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Review article

Digital Solutions in Epidemiology: International Experience

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Abstract

This review presents the of digital epidemiology, which based on the use of digital data and analytical methods to detect, analyze, and prevent outbreaks of infections. Digital epidemiology can start early investigation, diagnosis, and response measures at the regional level, and it is a useful approach to traditional surveillance in the modern world. The article provides an overview of early warning systems, including ProMed-mail, HealthMap, EIOS, and MedISys, highlighting their effective application in the early detection of disease outbreaks through digital tools.

The GLEAM project provides analytical and forecasting tools using the complex stochastic models of infection spread based on big data. Countries such as South Korea, Singapore, Taiwan, and Germany have demonstrated the effectiveness of digital epidemiology approach within the context of government initiatives that applied non-traditional medical data and digital solutions to manage disease outbreaks.

The research methodology blends specialized techniques, such as a literature review, comparative analysis, and SWOT analysis. A comparative table of early warning systems highlights the advantages of systems that use big data from open sources with minimal human intervention. The SWOT analysis suggests that digital epidemiology has potential for implementation in Kazakhstan, raising the bar for epidemiological surveillance and monitoring. The study aims to analyze modern approaches to epidemiological surveillance and monitoring of infectious diseases and assess the prospects for implementation in the healthcare system in Kazakhstan.

Keywords: public health, digitalization of healthcare, early warning systems, digital epidemiology, big data, artificial intelligence.

1. Introduction

The World Health Organization (WHO) reports that approximately 1 billion cases of infectious diseases are registered each year [1]. This indicator continuous to rise due to various factors influencing the spread of infections. A primary factor contributing to the growth is the rising population density in urbanized areas. High concentrations of people in limited areas contribute to the faster transmission of viruses. Moreover, globalization and the expansion of international connections have intensified cross-border

transmission, especially during pandemics. Climate change significantly accelerates this process. The Intergovernmental Panel on Climate Change (IPCC) indicates that a global temperature increases of up to 2°C may lead to the emergence of several infectious diseases [2]. Furthermore, in the context of modern urbanization and escalating transnational migrations, ancient viruses are being revived and spread at an unprecedented rate [3]. In response to these challenges, global specialists and researchers are actively investigating novel techniques and approaches for the prevention, control, and prediction of infectious disease outbreaks.

In 2023, more than 10,000 cases of infectious diseases were documented in Kazakhstan, including outbreaks of COVID-19 and natural-focal infections such as brucellosis, tularemia, and Crimean-Congo hemorrhagic fever [4]. This epidemic crisis highlights the urgent need to use digital technology into real-time data gathering, analysis, and exchange processes. Despite successful digitalization in various sectors of Kazakhstan's economy and public administration, where the country is ranked 24th in the 2024 UN E-Government Development Index [5], the level of digitalization of the sanitary-epidemiological service remains in its early stages.

The rapid digitalization of the service was largely driven by the worsening epidemiological circumstances resulting from the COVID-19 outbreak in 2020. New digital initiatives were launched to facilitate the collecting and processing of PCR test data and to maintain records of vaccinated persons [6]. In addition, a mobile application was implemented to mitigate the spread of COVID-19 in public spaces and safeguard citizens' well-being [7]. Nevertheless, these measures remain insufficient and underscore the necessity for novel strategies in epidemic surveillance and the integration of advanced technologies.

A possible avenue is digital epidemiology, which employs advanced analytical methods and extensive data from many sources to identify, examine, and prevent infectious disease outbreaks. The pioneers of this approach have demonstrated that digital data provide promising opportunities for real-time disease monitoring, significantly enhancing surveillance and response outcomes.

Despite the growing academic interest in digital epidemiology post-COVID-19 pandemic, its fundamental ideas have long been implemented into digital surveillance platforms like ProMed-mail, HealthMap, EIOS, and MedISys. These systems frequently offer large amounts of unfiltered data, although they also feature customizable tools for sorting and filtering, enabling users to obtain access to relevant information. Digital epidemiology approaches have been implemented in governmental initiatives across several countries. This has not only mitigated the spread of infections but also fostered mechanisms for public engagement.

This approach strengthens trust in the system, enables early threat detection, and fosters the creation of more resilient solutions. The experiences of countries like South Korea, Singapore, Taiwan, and Germany, who swiftly responded to the coronavirus outbreak and decreased infection rates in a short period, illustrate that implementing digital epidemiology in Kazakhstan could stimulate the transition of its epidemiological surveillance system to a superior standard of quality and effectiveness.

2. Methodology

We performed a systematic literature review to ascertain contemporary elements in the field of digitalization of sanitary-epidemiological monitoring. Data was obtained from databases such as Scopus and PubMed. Then, the articles were filtered based on selection criteria, resulting in the review of the following number of materials for further analysis:

A literature search was conducted to identify relevant studies on key topics related to digital epidemiology and infectious disease surveillance. The search for the term "digital epidemiology" yielded a total of 223 articles, of which 54 were selected for detailed review after filtering. The phrase "early warning/disease detection system" returned 208 articles, with 14 meeting the inclusion criteria. The broader topic of "surveillance of infectious disease" produced 371 articles, 95 of which were reviewed in depth. Lastly, a combined search using the terms "Big data" AND "public health" AND "disease" identified 2,421 articles, from which 6 were deemed relevant for the purposes of this study.

The main criteria for the article were based only scientific publications with a high citation index. Additionally, we used materials and publications from websites of the WHO, the Center for Disease Control and respective government institutions of South Korea, Singapore, Taiwan, and Germany. The study of digital solutions was conducted by the method of comparative

analysis, which revealed the similarities and differences between the digital solutions Pro MED, HealthMap, EIOS and MedISys. To assess the potential of digital epidemiology in Kazakhstan we used a SWOT analysis, which resulted in proposals for further development of strategic objectives in the field of epidemiology that maximize the use of advantages and minimize the impact of weaknesses and external threats, including cybersecurity and digital inequality.

3. The Concept of Digital Epidemiology

Against the backdrop of modern challenges such as globalization, urbanization, climate change, and increased international travel, scientists and professionals around the world are actively seeking novel methodologies to epidemiological monitoring and surveillance. In these circumstances, technologies that enable real-time outbreak detection are becoming more relevant than ever. Research indicates that the concept of digital epidemiology is gaining strategic importance for epidemiological surveillance systems. The COVID-19 pandemic has also played a key role in its development, transforming and enhancing fundamental approaches [8].

Digital epidemiology, using technologies such as artificial intelligence (AI), machine learning, big data, mobile data, and social media data, opens up new opportunities for the enhancement of traditional epidemiology [9]. Furthermore, genomics, GPS, and data modeling have become crucial components in the procedures of data collecting, processing, and monitoring [10]. Researchers assert that digital data holds great potential for disease monitoring, enabling real-time data collection and trend tracking, which significantly contributes to improved public health results [11].

4. International Applications of Digital Epidemiology

Today, the theory of digital epidemiology has been practically applied in several international digital platforms aimed at the early detection and surveillance of infectious diseases. Among the most well-known solutions are Pro Med-mail, HealthMap, EIOS, and MedISys.

Pro MED-mail is a global network that includes one primary and eight regional networks operating in multiple languages, including French, Spanish, Russian, and Arabic. Users can customize their subscriptions according to their preferences: they may receive real-time updates or digest-format messages. Topic preferences can also be selected, encompassing plant-related events, zoonoses, animal diseases, or only disease alerts without commentary or discussion. The network is moderated by experts from 37 countries, who are responsible for monitoring, analyzing, and publishing pertinent information [12].

In addition to timely notifications and broad coverage, including data sharing among users, an crucial element of the project is the expert assessment and validation of disease reports. This allows for proactive decision-making in reaction to emerging circumstances. However, the partial automation of the alert process increases the risk of errors caused by human factors and subjective data interpretation.

In contrast to ProMED-mail, the digital platform HealthMap functions autonomously, without human involvement. It automatically aggregates data from social media and many web sources in real time, which enables more effective identification of infectious disease outbreaks before they are identified by traditional methods [13]. However, material derived from social media and other unauthorized sources may contain false data, posing a risk of inaccuracies and compromising the trustworthiness of the analysis [14].

HealthMap and ProMED have become key components of the Epidemic Intelligence from Open Sources (EIOS) system, established by the World Health Organization (WHO) [15]. EIOS was launched in 2017 to consolidate several global projects and create a coordinated strategy to the early detection, assessment, and surveillance of public health threats using open-source information. Like HealthMap, EIOS operates under the "One Health" framework, integrating monitoring of threats related to human, animal, and environmental health. The system utilizes a web-based platform to automatically process thousands of articles and reports each day, categorizing them by topics such as disease symptoms, response measures, and outcomes. This allows experts to collaboratively analyze data and rapidly assess potential risks.

Key EIOS stakeholders, including the U.S. Centers for Disease Control and Prevention (CDC), WHO, national health institutes, academic entities, and non-governmental organizations, use the system to analyze outbreak data and enhance crisis management. EIOS also provides analytical tools and contextual data, including demographic and environmental factors,

helping decision-makers better understand threats and act under uncertainty [16].

The European Commission employed a comparable methodology for gathering and analyzing data from media sources, government websites, and medical databases in the creation of the Medical Information System (MedISys). One of MedISys's advantages is its capacity to monitor not only human infections but also biological threats, natural disasters, and other health-related emergencies [17]. However, as with HealthMap, full digital automation does not always interpret news content accurately, making human intervention necessary for further clarification.

Balcan, D et al. initiated the GLEAM (Global Epidemic and Mobility Model) project, which simulates virus transmission using big data and network analysis technologies [18]. GLEAM applies exact mathematical calculations, making it a valuable scientific tool for epidemiological research. It provides powerful capabilities for evaluating epidemic development, especially on a global scale. However, the project requires large volumes of data and significant computing power, and may also need supplemental data from social media to include social and behavioral context.

Table 1 presents a comparative analysis of early warning systems based on criteria recommended by the U.S. CDC for evaluating public health surveillance systems designed for early outbreak detection [19-23].

Table 1 - Comparative table of digital early warning platforms

Criterion/ year of launch	ProMED-mail /1994	HealthMap/2006	EIOS/2017	MedISys/2004
Recorded events	- Unusual events related to human and animal health - clinical syndrome	- Broad coverage of infectious diseases - wide range of syndromes	- wide coverage of infectious diseases - includes all major syndromes - customization option	- wide coverage of human infectious diseases - diseases among animals and plants - chemical, biological and emergency situations
Data sources	- Medical staff - official government websites - media reports	- WHO - promedmail, - news media (e.g. Google News, Yahoo News, Factiva, Lexisnexis-Blog)	> 12,000 web sources (WHO, news channels, news feeds, etc.) - 240 Twitter accounts Facebook, Sprinkle, websites of ministries of Health	>22,000 web sources from 107 countries (WHO, news channels, news feeds, etc.)
Languages of Sources	At least 6 languages (English, French, Spanish, Portuguese, Russian and Arabic)	In 15 languages	80 languages	> 50 languages
Languages of Dashboard	6 languages (English, French, Spanish, Portuguese, Russian and Arabic)	7 languages (English, Chinese, French, Spanish, Portuguese, Russian and Arabic)	English	27 interface language options
Collection frequency	Near real-time	Hourly	Near real-time (every 5 minutes)	Near real-time (every 5 minutes)
Data filtering	No automatic filtering	Automatic categorization and filtering (84% accuracy)	AI-based filtering, duplicate removal, object recognition, categorization (483 categories)	Automatic categorization and filtering during visualization
Fields in messages	- Time - Location - Disease/syndrome - Link to source	- Time - Location - Disease/syndrome - Link to source	- Time - Location - Disease: COVID-19 - Link to source	- Summary - Source name - Time

Criterion/ year of launch	ProMED-mail /1994	HealthMap/2006	EIOS/2017	MedISys/2004
Message mapping	Mapping and related reports	- Mapping, related reports - With search	- Mapping, related reports - With search	Mapping, related reports With search
Data Analytics	None		- the number of COVID-19 cases worldwide and in selected countries Other epidemics: - the number of reports over a given period - Risk analysis tool: INFORM Risk Index	Time-series by disease/syndrome/location
Public Data Access	Free access No downloadable datasets	publicly available	COVID-19 dashboard and web page: Online viewing of only the latest reports. Other epidemics: there is no public access	Public access with downloadable datasets
The ability to customize	No	Not mentioned	A common event management system module that can be customized according to your needs	User-customizable system
Number of publications for system validation	>10	>10	>10	>10
Web and mobile application development	Web and mobile applications available	Web app and mobile applications available (i.e. "Flashes near me")	COVID-19 web app (public); others internal only. Mobile app: not mentioned	The web application is publicly available. Mobile app: not mentioned

The study substantiates the importance of digital data in epidemiology as a new scientific direction within medical science. Digital forecasting tools, combined with data collection and analysis, hold significant potential for supporting decision-making aimed at improving epidemiological conditions.

At the same time, digital data from social media, mobile applications, electronic medical records, and other platforms are increasingly becoming vulnerable to cyberattacks, presenting significant risks to data confidentiality. Security breaches and unlawful data practices undermine public trust in government digital health initiatives and raise legal and ethical dilemmas.

Therefore, when considering the digital epidemiology approach, issues of information security and ethical standards must be addressed [24]. It is essential to apply advanced information security measures—such as encryption technologies, data anonymization, and multi-level authentication systems. In addition, strict regulations and data governance policies must be followed to safeguard citizens' rights and ensure the protection of their privacy.

The development of digital epidemiology is not limited to projects and systems designed by scientists and research groups. A critical step toward improving outbreak management has been the adoption of digital technologies at the level of government initiatives. The experience of various countries in integrating digital solutions into national healthcare systems demonstrates how digital epidemiology projects can form the foundation for larger-scale responses. This shift from theoretical concepts to practical implementation underscores the importance of government readiness to adopt innovative approaches for monitoring and responding to public health threats.

During the COVID-19 pandemic, South Korea emerged as a role model among many countries. One of the key factors contributing to its success in containing the infection was strict contact tracing. The South Korean government developed a rapid identification and contact tracing system using mobile device data and banking transactions, combined with information about locations visited in public spaces [25]. This digital solution helped keep the virus spread under control.

Singapore developed the Trace Together app, which uses Bluetooth wireless communication technology to detect contacts and inform users of potential exposure. This system does not collect

location data, thus preserving privacy and enhancing public trust [26].

Taiwan created a powerful system that integrates travel history, specialized data, and mobile tracking to efficiently isolate potential disease hotspots [27]. The government ensures data privacy by using the information exclusively for medical purposes. Taiwan's approach demonstrated the effectiveness of cross-agency data integration for rapid epidemiological surveillance.

The German government developed an open-source digital contact tracing application called Corona-Warn-App. Individuals who tested positive for COVID-19 could voluntarily share their status through the app. Other users could then track how long and how closely they had been in contact with the infected person. Germany's experience with digital epidemiology highlights the necessity of applying and maintaining high data protection standards, which helps foster public trust [28].

5. Opportunities and Challenges for Digital Epidemiology in Kazakhstan

Digital epidemiology has not yet been widely used in Kazakhstan. For a full-fledged analysis of the prospects for using Internet data in the early detection of disease outbreaks, it is necessary to assess both the opportunities and risks that can both facilitate and hinder the implementation of such innovative solutions.

Table 2 - SWOT analysis of factors influencing the application of the digital epidemiology concept in Kazakhstan

Strengths	Weaknesses
• government support • well-developed IT infrastructure	• disparate medical digital data • lack of a single monitoring platform
Opportunities	**Threats**
• legislative framework for the development of innovative approaches • cooperation with international organizations within the framework of projects	• leakage of confidential information public distrust of government initiatives • rapid technology change

Strengths

One of the key factors driving the development of digital technologies in Kazakhstan is consistent government support. President Kassym-Jomart Tokayev in his annual addresses regularly emphasizes the importance of implementing digital solutions across all sectors, including healthcare. The country has developed and is actively implementing programs aimed at the adoption of digital technologies and the creation of corresponding infrastructure.

A legal framework is being established to promote the development of artificial intelligence (AI) in Kazakhstan, with a particular focus on using AI to improve production processes, data analysis, and forecasting—including within the healthcare system. The concept of digital transformation in Kazakhstan highlights the importance of data management. Under the national project "SmartData Ukimet", there are plans to integrate AI technologies to support forecasting and decision-making at the level of public administration.

The existing IT infrastructure also serves as a strong catalyst for further digitalization of the sanitary-epidemiological service. A unified integration portal, developed during the COVID-19 pandemic, consolidated PCR test data from all laboratories in Kazakhstan. This initiative laid the foundation for a centralized repository for all types of laboratory research. In addition, the automated registration of vaccinated individuals became a vital tool for forecasting and making timely healthcare decisions.

To ensure secure communication and protected data exchange among government bodies in Kazakhstan, the Unified Transport Environment of State Bodies has been established. This infrastructure element plays a critical role in supporting integration and coordination across all public institutions,

enhancing the efficiency of their operations and improving the quality of public services.

Weaknesses

Currently, Kazakhstan faces fragmentation of digital medical data. Medical information systems in healthcare institutions are developed and maintained by various IT companies, which has fostered the growth of the domestic IT services market. However, the use of different standards and protocols across these systems creates significant difficulties in integrating interagency information platforms, negatively affecting the comprehensiveness and effectiveness of healthcare management.

The absence of a unified centralized platform for monitoring the epidemiological situation significantly limits the ability of the sanitary-epidemiological service to take timely and effective measures. Additionally, there is a shortage of qualified specialists capable of working with big data and modern digital technologies. The incomplete adaptation of legislation for the use of data from social media and other open sources also hinders the full implementation of digital epidemiology in practice.

Opportunities

The development of a legislative framework for the implementation of artificial intelligence in Kazakhstan opens new prospects for improving the healthcare system and epidemiological monitoring. AI technologies can analyze large volumes of data from social platforms such as Twitter, Facebook, and others, enabling real-time tracking of potential outbreak threats. This approach supports rapid response and the development of preventive measures.

Support from the World Health Organization and the success of international projects such as HealthMap and Epidemic Intelligence from Open Sources (EIOS) demonstrate the effectiveness of such solutions. Kazakhstan's cooperation with the EIOS platform offers a valuable opportunity to enhance its epidemiological surveillance by integrating advanced technologies such as machine learning and big data analytics. Participation in these initiatives also grants access to international datasets, best practices, and creates an innovative environment for training and collaboration, thereby strengthening national capacities in epidemiology and health threat response.

Threats

Cyber risks, including data breaches and cyberattacks on medical and governmental platforms, pose a serious threat to the healthcare system. Unauthorized access to citizens' confidential information can undermine public trust in innovation-driven initiatives and lead to significant financial and reputational damage. Insufficient attention to cybersecurity standards, especially amid rising global cyber threats, increases infrastructure vulnerability. To minimize these risks, it is essential to implement modern data protection technologies, raise staff awareness of cyber hygiene, and develop effective incident response plans.

Another major threat is public distrust of new initiatives, particularly those involving the use of personal data from social media. These concerns are often rooted in potential ethical issues, such as breaches of confidentiality or misuse of data for discrimination, commercial gain, or surveillance. A lack of transparency in data processing methods exacerbates these fears. To overcome this barrier, it is crucial to adhere to strict data protection standards, ensure informed user consent, and maintain transparent communication that clearly explains the benefits and security of such approaches.

Finally, the rapid pace of technological development creates a risk of obsolescence for existing solutions, as new tools and methods emerge faster than current systems can adapt. This requires constant modernization of software and infrastructure, entailing additional financial and time investments. Failure to update in a timely manner reduces the effectiveness of technologies, increases vulnerability to emerging threats, and limits the competitiveness of the system. Addressing this issue requires the implementation of flexible platforms that allow for scalability and regular updates. The presented SWOT analysis has identified a number of measures that can be taken to successfully implement digital epidemiology:

Develop a unified interactive national platform for epidemiological monitoring that integrates both traditional and digital data within the framework of digital epidemiology. Organize training programs for specialists in big data management, AI-based analytics, and the use of digital platforms.

Explore the possibility of integration with global early warning systems to enable data sharing and receive analytical support.

Establish regulations governing the use of social media data and open-source information in emergency situations, drawing on international best practices. Civil society should be engaged in the development of such regulations to ensure transparency of government actions.

Engage scientific and expert communities in the development of the platform model and in

epidemiological assessments. This will help ensure transparency in the activities of the sanitary-epidemiological service and increase public trust in new initiatives.

Implement data protection measures and cybersecurity protocols in line with international standards. This approach will help build public trust in the digital systems introduced by the state.

Ensure sustainable funding for the development of new tools and the modernization of existing systems.

Strengthen public awareness on the importance of digital data disclosure during emergencies, while guaranteeing data confidentiality.

The SWOT analysis can also serve as a tool for deeper examination of the issues discussed in this article and for formulating recommendations for future improvement.

6. Conclusions

The study has revealed the potential of digital epidemiology as a complementary approach to traditional mechanisms of epidemiological surveillance and monitoring of infectious diseases. Digital data from unconventional and open sources—such as search queries, social media, online news, mobile data, and mobile applications—can significantly enhance the performance of the sanitary-epidemiological service.

International experience demonstrates that integrating digital solutions into the public health governance system can strengthen effectiveness of national epidemiological surveillance. For Kazakhstan, the implementation of digital epidemiology and big data technologies requires a gradual, phased adaptation process, taking into account existing infrastructure, workforce readiness, and legal frameworks.

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Эпидемиологиядағы цифрлық шешімдер: Халықаралық тәжірибе

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[2] Қазақстан Республикасы Президентінің жанындағы мемлекеттік басқару академиясының профессоры, Астана, Қазақстан

Түйіндеме

Мақалада инфекциялардың өршуін анықтау, талдау және алдын алу үшін цифрлық деректер мен аналитикалық әдістерді қолдануға негізделген цифрлық эпидемиология тұжырымдамасы көрсетілген. Қазіргі әлемде цифрлық эпидемиология дәстүрлі қадағалаудың қосымша тәсілі болып табылады және аймақтық деңгейде ерте тергеу, диагностика және әрекет ету шараларын бастамалық ету мүмкін. Сонымен қатар, жұмыста аурудың өршуін ерте анықтауда цифрлық эпидемиология аспектілерінің сәтті қолданылуын көрсететін ProMed-mail, HealthMap, EIOS және MedISys сияқты ерте ескерту жүйелеріне шолу жасалған. GLEAM жобасы үлкен деректерге негізделген инфекциялардың таралуының күрделі стохастикалық үлгілерін қолдана отырып, аналитикалық және болжау құралдарын ұсынады. Оңтүстік Корея, Сингапур, Тайвань және Германияның тәжірибесі COVID-19 пандемиясы кезінде мемлекеттік бастамалар шеңберінде цифрлық эпидемиология тәсілін қолданудың тиімділігін көрсетті. Зерттеу әдіснамасы әдебиетке шолу, салыстырмалы талдау және SWOT талдауы сияқты жалпы ғылыми және мамандандырылған әдістерді қамтиды. Ерте ескерту жүйелерінің салыстырмалы кестесі адамның минималды араласуымен ашық көздерден алынған үлкен деректерді пайдаланатын жүйелердің артықшылықтарын көрсетеді. SWOT-талдау цифрлық эпидемиология тұжырымдамасының Қазақстанда қолдану үшін әлеуеті бар екенін көрсетті, бұл эпидемиологиялық қадағалау мен мониторинг жүйесін жаңа деңгейге шығаруға мүмкіндік береді.

Жұмыстың мақсаты - жұқпалы ауруларды эпидемиологиялық қадағалау мен мониторингтің заманауи тәсілдерін талдау және Қазақстанда денсаулық сақтау жүйесіне енгізу мүмкіндіктерін бағалау.

Түйін сөздер: қоғамдық денсаулық сақтау, денсаулық сақтауды цифрландыру, ерте ескерту жүйесі, цифрлық эпидемиология, эпидемиология, үлкен деректер, жасанды интеллект.

Цифровые решения в эпидемиологии: Международный опыт

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Резюме

В статье излагается концепция цифровой эпидемиологии, которая основана на использовании цифровых данных и аналитических методов для обнаружения, анализа и предотвращения вспышек инфекций. В современном мире цифровая эпидемиология выступает дополнительным подходом к традиционному надзору, и может инициировать раннее расследование, диагностику и меры реагирования на региональном уровне. Кроме того, в работе представлен обзор систем раннего оповещения, такие как ProMed-mail, HealthMap, EIOS и MedISys, демонстрирующие успешное применение аспектов цифровой эпидемиологии в раннем выявлении вспышек заболеваний. Рассмотренный проект GLEAM предоставляет аналитические инструменты и инструменты прогнозирования с применением сложным стохастических моделей распространения инфекций на основе больших данных. Опыт Южной Кореи, Сингапура, Тайвань и Германии показал эффективность применения подхода цифровой эпидемиологии в рамках государственных инициатив во время пандемии COVID-19. Методология исследования сочетает общенаучные и специализированные методы, такие как обзор литературы, сравнительный анализ и SWOT-анализ. Сравнительная таблица систем раннего оповещения подчеркивает преимущества систем, использующих большие данные из открытых источников с минимальным вмешательством человека. SWOT-анализ показал, что концепция цифровой эпидемиологии имеет потенциал для применения в Казахстане, что позволит вывести на новый уровень систему эпидемиологического надзора и мониторинга.

Цель данной статьи – проанализировать современные подходы эпидемиологического надзора и мониторинга за инфекционными заболеваниями и оценить перспективы внедрения в систему здравоохранения в Казахстане.

Ключевые слова: общественное здравоохранение, цифровизация здравоохранения, система раннего оповещения, цифровая эпидемиология, большие данные, искусственный интеллект.