Original Article

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Spatial Analysis and Evaluation of Carbon Monoxide Poisoning Admitted to A Tertiary Hospital- A Pilot Study

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Abstract

Objectives: In this study we aimed to define a free spatial analysis method that can be used for toxicology patients and contribute to the poisoning data of our country by performing this method on carbon monoxide poisoning cases admitted to emergency department of our hospital.

Materials and Methods: The population of this retrospective study included all adults who were admitted to our clinic with carboxyhemoglobin level above 10%. Two heat maps were created based on address of carbon monoxide poisoning and carboxyhemoglobin values of the persons in this position.

Results: 414 patients were included in the study. 39 patients were excluded from the study. 52.3% of the patients were female and 47.7% were male. Median of carboxyhemoglobin values was 14% (IQR = 13). The number of cases admitted during the winter was found to be higher than the other seasons. Two heat maps were created based on addresses of carbon monoxide poisoning.

Conclusion: Carbon monoxide poisoning is an important health problem in our country. Multicenter studies with Geographical Information Systems may contribute to the measures to be taken for carbon monoxide intoxication.

Key words: carbon monoxide, geographical information systems, spatial analysis

Özet

Amaç: Mekansal analiz yöntemi tanımlamak ve hastanemiz acil tıp kliniğine başvuran karbon monoksit zehirlenmesi olgularının demografik verileri ve karboksihemoglobin düzeyleri ile ilgili mekânsal analizler yaparak zehirlenme verilerine katkıda bulunmayı amaçladık.

Gereç ve Yönetim: Çalışmamız kliniğimize karbon monoksit zehirlenmesi ile başvuran hastalardan karboksihemoglobin düzeyi %10' un üzerinde olanlar dahil edildi. Hastaların demografik verileri değerlendirilerek zehirlenme adresleri kullanılarak vaka yoğunluğu ve karboksihemoglobin değerlerine göre iki ısı haritası oluşturulmuştur.

Bulgular: Çalışmaya 414 hasta dahil edildi. 39 hasta çalışma dışı bırakıldı. Hastaların %52,3'ü kadın, %47,7'si erkekti. Ortalama karboksihemoglobin değerleri %14 idi (IQR = 13). Kış aylarında kabul edilen vaka sayısının diğer mevsimlere göre daha yüksek olduğu bulundu. Karbon monoksit zehirlenmesinin adreslerine dayanarak iki ısı haritası oluşturuldu.

Sonuç: Karbon monoksit zehirlenmesi ülkemizde önemli bir sağlık sorunudur. Coğrafi Bilgi Sistemleri ile çok merkezli çalışmalar karbon monoksit zehirlenmesi için alınması gereken önlemlere katkıda bulunabilir.

Anahtar kelimeler: karbon monoksit, coğrafi bilgi sistemleri, mekânsal analiz

Introduction

With the developing technology, the importance of health applications is increasing rapidly among the fields of application of geographical information systems. These applications help the decision makers in the field of health through maps produced by associating the available data[1].

Carbon monoxide (CO) is a preventable cause of death, often caused by accidents. In our country, it often causes mortality and morbidity after stoves, water heaters and industrial poisonings[2]. CO can cause hypoxia at the tissue level by binding to hemoglobin after inhalation and decreasing the oxygen carrying capacity of the blood. Heart and nervous system, which needs oxygen more than other tissues, is particularly affected and life-threatening changes occur in the tissue[3].

The purpose of the present retrospective pilot study was to define a free spatial analysis method that can be used for toxicology patients and contribute to the poisoning data of our country by performing this method on carbon monoxide poisoning cases admitted to emergency department (ED) of our hospital.

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Materials and Methods

Study design

This retrospective study was conducted at a 672-bed tertiary academic hospital with an annual ED census of 438000. We collected data of the patients who visited our ED with a COHb level above 10% during the date January 1, 2015 and January 1, 2018 retrospectively.

Study population

Our study population was patients who admitted to our ED with a COHb level above 10% during the date January 1, 2015 and January 1, 2018. Patients with missing data on the hospital computer-based data system about address of poisoning especially workplace or hookah cafe were excluded.

Data collection

Demographic characteristics (age, gender), application seasons and COHb levels of the patients and spatial analysis of the poisonings were performed. The application seasons of patients were defined as spring (March, April, May), summer (June, July, August), autumn (September, October, November), and winter (December, January, February).

Primary outcome was a free spatial analysis method. The secondary outcomes were demographic data and carboxyhemoglobin levels.

Spatial analysis

Address data of poisonings were revised in Microsoft Office Excel 2007 environment due to possible repetition or missing data. Geocoding process was made by geocoding services which provide free services. A heat map was created based on these positions and COHb values of the persons in this position.

Statistical analysis

In the statistical evaluation of the data, IBM Statistics 20.0 (SPSS) statistical package program was used. The baseline patient characteristics are presented as frequencies for categorical variables and as medians and interquartile ranges for continuous variables. Averages were shown with standard deviations. Statistical analysis of categorical variables was done by "chi-square" test and numerical variables were analyzed by Mann Whitney U test and "t test". Spearman correlation was used to evaluate relationships involving ordinal variables. A p value less than 0.05 was regarded as statistically significant.

Ethics

Ethics committee approval required for the study was taken from Ethics Committee (date: 21/03/2018, approval number: B.10.1.TKH.4.34.H.GP.0.01/36). We retrospectively reviewed the secondary data extracted from the electronic medical records. However, the extracted data included clinical data only; it didn't include any personal identifiable information. Therefore, the need for informed consent was waived.

Results

The study included 414 patients with COHb levels above 10% who were admitted to our clinic. 39 patients were excluded from the study because of repetition or missing data. 52.3% (n = 196) of the patients were female and 47.7% (n = 179) were male.

The ages of the patients ranged from 3 to 94 years, and median of age was 36 years (IQR = 37.4). The measured COHb levels of patients ranged from 10-63%, and median of COHb levels was 14% (IQR = 13). No significant difference was found between COHb levels and gender (p=0.652). Cases were classified according to their decades. There was no statistically significant correlation between COHb levels and this decade groups (p=0,115) (Pearson correlation test).

The distribution of patients according to the seasons is evaluated; It was seen, 43.7% (n = 164) in winter, 23.7% (n = 89) in spring, 15.5% (n = 58) in summer, 17.1% (n = 64) in the autumn season. The number of cases admitted during the winter was found to be higher than the number of those admitted in the other seasons with a significant difference (p <0.001)

A heat map was created based on addresses of CO poisoning shown in figure 1. Second heat map was created based on these positions with COHb levels shown in figure 2. The second map shows the poisoning addresses in red circles. The diameters of the red circles were shown to be proportional to the COHb levels.

Discussion

Geographical Information Systems will play an active role in increasing the service quality and satisfaction as a decision support system that provides accurate analysis of spatial data in the areas of policy production, strategic planning and management, especially in the areas of corporate applications[4]. Heat maps are used for georeferencing health data. These maps might link such data geographically to potential sources of environmental exposures, the geodemographic characteristics of populations, and the locations of health resources[5,6]. They can be helpful tools for preventing, understanding, and treating diseases. Spatial analysis and heat maps performed for avian influenza and other topics relating to pandemic influenza by World Health Organization and The Centers for Disease Control and Prevention[7,8]. New live heat maps are preparing for new coronavirus pandemic[9,10].

The identification of spatial patterns of CO poisoning is a critical first step in a more complete understanding of the

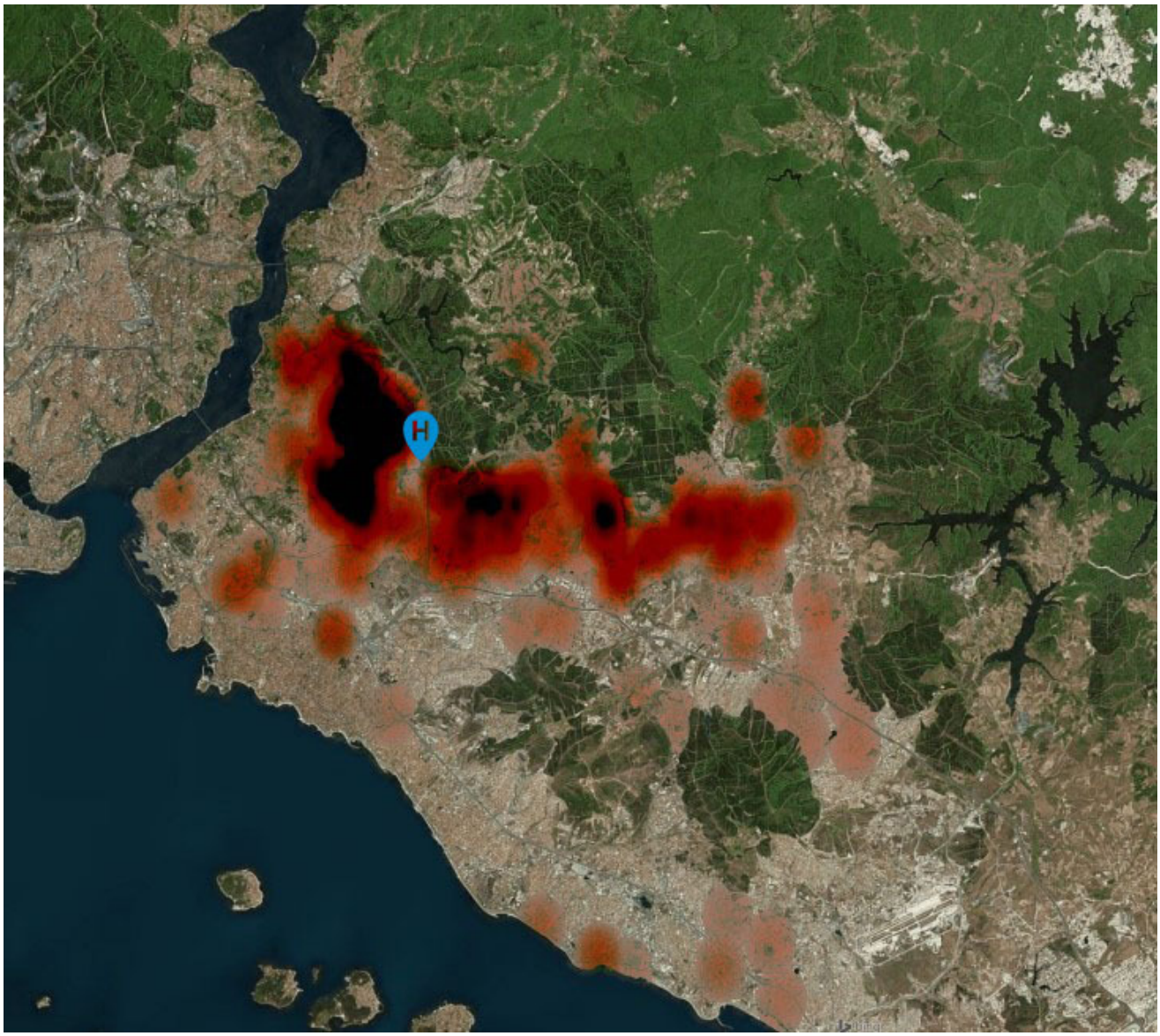

Figure 1. The heat map based on addresses of CO poisoning

epidemiology of this public health challenge and these techniques are instrumental in designing valid observational and analytical studies to more fully study the problem.

Black areas on the first map shows of the most intense of the patients. The fact that this region was close to the hospital where the data was obtained was associated with the single-centered study. We believe that the location of this black region may change in multicenter studies.

In the second map showing COHb levels, the regions with large circles were associated with higher COHb levels. High levels of arterial COHb were associated with increased intensive care mortality[11]. We believe that these regions could be associated with high mortality and morbidity.

In this study we found that the female patient group was more males. Over-exposure of women was consistent with the literature[12-15]. We believe that this is due to the fact that women get time indoor more than men.

The number of cases encountered increases during the winter months because of being in an indoor environment not ventilated enough during the fuel consumption for heating is the most common reason for intoxication[16-19]. We found that during the winter, there were more cases of CO intoxication than during the other seasons.

There are several limitations to our study. Firstly, in some cases, incomplete files or incorrect addresses were noticed. Therefore, we could not evaluate all the patients with CO poisoning. Also, we could not reach the mortality and morbidity data of the patients because of our study was designed retrospectively. Secondly, a usual pitfall of these analyses is that the maps must be corrected by the number of inhabitants in the various areas. Here, as we do not have the spatial repartition of the population, we cannot be sure the increased number of CO poisoning is not simply due to a high number of people living in those areas. Thirdly, the low

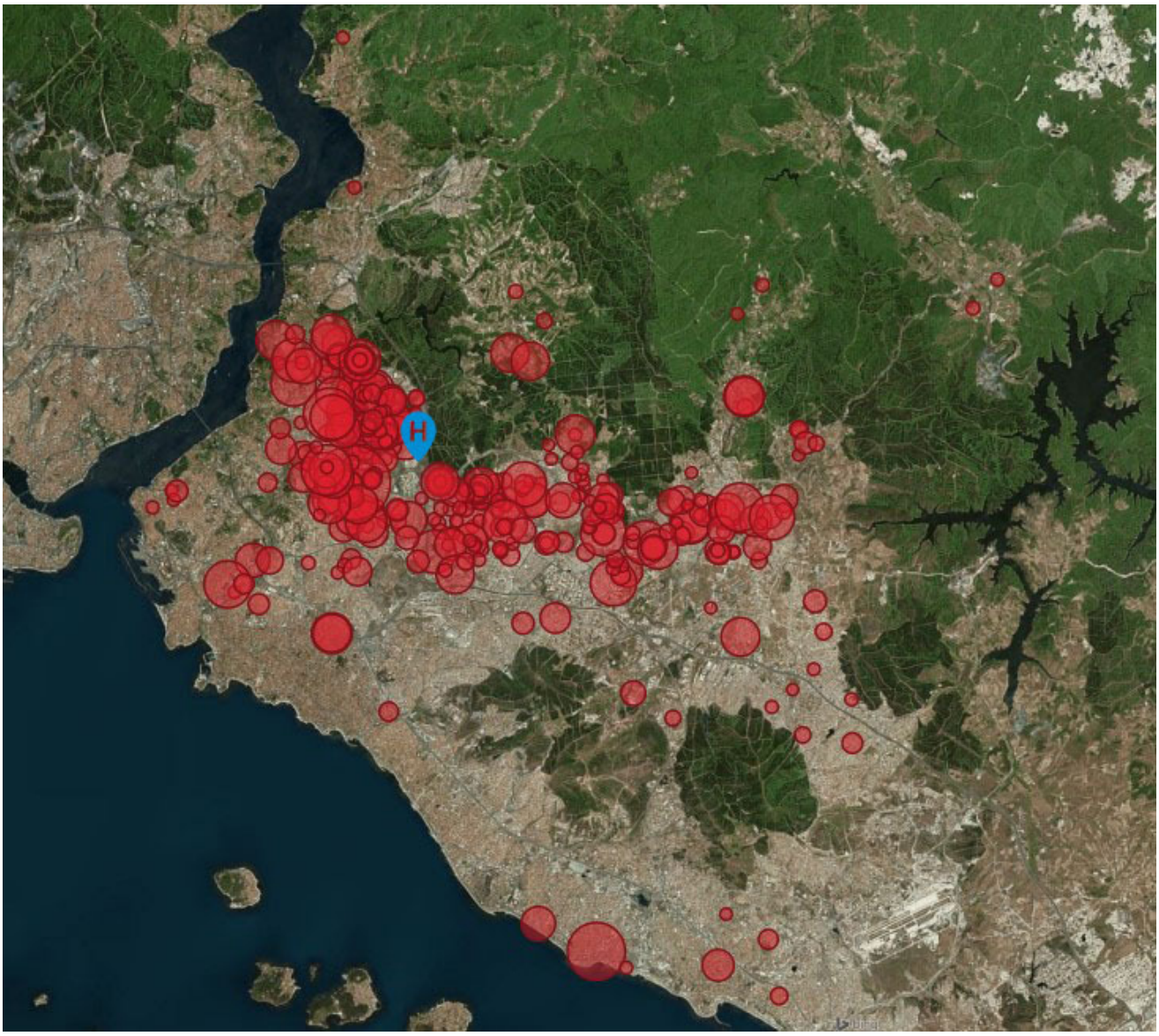

Figure 2. The heat map based on addresses of CO poisoning with COHb levels

number of cases in our study means that the results are limited in terms of generalization and wide applicability. Lastly, this is a single-center study and only shows the patients with CO poisoning coming to a single hospital and only one part of city. Consequently, multi-center studies are needed.

In conclusion, geographical analysis used to explore the possible links between accidents and geographical particularities. In CO poisoning, it may be used to detect the influence of certain area, social categories. Although the spatial analysis and evaluation of a local area has been conducted in our study, extensive studies and analyzes are needed. Multicenter studies with Geographical Information Systems may contribute to the measures to be taken for CO intoxication.

The manuscript was formally presented as oral presentation at 2nd Southeast European Congress of Emergency and Disaster Medicine (20 - 22 July 2019, İstanbul). http://www.atuder.org.tr/Download.aspx?data=C-7BYKE1RLGUSCCEFD552IB8YJ

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