Trends and characteristics in pre-hospital emergency care in Beijing from 2008 to 2017

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Abstract

Background: We aimed to describe and analyze the pre-hospital emergency medical service (EMS) in Beijing and provide information for the government and medical institutions to optimize EMS.

Methods: We collected all pre-hospital emergency data in Beijing from 2008 to 2017. The chief complaint in each case was classified according to the Medical Priority Dispatch System (MPDS). The sites' administrative districts were determined through geo-encoding of addresses and then classified into four functional regions. We analyzed the demand for EMS, emergency response times (ERT), and disease spectrum for Beijing as a whole, and for each functional region.

Results: A total of 4,192,870 pre-hospital EMS cases met the inclusion criteria, with a significant increase ($P < 0.001$) of 51.60% from 2008 to 2017. EMS demand was positively associated with population ($r = 0.946$, $P < 0.001$). The pre-hospital EMS demand rate was 1907.05 in 2008 and 2172.23 in 2017 per 100,000, with no significant change ($P = 0.57$). ERT increased significantly ($P = 0.001$), from 19.18 min in 2008 to 24.51 min in 2016. According to MPDS classifications, the demand for pre-hospital care increased for 14 diseases, remained stable for 19, and decreased for only 1 disease. Cases of injury-related disease increased significantly from approximately 90,000 in 2017, accounting for 20% of all pre-hospital EMS cases, and the demand rate decreased in the core region but increased in the sub-urban regions. Cases of heart problems and stroke/transient ischemic attack also increased significantly in the four functional regions, with the highest demand rate in the Core Functional Region.

Conclusions: More resources and effort should be devoted to pre-hospital EMS according to the increased pre-hospital EMS demand and prolonged ERT in Beijing over our 10-year study period. Changes in disease spectrum and differences between functional regions should also be considered.

Keywords: China; Emergency medical services; Emergency response time

Introduction

Pre-hospital emergency care is a crucial part of the emergency medical service (EMS) system and an important indicator of a society's overall medical services level. China's EMS system was developed in the 1980s.[1] Currently, there are problems such as insufficient pre-hospital EMS resources, wasted EMS resources, and excessively long pre-hospital response time.[2-4] Beijing Emergency Centers (emergency call number: 120)[5] and Beijing Red Cross Emergency Centers (emergency call number: 999),[6] under the supervision of the Beijing government and the Chinese Red Cross Society, respectively, are responsible for all pre-hospital emergency medical care in Beijing. Pre-hospital emergency information is automatically recorded by the dispatch system or entered by the dispatcher and the ambulance crew. From 2008 to 2017, Beijing's population and economic development increased rapidly. By the end of 2017, the population had reached 21.71 million, with a gross domestic product of more than 2.8 trillion Chinese Yuan, reflecting 10-year increases of 28.1% and 152.3%,

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respectively.[7] These increases, as well as lifestyle changes, increased traffic, environmental pollution, and public health emergencies such as sudden acute respiratory syndrome and influenza H1N1 outbreaks, all affected Beijing's emergency care needs and posed great challenges to its pre-hospital care services.

Currently, comprehensive study of Beijing's pre-hospital EMS is lacking. We speculate that there have been significant changes in pre-hospital demand and disease spectrum in Beijing. The main objectives of this study were to describe the trends in EMS demand, emergency response times (ERT), and the disease spectrum in Beijing overall, and in each functional region. We aimed to clarify the characteristics and problems associated with pre-hospital EMS in Beijing and provide information for the government and medical institutions to optimize EMS.

Methods

Overview

This study was approved by the Ethics Committee of Peking University People's Hospital. Data were collected from the pre-hospital emergency databases of Beijing Emergency Medical Centers and Beijing Red Cross Emergency Centers from 2008 to 2017, which included all emergency cases in Beijing during this period. We analyzed data for pre-hospital EMS demand, pre-hospital ERT, and the disease spectrum, especially demand secondary to injury-related disease, heart problems/automatic implantable cardioverter defibrillator, and stroke/transient ischemic attack (TIA), in Beijing overall and in each of its functional regions.

Figure 1 summarizes the data sources and schematic for data management. When calculating pre-hospital EMS demand rates (per 100,000 population), we used population numbers obtained from the Beijing Municipal Bureau of Statistics.[7]

Exclusion criteria

We excluded duplicated records, cases in which patients canceled emergency requests or the ambulances failed to receive the patients, cases in which a patient's site could not be verified, cases without a chief complaint, and cases in which the chief complaint could not be classified by the Medical Priority Dispatch System (MPDS) system.

For the emergency care-related time analysis, we excluded cases that were missing response time data, or those for which the active response time (ART) was $\leq$0 or >30 min, or the passive response time (PRT) was $\leq$0 or >60 min.

MPDS classification

Chief complaints were categorized according to the 34 categories of illness in the MPDS. We identified the chief complaint keywords by data mining from the chief complaints designated by the EMS, and classified the complaints retrospectively according to the MPDS. We chose the first keyword when there were several entries for the original chief complaint. To ensure accuracy, 0.1% of the pre-hospital emergency data were randomly selected and matched with the original chief complaint by a third party. If the chief complaint could not be classified, we changed the keyword and checked again according to the original data, until all chief complaints were classified correctly after random sampling and inspection. We repeated this process three times.

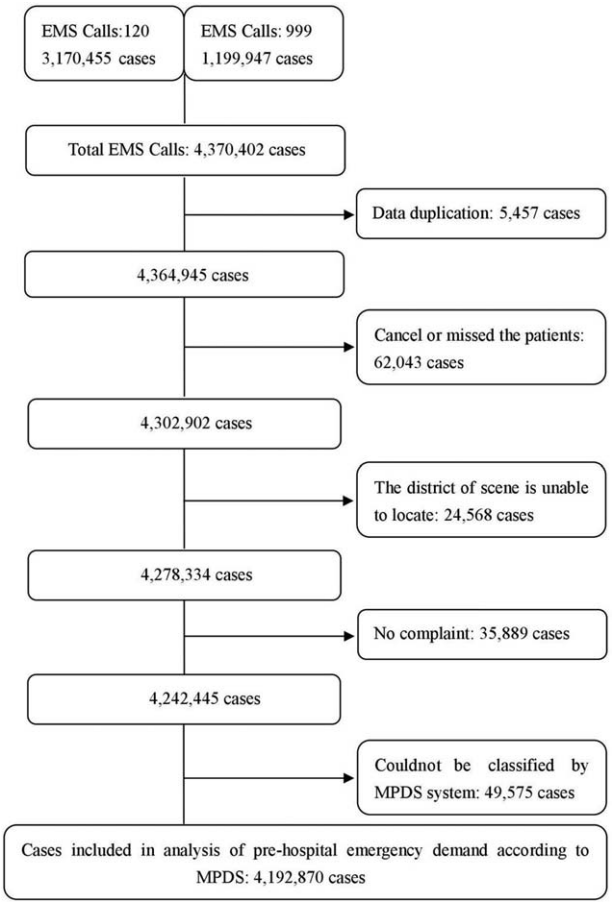

Figure 1: Summary of the data sources and schematic of the data management.

We defined injury-related disease as animal bites/attacks, burns (scalds)/explosions, electrocution/lightning, stabbing/gunshot/penetrating trauma, inaccessible incident/entrapments, traumatic injuries, and traffic/transportation injuries.

Geographic classification

We used the geo-encoding system according to scene location in various districts of Beijing, dividing cases into the four functional regions: Core Functional Region (comprising Dongcheng and Xicheng districts); Function Expanding Region (Chaoyang, Haidian, Fengtai, and Shijingshan districts); Urban Development Region (Tongzhou, Shunyi, Daxing, Changping, and Fangshan districts); and Ecological Conservation Region (Mentougou, Pinggu, Huairou, Miyun, and Yanqing districts).

ERT

Emergency care-related times constituted ERT, ART, and PRT. We defined ART as the time from the emergency call to ambulance departure; PRT as the time from ambulance departure to arrival at the scene; and ERT as the time from the emergency call to arrival, equivalent to ART plus PRT. For each pre-hospital service, we abstracted and analyzed the time the emergency call was received, the time the ambulance departed the station, and the time the ambulance arrived at the scene, and changes in ERT, ART, and PRT from 2008 to 2017.

Statistical analyses

The changing trends in total EMS demand, EMS demand per 100,000 population, and emergency care-related times across the 10-year study period were modeled by linear regression. Associations between pre-hospital EMS demand and population were examined by Pearson correlation. We used the paired *t*-test to compare the demand rates in different regions over the study period. All statistical inference testing was two-sided, and $P < 0.05$ was considered statistically significant. R software version 3.4.0 (www.R-project.org), and Excel (Microsoft Corp., Redmond, WA, USA) were used for data analysis.

Results

From 2008 to 2017, 4,370,402 records were contained in the two emergency databases we used in this study. We excluded duplicate records ($n = 5457$), cases in which patients canceled emergency requests or the ambulances failed to receive the patients ($n = 62,043$), cases in which the patient's site could not be verified (24,568), cases without a chief complaint (35,889), and cases in which the chief complaint could not be classified by the MPDS system ($n = 49,575$). A final total of 4,192,870 cases met the inclusion criteria [Figure 1].

For the emergency care-related times analysis, we excluded 808,004 cases, leaving 3,384,866 cases for analysis.

EMS cases increased significantly, but the demand rate remained stable

From 2008 to 2017, Beijing's pre-hospital EMS demand increased significantly by 51.60% ($P < 0.001$), from 311,422 cases in 2008 to 472,113 cases in 2017. Pearson correlation revealed that EMS demand was positively associated with population ($r = 0.946$, $P < 0.001$). EMS demand per 100,000 population remained relatively stable over the study period ($P = 0.57$) at 1907.05 and 2172.73 in 2008 and 2017, respectively [Figure 2].

Regarding the different functional regions, the Function Expanding Region, Urban Development Region, and Ecological Conservation Region all experienced significant increases ($P < 0.001$) in pre-hospital EMS cases. However, in the Core Functional Region, demand remained stable from 2008 to 2017 ($P = 0.723$) [Figure 3A]. The EMS demand rate (per 100,000 population) remained stable in all four regions, but the rate in the Core Functional Region was significantly higher than in the other three regions [Figure 3B].

ERT increased significantly from 2008 to 2016 and decreased in 2017

ART was 4.42 and 4.91 min in 2008 and 2017, respectively, and did not change significantly during the study period ($P = 0.33$). PRT was 14.75 min in 2008 and increased gradually, reaching 19.76 min in 2016 ($P = 0.006$); however, in 2017, PRT decreased to 17.35 min. Similarly, ERT was 19.18 min in 2008 and increased gradually, reaching 24.51 min in 2016 ($P = 0.001$). In 2017, ERT decreased to 22.26 min [Figure 4A]. PRT and ERT decreased significantly in 2017. Figure 4B displays the cumulative probability distribution for ERT: from 2008 to

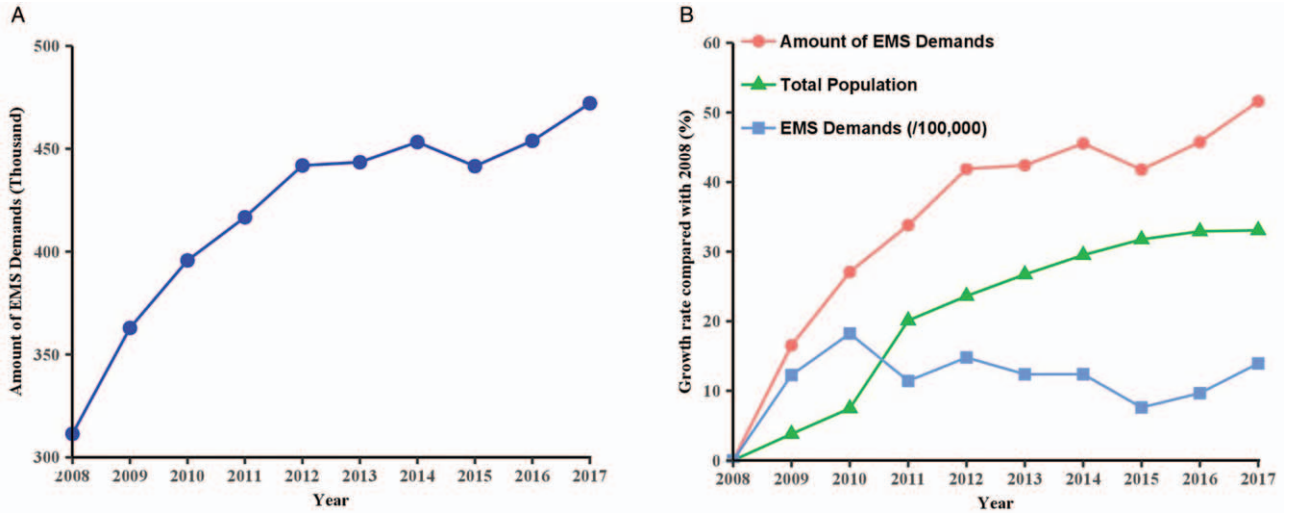

Figure 2: Cases of pre-hospital EMS demand and changing trends (A) and the growth rate for EMS demand, total population, and EMS demand per 100,000 population compared with 2008 (B), during 2008 to 2017. EMS: Emergency medical service.

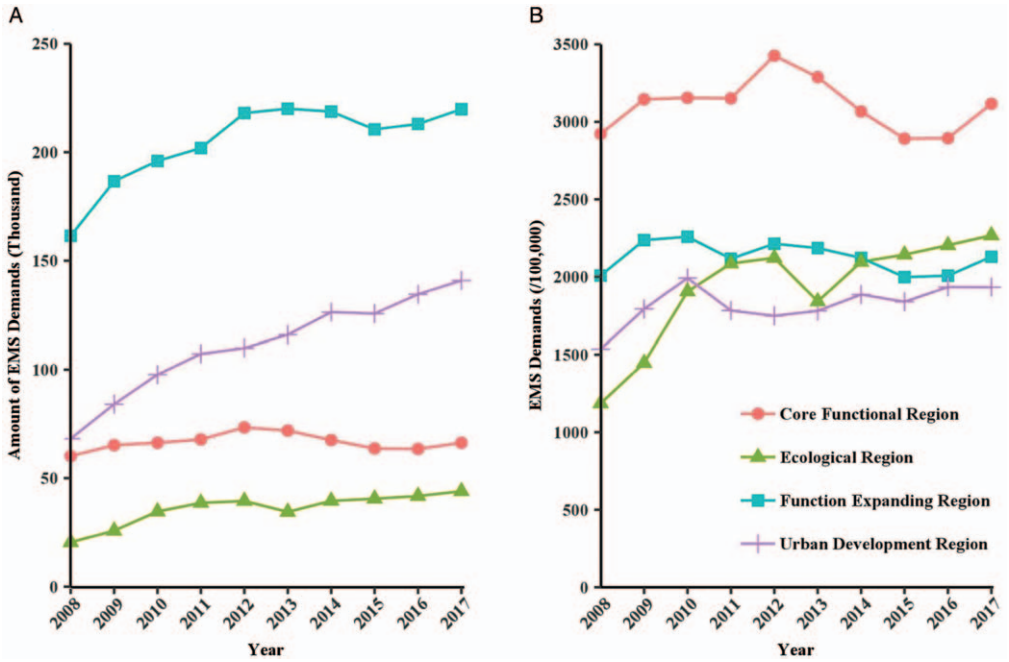

Figure 3: EMS demand (A) and EMS demand per 100,000 population (B) in the different functional regions in Beijing from 2008 to 2017. EMS: Emergency medical service.

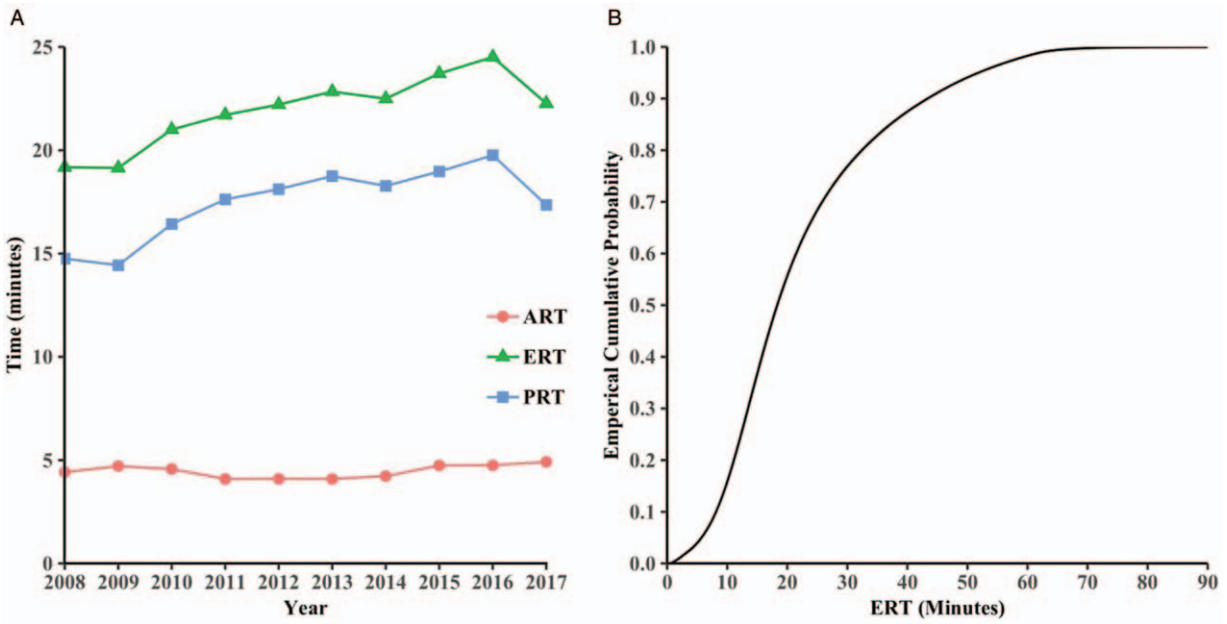

Figure 4: Changes in ART, PRT, and ERT (A) and the cumulative probability distribution for ERT (B) in Beijing from 2008 to 2017. ART: Active response time, ERT: Emergency response time; PRT: Passive response time.

2017, 10% of emergency cases were reached in 8.13 min; 25%, 50%, 75%, and 90% were reached in 12.32, 18.32, 28.73, and 43.35 min, respectively.

Disease spectrum changed significantly regarding pre-hospital EMS

From 2008 to 2017, the top five of the 34 illness categories in the MPDS regarding pre-hospital EMS demand, were sick person, heart problems, traumatic injuries, traffic/transportation incidents, and unconscious/fainting with cases numbering 768,718; 530,552; 463,984; 365,735; and 356,852, respectively, and accounting for 18.33%, 12.65%, 11.07%, 8.72%, and 8.51% of the demand [Table 1]. There were significant increases in 14 MPDS categories, and the pre-hospital EMS demand in 19 categories remained stable. Only the cardiac or respiratory arrest/death demand decreased [Table 1].

Table 1: Pre-hospital emergency call demand and trends from 2008 to 2017 according to the Medical Priority Dispatch System categories.

Category	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	*P*-value	Trend
Abdominal pain/problems	11,157	11,070	12,698	14,088	15,173	15,425	15,449	14,866	15,008	16,736	<0.001	↑
Allergies (reactions)/envenomations (stings, bites)	630	669	768	821	835	804	916	716	744	642	0.73	–
Animal bites/attacks	139	132	213	220	252	241	230	201	197	147	0.57	–
Assault/sexual assault/stun gun	0	0	0	0	0	0	0	0	0	0	–	–
Back pain (non-traumatic/non-recent)	1689	1885	2048	2236	2425	2496	2686	2722	3027	3201	<0.001	↑
Breathing problems	24,601	24,241	26,986	26,716	28,918	29,718	31,039	31,535	34,684	37,010	<0.001	↑
Burns (scalds)/explosions	789	881	881	1163	1093	1010	1064	964	1068	1066	0.06	–
Carbon monoxide/inhalation/ HAZMAT/CBRN	63	80	129	115	134	97	105	139	124	102	0.16	–
Cardiac or respiratory arrest/death	682	792	936	830	849	510	583	544	496	476	0.01	↓
Chest pain	2834	2740	2896	2511	2596	2729	2909	3058	3349	3744	0.02	↑
Choking	77	85	111	95	121	138	138	91	72	61	0.72	–
Convulsions/seizure	10,307	10,554	12,123	12,115	12,608	12,944	12,950	11,935	12,528	13,471	0.01	↑
Diabetic problems	1911	1873	2544	2696	2645	2647	2679	2442	2194	2358	0.34	–
Drowning/diving/SCUBA accident	192	168	197	232	195	185	232	190	204	189	0.65	–
Electrocution/lightning	242	245	295	299	249	268	243	214	253	242	0.32	–
Eye problems/injuries	203	238	290	370	369	347	303	329	276	247	0.57	–
Falls	15,903	16,830	20,653	23,146	25,248	27,483	27,886	29,358	31,213	34,560	<0.001	↑
Headache	1569	1576	1729	1967	1925	2115	2246	2225	2112	2286	<0.001	↑
Heart problems/AICD	37,157	41,711	49,438	53,572	56,944	57,883	58,263	58,693	58,627	58,264	0.001	↑
Heat/cold exposure	121	91	229	178	129	192	155	149	152	137	0.83	–
Hemorrhage/lacerations	5394	5773	6935	7876	7906	8339	8388	8395	8225	7943	0.00	↑
Inaccessible incident/entrapments	29	19	35	101	39	34	76	21	40	44	0.79	–
Overdose/poisoning (ingestion)	15,415	15,800	18,067	18,811	19,081	18,049	17,946	17,392	16,403	17,191	0.58	–
Pregnancy/childbirth/miscarriage	5499	5912	6093	7748	10,877	10,030	12,876	8368	11,254	10,027	0.01	↑
Psychiatric/suicide attempt	3478	3661	3771	3994	4050	4054	3919	3906	3880	3824	0.12	–
Sick person	54,924	58,482	67,542	72,698	80,090	84,130	86,992	87,427	85,655	90,778	<0.001	↑
Stab/gunshot/penetrating trauma	454	537	561	619	565	582	492	466	497	452	0.31	–
Stroke (CVA)/transient ischemic attack	4653	5437	6817	7481	7953	8370	8392	9715	11,224	12,594	<0.001	↑
Traffic/transportation incidents	25,828	28,009	35,877	38,358	37,369	37,021	38,136	38,204	41,929	45,004	<0.001	↑
Traumatic injuries	38,169	42,804	45,472	49,419	50,853	52,494	51,727	44,786	43,384	44,876	0.44	–
Unconscious/fainting (near)	30,019	30,072	32,960	33,486	35,095	37,801	37,434	36,815	40,316	42,854	<0.001	↑
Unknown problem (collapse, third-party)	1849	1540	1844	3397	6768	6564	5478	5918	4180	157	0.52	–
Inter-facility transfer/palliative care	68	91	315	846	1101	1107	1460	400	7	0	0.92	–
Flu-like symptoms (possible H1N1)	15,377	48,896	34,259	28,501	27,419	17,667	19,865	19,352	20,561	21,430	0.18	–

Values are the number of cases in each category and year. HAZMAT: Hazardous materials; CBRN: Chemical, biological, radiological, and nuclear; AICD: Automatic implantable cardioverter defibrillator; CVA: Cerebrovascular accident.

Injury-related disease and cardio-cerebrovascular disease accounted for a large proportion, and differed in functional areas

In 2008, there were 65,650 injury-related disease cases regarding pre-hospital demand, reaching 90,179 in 2011. From 2012 to 2017, the number remained relatively stable. More recently, the number of injury-related disease cases was approximately 90,000/year, accounting for 20% of pre-hospital care [Figure 5A1]. In 2008, the demand rate in the Ecological Conservation Region was significantly lower than in the other three regions, but the rate grew quickly and surpassed the other three regions in 2014 [Figure 5A2]. The demand rate in the Function Expanding Region decreased gradually ($P = 0.003$), and in the Core Functional Region and Urban Development Region, there was no significant change (Figure 5A2). Figure 5A3 and A4 are heat maps of the demand rate related to injury-related disease in the different regions in 2008 and 2017, respectively, and show that the demand rate for injury-related disease decreased gradually in the center of the city, but increased in the suburbs.

Demand because of heart problems increased significantly, from 37,157 cases in 2008 to 58,264 cases in 2017 [Figure 5B1], accounting for 12.34% of pre-hospital care in 2017. The demand per 100,000 was highest in the Core Functional Region, and the trend remained stable from 2008 to 2017 [Figure 5B2]. In the Ecological Conservation Region, the demand rate increased significantly, and in 2016, the demand rate reached the same level as that in the Urban Development Region [Figure 5B2]. Figure 5B3 and B4 are heat maps of the demand rate for heart problems in the different regions in 2008 and 2017, respectively. The demand rate decreased gradually from the city center to the suburbs, and the demand rate in the Ecological Conservation Region increased significantly.

Demand secondary to stroke/TIA was 4653 in 2008 and 12,594 in 2017, which was a significant increase

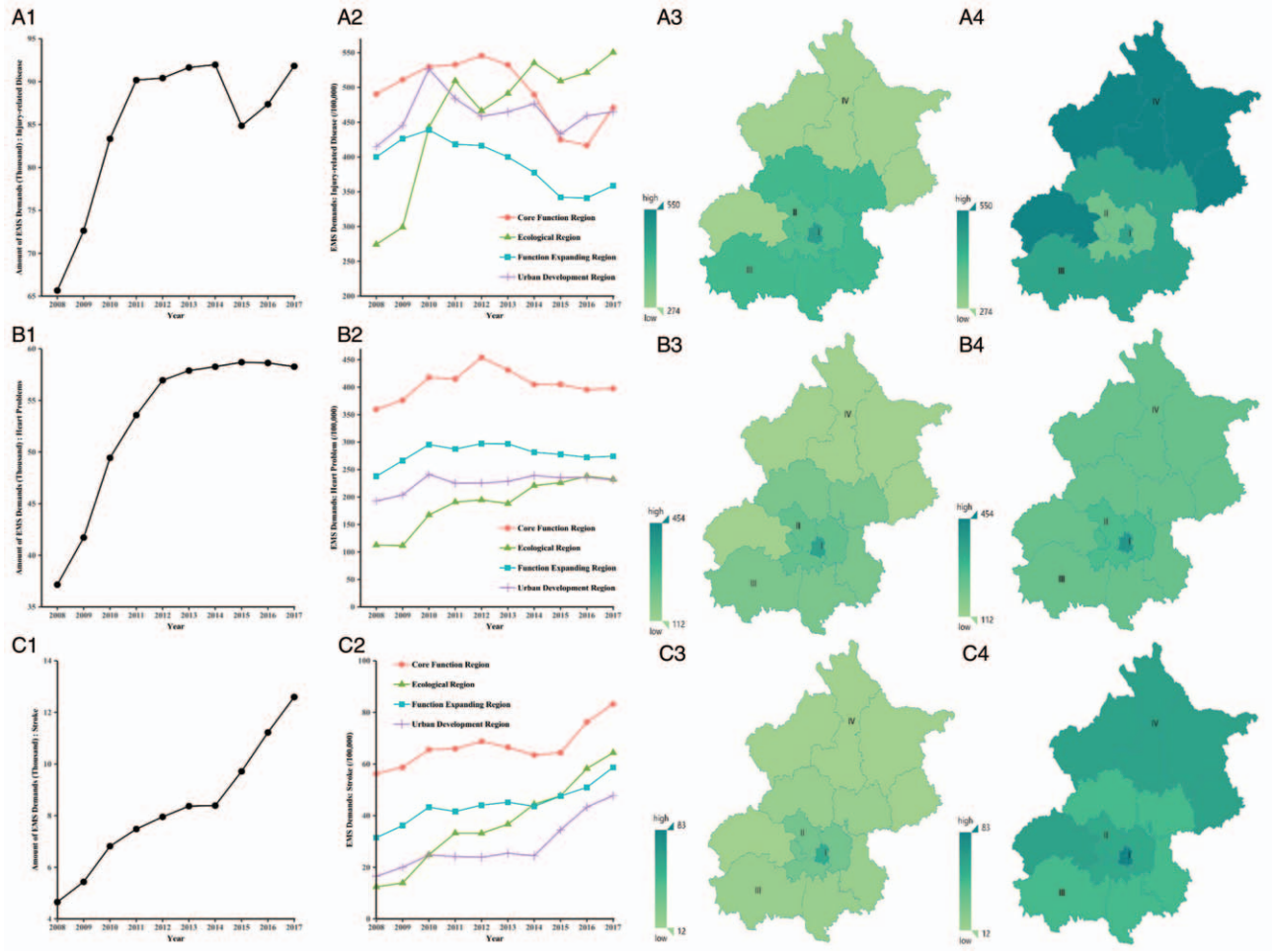

Figure 5: (A) Changes in the pre-hospital demand related to injury-related disease: A1, number of pre-hospital cases; (A2) demand rate (per 100,000) in the four functional regions in Beijing; (A3) heat map of the demand rate in the four functional regions in 2008; (A4) heat map of the demand rate in the four functional regions in 2017. (B) Changes in pre-hospital demand related to heart problems: (B1) number of pre-hospital cases; (B2) demand rate (per 100,000) in the four functional regions; (B3) heat map of the demand rate in the four functional regions in 2008; (B4) heat map of the demand rate in the four functional regions in 2017. (C) Changes in the pre-hospital demand related to stroke/TIA; (C1) number of pre-hospital cases; (C2) demand rate (per 100,000) in the four functional regions; (C3) heat map of the demand rate in the four functional regions in 2008; (C4) heat map of the demand rate in the four functional regions in 2017. I, Core Functional Region; II, Function Expanding Region; III, Urban Development Region; IV, Ecological Conservation Region. TIA: Transient ischemic attack.

[Figure 5C1]. Demand was highest in the Core Functional Region, and the same trend was maintained through the study period [Figure 5C2]. The demand rate was the lowest in 2008 in the Ecological Conservation Region but increased significantly and surpassed the rates in the Urban Development Region and Function Expanding Region [Figure 5C2]. Figure 5C3 and C4 are heat maps of the demand rate for stroke/TIA in 2008 and 2017, respectively. The demand rate decreased gradually from the center to the suburbs, and the demand rate in the Ecological Conservation Region increased significantly.

Discussion

Key findings

Our analysis using pre-hospital EMS data to report trends and characteristics for pre-hospital emergency care from 2008 to 2017 in Beijing yielded four key findings. First, pre-hospital EMS demand increased significantly, matching increases in Beijing's population. Second, ERT was significantly prolonged, and higher than international and domestic standards. Third, the disease spectrum of pre-hospital EMS changed markedly, and finally, injury-related disease and cardio-cerebrovascular disease accounted for a large proportion of the demand, and differed in the four functional regions.

Interpretation

Demand for pre-hospital care in Beijing rose steadily from 2008 to 2017 and related primarily to population growth; during the same period, the city's population increased 33%.[7] Over the 10-year study period, the life expectancy of Beijing's population increased by 2 years, reaching 82.15 years in 2017.[5] An aging population contributes to increased demand for pre-hospital care.[8-12] Citizens ≥75 years were more likely to call the EMS than those aged 65 to 74 years.[11] Additionally, with economic development and improved living standards, there has been a gradual increase in citizens' health consciousness, with more people seeking early diagnosis and treatment for a variety of conditions.[7,13,14] Other factors, such as improved social medical funding, and an increase in people

living alone,[9,15] may also have increased the demand for EMS. A continued rise in pre-hospital demand confers increased pressure on the system.

ERT and the quality of pre-hospital emergency care directly impact in-hospital treatment and patients' prognosis.[16] However, response times in Beijing are much longer than they should be. With the increased demand for pre-hospital EMS, ERT in Beijing has increased significantly. Further analysis indicates that ART remained almost unchanged, at 5 min; however, PRT (the ambulance's travel time to the site) increased gradually. PRT is based mainly on driving speed and distance. Beijing's increased traffic volume and congestion can slow ambulances. Another possible reason for the increasing PRT is that demand for pre-hospital EMS has increased, but the number of emergency stations has not increased accordingly, so an ambulance might not be dispatched from the nearest station. Beijing's ERT reached 24.51 min in 2016, compared with 6.0 min in Tokyo, 6.8 min in Seoul, 7.0 min in Taipei,[17,18] and 8 min in Yazd, Iran.[19] Thus, the difference between Beijing's ERT and those of other cities was considerable, and higher than China's national standard of 15 min. The geographic area of the city of Seoul is approximately 4% of the area of Beijing, but Seoul has a similar number of emergency stations.[17] Tokyo's population is half that of Beijing and is 1/8 its size, but Tokyo has 229 ambulance stations compared with 290 in Beijing.[17] Serious effort should be made to address this disparity, and multi-sector efforts are needed to reduce response times.

In addition to Beijing's increase in pre-hospital EMS demand and ERT, the spectrum of illnesses changed markedly over the study period. According to the MPDS, the demand for 14 types of disease increased, while that for 19 types remained unchanged. The highest proportion of demand was related to all types of injury, and it increased continuously. In 2017, injury-related disease accounted for approximately 20% of the total demand. In developed countries, the disease burden associated with trauma was relatively lower.[20,21] In China, with economic development, trauma has factored increasingly in overall mortality and disability rates, becoming the leading cause of death in those under 45 years of age.[22,23] Traffic injury is fourth in the burden of disease in China.[23] In our study, traffic injury accounted for quite a large proportion of injury-related diseases. In 2017, there were approximately 5.91 million vehicles in Beijing,[24] leading to a greater number of traffic accidents. Combined with these traffic effects on PRT, traffic injuries place undue stress on Beijing's EMS.

Heart problems and TIA EMS demand was high initially and grew rapidly. Cardiovascular disease is the leading cause of death globally. It is estimated that 17.5 million people died of cardiovascular disease in 2012, accounting for 31% of global mortality, with 75% of these deaths occurring in low- and middle-income countries.[22] Ischemic heart disease was a leading cause of death, and cardiovascular disease was the highest ranked cause of disease burden in China in 2010.[23] With changes in diet, increased life stresses, and an aging population, the incidence of heart disease has continued to increase.[23] The increasing demand of injury-related and cardiovascular disease indicates that Beijing is a rapidly developing city, and faces the problems of an aging city.

The pre-hospital EMS situation and changing trends differed in the four functional regions. Beijing's transportation network is ring-shaped. From the center to the edge of the city, population density and the level of economic development gradually decrease. The Core Functional Region is the most advanced and urbanized, and the population remained relatively stable through the study period. Therefore, the number of pre-hospital EMS cases and the demand rate remained stable, and was the highest demand rate among the regions. With population increases, demand in the other three functional areas increased significantly. Furthermore, in the city suburbs, which constitutes the Ecological Conservation Region, the demand rate for injury-related diseases increased significantly, while the similar demand rate in the other three regions declined or remained unchanged. Conversely, from the city center to the edge of the city, the demand rate for heart problems and stroke/TIA gradually decreased. These differences reflect inconsistent levels of development in the different functional regions. Effective allocation of pre-hospital emergency resources should be based on the characteristics of each functional region.

The Chinese government and medical institutions have made considerable efforts to meet the increasing demand for pre-hospital EMS, such as attaching greater importance to pre-hospital care and increasing state funding to health services.[7] Second, the number of ambulances and emergency stations has gradually increased. Third, the government has established strict pre-hospital medical care standards and protocols, and has promulgated the "Regulations for pre-hospital medical emergency services in Beijing." Fourth, the government has consolidated Beijing's two dispatch command emergency numbers, 120 and 999, into a unified 120/999 platform, so that if a call to one number is not answered within a specified time, it is automatically transferred to the other system. Pre-hospital EMS personnel also undergo regular professional training, thus improving their ability to react to an emergency. Despite these positive steps, greater specificity in EMS needs must receive attention, so that resources can be sufficiently and appropriately allocated.

Limitations

This study has the following limitations: First, because we collected our data from the records of the two emergency centers, data documentation and entry were not standardized. Second, documentation of time in the course of emergencies was sometimes incomplete, for example, the time when the ambulance arrived at the site might be missing. This might have introduced bias in our results. Third, the MPDS uses a standardized process and judges the severity of the help-seeker's situation through a few simple questions, which makes it possible to optimize the dispatch of emergency resources. Because the MPDS was not actively in use in Beijing during our study period, we could classify patients according to their complaints only retrospectively. Even with great effort to improve the

accuracy of the classifier, inconsistencies might have caused bias regarding the results of the disease spectrum analysis. Fourth, on-site treatment was not documented, and subsequent in-hospital treatment data was difficult to collect. The effect of this important aspect of the EMS is unknown. Thus, this study did not fully demonstrate the current status of EMS in Beijing.

Conclusions

Pre-hospital EMS demand has increased significantly in Beijing, and emergency services cannot currently meet patients' needs. One of the main manifestations of this lack is that ERT does not meet national or international standards. To shorten the ERT, and especially PRT, more funding is needed for pre-hospital EMS. Closer multi-sector cooperation is also required. Finally, pre-hospital EMS resources should be allocated appropriately according to changes in the disease spectrum and differences between regions. Hopefully, the characteristics of pre-hospital EMS in Beijing that we defined in this study can be used to construct and improve emergency systems in other large cities in China and elsewhere.

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Conflicts of interest

None.

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