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GEOSPATIAL ANALYSIS OF TERRITORIAL ASSESIBILITY OF THE AMBULANCE EMERGENCY STATION COVERAGE OF THE WITH ACUTE CORONARY SYNDROME INCIDENTS IN PAVLODAR (KAZAKHSTAN)

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Abstract

Background: Diseases of the cardiovascular system (CVD) remain the leading cause of death in the world today. Nowadays heart disease accounts for 16 per cent of all deaths in the world. This indicator in the Republic of Kazakhstan annually takes a leading position. Among CVDs, ischemic heart disease (IHD) remains the leading cause of death. Half of the patients die at the pre-hospital stage, without waiting for medical help, and many survivors become disabled. The time factor plays a very important role in the treatment of acute myocardial infarction (AMI).

The purpose of the study is to conduct a spatial analysis in order to determine the territorial availability of emergency cardiac care in Pavlodar city, taking into account the time, and using a geographic information system.

Materials and methods: Based on the number of the calls received at Pavlodar Emergency station for the period from 1st August 2017 to 30th July 2018, a retrospective analysis of 2053 cases of Acute Coronary Syndrome with and without ST segment elevation was carried out.

Spatial analysis and Network Analyst were conducted on QGIS 3.16 (Hannover) to determine the density of calls with acute coronary syndrome (e.g. to find 10, 15, and 20-minute areas of accessibility). Tools such as the Hot Spot Analysis and heat map were also used to identify a square kilometer congestion of calls and Kernel Density. That tool calculated a magnitude-per-unit area from point or polyline features using a kernel function to fit a smoothly tapered surface to each point or polyline. New Service Area tool creates a region that encompasses all accessible streets (e.g. streets within specified impedance). Statistical significance was set at the 95% confidence level.

Results: We found clusters in the largest cluster of calls, marked with red and orange colors, which, like the heat map analysis, corresponded to densely built-up areas. Thus, using Kernel density analysis, we identified 6 separate clusters with the call density of more than 42 calls per km^2: four clusters located in the northwest, north, and northeast of the city, and two clusters located in the southwest and southeast of the city. From the rest of the city, represented by multi-storey houses, there were received between 18.8 and 32.8 calls per km^2. About 18 calls per square kilometer were received from the outskirts of the city and from areas that were mostly of private sector.

To the areas densely built up with multi-storey buildings, as well as cluster plots, the ambulance can arrive within 5 minutes from the moment the call is received. The areas with low call density, an emergency medical services reaches within 10 minutes. Outskirts of the city and the suburbs can be served within 15 minutes.

Conclusion: Based on the data presented above, it is possible to assume that additional research is needed using geographic information systems.

Keywords: *Geographic information system (GIS), ST-elevation myocardial infarction (STEMI), Non-ST-Elevation Myocardial Infarction (NSTEMI).*

Резюме

ПРОСТРАНСТВЕННЫЙ АНАЛИЗ ТЕРРИТОРИАЛЬНОЙ ДОСТУПНОСТИ СТАНЦИИ СКОРОЙ МЕДИЦИНКОЙ ПОМОЩИ ПРИ ОСТРОМ КОРОНАРНОМ СИНДРОМЕ В ГОРОДЕ ПАВЛОДАР (КАЗАХСТАН)

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Введение. Основной причиной летального исхода, по сей день, в мире остаются заболевания сердечно-сосудистой системы (ЗССС). На долю болезней сердца сегодня приходится 16% всех случаев смерти в мире. Данный показатель в Республике Казахстан ежегодно занимает лидирующие позиции. Среди ЗССС ишемическая болезнь сердца (ИБС) остаётся основной причиной смерти. Половина больных погибает ещё на догоспитальном этапе, не дождавшись медицинской помощи, а многие выжившие становятся инвалидами. Временной фактор играет очень важную роль в лечение острого инфаркта миокарда (ОИМ).

Целью исследования является проведение пространственного анализа с целью определения территориальной доступности экстренной кардиологической помощи в городе Павлодар с учётом времени с помощью геоинформационной системы.

Материалы и методы. На основе вызовов, поступивших на станцию Скорой Медицинской Помомщи города Павлодар, Республика Казахстан за период с 1 августа 2017 года по 30 июля 2018 года был проведён ретроспективный анализ 2053 случаев с острым коронарным синдромом с элевацией сегмента ST и без элевации сегмента ST.

Пространственный анализ и Network Analyst проводились на программе QGIS 3.16 (Hannover) с целью определения плотности скопления вызовов с ОКС, в том числе с определением 10-, 15-, и 20-минутных зон доступности. Для определения степени перегруженности телефонных линий на один квадратный километр были использованы такие инструменты, как Hot Spot Analysis (теплокарта), и Kernel Density. Последний используется для вычисления показателя «площадь magnitude-per-unit» от точечных или полилинейных объектов с использованием функции Кернела для подгонки плавно сужающейся поверхности к каждой точке или полилинии. Новый инструмент Service Area создаёт область, охватывающую все доступные улицы (т.е. улицы с установленым импедансом). Статистическая значимость была установлена на уровне 95% достоверности.

Результаты. Мы обнаружили наличие кластеров по наибольшему скоплению вызовов, отмеченные красным и оранжевым цветами, что также, как и анализ теплокарты соответствует плотно застроенным районам. Таким образом, используя анализ Kernel density, мы выявили 6 отдельных кластеров с плотностью вызовов более 42 обращений на 1 км^2: 4 кластера расположены на северо-западе, севере и северо-востоке города, и 2 кластера на юго-западе и юго-востоке города. Из остальных других районов города, которые представлены в зонах многоэтажных домов, поступает от 18,8 до 32,8 обращения на 1 км^2. С окраин города и районов, преимущественно застроенных частными домами, поступает не более 18 вызовов на 1 км^2.

В плотно застроенных многоэтажными домами участки, а также кластерные участки, карета скорой медицинской помощи (СМП) успевает доехать в течении 5-ти минут, с момента поступления вызова. Участки с низкой плотностью вызовов карета СМП достигает в течение 10 минут. Окраины города и пригород могут быть обслужены в течение 15 минут.

Выводы. Основываясь на данных, которые были изложены выше, возможно предположить, что необходимо проведение дополнительных исследований в этой области с применением геоинформационных систем.

Ключевые слова: *Геоинфармационная система (ГИС), Острый коронарный синдроим с подъёмом сегмента ST (ОКСnST), Острый коронарный синдроим без подъёма сегмента ST (ОКСбnST).*

Түйіндеме

ПАВЛОДАР ҚАЛАСЫ (ҚАЗАҚСТАН) БОЙЫНША ЖЕДЕЛ КОРОНАРЛЫҚ СИНДРОМЫ КЕЗІНДЕГІ ЖЕДЕЛ КӨМЕК КӨРСЕТУ СТАНЦИЯСЫНЫҢ ТЕРРИТОРИЯЛЫҚ ҚОЛЖЕТІМДІЛІГІН КЕҢІСТІКТІ ТАЛДАУЫ

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Кіріспе. Жүрек-қантамыр жүйесі аурулары бүгінгі күнге дейін әлемде өлімнің негізгі себебі болып қала береді. Жүрек ауруы бүгінде әлемдегі барлық өлім-жітімнің 16% құрайды. Бұл көрсеткіш Қазақстан Республикасында жыл сайын жетекші орын алып келеді. Жүректің ишемиялық ауруы (ЖИА) жүрек-қантамыр жүйесі ауруы арасында өлімнің негізгі себебі болып қала береді. Науқастардың жартысы медициналық көмекті күтпестен, ауруханаға дейінгі кезеңде қайтыс болады, ал тірі қалғандардың көпшілігі мүгедек болып қалады. Жедел миокардиялық ишемияны (ЖМИ) емдеуде уақыт факторы өте маңызды рөл атқарады.

Зерттеудің мақсаты – географиялық ақпараттық жүйені (ГАЖ) пайдалана отырып, уақытты ескере отырып, Павлодар қаласында жедел кардиохирургиялық көмектің аумақтық қолжетімділігін анықтау мақсатында кеңістіктік талдау жүргізу.

Зерттеу материалдары мен әдістері. 2017 жылдың 1 тамызы мен 2018 жылдың 30 шілдесі аралығында Павлодар қаласындағы Жедел Медициналық Көмек (ЖМК) станциясына келіп түскен, ST сегментінің көтерілуі және ST сегментінің көтерілуі жоқ жедел коронарлық синдромы бар науқастардың 2053 карталарына ретроспективті талдау жасалынды.

Кеңістіктік талдау және желілік талдаушы (Network Analyst) QGIS 3.16 бағдарламасын (Hannover) пайдаланып, жедел коронарлық синдром ЖКС-нан келетін қоңыраулардың жиынтығының тығыздығын анықтау және 10, 15 және 20 минуттық қолжетімділік аймақтарын табу үшін жүргізілді. Hot Spot Analysis (жылу картасы) сияқты құралдар бір шаршы шақырымдағы қоңыраулардың шамадан тыс жүктелуін анықтау үшін пайдаланылды, ал Kernel Density құралы Kernel функциясын қолдана отырып, нүктеден немесе көп сызықты сипаттамалардан бір ауданның мөлшерін әр нүктеге немесе полилинияға тегіс жерге орналастыру үшін есептейді. Service Area жаңа құралы барлық қол жетімді көшелерді қамтитын аймақты жасайды (яғни, импеданс орнатылған көшелер). Статистикалық маңыздылығы 95% сенімділік деңгейінде белгіленді.

Нәтижелер мен талқылау. Біз қызыл және қызғылт сары түспен белгіленген қоңыраулардың ең үлкен кептелісі бойынша кластерлердің болуын анықтадық, бұл жылу картасының талдауы сияқты, тығыз елді мекендерге сәйкес келеді. Осылайша, Kernel density тығыздығының талдауын пайдалана отырып, біз 1 км2-ге 42 шақырудан асатын шақыру тығыздығы бар 6 бөлек кластерді анықтадық: 4 кластер қаланың солтүстік-батысында, солтүстігінде және солтүстік-шығысында, ал 2 кластер оңтүстік-батыста және оңтүстік-шығыс аумақтар. Көпқабатты үйлер болып табылатын қаланың қалған аудандарынан 1 км2-ге 18,8-ден 32,8-ге дейін жолдама алынған. Негізінен жеке тұрғын үйлер салынған қала және аудандардың шет аймақтарынан 1 км2-ге 18-ден аспайтын өтініш түседі.

Көпқабатты үйлер тығыз орналасқан аумақтар, сондай-ақ қызыл түспен белгіленген аумақтарға жедел жәрдем көлігі қоңырау түскен сәттен бастап 5 минут ішінде жетеді. Шақырулардың төмен тығыздығы бар аудандарда ЖМК тасымалы 10 минут ішінде жетеді. Шеткі және қала маңындағы аудандарға 15 минут ішінде қызмет көрсетуге болады.

Қорытынды. Жоғарыда келтірілген деректерге сүйене отырып, географиялық ақпараттық жүйелерді пайдалана отырып, осы ЖМК саласында қосымша зерттеулер қажет деп болжауға болады.

Түйінді сөздер: *Геоақпараттық жүйелер (ГАЖ), ST тісшесінің жоғарылауымен миокард инфарктісі, ST тісшесінің жоғарылауынсыз миокард инфарктісі.*

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Background

The diseases of cardiovascular system (CVD) are the main cause of death across the world. According to that, heart diseases accounts for 16% of all deaths in the world [2]. This indicator in the Republic of Kazakhstan (RK) annually occupies a leading position. Ischemic heart diseases stay the leading cause of death [3].

According to the foreign recourses, prime purpose of medical service in acute myocardial infarction (MI) is the repairment of myocardial reperfusion [4]. According to the recommendation of Ministry of Healthcare of RK and international guidelines for the management of patients with MI, emergency cardiological care service has only 120 minutes, from diagnosis to transportation to the nearest percutaneous coronary intervention (PCI) center [6, 10], which is the most optimal for the treatment of myocardial infarction. After the diagnosis of MI, based on the clinical picture, electrocardiogram (ECG) and a troponin test, a doctor determines the further tactics owing to the time and the distance to the nearest PCI center. If the time from the moment of diagnosis to the moment of PCI center admission is more than 120 minutes, a doctor uses thrombolysis for a treatment, otherwise, a patient is delivered to the PCI center without thrombolytic therapy [11, 21].

The only controversial moment here is as follows: when do we start counting those 120 minutes? Until 2017, the countdown began from the moment of the index event, that is from the beginning of the first symptoms, e.g. chest pain. This period of time can be roughly divided into four time periods.

The first one starts from the beginning of MI symptoms till the primary medical contact, which consists of time from first symptoms until calling the emergency medical service, time to receive a call by a dispatcher, and the time of the ambulance arrival to a patient. Unfortunately, it takes a lot of time and is affected by many factors: a low level of public awareness, reduced self-criticism, underestimation of the severity of conditions, and so on.

The second one starts from the first contact with a doctor until the diagnosis, which is no more than 10 minutes.

The third one is transportation to hospital. It depends from many factors: the distance between an ambulance and a patient, a part of the day. Sophistication of the urban transport system and conditions of the weather may also affect the delay of ambulances [1,14,25].

The fourth one is the time from the admission to the hospital until the start of PCI (reperfusion).

According to British studies, more than 75% of patients receive medical care within 150 minutes [24].

There are many factors that are associated with time, and should be taken into account to reduce negative outcome in patients with an acute coronary syndrome (ACS).

Half of the patients die at the prehospital stage, without waiting for an ambulance. Those who survive become disable [9]. Such factor as time plays general role in treatment of MI. The more time medical stuff have after patient arrives in the hospital, the greater the chances are to receive adequate and full medical care. These patients have a small area of myocardial necrosis, it means chances to be disabled are closer to zero. In that case, Emergency Medical Service (EMS) plays a very important role, which depends on localization of EMS Station, distance to a patient, presence of modern transport, credentials of EMS team to provide qualified assistance. A not-trivial moment is the experience of a driver, his awareness of the traffic state, presence of maintenance work on the road. This knowledge helps to reduce the time from diagnosis till the moment when a patient arrives to nearest PCI center.

Despite the fact that Geographic Information System (GIS) in medicine is a completely new concept to developing Kazakhstan, the methods of the GIS are widely used in medicine all over the world for the analysis of geographical patterns of disease, and the availability of hospitals [20]. The total area of Kazakhstan is 2 724 902 km². Considering the distances between the cities, population density is one of the lowest in the world, less than seven people per km^2. Economical, innovational and technological development, difference of climatic zones, and environmental conditions, are those factors that play an important role in the progress of healthcare system – by implementation of GIS. GIS is a basis for an integrated assessment of the population well-being, and complex solution in the infrastructure management and planning. Across Europe and Asia, GIS has proven to be a very useful and necessary tool and has found a wide application in health care, not only for the logistics of ambulance, but also for the transport of patients from home to the nearest hospital, in identification of disease clusters. GIS helps to improve logistics, reducing the economic costs of the organization [5,22].

GIS analysis techniques allow to geo-reference and visualize different data, providing a more comprehensive analysis.

Previous studies showed that inappopriate logistics can worsen an access to PCI centers. Thus, the mere addition of hospitals with PCI can improve the situation in a country. GIS and mathematical modelling can be used to choose the optimal STEMI treatment option depending on the patient's location and the transportation time to PCI center [31].

The studies over the past 10 years have demonstrated that the problems of the rapid response and the correct location of an ambulance station remain relevant [5].

In addition, these concerns are supported by the growing demand for ambulances [15].

This study explores coverage of EMS stations for the patients suffered from ST-elevation myocardial infarction (STEMI), non-ST-elevation myocardial infarction (NSTEMI), and unstable angina (UA).

Aim of the reported study is to conduct a spatial analysis to determine the territorial availability of emergency cardiac care in Pavlodar taking into account the time by means of a geographic information system.

Matherial and Methods

In order to achieve the goals, we conducted a retrospective analysis of 2053 cards with STEMI and non-STEMI ACS, which documented the calls received at the EMS station in Pavlodar (RK) for the period from 1st August 2017 to 30th July 2018.

Population of the Pavlodar region is 530,209, total area is a 267 km^2. The main EMS station serving emergency calls is located in the city center. All patients are hospitalized in the Pavlodar Regional Cardiology Center.

The analysed call cards contained the following data: sex, age, and nation, address of call, time (time of call application, time of ambulance arriving, time of hospitalization and call completion time), distance, and result of the call. According to the ambulance service database, STEMI ACS was defined as I21.1, 21.9, I22, I23.0, I23.2, I23.3, and I23.4. Non-STEMI ACS was coded as I20.0, I21.2, I21.4, and I24.9 in accordance with ICD-10 classification.

Spatial analysis and Network Analyst was conducted on the program QGIS 3.16 (Hannover) to determine the density of ACS calls and find 10, 15 and 20-minute service areas. Tools such as the Hot Spot Analysis and a heat map were also used to identify a square kilometer congestion of calls, Kernel Density tool, which calculates a magnitude-per-unit area from point or polyline features using a kernel function to fit a smoothly tapered surface to each point or polyline, was also applied. New Service Area tool creates a region that encompasses all accessible streets (e.g. streets within specified impedance). Statistical significance was set at the 95% confidence level.

In QGIS program, we made the first layer for spatial analysis. The map was taken from the Google map, on which a layer of vector maps of the road were superimposed. It helped to calculate later the time spent on the road. These two layers were used as a template to create a vector map of the city in the QGIS program.

Upon creation of the base layer with a vector map, we added the geocodes got from Yandex server. After that, we did a preliminary analysis of the data and found that the largest call aggregation was definitely from the areas with predominantly high-rise, multi-drive houses, defined as well-established areas. More detailed information of the methods of analysis is contained in our early publication [12].

Results

At the beginning, with the help of a heat map, we determined the patients position on the map in accordance with the number of calls per 1km^2 and distributed them by color (Figure 1).

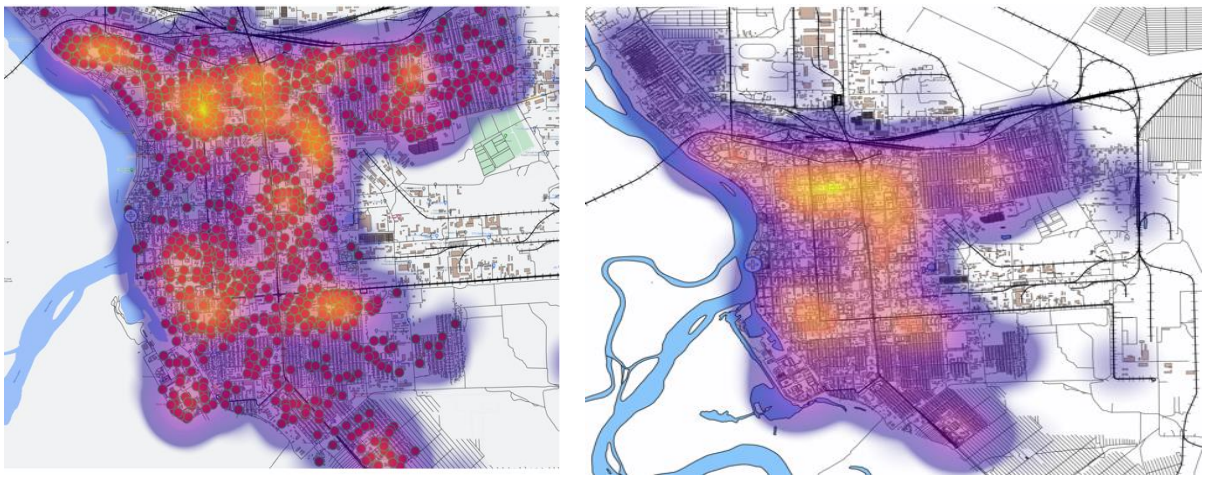

Figure 1. The map of ACS case density (left: The geographical distribution of ACS cases n=2053; right: Hotspot map)

The heat spectrum was presented from a purple colour (the smallest number of calls) to yellow colour (the largest number of calls). The figure depicts the areas painted in yellow, which are located in the districts with high-rise houses. Additionally, the area with high-rise houses colored in orange was found. The plots with the least number of calls are painted in lilac colour, these plots are mostly built by the private sector, and represented more often by single-storey, less frequent by two-storey houses, both on the outskirts and in the inside of the city. That tool helped to identify the areas with high call concentrations.

The next step of our study included the detection of disease focuses defined as clusters. Applying Kernel density tool, we found clusters with the largest focus of calls, marked with red and orange, which, like in the heat map analysis, corresponded to the densely built-up areas. Results of the Kernel density analysis for the Pavlodar city is presented in Figure 2. The density zones are divided into seven categories

from white (from 0 to 3 cases per km^2) to red (more than 42 cases per km2). Therefore, using Kernel density analysis, we identified six separate clusters with call density more than 42 hits per km2: four clusters were located in the northwest, north, and northeast areas of the city, and two clusters were located in the southwest and southeast territories of the city. The rest of the city, represented by multi-storey houses, received between 18.8 and 32.8 visits per km2. Visits from the outskirts of the city and from areas that are mostly privately built were registered at the level of not more than 18 visits per square kilometer.

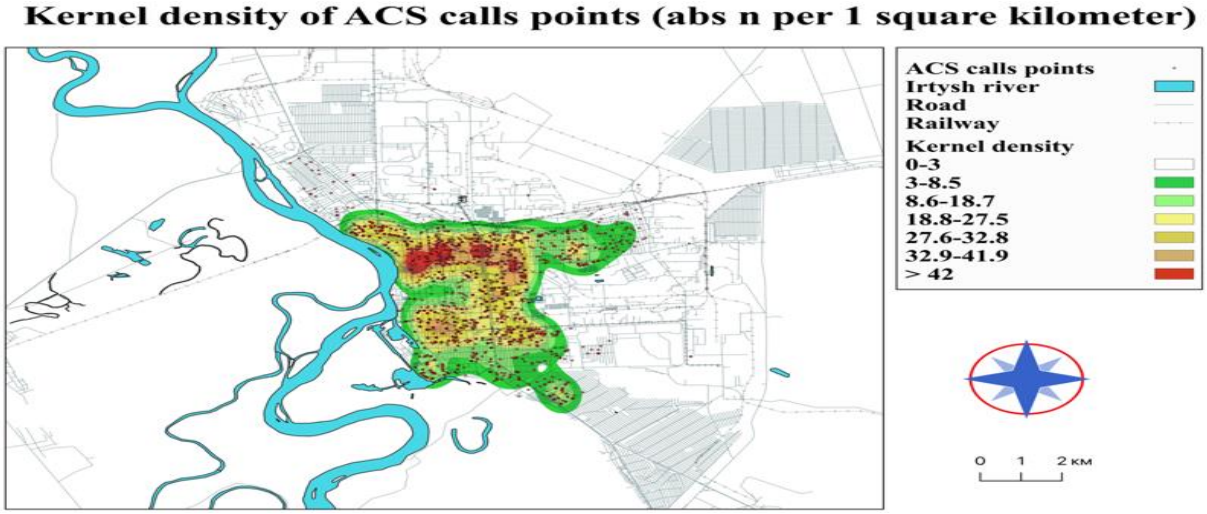

Figure 2. Hot spot map clusters and outliers of ACS incidents.

The final step was the analysis of territorial accessibility using roads and interchanges in the city applying Network Analysis and the analysis of ORS of Service Area. Our default analysis was based on two conditions: the ambulance leaves the EMS station and ambulance moves at an average speed of 50 km/h (Figure 5).

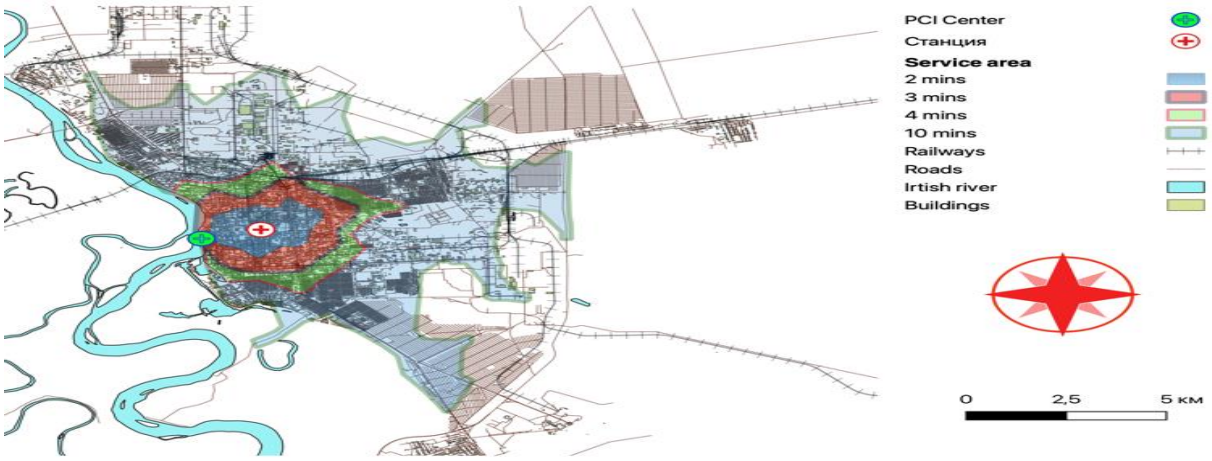

Figure 3. The map of ambulance service area.

In the zones, densely built by multi-storey houses, and in the areas colored in red (Hot Spots), ambulances reach patients within 5 minutes. Across the areas with low call density, ambulances reach patients within 10 minutes. Suburbs can be served in 15 minutes.

Disscussion

In the RK, the first study of the emergency cardiological care accessibility was conducted in Semey city. *A. Myssayev, et al.* in their study determined that Semey residents were able to receive qualified emergency cardiac care within 15 minutes [12].

Our research is the second study that GIS-analyzed ambulance coverage zones considering time-factor in Kazakhstan. After Hot Spots and Kernel density analysis, we identified six clusters and areas of the city with the highest number of patients. The highest frequency of calls corresponded to the density of multi-storey housing. We attributed it to the fact that neighbourhoods in the northern part were built and occupied more than 30 years ago. The opposite situation was in the south part of the city, which represented neighbourhoods that were also built with multi-storey houses but were inhabited more than 10 years ago, or in areas less than 5 years old where young families were housed under a government programme (these areas are represented in yellow in Figure 3).

The key findings were revealed in the work of EMS station. According to the decree, ambulance and emergency medical care, including sanitary aviation, is free for all population [7]. The SMP station operates 24/7. The ambulance team consists of a driver, a paramedic or a doctor, a nurse and optionally a specialist (cardiologists, neurologists, etc.). Pavlodar EMS station processes more than 215,000 calls per year, covering a total area of 267 km2. In the course of the study, it was found that a single

SMP station covered the most part of Pavlodar with a 10-minute corridor. Based on the Network Analyst definition and the OS of Service Area analysis, we have determined that the average speed of an ambulance is 50 km/h, and that the suburban area can be served within 15 minutes. Prehospital access to advanced care in Pavlodar is similar to that observed in the New Zeland, USA and Canada [13,23].

In Kazakhstan, the applying of GIS in healthcare is still poorly studied. Meanwhile, international studies proved the key role of the investigations of these kinds. Over the years, Canadian governmental and non-governmental organizations have tried to find a link between geography and health [28].

Clark RA et al. in the GIS analysis compared the 1-hour availability of PCI centers and rehabilitation centers. They found that the rehabilitation service was available to 91 per cent, while PCI centers were available only to 71 per cent of the population, older patients and indigenous people, who bore a heavier burden of disease than the general population and were more disadvantaged in terms of access [16].

In earlier studies, *Nallamothu B.K. et al.* showed that about 80% of adults in the United States lived in 60 minutes from the nearest PCI center. Despite this, among patients living in the vicinity of the hospital, almost ¾ patients experienced a 30-minute delay. These results indicated that a more thorough planning of the service in the future was needed [25].

Other studies in Australia showed that 78% of PCI centers were located in large cities, a significant number of Australians did not have access to PCI within the time recommended in the guidelines [18, 26].

These results may help further strategic development of the cardiac service. In places where access is limited, it is necessary to mobilize and synchronize relevant organizations to optimize temporary access to evidence-based medical services such as PCI [30]. If necessary, EMS stations may be relocated [29] or used to determine the number and location of new stations [27]. *Lilley R., et al.* in their study showed that 700,000 New Zealanders did not have timely access to tertiary care, the study revealed important socio-demographic differences in timely access for indigenous Maori, New Zealand Europeans, elderly New Zealanders and South Islanders, reflecting the geographical distribution of the New Zealand population. According to *Lilley R., et al.* the next step in the study is to determine the optimal location of the hospital providing advanced healthcare and to prevent deaths [23].

We assume that it is possible to perform spatial analysis regarding other nosologies (diseases) in order to form a complete picture of the EMS station coverage according to road networks and interchanges. The GIS system can also be used in the control of disease incidence and spread in particular areas. Hasker et al. used the system to control the spreading of tuberculosis among the Comoros people living in the northern islands of Madagascar, with an estimated population of about 800,000 people [19.

GIS system can be used not only to evaluate ground services but also to investigate an air emergency service. *Widener M.J.* et al. showed the work of the Maryland Air Force Air Traffic Control Service, located at the Maryland Emergency Medical Service Institute (n=2,208 geocodes) [17]. *S. Schierbeck, et al.,* performed spatial analysis using a GIS model. They identified the required amount of drones with an external defibrillation function for cardiac arrest, for 100% coverage of the entire territory of Sweden, with 8 minutes access to patient. They concluded that only 70% of patients were reached in less than 20 minutes (Me 12 minutes) [29].

Currently, this problem remains one of the most important social issues and has been widely reflected in the State Health Development Programme for 2011 – 2015 and for 2016-2020, where one of the main missions is to improve diagnostics, providing the development and implementation of comprehensive diagnostic programs, introduction of international standards, diagnostic protocols and methodologies for all levels of health organizations, based on the principles of evidence-based medicine [8].

All the above-mentioned facts claim that GIS systems are widely used in many countries. The next research step should include the assessment of the service availability to identify available time, areas and zones that require reorganization for more productive work. As a practical result, mobilization and synchronization of all necessary services could be expected. In the next step we plan to carry out research in a real time mode with conditions that the ambulance team is located at the EMS station, and excluding the possibility of accepting a call while on the route It will allow to study the real picture of EMS work, and, most importantly, a picture of the accessibility of the EMS service to the public and its various segments. This will have the beneficial effect of reducing travel time and increasing the number of timely service calls, which are far more cost-effective for the region.

Conclusion

Overall, our study revealed that emergency cardiac care is able to cover a large area of Pavlodar within the period of 10 minutes. Continuous development and urban growth warrant a repetitive analysis according to the reported methodology to establish proper and cost-effective emergency cardiac care system.

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