THE BENEFITS OF INTEROPERABILITY TO PREVENT MEDICATION ERROR IN HOSPITAL

Heppi Kartika Rahmawati[1)], Wiku Bakti Bawono Adisasmito[2)]

[1)]Hospital Administration Study Program,
Faculty of Public Health, Universitas Indonesia
[2)]Department of Health Policy Administration,
Faculty of Public Health, Universitas Indonesia

ABSTRACT

Background: Healthcare Information and Management Systems Society (HIMSS) describes interoperability as the extent to which systems and devices can exchange data, and interpret that shared data. Interoperability of health information systems can improve the accuracy of diagnosis, quality of care, and patient safety. One problem in patient safety is medication errors. Medication error defined as a failure in the treatment process that has the potential to lead to harm among patients. This study aimed to analyze the benefits of interoperability to prevent medication error in hospital.
Subjects and Method: This was a systematic review study. The study were done by collecting related articles in English, published in 2014 to 2019. The databases used in this study were ProQuest, PubMed, and Sage Publication. The keywords used were interoperability, interoperable, electronic health records, data sharing, big data, health care information technology, hospitals, medication errors, medication without harm, unsafe medication, medication safety, prescribing errors, and prescription errors.
Results: There were 10 articles that met the study criteria. From the articles it were found that interoperability prevents medication errors through (1) Providing quality information with credibility; (2) Preventing the occurrence of making recipes; (3) Increasing the effectiveness of information by direct transfer between systems; (4) Preventing data duplication, (5) Updating data in real time; (6) Data access in parallel by several users; (7) Prevention of data loss, differences in interpretation, and differences in measurement unit; (8) Reconciliation of treatment between patient and hospital; (9) Evaluation of diagnoses and services to patients remotely; and (10) Prevention of medication errors at the administrative stage.
Conclusion: Interoperability increases accuracy of diagnoses, quality of care, patient safety, by increasing credibility of information. The existence of reconciliation between users, both doctors, nurses, pharmacists, service units, and patients, can prevent administrative errors and prescription making, and help doctors make decisions.

Keywords: interoperability, medication error, hospital

Correspondence:
Heppi Kartika Rahmawati. Hospital Administration Study Program, Faculty of Public Health, Universitas Indonesia, Depok, Indonesia. Email: heppi.diamond@gmail.com. Mobile: 087883960923.

BACKGROUND

In March 2017, the World Health Organization (WHO) initiated the 3rd Global Patient Safety Challenge with the theme of medication safety, which was published at the Global Ministerial Summit on Patient Safety in Bonn, Germany. According to WHO (2017), medication errors are inevitable and most are triggered by a weak health system. Therefore, efforts to reduce the frequency and impact of medication errors are very important.

Ferner and Aronson (2006) in Aronson (2009), defines medication error as a failure in the treatment process that can cause danger to patients. According to WHO (2017), there are five severity levels of medication errors, namely (1) unsafe treatment practices

https://doi.org/10.26911/the6thicph-FP.04.21

and medication errors will lead to danger, which can be avoided, in health care systems throughout the world; (2) the hazards caused can differ between countries with low-moderate-high income, globally, the associated costs are estimated at US $ 42 billion per year; (3) Compared to high-income countries, patients from low-income countries have twice the rate of adjustment for the year of life lost due to disability, caused by harmful treatment; (4) medication errors occur when the treatment system and / or human factors are weak; (5) often, errors occur during administration.

The aim of the issuance of this challenge is to improve each stage of the treatment process, from prescribing, dispensing, administration, monitoring and drug use. The target of these challenges is to obtain global commitment and action to reduce the severity and avoidable hazards associated with treatment by 50% by 2022, especially hazards caused by unsafe practices due to weak health systems (WHO, 2017).

Provision of quality, consistent, and efficient health services can be supported by digital solution to help personalization and patient center care.

Interoperability is a key factor in digitalized health. According to Health Information and Management Systems Society (HIMSS, 2013), interoperability is the ability of several information technology systems and software applications to communicate, exchange, and use information (GSMA, 2016).

The schema and standard of data exchange allow data sharing between clinicians, labs, hospitals, pharmacy, and patients without requiring the type of application or application provider. In the absence of boundaries between health information systems for working together in and across organizations, health status and the provision of effective health services for individuals and communities will thus increase (GSMA, 2016).

According to HIMSS, there are three levels of interoperability, namely foundational, structural and semantic. All three are needed to realize full interoperability in health digitalization. Foundational interoperability enables the exchange of data from one information technology system to another without looking at the ability of interpreting data systems for receiving information technology data systems. Structural interoperability requires uniform movement of data from one system to another, so that clinical and operational objectives and the meaning of the data can be maintained and unchanged.

Thus the data exchanged can be interpreted up to the data level. Semantic interoperability provides four main areas of benefit for health services, namely easier and faster access to patient information, opportunities for getting a better diagnosis, getting quality of service and patient safety, increasing cost effectiveness, expanding patient choice, and increasing competition. Specifically, to get a better diagnosis, quality of service and patient safety, it is hoped that interoperability can avoid interactions or errors in treatment, including errors during prescribing and treatment administration (GSMA, 2016).

Medication error is one part of medical error, as Dwiprahasto (2004) states that there are two types of medical errors, namely error of omission and error of commission. Medication errors are included in the error of commission, which is a mistake in deciding the choice of therapy, giving the wrong medication, or giving the wrong medication. Bock et al. (2005) in Olaronke (2013) stated that medical error is a matter that must be considered in the area of health care, because it is the sixth leading cause of death in hospitals.

In the same study, Bock et al. (2005) state that there were 44,000 to 98,000 Americans dying in hospitals each year, due to medical errors that could lead to death. The

https://doi.org/10.26911/the6thicph-FP.04.21

study of Johnston et al. (2004) in Olaronke (2013), estimates that 18% of medical errors that result in adverse drug events, are caused by the lack of availability of patient information. Furthermore, Olaronke (2013) states that full interoperability is one way to prevent medical errors. Full interoperability can guarantee the format of data related to health on different computer systems can be structurally connected and the information content is exchanged.

Based on data from the Organization for Economic Cooperation and Development Countries (OECD) (2017), hospitals are health service providers with a proportion of 38% of the health expenditure of OECD member countries. Based on data from the Indonesian National Health Account (NHA) 2010-2016, most of the portion of health expenditure is on curative services (78.3%), both inpatient and outpatient, with the largest portion being in hospitals (58.6%). Therefore, this study aims to find out how interoperability provides benefits in preventing medication errors in hospitals.

SUBJECTS AND METHOD

1. Study Design

This study was conducted using a systematic review method with PRISMA-P (Preferred Reposting Items for Systematic review and Meta-Analysis Protocols) as a search protocol in accordance with the flowcharts that have been prepared based on PRISMA-P (2009), so as to eliminate inappropriate articles through identification, screening, and inclusion and exclusion criteria.

This study employed three databases, namely ProQuest, PubMed and Sage Publication, to obtain relevant articles. The key words of this study are interoperability, interoperable, electronic health records, data sharing, big data, or health care information technology. By using these keywords, we get 1,294,775 articles of search results, filtering with more specific keywords that is hospitals produce 222,523 search results. From 222,523, we filter with more specific keywords, namely medication error, medication without harm, unsafe medication, medication safety, prescribing error, and prescription error, so we get 8,172 searches.

2. Study Variables

The dependent variable in this study is medication error. The independent variable is interoperability.

3. Inclusion and exclusion criteria

The inclusion criteria used were scholarly journals or research articles and excluded the others. To get the latest articles, the time period that we use is between 2014-2019. The article we use is only a full text article in English and has a hospital scope. We exclude articles with different topics, only abstracts, not research, as well as review studies.

Based on the inclusion and exclusion criteria, we found 10 articles that matched and met all the criteria of the article that we would review.

RESULTS

Ten reviewed studies were conducted in the United Kingdom (4), the United States (4), Netherlands (1), and Brazil (1). Of the 10 articles, only 3 articles clearly stated interoperability clauses, namely Topaz et al. (2018), Cresswell et al. (2017) and Suess et al. (2019). The other seven articles do not explicitly mention interoperability, but rather mention the integration of information systems.

Akbarov et al. (2015) in the United Kingdom found that the integration of information between service units provides credible and useful information related to medication safety. Topaz et al. (2018) in the United States found that good interoperability in allergic health information systems prevents errors in prescribing drugs.

https://doi.org/10.26911/the6thicph-FP.04.21

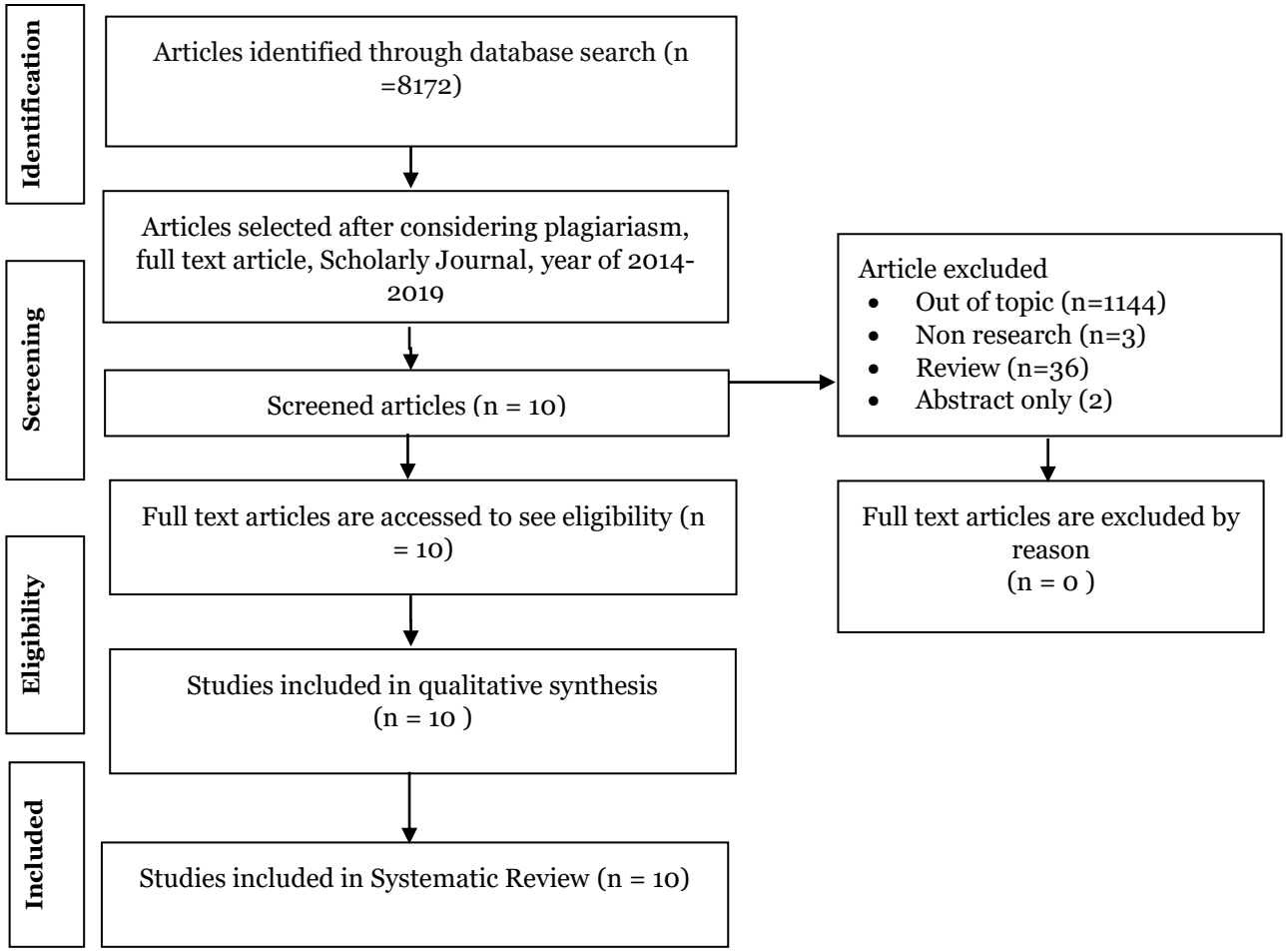

Figure 2. PRISMA Search Protocol Results

In line with the study, research conducted by Pontefract et al. (2018) in the United Kingdom shows that the integration of electronic prescribing with a support system for decision making by doctors helps prevent errors in prescribing. Cresswell et al. (2017) conducted a study in the United Kingdom and found that interoperability increases the effectiveness of information transfer directly between systems and avoids data entry duplication.

Mozaffar et al. (2017) in the UK shows that an integrated information system that is well designed, can provide updates in real time, and can be accessed in parallel by multiple users, and allows for the proper transfer of information between systems, so that it can prevent data loss, misinterpretation and measurement unit differences.

https://doi.org/10.26911/the6thicph-FP.04.21

Table 1. Selected articles based on PRISMA Protocol

No	Title	Author, Year, Journal	Study Design	Subjects and Samples	Conclusions and Recommendation
1	Primary Care Medication Safety Surveillance with Integrated Primary and Secondary Care Electronic Health Records: A Cross-Sectional Study	Akbarov et al, 2015, Drug Saf. 2015; 38(7): 671–682	Salford, Inggris Cross sectional	one hospital and over 50 general practices in Salford, UK	This journal explains that electronic Health Records that are connected between primary and secondary units (hospitals) can provide information that is reasonable and useful for medication safety. However, attention must be given to the level of data confidence so that no monitoring is carried out.
2	Malpractice Cases Involving Allergy Information in Electronic Health Records: Implications for Safer Systems	Topaz et al, 2018, Perspectives of Health Information Management. 2018: 1-9.	Amerika Serikat retrospective descriptive cohort analysis	Malpractice claims in the Comparative Benchmarking System (CBS) of the Controlled Risk Insurance Company (CRICO), an insurance company responsible for medical professionals, between 1 January 1990 and 31 December 2014.	This journal explains that there are 9 out of 90 EHR related to allergic information, of which the 9 HERs mention that allergies are one of the causes of malpractice, especially related to medication, either wrong medication, or dosage errors. The study shows that an EHR is needed with a view that emphasizes the critical need for allergic information systems that are safer and have interoperability.
3	Safety risks associated with the lack of integration and interfacing of hospital health information technologies: A qualitative study of hospital electronic prescribing systems in England	Cresswell KM, Mozaffar H, Lee L, et al. BMJ Qual Saf 2017;26:530–541.	The UK longitudinal qualitative data	Six hospitals in the UK	This journal explains that interoperability with external systems and different user groups on ePrescribing systems provides higher flexibility and opportunities for innovation and can guarantee patient safety, especially in preventing data entry duplication.
4	Exploring the roots of unintended safety threats associated with the introduction of hospital ePrescribing systems and candidate avoidance and/or mitigation strategies: a qualitative study	Mozaffar H, Cresswell KM, Williams R, et al. BMJ Qual Saf 2017; 26: 722–733.	The UK longitudinal qualitative data	Six hospitals in the UK	This journal explains that interoperability is well designed, can provide updates in real time, and can be accessed in parallel by several users, and allows for the proper transfer of information between systems, so as to prevent data loss, misinterpretation, and differences in measurement units.
5	Patient empowerment through provision of a mobile application for medication reconciliation: a proof of	Werumeus Buning A, Klopotowska JE, Duyvendak M, et al. BMJ Innov 2016; 2:	Netherland Random sample of 17	August–September 2014 in Antonius Hospital, Sneek and Emmeloord, Belanda, August – September 2014	This journal explains that interoperability between patients and hospitals through application, related to treatment reconciliation, is proven to be a tool to improve

https://doi.org/10.26911/the6thicph-FP.04.21

	concept study	152–157.	patients aged 18 years and over,		patient safety (prevent medication errors)
6	Electronic medical record use and perceived medical error reduction	Jindal & Raziuddin, InternationalJournal of Quality and Service Sciences 10(1): 84-95	Arizona,USA cross-sectional	99 medical professionals who use EMR in practice in Arizona, USA.	This journal explains that interoperability enables the evaluation of diagnoses and services for patients remotely using communication technology
7	Evaluation of medication errors with implementation of electronic health record technology in the medical intensive care unit	Liao et al, Open Access Journal of Clinical Trials 2017: 9 31–40 Open Access Journal of Clinical Trials Dovepress	single MICU service, USA Prospective, observational	all patients were treated in a single MICU service in an academic medical center over four periods of more than 2 years: August 2010-February 2013	This journal explains that interoperability, with information system users (doctors, nurses and pharmacists) who are trained, can meet user needs in real time, so as to prevent, errors in medication, as one of the health services
8	Impact of a commercial order entry system on prescribing errors amenable to computerised decision support in the hospital setting: a prospective pre-post study	Pontefract SK, Hodson J, Slee A, et al. BMJ Qual Saf 2018; 27 : 725–736.	Three acute hospitals in the UK preintervention/ postintervention study	4000 recipes have been reviewed both before CPOE and 6 months after CPOE implementation	This journal explains that interoperability between electronic prescribing and system support for decision making by doctors helps prevent prescribing errors.
9	Impact of Patient-Controlled Analgesia (PCA) Smart Pump-Electronic Health Record (EHR) Interoperability with Auto-Documentation on Chart Completion in a Community Hospital Setting	Suess, T.M., Beard, J.W. & Trohimovich, B. Pain Ther (2019). https://doi.org/10.1007/s40122-019-0132-2 , Springer Healthcare	Lancaster General Hospital, Lancaster, Pennsylvania retrospective cohort study	data from patients treated at the Lancaster General Hospital, a 663 bed public health system (Pennsylvania, PA, USA) during the study period August-October 2016 and April-June 2017.	This journal explains that interoperability between EHR and medical devices accompanied by documentation can automatically prevent medication errors at the administrative stage
10	Medication errors in emergency departments: is electronic medical record an effective barrier?	Vaidotas M, Yokota PK, Negrini NM, Leiderman DB, Souza VP, Santos OF, Wolosker N, einstein (São Paulo). 2019; 17(4): 1-5	Brazil A cross-sectional, retrospective, and observational study	National Coordinating Council for Medication Error Reporting and Prevention, related to the use of electronic and conventional medical records, in the emergency department of the same organization, for one year	This journal explains that interoperability facilitates multidisciplinary team access to patient data, thereby increasing communication between professions and information quality

https://doi.org/10.26911/the6thicph-FP.04.21

Vaoditas et al. (2019) conducted a study in Brazil using National Coordinating Council for Medication Error Reporting and Prevention data, also found that integrated information systems made it easier for multidisciplinary team access to patient data, thereby increasing communication between professsions and information quality.

Research in the Netherlands conducted by Buning et al. (2016) in the Netherlands shows that the connection between patients and hospitals through application, related to treatment reconciliation, is proven to be a tool to improve patient safety (preventing medication errors).

Jindal and Raziuddin (2018) conducted a study in America and found that integrated information systems could allow the evaluation of diagnoses and services for patients remotely using communication technology. Liao et al. (2017) conducted a study in the United States and found that an integrated information system, with users (doctors, nurses, and pharmacists) trained, could meet the needs of users in real time, thus preventing errors in medication, as one of the health services.

Suess et al. (2019) in the United States, show that interoperability between EHR and medical devices, accompanied by documenttation can automatically prevent medication errors at the administrative stage.

DISCUSSION

According to the National Alliance for Health Information Technology Report to the Office of the National Coordinator for Health Information Technology (2008), EHRs that have interoperability, can provide information that can be contributed and accessed, some of which are:

a. Current and past clinical information from all organizations involved in the care and maintenance of certain individual health.
b. Administrative information is related to making clinical judgments and cost-sensitive decisions, for example formularies used in drug selection based on insurance benefits obtained by patients.
c. Information from remote monitoring devices, which capture vital signs, heart or respiratory status, and real-time lab results.

The benefits of interoperability are in accordance with study conducted by Akbarov et al. (2015), Cresswell et al. (2017), Mozaffar et al. (2017), Jindal and Raziuddin (2018), Liao et al. (2017), Pontefract el al. (2018), and Vaoditas et al. (2018). Wu et al. (2004) in Lienhard and Legner (2014), states that computational tools can support clinicians in preventing medication errors.

Sedano et al. (2011) from the Institute for Healthcare Improvement (2011) and the National Institute for Health and Clinical Excellence (NICE) / National Patient Safety Agency (2007) concluded that many factors contribute to medical errors, including:

a. Lack of access to a list of patient prescriptions from primary services, as information is usually not collected in a standardized way, the system fails to transfer information from primary services to hospitals.
b. Difficulties in obtaining an accurate account of the patient's treatment due to acute conditions, sensory or cognitive impairments, lack of access to family or caregivers, or because of obstacles.
c. Errors in copying drug details to hospital clinical records: in the case of handwritten prescriptions, which can contribute to errors if they cannot be read, are incomeplete, or use inappropriate abbreviations.

Interoperability or integrated information systems between primary and secondary service units (Akbarov et al., 2015); between health information systems (Topaz et al., 2018 and Cresswell et al, 2017); and between

https://doi.org/10.26911/the6thicph-FP.04.21

multidisciplinary teams, nurses and pharmacists (Vaoditas et al., 2019; Liao et al., 2017), can prevent medication errors because they can answer the three problems above. Interoperability also enables real time data updates (Mozaffar et al., 2017), data reconciliation with patients and patient families (Buning et al., 2017), preventing prescribing and recording errors (Pontefract et al., 2018; Suess et al., 2019), and evaluation diagnosis and service for patients remotely using communication technology (Jindal and Raziuddin, 2018), so that the incidence of medication errors can be avoided.

In the ten studies that were reviewed, it was found that interoprability increases the accuracy of diagnosis, quality of care, and patient safety through increased credibility of information. Interoperability enables recon ciliation between users, doctors, nurses, pharmacists, service units, and patients, so as to prevent medication errors at the administrative stage, prescribing, and assisting doctors in making decisions.

REFERENCES

Akbarov et al. (2015). Primary care medication safety surveillance with integrated primary and secondary care electronic health records: A crosssectional study. drug saf, 38 (7):671–682.

Aronson JK (2009). Medication errors: Definitions and classification. British journal of clinical pharmacology, 67 (6): 599–604. doi:10.1111/j.13652125.2009-.03415.x

Cresswell KM, Mozaffar H, Lee L, et al. (2017). Safety risks associated with the lack of integration and interfacing of hospital health information technologies: A qualitative study of hospital electronic prescribing systems in England. BMJ Qual Saf, 26: 530-541.

Dwiprahasto (2004). Medical error di rumah sakit dan upaya untuk meminimalkan risiko (Medical errors in hospitals and efforts to minimize risk). https://jurnal.ugm.ac.id/jmpk/article/view/2884/2605

Groupe Speciale Mobile Association (2016). Digital healthcare interoperability. Retrieved from https://www.gsma.com/-iot/wp-content/uploads/2016/10/-Interoperability-reportv1.2.pdf.

Jindal SK, Raziuddin F (2018). 'Electronic medical record use and perceived medical error reduction'. International Journal of Quality and Service Sciences, 10(1): 84–95. doi: 10.1108/IJQSS-12-2016-0081.

Kemenkes (2018). Final Report NHA 2016. http://www.depkes.go.id/resources/-download/info-terkini/Final-Report-NHA-2016-(LAMPIRAN).pdf.

Liao et al. (2017). Evaluation of medication errors with implementation of electronic health record technology in the medical intensive care unit. Journal of Clinical Trials, 9: 31-40.

Lienhard K, Legner C (2014; 2017). A systems theory approach for information systems planning in hospitals', Tagungsband Multikonferenz Wirtschaftsinformatik 2014, MKWI 2014.

Mozaffar H et al. (2017). Exploring the roots of unintended safety threats associated with the introduction of hospital ePrescribing systems and candidate avoidance and/or mitigation strategies: A qualitative study', BMJ Quality and Safety, 26(9): 722–733. doi: 10.1136-/bmjqs-2016-005879.

Office of the National Coordinator for Health IT in the Dept of Health and Human Services (2008). The national alliance for health information technology report: Defining key health information terms, 24. Retrieved from https://www.himss.org/library/ehr/%3FnavItemNumber%3D13261%0Ahttp://www.hi

https://doi.org/10.26911/the6thicph-FP.04.21

mss.org/library/ehr.
Olaronke I, Gambo I (2013). Interoperability in healthcare : benefits, challenges and resolutions interoperability in healthcare: benefits, challenges and resolutions'.
Organisation for Economic Co-operation and Development (OECD) (2017). Health at a Glance 2017: OECD Indicators, OECD Publishing, Paris, https://doi.org/10-.1787/healthglance-2017-en.
Pontefract SK et al. (2018). Impact of a commercial order entry system on prescribing errors amenable to computerised decision support in the hospital setting: A prospective pre-post study. BMJ Quality and Safety, 27 (9): 725–736. doi: 10.1136/bmjqs-2017-007135.
Sedano FJ, Farfán et al. (2011). Patient Summary and Medicines Reconciliation. IOS Press. doi:10.3233/978-1-60750-740-6-105
Suess TM, Beard JW & Trohimovich B. Pain Ther., 2019. Impact of Patient-Controlled Analgesia (PCA) Smart Pump-Electronic Health Record (EHR) Interoperability with Auto-Documentation on Chart Completion in a Community Hospital Setting. https://doi.org/10.1-007/s40122-019-0132-2
Topaz et al. (2018). Malpractice cases involving allergy information in electronic health records: Implications for safer systems. perspectives of health information management, 1-9.
Vaidotas M, Yokota PK, Negrini NM, Leiderman DB, Souza VP, Santos OF, Wolosker N (2019). Medication errors in emergency departments: Is electronic medical record an effective barrier? Einstein, 17 (4): 1-5
Buning, Werumeus A, Klopotowska JE, Duyvendak M et al. (2016). Patient empowerment through provision of a mobile application for medication reconciliation: A proof of concept study. BMJ Innov, 2: 152-157.
World Health Organization (2017). Global patient safety challenge: Medication without harm', WHO global patient safety challenge, 16. Retrieved from http://apps.who.int/iris/bitstream/1-0665/255263/1/WHO-HIS-SDS-2017.6-ng.pdf?ua=1&ua=1.