

# IMPACT OF ELECTRONIC HEALTH RECORD SYSTEMS ON QUALITY OF PRIMARY CARE WITHIN ESSENTIAL PUBLIC HEALTH FUNCTION FRAMEWORK

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## Abstract

Quality healthcare is the primary objective of any healthcare system. An effective electronic health record system is a crucial tool for achieving this goal. Its objectives are to improve the quality of medical care by automating the work of doctors and medical personnel in all areas of activity.

*The purpose of this study.* To explore the impact of electronic health records systems in primary health care facilities on improving the quality of care to ensure a sustainable organizational structure as an essential public healthcare function.

*Materials and methods.* The search was conducted in the MEDLINE, EMBASE, CINAHL, and Cochrane Central Register of Controlled Trials databases. The search strategy was based on the PICO Framework. The studies selected for the meta-analysis were published between January 1, 2010, and May 1, 2023. Two authors independently reviewed article titles and abstracts for eligibility. Information from the search was deduplicated using EndNote X9 and imported into the Covidence Systematic Review for review. Statistical processing was performed in RStudio 2023.03.1 Build 446 (Posit Software, PBC).

*Results.* A literature search identified 640 publications; 11 of them were included in the review. Meta-analysis showed that the use of electronic health records (EHRs) helps to reduce the time to complete medical records by 33.4 % (95% CI = 0.8 % to 1.2 %;  $p < 0.007$ ), promotes adherence to clinical recommendations (RR 1.30; 95 % CI = 1.04 to 1.79;  $p = 0.05$ ) and reduces prescribing errors (RR 0.44; 95 % CI = 0.34 to 0.53;  $p < 0.001$ ), which undoubtedly improves the quality of medical care.

*Conclusion.* This study validates the positive influence of EHRs on enhancing care quality in PHC settings, primarily by streamlining documentation, reducing prescription errors, and aligning workflow with clinical guidelines. These findings can help healthcare and public health professionals make informed decisions about EHR adoption.

**Keywords:** *Electronic health record systems (EHRs), electronic health record (EHR), quality of care, sustainable organizational structure, meta-analysis, essential public health function (EPHF), primary health care (PHC).*

## Introduction

Quality healthcare is the primary objective of any healthcare system [1]. An effective electronic health record system (hereinafter – EHR) is a key tool to achieve this goal. Its objectives are

to improve the quality of medical care by automating the work of doctors and medical personnel in all areas of activity, and to de-bureaucratize the work of medical staff [2]. This tool is recognized as one of the elements of a sustainable organizational

structure, which is also the fourth essential public health function of the health system, according to the World Health Organization document [3].

The World Health Assembly, in its resolution WHA69.1, identified the main public health functions as the most cost-effective, comprehensive, and sustainable ways to improve health and reduce disease burden [4].

The WHO Regional Office for Europe has developed and recommended ten essential public health functions, which serve as a detailed checklist of key public health activities and a resource for assessing public health services and capacities within a national approach. EPHFs are constantly evolving and should be updated regularly to reflect current assessments, new issues, and communication technologies, including social networks [5; 6].

The World Health Organization recognizes Primary Health Care (hereinafter – PHC) as the most important element of national health systems. WHO's policy of continuous improvement of PHC once again proves the essential contribution of PHC to individual and public health.

The following 5 functions are implemented at the PHC level:

1. Health promotion, including the impact on social determinants and reducing inequalities in health outcomes;
2. Prevention of diseases, including early detection of health problems;
3. Ensuring that the public health sector has sufficient qualified personnel;
4. Ensuring sustainable institutional structures and funding;
5. Advocacy, Communication, and Social Mobilization for Health.

Electronic health record systems (EHRs) ensure continuity of production and organizational processes by serving as direct elements of forming a stable organizational structure.

Increasingly, medical organizations are adopting electronic document processing to reduce the time required to complete necessary documentation [7]. At the same time, there is a lack of studies on the effectiveness of EHRs and their impact on the quality of care provided to ensure an organizational structure [8]. Contrary to the widespread belief that EHRs have an undeniable advantage, some studies show contradictory results, indicating

a decrease in the quality of medical care after the implementation of these systems [9; 10].

The purpose of this meta-analysis is to investigate the impact of EHRs on improving the quality of healthcare in order to ensure a sustainable organizational structure in PHC institutions, as an operational function of public health.

The study is of value to healthcare managers and public health professionals because the results can contribute to the optimization and improvement of the quality of medical care, including primary healthcare institutions.

*The purpose of this study.* To explore the impact of electronic health records systems in primary health care facilities on improving the quality of care to ensure a sustainable organizational structure as an essential public healthcare function.

*Novelty of the work:* For the first time, the impact of EHRs on improving the quality of medical care was examined to ensure a sustainable organizational structure in PHC institutions as an operational function of public health.

### **Materials and methods**

Criteria for inclusion in the study: papers that explored the role of EHRs in improving quality in institutions with PHC units; papers examining the impact of EHRs on the quality of clinical care; research using electronic health record (hereinafter – EHR) data for decision making; works investigating the impact of EHRs on the organizational structure; studies published no earlier than January 01, 2010, and no later than May 01, 2023.

*Criteria for exclusion from the study:* works published not in the appropriate time interval; studies that are only available as abstracts or conference proceedings; studies whose conclusions are based on the study of patient feedback; studies that use performance data from third-party registries; studies in which EHR resources were used to make decisions on the spot, without additional analysis of the information received.

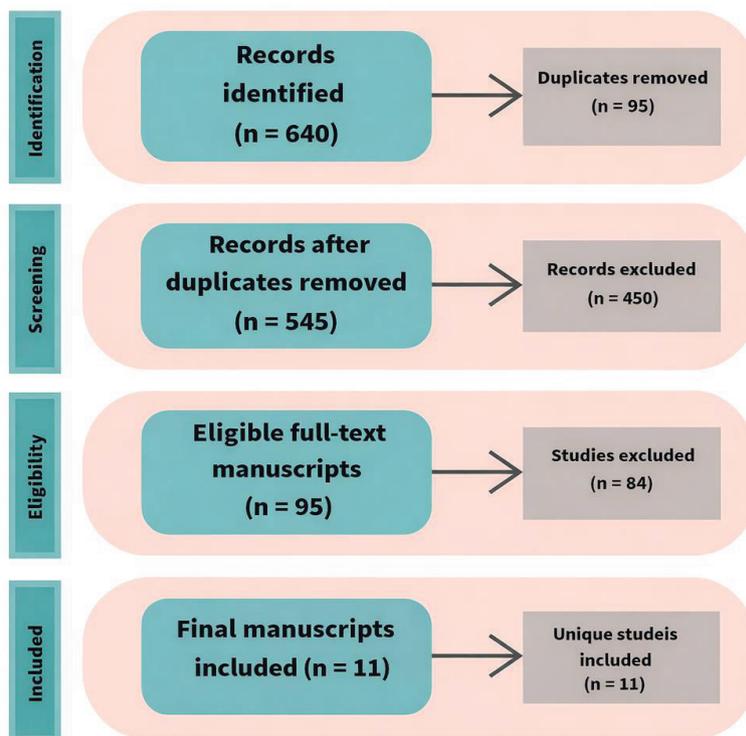
### *Search strategy and study selection*

The PICO Framework [11] guided our search strategy. EHRs refers to computerized patient data systems, including EHRs and clinical decision support systems (hereinafter – CDSS). Searches covered MEDLINE, EMBASE, CINAHL, and Cochrane databases, reflecting their scientific medical community use [12]. English language searches were used, including manual searches, citation searches, and

keywords: «Electronic health record», «Improving the quality of medical care», «Improvement», «Electronic decision support systems», «Optimization», and «Reduction of medical errors», «Electronic medical documentation», «Sustainable organizational structure», «Adverse drug reactions», «Completion of medical documentation».

Two authors independently screened article

titles and abstracts against exclusion criteria. Full texts were analyzed if exclusions were unclear. Disagreements were resolved by discussion. Full-text analysis was by one author, with inclusion confirmed by another. Our study adheres to PRISMA guidelines for systematic review and meta-analysis reporting [13]. The article selection process is illustrated in Figure 1.



**Figure 1.** Selection of studies for meta-analysis according to PRISMA guidelines [13]

#### *Data extraction and quality assessment*

The data collection template was developed in Microsoft Excel version 16.34. Using the Cochrane EPOC tool, the following data were extracted: authors' names, country, year, study design, conditions, duration, and results.

#### *Statistical data processing*

The search information was imported into the EndNote X9 link manager for deduplication and then imported into the Covidence Systematic Review software, a web-based review platform. Statistical processing was performed using RStudio 2023.03.1 Build 446 (Posit Software, PBC). A meta-analysis was conducted using a random effects model for each indicator. Heterogeneity was assessed using Cochran's Q-test.

#### **Results**

A literature search identified 640 studies.

After removing duplicates, 545 potentially relevant abstracts of articles were examined, and then 450 were excluded. A total of 95 full-text articles were selected for further review, of which 84 were excluded based on exclusion criteria. A total of 11 manuscripts were included in the review, which examined the relationship between the use of electronic medical records systems and the quality of care.

A summary of the main characteristics of the studies is described in Table 1. The design of the studies included in this meta-analysis was diverse, including review (n = 3), prospective cohort study (n = 1), systematic review (n = 1), descriptive qualitative study (n = 1), action research (n = 1), retrospective, observational study (n = 1), intervention evaluation study (n = 2), research before and after implementation (n=1).

**Table 1.** Main characteristics of the studies included in the meta-analysis

No.	Article	Study Design	Place of the study	Key parameter to include in meta-analysis	Indicators assessed during the meta-analysis	Average <i>p</i> -value for each indicator	Average confidence interval for each value
1	Robert S. Janet. 2019 [14]	Review	Multidisciplinary medical center with PHC departments and an emergency room (ER)	Application of EHRs	Time to complete medical records Adherence to clinical recommendations Mistakes in prescribing medications Adverse drug reactions	<0.007	0.8-1.2
2	Dara Koper [15]	Prospective cohort study	Multidisciplinary medical center with a PHC department	Application of EHRs	Time to complete medical records Adherence to clinical recommendations Mistakes in prescribing medications Adverse drug reactions	0.05	1.04-1.79
3	Sofia Säfholm [16]	Systematic review	For a systematic review, studies were taken that were conducted in multidisciplinary institutions with a PHC department	Application and implementation of EHRs	Time to complete medical records Adherence to clinical recommendations Mistakes in prescribing medications Adverse drug reactions	< 0.001	0.34-0.53
4	Kok Wai Kee [9]	Review	Medical centers (including PHC departments)	Consistent implementation of EHRs	Time to complete medical records Adherence to clinical recommendations Mistakes in prescribing medications Adverse drug reactions	< 0.001	0.43-0.90
5	Shamma Al Alawi [17]	Descriptive qualitative research	Health Center with the PHC Department	The use of paper carriers in comparison with EHRs	Time to complete medical records Adherence to clinical recommendations Mistakes in prescribing medications Adverse drug reactions	<0.001	61.0-79.4

6	Wetterneck TB et al. 2011 [18]	Research before and after implementation	City Medical Center at the University Hospital, including the Department of PHC	The effectiveness of the use of EHRs	Time to complete medical records Adherence to clinical recommendations Mistakes in prescribing medications Adverse drug reactions	0.05	1.03-1.80
7	Shabbir SA et al. 2010 [19]	Action Research	Multidisciplinary medical center with a PHC department	Use of paper documentation and EHRs	Time to complete medical records Adherence to clinical recommendations Mistakes in prescribing medications Adverse drug reactions	0.05	1.04-1.33
8	Banerjee D., et al., 2017 [20]	Intervention Evaluation Study	Multidisciplinary medical center with a PHC department	Application of EHRs	Time to complete medical records Adherence to clinical recommendations Mistakes in prescribing medications Adverse drug reactions	0.03	1.04-1.75
9	Armor BL et al., 2016 [21]	Retrospective, observational study	Academic medical center with a PHC department	Prescribing medications EHRs	Time to complete medical records Adherence to clinical recommendations Mistakes in prescribing medications Adverse drug reactions	0.03	1.04-1.79
10	Chen J. et al., 2023 [22]	Intervention Evaluation Study	Oncology clinic with PHC department	Application of CDSS tools	Time to complete medical records Adherence to clinical recommendations Mistakes in prescribing medications Adverse drug reactions	0.05	1.03-1.67
11	Graeme N. et al., 2014 [7]	Review	For the review, studies were taken that were conducted in multidisciplinary institutions with a PHC department	EHR and EHRs	Time to complete medical records Adherence to clinical recommendations Mistakes in prescribing medications Adverse drug reactions	0.05	1.04-1.79

\*Note: **EHRS** – Electronic Health Records System

**ER** – Emergency Room

**EHR** – Electronic Health Record

**CDSS** – Clinical Decision Support System

Source: elaborated by the authors.

Selected studies have examined the relationship between the use of EHRs and the reduction in time spent by healthcare professionals complet-

ing paperwork. The association between EHRs use and adherence, medication use, medical errors, and adverse effects was assessed in Table 2.

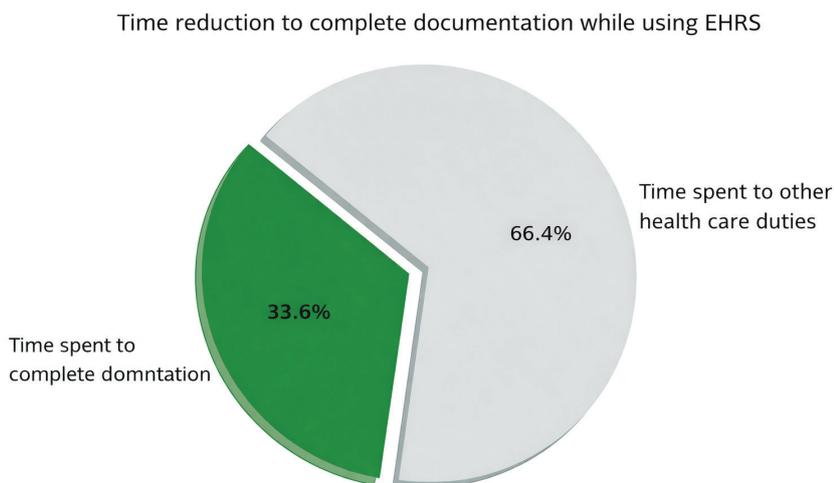
**Table 2.** Association between EHRs use and adherence, medication use, medical errors, and adverse effects

Index	Description	Value	95 % Confidence Interval	Significance level (p)
Time to complete documentation	%	33.4	0.8-1.2	<0.007
Adherence to clinical recommendations	Relative risk (RR)	1.30	1.04-1.79	0.05
Mistakes in prescribing medications	Relative risk (RR)	0.44	0.34-0.53	<0.001
Adverse drug reactions (ADRs)	Relative risk (RR)	0.59	0.43-0.90	0.045

Source: compiled by the authors

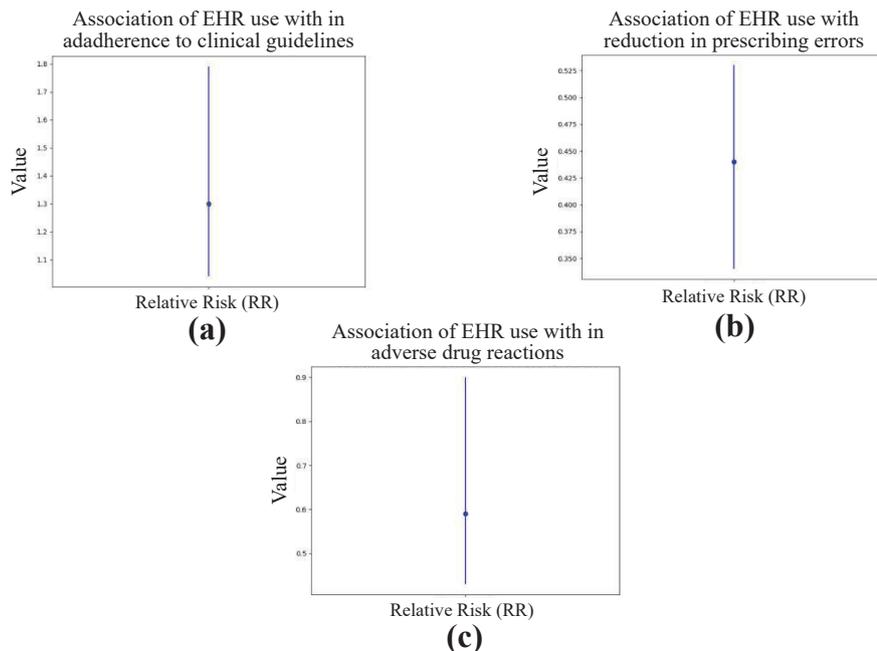
A meta-analysis found an association between the use of EHRS by medical professionals and a reduction in the time to complete documentation (Figure 2), with a mean difference of 33.4 % (95 % CI = 0.8 % to 1.2 %; p < 0.007). The use of EHR was also found to be associated with a higher rate of adherence to clinical guidelines (Figure 3a), a relative risk (RR) of 1.30 (95 % CI = 1.04 to 1.79; p = 0.05) and with a decrease in prescribing errors (Figure 3b), RR 0.44 (95 % CI = 0.34 to 0.53; p < 0.001), and with a reduction in adverse drug reac-

tions (Figure 3c), RR 0.59 (95 % CI = 0.43 to 0.90; p = 0.045). There was no association between EHR use and mortality (p = 0.936). High interstudy heterogeneity was found in terms of time spent completing documentation (Q-test p < 0, 001 and I<sup>2</sup> = 92.3 %), adherence to clinical guidelines (Q-test p < 0.001 and I<sup>2</sup> = 91.2 %), prescribing errors (Q-test p < 0.001 and I<sup>2</sup> = 96.1 %), and ADRs (Q-test p < 0.001 and I<sup>2</sup> = 79.4 %). There was also moderate heterogeneity in mortality (Q-test, p = 0.012; I<sup>2</sup> = 61.0 %).



**Figure 2.** Reduction of time costs when using EHRS

Source: compiled by the authors



**Figure 3.** Association of EHR use with (a) adherence to clinical guidelines, (b) reduction in prescribing errors, (c) reduction in adverse drug reactions

*Source: compiled by the authors*

#### *Sensitivity analysis and publication bias*

Sensitivity analysis showed that the overall effect remains stable even when any study is excluded from the analysis, and this does not lead to a significant improvement in the level of heterogeneity.

#### **Discussion**

The application of EHRs represents a significant step in improving healthcare effectiveness and sustainability [1; 2; 23].

By analyzing the meta-analysis results obtained in the context of ensuring a sustainable organizational structure, it is possible to highlight the significant role of EHRs in enhancing the quality of healthcare [16; 24].

Based on the results obtained in this study, we can affirm that the introduction and proper use of EHRs undoubtedly contribute to the improvement of the quality of medical care. These systems help to reduce the time (on average, 33.4%) that medical staff spend on completing paperwork, which in turn improves operational processes and allows staff to focus on more critical aspects of medical care. This represents a crucial balance between optimizing processes and maintaining a stable organizational structure.

An important aspect which is confirmed by this meta-analysis is the connection between the use of EHRs and the reduction of medication errors in prescribing medicines (RR 0.44; 95 % CI = 0.34 to 0.53;  $p < .001$ ), as well as undesired drug

reactions (overall RR 0.59; 95 % CI = from 0.43 to 0.90;  $p = 0.045$ ). It is known that effects like that can have a serious impact on patient health and the financial sustainability of medical institutions [25-27]. Reducing medical errors and adverse reactions from EHRs is important to patient safety and minimizing the cost of treating complications [28-30].

It is also important to consider that well-designed EHRs support adherence to clinical guidelines and protocols, which is important for maintaining the organizational structure [31-33]. This directly affects the operational function of public health, providing a more coherent and effective approach to treatment and care for patients [34; 35].

At the same time, in the clinical care setting, information is recorded into EHRs by various healthcare professionals, including physicians, nurses, medical assistants, and other clinical staff. The accuracy and completeness of the data entered depend heavily on the documentation practices of these health care providers, which can vary between institutions and countries.

Furthermore, we also face infrastructural problems, including accessibility, cost, and quality of internet in remote rural areas, as well as the availability of good computer technology.

Not all health managers and health workers are fully familiar with the digital tools available and the new opportunities they present. For many older doctors, the transition to EHRs is a challenge [36].

Nonetheless, we should note that despite its advantages, this study has limitations. Furthermore, increasing the heterogeneity between studies can affect the stability of results and requires further analysis. In addition, the technical aspects of different EHRSs are not always provided when evaluating a system, thereby limiting the full understanding and assessment of the effectiveness of these systems [37; 38].

Further studies devoted to technical aspects and implementation strategies will undoubtedly help improve and refine approaches to EHRS. Moreover, it will be possible to fully exploit their potential to maintain the effectiveness and stability of the health system.

### Conclusion

A meta-analysis of studies examining the relationship between EHRS and quality improvement in healthcare, within the context of organizational sustainability, has provided valuable research results. A meta-analysis of sources, including 11 studies analyzed in detail, found statistically significant associations between the use of EHRS and improved quality of care. As a result, it became possible to formulate key recommendations for PHC medical institutions and the public health system.

A meta-analysis confirmed a significant association between the use of EHRS and a reduction in the time spent by medical professionals on completing documentation (mean reduction in time by 33.4 %, (95 % CI = 0.8 % to 1.2 %;  $p < 0.007$ ) This is direct evidence of an increase in operational efficiency and the release of resources for more important medical tasks.

Most importantly, the use of EHRS was also associated with improved adherence to clinical guidelines (RR 1.30, 95 % CI 1.04-1.79;  $p = 0.05$ ), highlighting the role of these systems in providing structured and coordinated medical care. Reduced prescribing errors (RR 0.44, 95 % CI = 0.34 to 0.53;  $p < 0.001$ ) and adverse drug reactions (RR 0.59, 95 % CI = 0.43 to 0.90;  $p = 0.045$ ) emphasize the importance of using EHRS to ensure patient safety and minimize adverse effects.

Despite the noted positive outcomes, it is crucial to acknowledge significant study heterogeneity, necessitating further scrutiny. These meta-analysis findings hold practical implications for healthcare providers, managers, and public health experts. The study confirms that implementing

electronic medical record systems enhances care quality, process efficiency, and organizational structure. More research on technical aspects and implementation strategies could deepen understanding of EHRS's practical role and potential in achieving a sustainable structure.

These results suggest the need for proactive implementation and optimization of EHRS in medical institutions to achieve enhanced care quality and a sustainable organizational structure. This approach, aligned with IT trends, will enhance treatment outcomes, resource utilization, patient safety, and organizational sustainability.

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## АЛҒАШҚЫ МЕДИЦИНАЛЫҚ-САНИТАРЛЫҚ КӨМЕК ДЕҢГЕЙІНДЕ ҚОҒАМДЫҚ ДЕНСАУЛЫҚ САҚТАУДЫҢ ОПЕРАТИВТІ ФУНКЦИЯСЫН ҚАМТАМАСЫЗ ЕТУ ШЕҢБЕРІНДЕ МЕДИЦИНАЛЫҚ ҚҰЖАТТАМАНЫҢ ЭЛЕКТРОНДЫҚ ЖҮЙЕЛЕРІНІҢ МЕДИЦИНАЛЫҚ КӨМЕК САПАСЫНА ӘСЕРІ

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### Андатпа

Сапалы медициналық көмек көрсету-кез келген денсаулық сақтау жүйесінің негізгі мақсаты. Мақсатқа жетудің негізгі құралдарының бірі-медициналық құжаттаманың тиімді жүйесі. Оның міндеттері-қызметтің барлық бағыттары бойынша дәрігерлер мен медициналық персоналдың жұмысын автоматтандыру есебінен медициналық көмектің сапасын арттыру.

*Мақсаты.* Қоғамдық денсаулық сақтаудың жедел функциясы ретінде тұрақты ұйымдық құрылымды қамтамасыз ету мақсатында алғашқы медициналық-санитарлық көмек мекемелеріндегі медициналық құжаттаманың электрондық жүйелерінің медициналық көмектің сапасын арттыруға әсерін зерттеу.

*Материалдар мен әдістер.* Іздеу MEDLINE, EMBASE, CINAHL дерекқорларында және Cochrane бақыланатын сынақтардың орталық тізілімінде жүргізілді. Іздеу стратегиясы PICO Framework-қа негізделген. Мета-талдау үшін таңдалған зерттеулер 01.01.2010 және 01.05.2023 жылдар аралығында жарияланды. Екі автор мақалалардың тақырыптары мен критерийлерге сәйкестігін тәуелсіз зерттеді. Іздеуден алынған ақпарат EndNote X9 көмегімен көшірілді, тексеру үшін Covid Systematic Review-ке импортталды. Статистикалық өңдеу R Studio 2023.03.1 Build 446 (Post Software, PC) бағдарламасында орындалды. Мета-талдау әр көрсеткіш үшін кездейсоқ эффект моделін қолдана отырып жүргізілді, гетерогенділік Кохреннің Q критерийі арқылы бағаланды.

*Нәтижелер.* Әдебиеттерді іздеу 640 зерттеуді анықтады, шолуға 11 қолжазба енгізілді. Мета-талдау көрсеткендей, электронды медициналық карталарды (ЕМС) пайдалану медициналық құжаттарды толтыру уақытын 33,4 %-ға (95 % сі = 0,8 %-дан 1,2 %-ға дейін;  $p < 0,007$ ) қысқартуға көмектеседі, клиникалық ұсыныстардың сақталуына ықпал етеді (о 1,30; 95 % сі = 1,04-тен 1,79-ға дейін;  $p = 0,05$ ) және дәрі-дәрмектерді тағайындау кезінде қателерді азайтуға мүмкіндік береді (о 0,44; 95 % сі = 0,34 0,53 дейін;  $p < 0,001$ ), бұл сөзсіз медициналық көмектің сапасын арттырады.

*Қорытынды.* Бұл зерттеу медициналық құжаттаманың электрондық жүйелерінің алғашқы медициналық-санитариялық көмек мекемелеріндегі медициналық көмектің сапасын арттыруға, негізінен құжаттаманы толтыру уақытын оңтайландыру, персоналдың қателер санын азайту және клиникалық ұсынымдарға сәйкес жұмысты ұйымдастыру есебінен оң әсерін растайды. Зерттеу нәтижелері медициналық құжаттаманың электрондық жүйелерін енгізу туралы негізделген шешімдер қабылдау кезінде денсаулық сақтауды ұйымдастыру мамандары, қоғамдық денсаулық сақтау мамандары үшін пайдалы болады.

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## ВЛИЯНИЕ ЭЛЕКТРОННЫХ СИСТЕМ МЕДИЦИНСКОЙ ДОКУМЕНТАЦИИ НА КАЧЕСТВО МЕДИЦИНСКОЙ ПОМОЩИ В РАМКАХ ОБЕСПЕЧЕНИЯ ОПЕРАТИВНОЙ ФУНКЦИИ ОБЩЕСТВЕННОГО ЗДРАВООХРАНЕНИЯ НА УРОВНЕ ПМСП

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### Аннотация

Оказание качественной медицинской помощи – основополагающая цель любой системы здравоохранения. Одним из ключевых инструментов для достижения цели является эффективная система медицинской документации. Ее задачи – повышение качества медицинской помощи за счет автоматизации работы врачей и медицинского персонала по всем направлениям деятельности.

*Цель.* Изучить влияние электронных систем медицинской документации в учреждениях первичной медико-санитарной помощи на повышение качества медицинской помощи в целях обеспечения устойчивой организационной структуры, как оперативной функции общественного здравоохранения.

*Материалы и методы.* Поиск осуществлялся в базах данных MEDLINE, EMBASE, CINAHL и в Кокрановском центральном регистре контролируемых испытаний. Стратегия поиска базирова-

лась на PICO Framework. Исследования, отобранные для мета-анализа, были опубликованы в период с 01.01.2010 г. по 01.05.2023 г. Два автора независимо друг от друга изучали заголовки и резюме статей на соответствие критериям. Информация из поиска была дедублирована с помощью EndNote X9, импортирована в Covidence Systematic Review для проверки. Статистическую обработку выполняли в RStudio 2023.03.1 Build 446 (Posit Software, PBC). Мета-анализ проводили с использованием модели случайных эффектов для каждого показателя, гетерогенность оценивали через Q-критерий Кохрена.

**Результаты.** Поиск литературы выявил 640 публикаций, 11 статей были включены в обзор. Мета-анализ показал, что использование электронных медицинских карт (ЭМК) помогает сократить время на заполнение медицинской документации на 33,4 % (95 % ДИ = 0,8 % до 1,2 %;  $p < 0,007$ ), способствует соблюдению клинических рекомендаций (ОР 1,30; 95 % ДИ = 1,04 до 1,79;  $p = 0,05$ ) и позволяет снизить ошибки при назначении препаратов (ОР 0,44; 95 % ДИ = 0,34 до 0,53;  $p < 0,001$ ), что несомненно повышает качество медицинской помощи.

**Заключение.** Данное исследование подтверждает положительное влияние электронных систем медицинской документации на повышение качества медицинской помощи в учреждениях первичной медико-санитарной помощи, главным образом за счет оптимизации времени заполнения документации, снижения количества ошибок персонала и организации работы в соответствии с клиническими рекомендациями. Результаты исследования будут полезными для специалистов по организации здравоохранения, специалистов общественного здравоохранения при принятии обоснованных решений о внедрении электронных систем медицинской документации.

**Ключевые слова:** Электронные системы медицинской документации (ЭСМД), электронная медицинская карта (ЭМК), качество медицинской помощи, устойчивая организационная структура, мета-анализ, оперативная функция.

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