ORIGINAL ARTICLE

Exploring Medical Utilization Patterns of Emergency Department Users

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Background/Purpose: The intercategory relationship of various medical services is of importance to both health care management and policy-making. The purpose of this study was to explore the intercategory relationship of emergency medical services and other medical services and to examine the medical utilization patterns of emergency department (ED) users.

Methods: The sample was selected from the National Health Insurance Research Database in Taiwan for the year 2004. A total of 6775 patients who visited the ED were included. Multiple logistic regression analyses were performed to determine relationships between emergency medical services and other medical services, and cluster analysis characterized different medical utilization patterns of ED users.

Results: Frequent ED users (≥ 4 ED visits during the year) were more likely to use other health care services: their odds ratios (ORs) were 10.30 (95% confidence interval [CI], 7.53–14.10) for 11 or more visits to hospital outpatient departments, 1.51 (95% CI, 1.14–1.99) for 13 or more visits to primary care physicians, and 4.90 (95% CI, 3.74–6.43) for in-hospital care. Moreover, ED users fell into four medical utilization patterns: low health care users (61.91%), hospital fans (11.93%), primary care favorers (21.21%) and high health care users (4.95%).

Conclusion: Frequent ED users also heavily used other health care services. ED users have different utilization patterns, which is a reflection of the unique needs for various health care services. Such knowledge is critically important for both health care providers and policy-makers who must meet the needs of different patient groups. [*J Formos Med Assoc* 2008;107(2):119–128]

Key Words: emergency medical services, health services, medical utilization

Emergency departments (EDs) are designed to provide highly professional medical treatment to those who need urgent or emergency care.[1] However, no matter how health care systems are organized, a large portion of ED visits are viewed by medical personnel as nonurgent.[2–6] Inappropriate use of the ED is considered to result in overcrowding in the ED[4,7–9] and to contribute substantially to increased health care costs[7,8] and to decreased quality of care.[10,11] Furthermore, a relatively small number of patients use the ED frequently and constitute a considerable proportion of the total number of visits.[12–16] Many of these visits by frequent ED users are for health

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problems other than emergencies, which can be handled more efficiently and at a reduced cost by primary care.[13,17–20]

Frequent ED use has been attributed to visits by individuals who lack a regular source of primary care.[7,21] However, even though the National Health Insurance (NHI) in Taiwan covers 96% of citizens and is contracted with 93.8% of medical institutions nationwide, frequent ED users still comprise 3.5% of the total number of ED patients.[13] Obviously, frequent ED use does not occur just because patients lack a regular source of primary care. Some patients might have a regular source of care but prefer to use the ED for their ongoing medical problems.[22] Others even identified the ED as their regular source of care, using the ED for primary care, minor illnesses or nonurgent visits.[7,23,24]

While some ED users identify the ED as their regular source of health care, they may also use additional health care facilities. Baker et al[7] found that 56% of non-emergency patients reported a regular source of care other than an ED. Hansagi et al[1] found that frequent ED users were more likely to visit primary physicians, visit the outpatient department (OPD), and be admitted to hospital; that is, frequent use of the hospital ED is an indicator of high use of other health care services.[1,22] Additionally, Huang et al[13] found that high use of health care services other than the ED is also strongly associated with frequent use of the ED. Taken together, these findings indicate that there is a close relationship between emergency medical services and other medical services. However, to our knowledge, this relationship has not been extensively studied. We believe that such knowledge is of critical importance to both health care management and policy-making.

The literature on medical care utilization by ED patients is limited by the fact that most studies have been conducted in individual EDs and focus on special populations, such as frequent users. More importantly, previous studies[1,7,13,22,23] that assessed medical care utilization by ED patients usually relied on patients' self-reports, a method that is subject to recall bias or unwillingness to answer, and encompassed short time periods after or before the current ED visit, which cannot provide a complete picture of the comprehensive utilization patterns of ED patients. Moreover, these studies were hospital-based and used convenience samples of patients who visited the ED. By using a computerized population-based patient database that covers nearly all health care services in Taiwan, this study aimed to explore the intercategory relationship of emergency medical services and other medical services, and to examine the medical utilization patterns of ED users.

Methods

Data source and processing

Secondary data analysis was applied to two data files: the NHI claim file for the beneficiaries and the registry file for contracted medical facilities in Taiwan for 2004. These two files were obtained from the NHI Research Database (NHIRD), provided by the Bureau of the NHI, Department of Health, and managed by the National Health Research Institute in Taiwan. The claim file for the beneficiaries comprised 50,000 beneficiaries' claim data, which were randomly sampled from 23,750,000 beneficiaries' records and included each patient's identification number (ID), age, gender and summary statistics for all medical care use under the NHI. The registry file for contracted medical facilities provided the medical institution's ID and contract type (medical center, regional hospital, district hospital, primary care). By merging the claim file for the beneficiaries with the registry file for contracted medical facilities, we identified the total health care use for each beneficiary, including hospital ED visits, hospital OPD visits, hospital admissions, and primary care visits. Citizens and institutions in Taiwan have access to the NHIRD for academic and non-academic purposes. Patients' and medical facilities' IDs in the database were scrambled to safeguard their privacy and confidentiality. This study was approved by the institutional review board of Taichung Veterans General Hospital,

Taiwan, and was granted a waiver of informed consent.

Subjects

Any patient who visited the hospital ED between January 1 and December 31, 2004 was eligible for the study. A total of 6775 ED users were included. Patients were categorized into four ED classes on the basis of their number of ED visits during the year as follows: E1 (1 ED visit); E2 (2 ED visits); E3 (3 ED visits); and E4 (≥ 4 ED visits).[1] E4 is the so-called frequent ED users class.[1,13,14,25,26] High health care use was dichotomized arbitrarily on the basis of the 75th percentile as follows: ≥ 11 hospital OPD visits; ≥ 13 physician visits in primary care; and ≥ 1 hospital admissions.

Statistical analysis

All data were managed and analyzed using SPSS Chinese version 10.1 (SPSS Inc., Chicago, IL, USA), except for data extraction and merging, for which SAS version 8.2 (SAS Institute Inc., Cary, NC, USA) was used. A frequency distribution was used to describe the demographic characteristics among ED classes, and the χ^2 test was used to determine the differences between ED classes with regard to age, gender and high use of health care other than ED. To explore the relationship between ED use and other health care use, logistic regression analyses were performed to test the likelihood of high use of other health care.[1] A p value of less than 0.05 was considered statistically significant.

In our core analysis, we performed a two-stage cluster analysis to examine the medical utilization patterns of ED users by using the number of each health care site use as cluster variables, that is, after the hierarchical method (squared Euclidean distance; average linkage) had identified the appropriate number of clusters and profiled the cluster centers, subjects were clustered by the non-hierarchical method (K-means clustering) to fine-tune the results further with the cluster centers obtained from the hierarchical results as the initial seed points.[27] Consequently, the advantages of the hierarchical and nonhierarchical methods were complementary.[28] In addition, analysis of

variance (ANOVA) was used to profile and describe the cluster means with regard to each cluster variable.

Results

During the study year, the majority of patients (5038 patients; 74.4%) only visited the ED once (ED class E1). Frequent ED users (ED class E4) comprised only 3.8% (260 patients) of the total number of patients, but accounted for 13.1% of all visits to the ED. E2 and E3 included 1153 (17.0%) and 324 (4.8%) patients, respectively (Table 1). A total of 6775 individuals made 9567 visits to the hospital ED, and their average numbers of each health care site use were: 1.41 for hospital ED, 8.50 for hospital OPD, 0.38 for hospital admission, and 9.62 for primary care. Among the frequent ED users, the proportion of men was not significantly higher than that of women ($\chi^2 = 0.247$, $p = 0.619$). The higher the proportion of elderly patients (≥ 65 years), the higher the ED class. In addition, high number of hospital OPD visits, hospital admissions and primary care visits were significantly different among the ED classes (χ^2, $p < 0.001$).

Table 2 shows the logistic regression models for high use of care sites other than ED by ED class controlled for age (10-year intervals) and gender. Compared with patients who sought care at the ED once during the year (ED class E1), frequent ED users (ED class E4) tended to make ≥ 11 visits to hospital OPDs (odds ratio [OR], 10.30; 95% confidence interval [CI], 7.53–14.10) and to make ≥ 13 visits to primary care physicians (OR, 1.51; 95% CI, 1.14–1.99). In addition, frequent ED users were more likely to have been admitted for inpatient care (OR, 4.90; 95% CI, 3.74–6.43).

As for cluster analysis, although there is no standard selection criterion to determine the final number of clusters to be formed, the agglomeration coefficient is particularly accountable for use as a stopping rule that evaluates the changes in the coefficient at each stage of the hierarchical

Table 1. Patient characteristics by ED class*

| | ED class (no. of ED visits/patient) | | | | Total | χ^2 | p |
	E1 (1)	E2 (2)	E3 (3)	E4 (≥4)			
Total	5038 (74.4)	1153 (17.0)	324 (4.8)	260 (3.8)	6775 (100.0)		
Age (yr)						86.306	0.000
0–14	842 (16.7)	190 (16.5)	51 (15.7)	27 (10.4)	1110 (16.4)		
15–44	2481 (49.2)	504 (43.7)	130 (40.1)	97 (37.3)	3212 (47.4)		
45–64	1006 (20.0)	248 (215)	72 (22.2)	54 (20.8)	1380 (20.4)		
≥65	709 (14.1)	211 (18.3)	71 (21.9)	82 (31.5)	1073 (15.8)		
Gender						1.310	0.727
Male	2660 (52.8)	597 (51.8)	178 (54.9)	133 (51.2)	3568 (52.7)		
Female	2378 (47.2)	556 (48.2)	146 (45.1)	127 (48.8)	3207 (47.3)		
High hospital OPD visits						481.539	0.000
Yes	1075 (21.3)	396 (34.3)	162 (50.0)	190 (73.1)	1823 (26.9)		
No	3963 (78.7)	757 (65.7)	162 (50.0)	70 (26.9)	4952 (73.1)		
Hospital admissions						372.724	0.000
Yes	1004 (19.7)	443 (35.8)	168 (43.4)	157 (59.2)	1772 (25.3)		
No	4101 (80.3)	796 (64.2)	219 (56.6)	108 (40.8)	5224 (74.7)		
High primary care visits						58.785	0.000
Yes	1205 (23.9)	356 (30.9)	121 (37.3)	92 (35.4)	1774 (26.2)		
No	3833 (76.1)	797 (69.1)	203 (62.7)	168 (64.6)	5001 (73.8)		
ED visits	5038 (52.7)	2306 (24.1)	972 (10.1)	1251 (13.1)	9567 (100.0)		

*Data are presented as n (%). ED = emergency department; OPD = outpatient department.

Table 2. Logistic regression models for high use of other services by ED class (no. of ED visits)*

| | High use of hospital OPD[†] | | | Hospital admissions[‡] | | | High use of primary care[§] | | |
	OR	95% CI	p	OR	95% CI	p	OR	95% CI	p
ED class									
E1 (1)	1.00	–	–	1.00	–	–	1.00	–	–
E2 (2)	1.95	1.66–2.28	<0.001	2.15	1.85–2.50	<0.001	1.34	1.15–1.55	<0.001
E3 (3)	4.08	3.14–5.31	<0.001	3.33	2.61–4.26	<0.001	1.85	1.45–2.37	<0.001
E4 (≥4)	10.30	7.53–14.10	<0.001	4.90	3.74–6.43	<0.001	1.51	1.14–1.99	0.004
Likelihood ratio for model	$\chi^2 = 879.557, p < 0.001$			$\chi^2 = 646.365, p < 0.001$			$\chi^2 = 1804.160, p < 0.001$		
Hosmer-Lemeshow test	$\chi^2 = 3.122, p = 0.926$			$\chi^2 = 14.714, p = 0.065$			$\chi^2 = 10.224, p = 0.250$		

*Adjusted for age (10-year intervals) and gender. ED = emergency department; OPD = outpatient department; OR = odds ratio; CI = confidence interval.

cluster analysis from SPSS.[27] As a large percentage increase of the agglomeration coefficient occurred when the four clusters were combined into three, we accepted a four-cluster solution from the hierarchical cluster analysis. Table 3 contains the clustering variable profiles for the four-cluster solution, and all of the clustering variables differed in a statistically significant manner across the four groups (ANOVA, $p < 0.001$).

By taking the initial seed points from the cluster centroids in the hierarchical cluster analysis, the four-cluster solution of the nonhierarchical cluster analysis was obtained (Table 4). The average numbers of all health care site use were below

Table 3. Clustering variable profiles for four-cluster solution from the hierarchical cluster analysis

Cluster variable profiles

Cluster	Clustering variable mean values				Cluster size
	ED visits (*n*)	Hospital OPD visits (*n*)	Hospital admissions (*n*)	Primary care visits (*n*)	
1	1.38	7.20	0.34	8.74	6479
2	2.18	50.30	1.30	5.08	109
3	2.19	32.90	1.17	35.60	144
4	2.00	15.91	1.02	65.35	43

Significance testing of differences between cluster centers

Variable	Cluster mean square	*df*	Error mean square	*df*	*F*
ED visits (*n*)	58.488	3	0.767	6771	76.247*
Hospital OPD visits (*n*)	96,488.007	3	61.778	6771	1,561.863*
Hospital admissions (*n*)	70.408	3	0.689	6771	102.199*
Primary care visits (*n*)	79,326.734	3	90.501	6771	876.525*

*$p < 0.001$. ED = emergency department; OPD = outpatient department; df = degrees of freedom.

Table 4. Four-cluster solution of the nonhierarchical cluster analysis

Cluster	Clustering variable mean values				Cluster size
	ED visits (*n*)	Hospital OPD visits (*n*)	Hospital admissions (*n*)	Primary care visits (*n*)	
Low health care users	1.29	4.83	0.24	3.97	4195
Hospital fans	1.85	30.26	1.13	8.30	808
Primary care favorers	1.39	6.10	0.29	18.59	1437
High health care users	1.77	12.14	0.60	44.94	335
Statistical significance of cluster differences					
F	113.183	3983.042	289.881	8289.843	
p	<0.001	<0.001	<0.001	<0.001	

ED = emergency department; OPD = outpatient department.

sample means in cluster 1, and we labeled them "low health care users". In cluster 2, the average numbers of hospital ED visits, hospital OPD visits and hospital admissions were distinctly higher than those of other clusters, so we labeled them "hospital fans". The average numbers of all hospital care use were below sample means in cluster 3, but the average number of primary care visits was more than that of clusters 1 and 2. Thus, we labeled them "primary care favorers". As the average numbers of all health care site use were above sample means in cluster 4, we labeled them "high health care users".

Table 5 provides a descriptive profile of four different patterns of ED users. Without doubt, more than half of the low health care users were in the prime of their lives. Compared with the other three groups of ED users, the hospital fans group included more elders with chronic medical illness or major illness, and they therefore tended to make more visits to EDs and OPDs and use more in-hospital care. Primary care favorers were mostly female and had more children, and they identified primary physicians as their major source of health care. Most of the people in the high health care users group were

Table 5. Profile of four medical utilization patterns of ED users on patient characteristics*

	Low health care users	Hospital fans	Primary care favorers	High health care users	Total
Total	4195 (61.9)	808 (11.9)	1437 (21.2)	335 (4.9)	6775 (100.0)
Age (yr)					
0–14	570 (13.6)	26 (3.2)	438 (30.5)	76 (22.7)	1110 (16.4)
15–44	2493 (59.4)	152 (18.8)	514 (35.8)	53 (15.8)	3212 (47.4)
45–64	773 (18.4)	239 (29.6)	293 (20.4)	75 (22.4)	1380 (20.4)
≥ 65	359 (8.6)	391 (48.4)	192 (13.3)	131 (39.1)	1073 (15.8)
Gender					
Male	2386 (56.9)	358 (47.6)	631 (43.9)	166 (49.6)	3568 (52.7)
Female	1809 (43.1)	423 (52.4)	806 (56.1)	169 (50.4)	3207 (47.3)
Frequent ED use					
Yes	82 (2.0)	93 (11.5)	53 (3.7)	32 (9.6)	260 (3.8)
No	4113 (98.0)	715 (88.5)	1384 (96.3)	303 (90.4)	6515 (96.2)
High hospital OPD visits					
Yes	556 (13.3)	808 (100.0)	305 (21.2)	154 (46.0)	1823 (26.9)
No	3639 (86.7)	0 (0.0)	1132 (78.8)	181 (54.0)	4952 (73.1)
Hospital admissions					
Yes	727 (17.3)	447 (55.3)	288 (20.0)	123 (36.7)	1585 (23.4)
No	3468 (82.7)	361 (44.7)	1149 (80.0)	212 (63.3)	5190 (76.6)
High primary care visits					
Yes	0 (0.0)	191 (23.6)	1248 (86.8)	335 (100.0)	1774 (26.2)
No	4195 (100.0)	617 (76.4)	189 (13.2)	0 (0.0)	5001 (73.8)
Chronic illness[†]					
Yes	398 (9.5)	117 (14.5)	108 (7.5)	23 (6.9)	646 (9.5)
No	3797 (90.5)	691 (85.5)	1329 (92.5)	312 (93.1)	6129 (90.5)
Major illness/injury[†]					
Yes	80 (1.9)	174 (21.5)	39 (2.7)	25 (7.5)	318 (4.7)
No	4115 (98.1)	634 (78.5)	1398 (97.3)	310 (92.5)	6457 (95.3)
Metropolitan area					
Yes	1596 (38.0)	324 (40.1)	519 (36.1)	106 (31.6)	2545 (37.6)
No	2599 (62.0)	484 (59.9)	918 (63.9)	229 (68.4)	4230 (62.4)

*Data are presented as n (%); [†]as designated by the Bureau of National Health Insurance, Taiwan.

elderly and children; they were all high users of primary care services, and they also tended to be high users of hospital health care services.

Discussion

The national computerized patient database provided us with the overall health care use by ED patients in Taiwan. We confirmed some findings of previous studies: frequent ED users comprised a relatively small number of patients who were responsible for a disproportionate number of total ED visits, and they were also high users of other health care services. In other words, there were intercategory relationships between emergency medical services and other medical services. In the United States, because the EDs of hospitals will not refuse patients, many people with no health insurance will treat emergency care as primary care.

Contrary to that situation, our analysis showed that high ED users did not lack a regular source of primary care, nor did they identify the ED as their regular source of care. Most importantly, our results indicate that ED users have four distinctive medical utilization patterns.

The findings that 3.8% of patients at hospital EDs accounted for 13.1% of the ED visits in our analysis can be compared with those of previous studies that defined frequent ED use as ≥ 4 visits per patient per year.[1,13,25,29] In a hospital-based study, Hansagi et al found that 4% of ED patients were responsible for 18% of ED visits.[1] Similarly, Huang et al showed that 3.5% of the patients at a hospital ED made 14.3% of the ED visits.[13] In a word, frequent ED users comprise a relatively small number of ED patients but utilize a disproportionate number of total ED visits. In addition, are frequent ED users in a more serious medical predicament? Huang et al indicated that patients who visited EDs with a low level of emergency were more likely to be frequent ED users.[13] Therefore, high ED use may not be associated with disease severity.

Increasing frequency of ED visits was associated with increasing use of primary care and other hospital services. After age and gender were controlled for in our study, it was found that frequent ED users were about 10 times more likely to be high users of hospital OPD services (≥ 11 visits), five times more likely to receive in-hospital care, and 1.5 times more likely to be high users of primary care (≥ 13 visits) (reference group: 1 ED visit). These findings are in accordance with those from a hospital-based study from Sweden[1] in which increasing frequency of ED visits was associated with increasing use of other health services and other sites besides the ED. The finding that frequent ED visitors were also frequent users of other health care services suggests a real or patient-perceived need for all health care.

Rask et al[30] found that hospital admission and primary care visits were associated with a higher ED visit rate. Similarly, as was found in a hospital-based study in Taiwan,[13] patients who were high users of outpatient services were approximately 2.5 times more likely to be frequent ED users, and patients who had previously used in-hospital care were also approximately three times more likely to be frequent ED users. That is, high use of health care services other than ED is strongly associated with frequent use of hospital EDs. By summarizing the findings from our study and those of previous studies,[1,13] we found that there is an intercategory relationship between emergency medical services and other medical services.

Our cluster analysis results further explicate the intercategory relationships between various medical services. To our knowledge, no such study of the medical utilization patterns of ED users has previously been conducted. Among 6775 ED users, 4195 were *low health care users*, 808 were *hospital fans*, 1437 were *primary care favorers*, and 335 were *high health care users*. In summary, there is an intercategory relationship not only between emergency medical services and other medical services, but also between various medical utilization patterns among ED users.

Emergency medical services cover a higher proportion of total ambulatory care in some geographic areas, even in a health care system with an adequate supply of primary care physicians and universal insurance, as found in a study conducted in Taiwan[13] and a study in Canada.[5] Contrary to the previous findings that frequent ED users might lack a regular source of primary care,[7,31] or identified the ED as a regular source of care,[23,32] our analyses have shown that high health care users heavily utilized not only emergency care but also primary care. This is most likely a consequence of the high prevalence of chronic medical conditions among high health care users. In addition, hospital fans made primary physician visits as well. In other words, heavy ED users surprisingly had adequate access to primary care physicians, even though they identified the hospital ED or OPD as their site of health care,[1] and they did not appear to use the ED as a substitute for their primary care.[7,33,34] Furthermore, because the EDs of American hospitals will not refuse patients, many people without health insurance will regard emergency care as primary care.

Frequent ED users have better access to care and therefore are also frequent users of ambulatory care services.[35] An important implication of our finding that frequent ED users are also frequent users of other health care services is that it might not be sufficient simply to divert non-urgent ED visits to primary care facilities by encouraging patients or educating them about primary care physicians before arriving at an ED because they might already be seeking care there. The reason for why patients choose not to use alternative sites of care, even if they are aware of them, may be because they are dissatisfied with the care or their needs may be unmet in those ambulatory sites.[7,23] Our results echo those of some previous studies that problems of non-urgent use will not be solved solely by policies targeting the ED itself, and the most effective measure is to examine access issues in other health care settings and to evaluate the health care needs of specific populations.[19,34,36] For example, time constraints imposed by occupational conditions may limit the accessibility of conventional primary care;[5] patients may use the ED less frequently if their primary care settings have evening or weekend hours.[37]

Most ED patients believed that they were seriously ill and therefore needed immediate medical care,[26] as shown in several studies indicating that heavy ED users belonged to a medically vulnerable group[7,14,20,23,25,31,32,38] and have a higher than expected mortality.[1,31,38] That is why heavy ED users need and use more care overall.[34] This phenomenon is particularly obvious in Taiwan. The NHI in Taiwan is a monopoly and its coverage has reached more than 96% of the population since its implementation in 1995. Hospital-based care and primary care have largely been separated from each other, and most hospitals have a large OPD. In addition, patients have the freedom to choose their care providers, and they may visit the ED or OPD in a medical center merely for a common cold.

The databases used here are based on information collected and processed to facilitate claims payment. Such data have been reported as discordant with clinical information and therefore of limited use in outcome research.[39] However, for utilization data such as those described here, claims databases are reliable and have become more accurate over time.[40,41] Dendukuri et al[42] have shown that compared with hospital medical charts and patient-reported use, the claims database is the most comprehensive and valid method of measuring ED use. Nevertheless, one major limitation of the study is that the claims databases can only show patients' utilization patterns, but they do not reveal patients' preferences in medical decision-making. Further research can apply a consumer decision model to better understand the cross-category considerations and choices that patients make. Another limitation of the study is that because the databases do not include health care in medical facilities that are not contracted with the NHI, we have no data on patients' use of health care outside the NHI. However, because the coverage of the NHI in Taiwan is over 96% and the contracted rate of medical institutions is at least 93%, there is no reason to believe that such additional information would weaken the results. Finally, this was an ecological study, so the results cannot be inferred to the sample of individuals or specific diseases. Besides the analysis of ED visits, future research can also analyze ED expenditure.

We have demonstrated that patients who visit the ED only once during the year comprise the majority while frequent ED users comprise a minority, but frequent ED users account for a disproportionately high number of total ED visits. We also found that the higher the number of ED visits, the lower the number of patients. Furthermore, frequent ED users also used other health care services besides the ED. That is, there are intercategory relationships between emergency medical services and other medical services. Most importantly, we found that there are four different patterns of medical utilization among ED users, namely low health care users, hospital fans, primary care favorers and high health care users. Each pattern of medical utilization by ED users is presumably a reflection of a unique need for various health care services. We believe that such

knowledge is of critical importance to both service providers and policymakers as they endeavor to meet their service needs.

Our study would have been improved by analyzing more years of data to explore intercategory relationships of emergency medical services and other medical services, examine utilization patterns of ED users, and also by developing a model to predict which frequent ED users will persist in high utilization rates in subsequent years. In addition, we might also establish a utilization model of ED services to predicate and discriminate the medical patterns of ED users.

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