interventions [27,28,37]. Using this technique, Tadros et al (2012) [28] observed a reduction in EMS use by 38%, EMS charges by 32%, and ED visits by 28% in a population of patients with ≥10 visits per year. Rinke et al (2012) [27] demonstrated an even greater reduction (79%) in EMS transports using case management–based interventions with 10 of the most frequent patients identified by EMS, reporting $15,000 in savings over 12 weeks. Other

interventions, including community paramedicine, community health workers and nursing extenders, hospital collaboration, and institution of "best practices" with regard to FPs, have all shown potential as successful interventions in the FP group [38–41]. Our study supports the use of EMS as a method of identifying FPs and the financial data necessary to explore both case management and more novel interventions with the FP population.

5. Limitations

5.1. EMS cost estimation

Although our hospital cost data were obtained directly from our institution's Billing Office, we did not have the ability to directly obtain the cost of responding to a medical emergency and transporting a patient to the ED. Some argue that the cost of transport is mostly fixed, with variable costs equaling the amount spent on fuel, supplies, and others during the call. Others assert that the cost of maintaining a capable EMS response system, including stations, ambulances, and paramedic staffing, should be accounted for in estimating the cost of transport. Peer-reviewed assessments of the cost of transport are lacking. A recent Government Accountability Office study of EMS transport found a median cost varying widely from $224 to $2204 per transport [42]. A private-industry study of Baltimore City Fire Department estimated that transport calls cost the Fire and EMS system an average of $762. These attempts to quantify the cost of EMS response might be less applicable to an ED that serves a large catchment area such as our own, where some transports are more than 100 miles, which figures significantly into both cost and reimbursement. Our estimation used transport distance and Medicare Reimbursement formulas, which lie within the lower end of the Government Accountability Office estimate and far below the Baltimore City estimate and reflects cost of transport as seen by the payer; the true cost of transport is unknown. Additional nonmonetary costs, such as the opportunity cost of not having resources available for other emergencies, are beyond the scope of this article but are definitely an important concern worthy of further investigation.

5.2. Generalizability

A second limitation is the generalizability of our data. Our institution is situated in a rural area, requiring longer transport distances and times (many are more than 60 miles and take longer than 1 hour each way). The impact of frequent use on our EMS system, therefore, may be greater than on institutions in more urban locations. However, our hospital is likely representative of the situation in many rural locations and EMS systems across the country, but the extent to which our estimates of cost mirror the expenses at these other institutions is unknown. We also were unable to include data pertaining to reimbursement by private insurance, which is often loosely based upon Medicare rates but was not available for our study.

6. Conclusions

The population of patients that visit the ED frequently has a high burden of chronic disease with increased mortality, demonstrating a need for intensive intervention. Receiving this intervention in the ED, however, represents a suboptimal and expensive method of delivering of care for the patient, hospital, community, and public. Our study adds an estimate of the cost of EMS transport to the overall health care cost in this population for the first time, demonstrating an aligned financial incentive for communities, hospitals, and sources of public health care funding to develop and implement appropriate interventions. Interventions aimed at this population have the ability to produce a better care system for these patients, improve health outcomes, and produce a substantial reduction in public health care expenditures.

7. Footnotes

1.1 Demographics: Demographic information included gender, age, race, and ethnicity.

1.2 Visit information: Visit information included total number of visits, total number of admissions, and length of stay for each patient. Method of arrival, triage acuity, and disposition were collected for individual visits. Disposition categories are defined in the CDR as "Admitted to observation," "Deceased," "Discharged," "Eloped," "Left without being discharged," "Left without being seen after triage," "Left without being seen before triage," "Pre-admit," "Sexual Assault Nurse Examiner visit," "sent to L&D," "Shelter for help and emergency," "transferred to another facility," "unknown," "left," or "other." Dispositions were grouped into "admitted," "discharged," "left prior to being discharged," "deceased" or "other" for the purpose of analysis. Triage acuity is listed as "non-urgent," "less urgent," "urgent," "emergent," or "immediate," indicating increasing level of acuity.

1.3 Health information: Health information collected included primary diagnosis, chronic diagnoses, and age-adjusted Charlson illness severity score [43]. Chronic disease data were also gathered but limited to diagnoses displayed in Table 2 for the purpose of comparison. Outcomes included disposition; death within 30 days, 90 days, or 1 year; and status as living or deceased at the time of data collection (December 2014).

1.4 Financial information: Financial information included "Payer," institutional pay scale, total hospital cost, ED cost, and inpatient cost. Payer analysis was limited to the categories of self-pay, Medicare, Medicaid, or Medicaid HMO. Pay scale is reported on a scale of 1-7 in the CDR, corresponding to a percent indigent rating assigned by the institution's financial screening process. Pay scale ratings 1-7 correspond to 100% indigent (1), 90% indigent (2), 75% indigent (3), 50% indigent (4), 25% indigent (5), or not indigent (6-7).

1.5 Transport data: Method of arrival was used to determine transporting EMS Agency. The CDR lists the specific EMS Agency for transported patients and contains several other categories of method of arrival, including transport by police agencies, transport by Air-only EMS Agencies, "parent," "walk-in," "other," "unknown," or was not recorded. These categories were not included in the "Arrival by Ambulance" group for analysis and were also omitted from cost analysis. For transport agencies that provide both Air and Ground services, the type of service was not available from our data. Transports by these agencies (3 EMS providers) accounted for 807 transports (1.35% of total ED visits and 3.61% of total transports). Because the type and distance of these transports could not be determined from our data, these transports were also omitted from the cost analysis.

2. The city's Rescue Squad, which transported 61% of FPs in our study, does not charge for services, possibly facilitating frequent use by removing any financial barrier to transport. The surrounding County's Fire and EMS system, the second highest transporter of FPs, started billing for insurance for services in 2012.

3. Although no identifying health information was collected, the study was conducted under approval from the Institutional Review Board, protocol no. 17052.

References

[1] Hoot NR, Aronsky D. Systematic review of emergency department crowding: causes, effects, and solutions. Ann Emerg Med 2008;52:126–136.e1.
[2] Morganti KG, Bauhoff S, Blanchard JC, Abir M, Iyer N, Smith A, et al. The evolving role of emergency departments in the United States. Santa Monica, Calif: RAND; 2013.
[3] van Tiel S, Rood PPM, Bertoli-Avella A, Erasmus V, Haagsma J, van Beeck E, et al. Systematic review of frequent users of emergency departments in non-US hospitals. Eur J Emerg Med 2015;22:306–15.
[4] Kumar GS, Klein R. Effectiveness of case management strategies in reducing emergency department visits in frequent user patient populations: a systematic review. J Emerg Med 2013;44:717–29.
[5] LaCalle E, Rabin E. Frequent users of emergency departments: the myths, the data, and the policy implications. Ann Emerg Med 2010;56:42–8.
[6] Martin G, Stokes-Buzzelli S, Peltzer-Jones J, Schultz L. Ten years of frequent users in an urban emergency department. West J Med 2013;14:243–6.

[7] Medford-Davis L, Eswaran V, Shah RM, Dark C. The Patient Protection and Affordable Care Act's effect on emergency medicine: a synthesis of the data. Ann Emerg Med 2015;66:496–506.
[8] McClelland M, Asplin B, Epstein SK, Kocher KE, Pilgrim R, Pines J, et al. The Affordable Care Act and emergency care. Am J Public Health 2014;104:e8-10.
[9] Taubman SL, Allen HL, Wright BJ, Baicker K, Finkelstein AN. Medicaid increases emergency-department use: evidence from Oregon's health insurance experiment. Science 2014;343:263–268.12.
[10] Machlin S. Expenses for a hospital emergency room visit, 2003. Rockville, MD: Agency for Healthcare Research and Quality; 2006[http://meps.ahrq.gov/mepsweb/data_files/publications/st111/stat111.shtml].
[11] Meps.ahrq.gov. Medical Expenditure Panel Survey [Internet]; 2015[cited 2015 Jun 23; Available from: http://meps.ahrq.gov/mepsweb/data_stats/MEPS_topics.jsp?topicid = 23Z-1].
[12] Lee MH, Schuur JD, Zink BJ. Owning the cost of emergency medicine: beyond 2%. Ann Emerg Med 2013;62:498–505.e3.
[13] Hall MK, Raven MC, Hall J, Yeh C, Allen E, Rodriguez RM, et al. EMS-STARS: Emergency Medical Services 'Superuser' Transport Associations: an adult retrospective study. Prehosp Emerg Care 2015;19:61–7.
[14] Billings J, Raven MC. Dispelling an urban legend: frequent emergency department users have substantial burden of disease. Health Aff 2013;32:2099–108.
[15] Pines JM, Asplin BR, Kaji AH, Lowe RA, Magid DJ, Raven M, et al. Frequent users of emergency department services: gaps in knowledge and a proposed research agenda. Acad Emerg Med 2011;18:e64–9.
[16] Durand A, Gentile S, Devictor B, Palazzolo S, Vignally P, Gerbeaux P, et al. ED patients: how nonurgent are they? Systematic review of the emergency medicine literature. Am J Emerg Med 2011;29:333–45.
[17] Sun BC, Burstin HR, Brennan TA. Predictors and outcomes of frequent emergency department users. Acad Emerg Med 2003;10:320–8.
[18] Moe J, Kirkland S, Ospina MB, Campbell S, Long R, Davidson A, et al. Mortality, admission rates and outpatient use among frequent users of emergency departments: a systematic review. Emerg Med J 2015 [cited 2015 Oct 10. Available From: http://emj.bmj.com/content/early/2015/03/24/emermed-2014-204496].
[19] Miller JB, Brauer E, Rao H, Wickenheiser K, Dev S, Omino R, et al. The most frequent ED patients carry insurance and a significant burden of disease. Am J Emerg Med 2013;31:16–9.
[20] Lucas RH, Sanford SM. An analysis of frequent users of emergency care at an urban university hospital. Ann Emerg Med 1998;32:563–8.
[21] Einbinder JS, Scully KW, Pates RD, Schubart JR, Reynolds RE. Case study: a data warehouse for an academic medical center. J Healthc Inf Manag 2001;15(2):165–75.
[22] Locker TE, Baston S, Mason SM, Nicholl J. Defining frequent use of an urban emergency department. Emerg Med J 2007;24:398–401.
[23] Doupe MB, Palatnick W, Day S, Chateau D, Soodeen RA, Burchill C, et al. Frequent users of emergency departments: developing standard definitions and defining prominent risk factors. Ann Emerg Med 2012;60:24–32.
[24] Ondler C, Hegde GG, Carlson JN. Resource utilization and health care charges associated with the most frequent ED users. Am J Emerg Med 2014;32:1215–9.
[25] Hunt KA, Weber EJ, Showstack JA, Colby DC, Callaham ML. Characteristics of frequent users of emergency departments. Ann Emerg Med 2006;48:1–8.
[26] Ruger JP, Richter CJ, Spitznagel EL, Lewis LM. Analysis of costs, length of stay, and utilization of emergency department services by frequent users: implications for health policy. Acad Emerg Med 2004;11:1311–7.
[27] Rinke ML, Dietrich E, Kodeck T, Westcoat K. Operation care: a pilot case management intervention for frequent emergency medical system users. Am J Emerg Med 2012;30:352–7.
[28] Tadros AS, Castillo EM, Chan TC, Jensen AM, Patel E, Watts K, et al. Effects of an Emergency Medical Services–based resource access program on frequent users of health services. Prehosp Emerg Care 2012;16:541–7.
[29] Scott J, Strickland AP, Warner K, Dawson P. Frequent callers to and users of emergency medical systems: a systematic review. Emerg Med J 2013;31:684–91.
[30] Centers for Medicare and Medicaid Services. Ambulance fee schedule public use files. [Internet]; 2015[cited 2015 Oct 10; Available from: https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AmbulanceFeeSchedule/afspuf.html].
[31] Geurts J, Palatnick W, Strome T, Weldon E. Frequent users of an inner-city emergency department. CJEM 2012;14:306–13.
[32] Castillo EM, Brennan JJ, Killeen JP, Chan TC. Identifying frequent users of emergency department resources. J Emerg Med 2014;47:343–7.
[33] Brennan JJ, Chan TC, Vilke GM, Killeen JP, Castillo EM. 287 Identification of frequent users of hospital emergency department resources using a community-wide approach. Ann Emerg Med 2012;60:S102.
[34] Public Financial Management. Baltimore City Fire Department comprehensive fee study; 2008[http://www.pfm.com].
[35] Medicare Payment Advisory Commission. Medicare payment for ambulance services. Report to the Congress: Medicare and the Health Care Delivery, System [Internet]; 2013[cited 2015 Jun 23].
[36] Althaus F, Paroz S, Hugli O, Ghali WA, Daeppen JB, Peytremann-Bridevaux I, et al. Effectiveness of interventions targeting frequent users of emergency departments: a systematic review. Ann Emerg Med 2011;58:41–52.e42.
[37] Knowlton A, Weir BW, Hughes BS, Southerland RJ, Schultz CW, Sarpatwari R, et al. Patient demographic and health factors associated with frequent use of Emergency Medical Services in a midsized city. Acad Emerg Med 2013;20:1101–11.
[38] Enard KR, Ganelin DM. Reducing preventable emergency department utilization and costs by using community health workers as patient navigators. J Healthc Manag 2013;58:412–27 [discussion 428].
[39] Garson A, Green DM, Rodriguez L, Beech R, Nye C. A new corps of trained grand-aides has the potential to extend reach of primary care workforce and save money. Health Aff 2012;31:1016–21.
[40] Shapiro JS, Johnson SA, Angiollilo J, Fleischman W, Onyile A, Kuperman G. Health information exchange improves identification of frequent emergency department users. Health Aff 2013;32:2193–8.
[41] Hoover T. Hospitals collaborate to reduce ED overuse. Hosp Case Manag 2012;20:151–3.
[42] United States Government Accountability Office. Ambulance providers: costs and medicare margins varied widely; transports of beneficiaries have increased. [Internet]; 2012[Cited 2015 Sept 1; Available from: http://www.gao.gov/products/GAO-13-6].
[43] Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis 1987;40:373–83.