

## **Meta-Analysis the Effect of Electronic Health Record Utilization on Mortality and Readmission**

**Desi Syahbaniar<sup>1)</sup>, Didik Gunawan Tamtomo<sup>2)</sup>, Bhisma Murti<sup>1)</sup>**

<sup>1)</sup>Masters Program in Public Health, Universitas Sebelas Maret

<sup>2)</sup>Faculty of Medicine, Universitas Sebelas Maret

### **ABSTRACT**

**Background:** The development of technology shows a very rapid development, especially in the health sector. One example of the use of technology in the health sector is the electronic health record. Electronic health records provide several benefits, one of which can reduce mortality and readmission rates in patients. The purpose of this study was to estimate the effect of electronic health records on mortality and readmission rates by meta-analysis.

**Subjects and Method:** This was a meta-analysis study using PRISMA flowchart guidelines. The article search process was carried out between 2011-2022 using databases from PubMed, Google Scholar, ProQuest, Science Direct and Scopus. The PICO formula used is P = patients with asthma. I= using internet-based self-management. C= without using internet-based self-management. O= asthma control. Article searches were performed using the keywords “mhealth” OR “mobile health” OR “telemedicine” AND “self management” AND “asthma control” OR “asthma treatment” AND “asthma control”. The inclusion criteria were full paper articles with randomized controlled trial study design, articles using English, the intervention provided was the application of internet-based self-management, and the outcome was asthma control. Based on the database, there were 9 articles that met the inclusion criteria. The analysis was carried out using Revman 5.3 software.

**Results:** A total of 13 articles spread across 2 continents, namely Asia (Taiwan, Singapore, and South Korea) and North America (South America). Articles reviewed in the meta-analysis showed that electronic health records had an effect on reducing mortality by 0.74 times compared to those without using electronic health records (aOR= 0.74; 95% CI= 0.64 to 0.86; p<0.001). In addition, it was also found that electronic health records had an effect on reducing readmission by 0.77 times compared to without using electronic health records (aOR= 0.77; CI 95%= 0.62 to 0.95; p= 0.010)

**Conclusion:** The application of electronic health records has an effect on reducing mortality and readmission rates.

**Keywords:** Electronic health record, mortalitas, readmission

### **Correspondence:**

Desi Syahbaniar. Masters Program in Public Health, universitas Sebelas Maret. Jalan Ir. Sutami 36A, Surakarta 57126, Central Java, Indonesia. Email: desiniar15@gmail.com. Mobile: +628-7708465646

### **Cite this as:**

Syahbaniar D, Tamtomo DG, Murti B (2022). Meta-Analysis the Effect of Electronic Health Record Utilization on Mortality and Readmission. *J Health Policy Manage.* 07(02): 103-111. <https://doi.org/10.26911/thejhp.2022.07.02.02>.



Journal of Health Policy and Management is licensed under a Creative Commons Attribution-Non Commercial-Share Alike 4.0 International License.

### **BACKGROUND**

Currently, the development of science and technology shows very rapid development in all fields, including the health sector. One example of the use of information technology in the health sector which is current-

ly a trend in global health services is the electronic health record or the so-called Electronic Health Record (EHR). EHR is an electronic record or record of health-related information (Health Record Information) that includes patient information such as

personal contact information, patient medical history, allergies, test results, treatment plans and radiology reports. Some of the benefits of EHR include increasing efficiency, increasing positive patient outcomes, and population health (Kruse et al., 2018). The EHR may also include a Decision Support System that provides up-to-date medical knowledge, reminders or other measures that assist healthcare professionals in making decisions (Sudarmaji et al., 2020).

Over the past few years, there has been a lot of research on the benefits of using an EHR. The implementation of EHR is believed to be able to improve several aspects such as service quality, patient satisfaction and patient care outcomes. Based on research by Campanella et al. (2016) it is known that the implementation of EHR can improve the quality of communication between medical personnel, provide better access to the necessary information, reduce side effects and medication errors and actions on patients. The advantages of using the EHR are seen as important in saving unnecessary hospital costs.

Other studies also suggest that the existence of CDSS in the EHR promotes better adherence to evidence-based guidelines, increases the use of preventive measures, identifies potential risks associated with prescribing multiple drugs, increases the availability of more accurate medical records, and improves patient-physician communication. Amato et al., (2017). Yanamadala et al. (2016) stated that patients in hospitals equipped with EHR have a low inpatient mortality rate, low readmission rates and low patient safety indicators. Research by Han et al. (2016) also showed that mortality was reduced by 2.10 times after the implementation of EHR for 4 months.

Based on the description of the background, the researchers are interested in conducting study with a systematic review approach to relevant studies, namely by using meta-analysis. This study aim to investigate relevant primary studies to assess the effect of implementing EHR on mortality and readmission.

## SUBJECTS AND METHOD

### 1. Study Design

This study uses a meta-analysis research design. This study article was obtained from several online databases such as MEDLINE/PubMed, Google Scholar, ProQuest, Science Direct dan Spinger Link. Kata kunci yang digunakan dalam proses pencarian adalah “electronic health record” OR “computerized health record” OR “healthcare system information” AND “patient outcomes” OR “health outcomes” AND “mortality” AND “readmission”.

### 2. Inclusion and Exclusion Criteria

The inclusion criteria used in this study were full text articles published between 2012-2022, using English and using a Randomized Controlled Trial study design. The outcomes were in the form of mortality and readmission. The final results of the study were reported using the Adjusted Odds Ratio (aOR).

### 3. Inclusion Criteria

The exclusion criteria used were articles published before 2012, the study subjects were hospitals and articles were not in English.

### 4. Definition of Operational Variables

The articles included in this study were PICO-adjusted. The search for articles was carried out by considering the eligibility criteria using the following PICO model: Population = Patients. Intervention= Using electronic health records. Comparison = do not use electronic health records. Outcome= mortality and readmission.

**Electronic Health Record** is an information system or technology that contains all information related to patient health records in the long term.

**Mortality** is the permanent loss of signs of life in individuals and the loss of bodily functions.

**Readmission** is a condition where a patient is re-treated who previously received inpatient services at the hospital.

### 5. Study Instruments

This study was guided by the PRISMA flow diagram and the assessment of the quality of research articles using the Critical Appraisal Skills Program (CASP) for Randomized Controlled Trials. The 11 questions used are as follows:

- a. Does the experiment clearly address the clinical problem?
- b. Is the intervention given to participants randomly?
- c. Are all patients included in the study properly accounted for in the conclusions? Are all patients analyzed according to the randomized study groups?
- d. Are patients, health workers and researchers blinded?
- e. Are the study groups similar at the start of the study?
- f. Outside of the intervention studied, are the study groups treated equally?
- g. Is the intervention group large enough?
- h. How precise is the estimation of the effect of the intervention?
- i. Do the benefits provided by the intervention outweigh the costs and disadvantages?
- j. Are the results applicable to the context of practice or the local population?
- k. Are all other clinically important outcomes considered in this article?

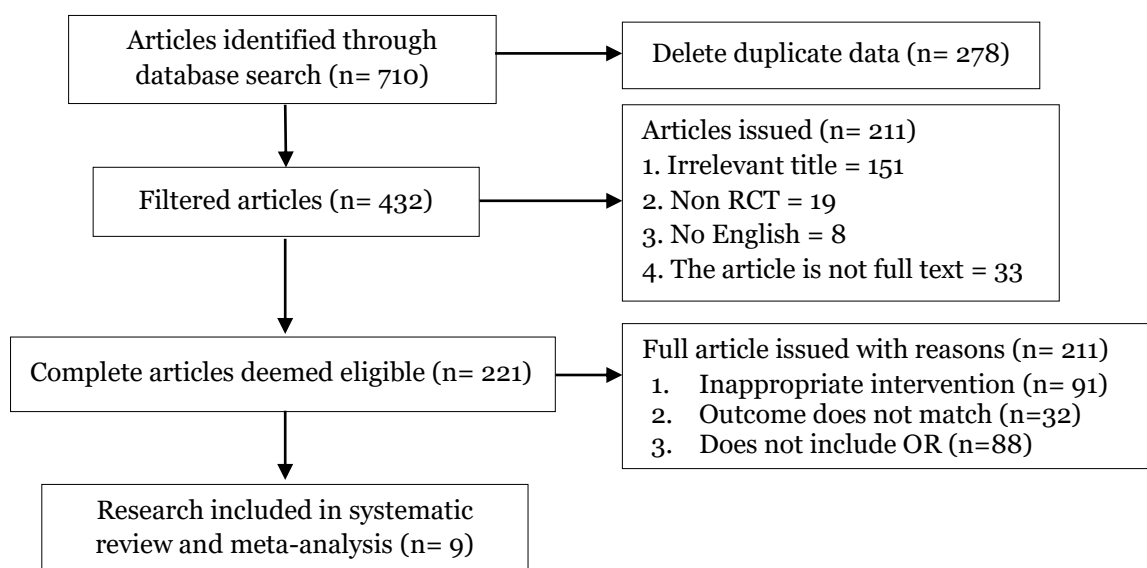
### 6. Data analysis

The articles obtained were processed using the Review Manager application (RevMan 5.3). Data processing was carried out by calculating the effect size and heterogeneity values to determine the research combination model and form the final results of the meta-analysis in the form of forest plots and funnel plots.

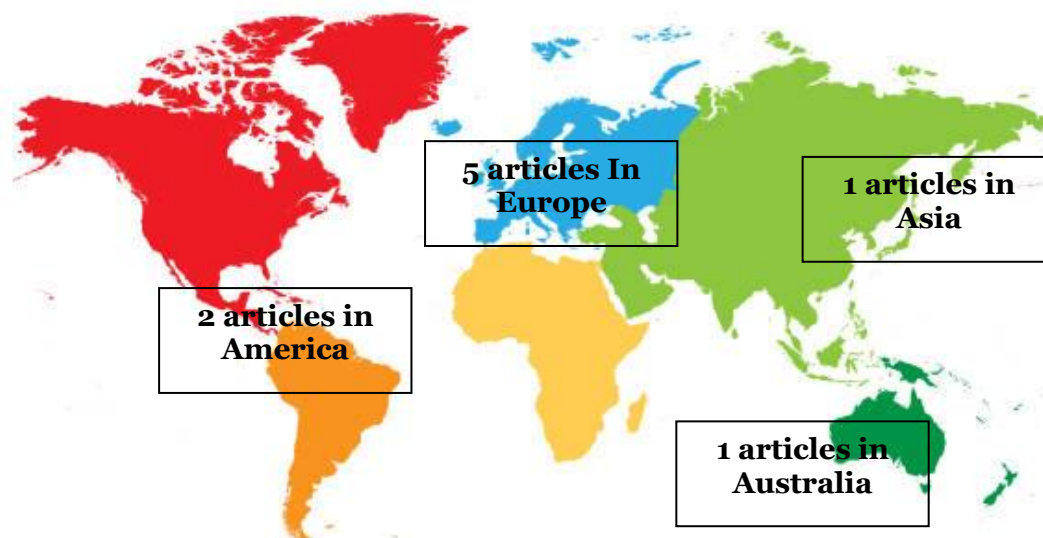
## RESULTS

The article review in this study used the PRISMA flow diagram which can be seen in Figure 1. The total articles obtained were 9 articles spread across continents, namely the Asian continent, the American continent, the European continent and the Australian continent. The following is the process of reviewing the articles used in this research.

The following are the results of the quality assessment of the Randomized Controlled Study on the effectiveness of internet-based self-management research on asthma control.



**Figure 1. Article search results with PRISMA flow diagram**



**Figure 2. Map of the research area**

**Table 1. Results of quality assessment of randomized controlled studies**

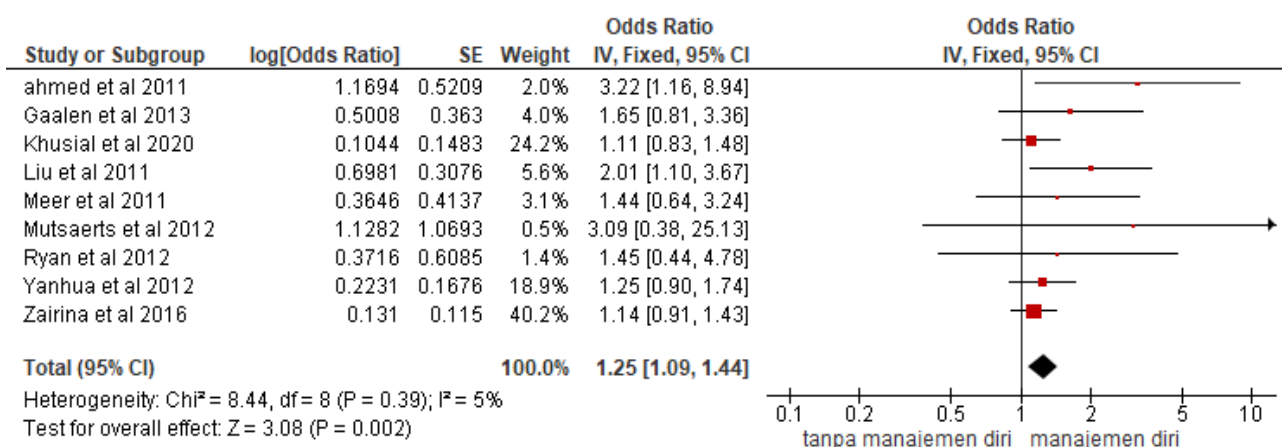
Primary Study	Criteria											Total
	1	2	3	4	5	6	7	8	9	10	11	
Ahmed et al. (2011)	1	1	1	1	1	1	1	1	1	1	1	11
Galen et al. (2013)	1	1	1	1	1	1	1	1	1	1	1	11
Khusial et al. (2020)	1	1	1	1	1	1	1	1	1	1	1	11
Liu et al. (2011)	1	1	1	1	1	1	1	1	1	1	1	11
Meer et al. (2021)	1	1	1	1	1	1	1	1	1	1	1	11
Mutsaerts et al. (2012)	1	1	1	1	1	1	1	1	1	1	1	11
Ryan et al. (2012)	1	1	1	1	1	1	1	1	1	1	1	11
Yanhua et al. (2012)	1	1	1	1	1	1	1	1	1	1	1	11
Zairina et al. (2016)	1	1	1	1	1	1	1	1	1	1	1	11

**a. Forest plot**

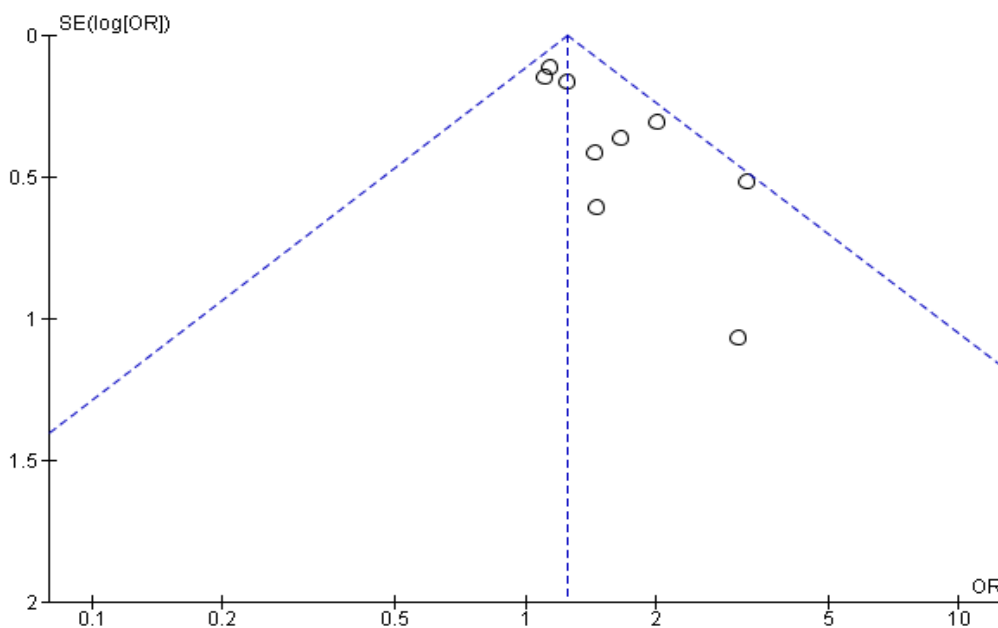
The forest plot in the figure shows that the use of Internet-based self-management in asthmatics is effective in changing asthma control as much as 1.25 times compared to without using Internet-based self-management and the results are statistically significant (OR= 1.25; 95% CI= 1.09 to 1.44; p= 0.002). The heterogeneity value in the forest plot shows I2 = 5%, so that the data analysis in the forest plot uses the fixed effect model.

**b. Funnel plot**

The funnel plot presented in Figure 4 shows that there is a potential for publication bias which is indicated by an overestimated effect. This is indicated by the asymmetry of the plots on the right and left sides where the left plot is 2 and the right plot is 6. The left plot has a standard error of 0 to 0.5, while the right plot has a standard error of 0 to 0.2.



**Figure 3. Forest plot of internet-based self-management effectiveness on asthma control**



**Figure 4. Funnel plot of the effectiveness of internet-based self-management on asthma control**

**Table 2. Description of the primary studies included in the meta-analysis**

<b>Author (year)</b>	<b>Country</b>	<b>Study Design</b>	<b>Sample</b>	<b>P Population</b>	<b>I Intervention</b>	<b>C Comparison</b>	<b>O Outcome</b>	<b>OR (CI95%)</b>
Ahmed et al. (2011)	Canada	RCT	80	Asthma patients aged 18-69 years	Web-based self-management (My Asthma Portal)	Not using web-based self-management (My Asthma Portal)	Asthma control	3.22 (1.16 to 8.9)
Gaalen et al. (2013)	Netherland	RCT	200	Adult patient	Internet-based self-management	Do not use Internet-based self-management	Asthma control	1.65 (0.81 to 3.36)
Khusial et al. (2020)	Amerika Serikat	RCT	82	Asthma patients aged 18 years or older	MyAirCoach (internet-based self-management)	Not using MyAirCoach (internet based self-management)	Asthma control	1.11 (0.83 to 1.48)
Liu et al. (2011)	Spanyol	RCT	120	Outpatient asthma patient	Internet-based self-management	Do not use Internet-based self-management	Asthma control	2.01 (1.10 to 3.67)
Meer et al. (2011)	Netherland	RCT	200	Inpatient asthma	Internet-based self-management	Do not use Internet-based self-management	Asthma control	1.44 (0.64 to 1.24)
Rikkers-Mutsaerts et al. (2012)	Belanda	RCT	688	Asthma patients aged 12-18 years	Internet-based self-management	Do not use Internet-based self-management	Asthma control	3.09 (0.38 to 25.11)
Ryan et al. (2012)	Inggris	RCT	288	Teen patient	Internet-based self-management	Do not use Internet-based self-management	Asthma control	1.45 (0.44 to 78)
Yanhua et al. (2012)	China	RCT	150	Asthma patients aged 18 years and over	Internet-based self-management	Do not use Internet-based self-management	Asthma control	1.25 (0.90 to 1.74)
Zairina et al. (2016)	Australia	RCT	72	Asthma patients in pregnant women	Telehealth	Not using telehealth	Asthma control	1.14 (0.91 to 1.43)



This meta-analysis study raised the theme of applying electronic health records to mortality and readmission. The independent variable in this study was the electronic health record. The dependent variables in this study were mortality and readmission.

### **1. The effect of electronic health record on mortality**

The results of the meta-analysis in this study related to the effect of electronic health records on mortality with a sample size of 37,610 participants from 9 primary randomized controlled trials, indicating that there was an effect of implementing electronic health records on mortality. The results of the forest plot reveal that the use of electronic health records can reduce mortality by 0.74 times compared to not using electronic health records (OR= 0.74; CI 95%= 0.64 to 0.86;  $p < 0.001$ ).

These results are supported by the research of Ndifon et al. (2016) which states that the implementation of electronic health records in several hospitals in the United States can improve the quality of care, especially in patient care outcomes. Research by Han et al. (2016) also reported the similar results. The study showed that the outcome of patient care, namely mortality, was reduced by 2.10 times after the implementation of the electronic health record for 4 months. This is because in the electronic health record there is a Computerized Clinical Decision Support System (CDSS) which can assist health workers in making decisions quickly and accurately.

The findings of this study are supported by the results of research by Encinosa and Bae (2012) which states that the implementation of electronic health records in hospitals can improve patient care outcomes, one of which is death caused by Hospital Acquired Conditions (HAC). The implementation of electronic health records can reduce deaths due to Hospital Acquired

Conditions (HAC) by 4%. Doctors and nurses believe that the quality of patient data is better when using electronic health records and that it is easier to use than conventional medical records. This is what causes many hospitals in developed countries to adopt the use of electronic health records. The data and information contained in the electronic health record can improve coordination in patient care because the data in the electronic health record is presented in detail.

### **2. The effect of electronic health record on readmission**

The results of the meta-analysis in this study related to the effect of electronic health records on mortality with a sample size of 37,610 participants from 7 primary randomized controlled trials, indicating that there was an effect of implementing electronic health records on readmissions. The results of the forest plot reveal that the use of electronic health records can reduce readmission by 0.77 times compared to without using electronic health records (OR= 0.77; CI 95%= 0.62 to 0.95;  $p = 0.020$ ).

Brenner et al. (2016) examine determinants effect of the use of health information technology on patient care outcomes. Using 68 articles with Randomized Controlled Trial (RCT) and non-Randomized Controlled Trial (RCT) study designs. The results showed that 23 (36%) articles proved that the use of health information technology had an effect on patient care outcomes consisting of mortality, length of stay and readmission.

Readmission can indicate inadequate care of the patient's needs during treatment, or it can be said as poor quality of care. Incorrect prescribing for patients at home and inadequate follow-up can also lead to increased readmission rates. The application of electronic health records and their components can improve the quality of

inpatient care and make it easier to track patient medication lists and develop appropriate home regimens, thereby reducing readmission rates. This is supported by Agha (2014) which states that there was a decrease of 0.14 readmission in patients after the implementation of electronic health records and their components in hospitals.

Based on the description of the results and discussion, we can see that the application of electronic health records can reduce mortality and readmission. Therefore, it is necessary to implement an electronic health record as a strategy in improving the quality of patient care outcomes in hospitals.

#### AUTHOR CONTRIBUTION

Desi Syahbaniar is the main researcher who choosed the topic, searched for data and collected the data. Didik Gunawan Tamtomo and Bhisma Murti are the supervisors in data analysis and compilation of publications.

#### CONFLICT OF INTEREST

There was no conflict of interest in this study.

#### FUNDING AND SPONSORSHIP

This study is self-funded.

#### ACKNOWLEDGEMENT

We are very thankful to the database providers namely PubMed, Google Scholar, ProQuest, Science Direct and Scopus.

#### REFERENCE

Agha L (2014). The effects of health information technology on the costs and quality of medical care. *J Health Econ*. 34(2): 19–30. doi: 10.1016/j.jhealeco.2013.12.005.  
Amato MG, Salazar A, Hickman TTT, Quist

AJL, Volk LA, Wright A, McEvoy D, et al. (2017). Computerized prescriber order entry-related patient safety reports: Analysis of 2522 medication errors. *J Am Med Informatics Associ*. 24(2): 316–322. doi: 10.1093/jamia/ocw125.

Blecker S, Goldfeld K, Shine D, Austrian J, Braithwaite R, Radford M, Gourevitch M (2015). Electronic health record utilization, intensity of hospital care and patient outcomes. *Am J Med*. 127(3): 216–221. doi: 10.1016/j.amjmed.2013.11.010.

Campanella P, Lovato E, Marone C, Fallacara L, Mancuso A, Ricciardi W, Specchia ML (2016). The impact of electronic health records on healthcare quality: A systematic review and meta-analysis. *Eur J Pub Health*. 26(1): 60–64. doi: 10.1093/eurpub/ckv122.

Encinosa W, Bae J (2012). How Can We Bend the Cost Curve? Health Information Technology and Its Effects on Hospital Costs, Outcomes, and Patient Safety', *Inquiry*. 48(4): 288–303. doi: 10.5034/inquiryjrnl\_48.04.02.

Flatow VH, Ibragimova N, Divino CM, Eshak DSA, Twohig BC, Bassily-Marcus AM, Kohli-Seth R (2015). Quality outcomes in the surgical intensive care unit after electronic health record implementation. *Appl Clin Inform*. 6(4): 611–618. doi: 10.4338/ACI-2015-04-RA-0044.

Han JE, Rabinovich M, Abraham P, Satyanarayana P, Liao TV, Udoji TN, Cottonis GA, et al. (2016). Effect of Electronic Health Record Implementation in Critical Care on Survival and Medication Errors. *Am J Med Sci*. 351(6): 576–581. doi: 10.1016/j.amjms.2016.01.026.

Hwang JI, Park HA, Bakken S (2012). Impact of a physician's order entry



- (POE) system on physicians' ordering patterns and patient length of stay. *Int J Med Inform.* 65(3): 213–223. doi: 10.1016/S1386-5056(02)00044-8.
- Krive J, Shoolin JS, Zink SD (2015). Effectiveness of Evidence-based Pneumonia CPOE Order Sets Measured by Health Outcomes. *Online J Pub Health Inform.* 7(2): 1–15. doi: 10.5210/ojph.v7i2.5527.
- Kruse CS, Stein A, Thomas H, Kaur H (2018). The use of Electronic Health Records to Support Population Health: A Systematic Review of the Literature. *J Med Syst*, 42(11). doi: 10.1007/s10916-018-1075-6.
- Lin HL, Wu DC, Cheng SM, Chen CJ, Wang M C, Cheng CA (2020). Association between Electronic Medical Records and Healthcare Quality. *Medicine.* 99(31): e21182. doi: 10.1097/MD.00000000021182.
- McGregor J, Weekes E, Forrest E, Furuno J, Harris A (2015). Impact of a Computerized Clinical Decision Support System on Reducing Inappropriate Antimicrobial Use: A Randomized Controlled Trial. *Online J Public Health Inform.* 13(4): 378–384. doi: 10.1197/jamia.M2049.Introduction.
- Moja L, Polo Friz H, Capobussi M, Kwag K, Banzi R, Ruggiero F, González-Lorenzo M, et al. (2019). Effectiveness of a hospital-based computerized decision support system on clinician recommendations and patient outcomes: A randomized clinical trial. *JAMA Netw Open*, 2(12): 1–16. doi: 10.1001/jamanetworkopen.2019.17094.
- Ndifon L, Edwards JE, Halawi L (2016). Impact of Electronic Health Records on Patient Outcomes. *Issues Inf Syst.* 17(2): 187–196. doi: 10.48009/4\_isis\_2016\_187-196.
- Paul M, Andreassen S, Tacconelli E, Nielsen AD, Almanasreh N, Frank U, Cauda R, et al. (2016). Improving empirical antibiotic treatment using TREAT , a computerized decision support system : cluster randomized trial. *J Anti-microb Chemother.* 58(2): 1238–1245. doi: 10.1093/jac/dkl372.
- Sudarmaji WP, Sholihin S, Permana RA, Soares A, Nugraha YA (2020). A Clinical Decision Support System as a Tool to Improve the Accuracy of Nursing Diagnoses. *J Ners*, 14(3): 388. doi: 10.20473/jn.v14i3.17171.
- Wilson FP, Shashaty M, Testani J, Aqeel I, Borovskiy Y, Ellenberg SS, Feldman HI, et al. (2015). Automated, electronic alerts for acute kidney injury: a singleblind, parallel-group, randomised controlled trial. *Lancet (London, England) J.* 385(9981): 1966–1974. doi: 10.1016/S0140-6736(15)60266-5.
- Wilson FP, Martin M, Yamamoto Y, Partridge C, Moreira E, Arora T, Biswas A, et al. (2021). Electronic health record alerts for acute kidney injury: multicenter , randomized clinical trial. *BMJ.* 37(2): 1–10. doi: 10.1136/bmj.m4786.
- Yanamadala S, Morrison D, Curtin C, McDonald K, Hernandez-Boussard T (2016). Electronic health records and quality of care an observational study modeling impact on mortality, readmissions, and complications. *Med (United States).* 95(19): 1–6. doi: 10.1097/MD.0000000000003332.