
Research article

Evaluation Of Computerized Prescribing Order Entry (Cpoe) Implementation In Preventing Medication Error

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Abstract:

Regulation of the Minister of Health of the Republic of Indonesia number 1333/Menkes/SK/XII/1999 on Standards of Hospital Services stated that the hospital pharmacy service is inseparable from the hospital healthcare system with orientation towards patient care, provision of drugs' quality, and clinical pharmacy services which are affordable for all society. Plenty types of drugs, examinations, procedures, besides large number of patients and staffs in a big hospital are potentially contribute for the occurrence of medication error. The use of computerized prescribing order entry (CPOE) could potentially reduce medication error. Nevertheless, there was still reluctance among some doctors to use CPOE, impacting its response time.

This research is aimed to evaluate the effectiveness of CPOE application in reducing the incidence of medication error and response time compared to manual prescribing, and factors that influence non-compliance among doctors in using CPOE.

Material and methodes: Quantitative research was done to compare incidence of medication error and response time between groups, using primary data by collecting drugs prescription in Cipto Mangunkusumo National Central General Hospital. Qualitative research was conducted by taking several in-depth interviews toward management of integrated inpatient unit building "A", management of information system, person in charge for pharmacy, nurse representative and group of physicians to determine factors that influence CPOE implementation at the integrated inpatient unit building "A".

Results: Proportion of medication errors in manual prescription (11,5%) was higher than proportion of medication errors with CPEO (7,5%). Shortest time (from prescribing to administration) observed from 400 manual prescriptions and CPOE was 5 minutes, while the longest was 11 hours 24 minutes. Based on interval estimation, it can be concluded with 95% confidence level that the average time for prescribing until administration required 2 hours 37 minutes to 3 hours 3 minutes.

Conclusion:, prescribing with CPOE resulted in 4% decrease of medication error compared to manual prescription. Factors such as: prescriber, type of drugs, number of drugs and lack of staffs had been proved to affect the response time of prescribing process, both manually or with CPOE.

Introduction

A. Background

Pharmaceutical services within a hospital setting represent an integrated activity aimed at identifying, preventing, and resolving problems related to medications and health. However, in reality, majority of the hospitals in Indonesia do not deliver these services as expected. This has occurred as a consequence of several obstacles, such as limited knowledge among the management regarding the function of hospital pharmacy; capability of the pharmacists; hospital policy; and limited knowledge among associated parties regarding pharmaceutical services in the hospital. (Menteri Kesehatan RI 2004).

According to Sari *et al.* (2013), in accordance with Regulations from the Ministry of Health Number 1333/Menkes/SK/XII/1999 regarding the Standard of Hospital Services states that pharmaceutical services are an inseparable part of the hospital oriented towards patient services,

availability of quality medications, including clinical pharmaceutical services, affordable to all layers of the community.

Problems in the pharmaceutical services of a hospital that are not delat with appropriately may lead to medication errors. In the process of medication prescribing, medication errors may occur at various steps, beginning at prescription, transcription, dispensing, and administration (van den Bemt *et al.* 2000). According to Analecto *et al.* (2007), errors mostly occur during the dispensing phase of medication prescriptions in the hospital.

Medication errors represent a primary problem in the healthcare system all around the world with serious impacts to the patient (Morimoto *et al.*, 2010). According to Muchtar (2012), majority of errors occur during the dispensing process (53%), followed by prescribing (17%), dispensing (14%), and transcription process (11%). On the other hand, Pots *et al.*, (2004) in their research involving pediatric patients at the

intensive care unit of The Children's Hospital in Tennessee stated that majority of prescribing errors occur during the order phase.

The World Alliance for Patient Safety is a healthcare organization that studies the epidemiology of adverse drug events and medication errors states that majority of medication errors in Japan and America occur during the order phase (Morimoto *et al.*, 2010). Van Doormal *et al.* (2013), showed that 60% of medication errors on the 7200 medication prescription in two hospitals in the Netherlands occur during the transcription phase (Schacter 2009). In Indonesia, no systematic reporting of medication errors has been done.

The use of computerized prescribing order entry (CPOE) and supporting systems in a hospital is found to be safe and effective in reducing the occurrence of medication errors (Van den Bemt *et al.*, 2000). According to Rochon *et al.*, (2006), the use of CPOE as recommended by the Institute of Medicine in 1999 was aimed at reducing the occurrence of medication errors. Next, in 2000, the implementation of a technology program such as CPOE was made mandatory in all hospitals in California, USA, with the aim of reducing the number of medication errors. In 2005, the implementation of CPOE application was also recommended by the Leapfrog Group and National Quality Forum in USA (Doolan *et al.*, 2002; Rochon *et al.*, 2006).

Computerized Prescribing Order Entry (CPOE) is a computerized system of medication orders with the potential of preventing medication errors; improve the quality of services; and reducing the cost of treatment (Teich *et al.*, 2000). CPOE has been acknowledged by various health institutions, including the Institute of Medicine (IOM), Leapfrog group, Institute for Safe Medication Practices and American Academy of Pediatrics as a system with the capability to prevent errors throughout the medication prescribing process (Pots *et al.*, 2004). Shu *et al.*, (2001) compared manually written medication errors with CPOE. The results show that other than improving the quality and safety of patient care, CPOE lengthens the response time. Contrastingly, Nam *et al.*, (2007) reports a shorter response time of medication prescribing for stroke patients being treated in the emergency care unit of a hospital in Korea with the use of CPOE, starting from patient admission into the emergency unit until patient discharge.

RSUPN Dr Cipto Mangunkusumo, as the national referral and academic health center is required to develop the best specialistic and sub-specialistic services to fulfill the needs of the community, and achieve patient safety and patient satisfaction.

In its development, RSUPN Dr Cipto Mangunkusumo began to improve its services and in April 2013 became the first government hospital in Indonesia to achieve JCI (Joint Commission International) accreditation, as a World Class Hospital. JCI is an evaluation process towards the healthcare institution, including for hospitals, which aims to improve the quality of management that is oriented towards customer care and patient safety.

The Building A Integrated In-Patient Care Unit of Dr Cipto

Mangunkusumo National Referral Hospital has an international standard of in-patient services. According to its name, Building A integrated services from various departments of RSUPN Dr Cipto Mangunkusumo, including the Obstetrics and Gynaecology, Surgery, Neurosurgery, ENT, Internal Medicine, Anesthesia, Skin and Venereal Diseases, and Geriatric Departments.

The use of CPOE/e-prescribing has been implemented in a large section of the Building A Integrated In-Patient Care Unit, expected to seduce the occurrence of medication errors/medication administration errors, and making time for medication receipt more efficient compared to the manual system. However not all physicians in Building A use CPOE, thus the verification process may not be conducted diligently, and the potential for medication errors is still high. This study was conducted in an effort to compare the manual and CPOE system, and to evaluate the factors as mentioned above.

B. Problem Identification

In various parts of the world, one primary problem in the healthcare system is medication errors (Morimoto *et al.*, 2010). Losses that occur as a result of medication errors include patient morbidity, longer hospital stay, economic losses as cost of treatment increases, and even death (Charatan 1999; Bemt *et al.*, 2000; Weingart *et al.*, 2000). In reality, medication errors may be reduced by the use of Computerized Prescribing Order Entry (CPOE) (Rochon *et al.*, 2006; Nuckols *et al.*, 2014). As the first government hospital to attain Joint Commission International (JCI) accreditation, Dr Cipto Mangunkusumo National Referral Hospital has implemented CPOE in Building A Integrated In-Patient Care Unit. Unfortunately, manual prescription orders are still written, thus holistic implementation of CPOE has yet to occur. In addition, though CPOE implementation has been authorized since 2008, it has never been evaluated. Therefore, this research conducted on floors 1, 3, and 7 of the in-patient care unit is aimed at evaluating CPOE use in an effort to reduce the occurrence of medication errors and response times, as compared to manual prescription orders.

Literature Review

A. Medication errors

Medication errors are failures within the medication process with the potential of causing harm to the patients. These failures may occur at any phase of the medication process including prescribing, packaging, transcribing, dispensing, administration, and side effects monitoring (Lisby *et al* 2005, Abuelhasan 2011, Khalili *et al* 2013, Radley *et al* 2013).

Schachter (2009) conducted a research on the occurrence of prescribing errors in an academic health center in London, and from 36,000 written prescriptions, 60% of errors occurred due to incorrect prescriptions and 50% of them were considered as serious prescription errors. On the other hand, Shamliyan *et al.*, (2008) concluded that 50 – 61% of medication errors occur during the prescribing and transcription phases. Meanwhile, Anacleto *et al.* 2014 in USA reported thath 50%

of medication errors occur during the transcription and administration phases.

B. Computerized Prescribing Order Entry (CPOE)

Computerized Prescribing Order Entry with clinical decision support is an application used by physicians to input patient medication orders into the computer which gives important, direct feedback regarding the prescribed medications. This application has the capability to reduce the occurrence of medication errors by 55% (Rochon *et al*, 2006).

Kopel *et al* (2005) reported that CPOE has the capability of reducing medication administration errors up to 81%. According to Shamliyan *et al* (2008), on the study regarding the association between CPOE and medication errors showed that CPOE can significantly reduce medication errors in the adult and pediatric patient populations. Meanwhile, Nuckols *et al*. (2014) performed a systematic review and meta-analysis that compared CPOE and manually written prescriptions, and concluded that CPOE reduced and prevented patient injury due to medication errors compared to manual prescriptions.

C. Computerized Prescribing Order Entry (CPOE) implementation at Dr. Cipto Mangunkusumo Hospital

CPOE has been implemented in most parts of Dr Cipto Mangunkusumo Hospital. In building A (integrated in-patient ward) of Dr Cipto Mangunkusumo Hospital uses CPOE for medication prescriptions in almost every floor of the building. Manual prescriptions are still written in Building A by several physicians, though it only represents a small portion of all prescriptions. According to the information from healthcare personnel, there are several reasons underlying a physician's decision for not using CPOE, including lack of time, not understanding how to use the application and many others. This impacts response time, as after verification, healthcare personnel have to input the prescription into the EHR system

Material and Methods

A. Research Design and Construction

This is an observational study with a cross-sectional approach. Two groups were observed in this research, physicians who prescribed manually, and those who prescribe by CPOE. Meanwhile, to answer the questions of this research, the method for quantitative and qualitative data collection have been determined. Quantitatively, this research is aimed at observing the difference in medication errors and response times between groups using primary data from medication prescriptions. Qualitative data was obtained through in-depth interviews of physicians who use the CPOE system to identify the factors that affect CPOE implementation in Dr Cipto Mangunkusumo Hospital. The researcher also interviewed the head of Building A, head of systems information unit head of Dr Cipto Mangunkusumo Hospital, primary nurses and satellite pharmacy staff in Building A.

B. Research Time and Place

Quantitative research was conducted on floors 1, 3, and 7 of building A of Dr Cipto Mangunkusumo Hospital. These floors were chosen based on the consideration that there are

physicians on floors 1 and 3 who still prescribe medications manually, whereas physicians on floor 7 use CPOE. In addition, the researcher also had more access to prescriptions from floors 1, 3 and 7 compared to the other five floors, thus the three floors were chosen to ease data collection. Qualitative data collection was done specifically with physicians from floors 1, 3 and 7. Quantitative data collection was done from 13 June 2016 – 13 July 2016. Qualitative data were collected alongside quantitative data collection.

Research Subjects

1. Population and sample

Research population include medication prescriptions in building A Integrated In-patient Ward of Dr Cipto Mangunkusumo Hospital by physicians on duty. The research samples include prescribed manually and by CPOE from 13 June 2016 – 13 July 2016 on floors 1, 3, and 7 of Building A.

2. Sample size

The minimal research sample size was calculated through an estimation of the difference between two proportions. Based on the research, Taylor *et al*. 2008, the proportion of medication errors that occur among manual prescriptions is 19%, whereas in CPOE it is 11%. Using the estimation test of two proportions, at 95% confidence interval, a margin error of 5%, and a 10% precision, thus the sample size is:

a. Medication prescriptions ordered by CPOE – 200 prescriptions

b. Medication prescriptions ordered manually – 200 prescriptions

Results

A. Correlation between prescription type and medication errors.

The analysis between the type of medication orders and the occurrence of medication errors revealed that errors were found in 15 (7.5%) of the CPOE prescriptions and 23 (11.5%) of the hand-written prescriptions. Therefore, the proportion of medication errors is higher in hand-written prescriptions compared to the CPOE prescriptions. Statistical analysis resulted in a p-value > 0.05 (p=0.23), showing that there is no statistical difference in the occurrence of medication errors with respect to the type of medication prescription (Table 1).

Statistical analysis of the type of medication order and the occurrence of prescribing error resulted in a p-value > 0.05 (p=0.23), thus there is no difference in the occurrence of prescribing errors based on the type of medication prescription (Table 1).

Statistical analysis of the occurrence of transcription errors based on the type of medication prescriptions resulted in a p-value > 0.05 (p=0.85), showing no statistical significance in the occurrence of these errors (Table 1).

Further, statistical analysis of the occurrence of dispensing errors between the two types of medication prescriptions gave a p-value < 0.05 (p=0.02), showing a significant association between the occurrence of medication errors and the type of medication prescription. The odds ratio (OR = 4.6) indicate a 4.6 times increase in the possibility of a dispensing error with CPOE prescriptions compared to the hand-written prescriptions (Table 1). Based on the in-depth interview of

primary nurses in Building A, dispensing errors occur more with CPOE compared to hand-written prescriptions due to the syrups, 3x1 teaspoon is typed as 3x1ml. The ml unit is readily available in the EHR system, whereas the teaspoon unit of measurement is not available. Statistical analysis of the type of medication order with the occurrence of an administration error resulted in p-value < 0.05 (p = 0.04), showing a errors

presence of typing errors, such as in the instructions for use of based on the type of medication prescription. The odds ration statistically significant difference in the occurrence of such (OR = 4.1) showed the possibility of administration errors occurring 4.1 times more likely with CPOE compared to hand-written prescriptions (Table 1).

No	Characteristic	No ME		ME		Total		p*	OR
		n	%	N	%	n	%		
1.	Medication Error								
	Prescription Type								
	CPOE	185	92,5	15	7,5	200	100,0	0,23	1
	Manual	177	88,5	23	11,5	200	100,0		1,61 (0,81 – 3,17)
2.	Prescribing error								
	Prescription Type								
	CPOE	185	92,5	15	7,5	200	100,0	0,23	1
	Manual	177	88,5	23	11,5	200	100,0		1,61 (0,81 – 3,17)
3.	Transcription error								
	Prescription Type								
	CPOE	185	92,5	15	7,5	200	100,0	0,85	1
	Manual	183	91,5	17	8,5	200	100,0		1,15 (0,56 – 2,36)
4	Dispensing error								
	Prescription Type								
	CPOE	197	98,5	3	1,5	200	100,0	0,02	1
	Manual	187	93,5	13	6,5	200	100,0		4,6 (1,28 – 16,2)
5	Administration error								
	Prescription Type								
	CPOE	197	98,5	3	1,5	200	100,0	0,04	1
	Manual	188	94,0	12	6,0	200	100,0		4,1 (1,16 – 15,1)

Table 1. The relation between errors with the type of medication prescription in building A of Dr Cipto Mangunkusumo Hospital

B. Correlation response time between hand-writing and CPOE prescriptions.

From the 400 hand-written and CPOE prescriptions, from prescribing until packaging, majority of them required a long

time for completion of the process, or more than 1 hour and 35 minutes. The proportion of prescriptions with a long response time was 66% (264 prescriptions), and 34% had short response times (136 prescriptions) (Table 2).

Response time (Hour:minute)	Manual		CPOE		Total (N=400)	%
	n=200	%	n=200	%		
1. Prescribing – packaging						
Short (< 1:35)	46	23,0	90	45,0	136	34,0
Long (≥ 1:35)	154	77,0	110	55,0	264	66,0
2. Prescribing – dispensing						
Short (< 0:58)	97	48,5	106	53,0	203	50,8
Long (≥ 0:58)	103	51,5	94	47,0	197	49,3
3. Prescribing - transcription						
Short (< 0:12)	41	20,5	21	10,5	62	15,5
Long (≥ 0:12)	159	79,5	179	89,5	338	84,5

Tabel 2. Response time for hand-written and CPOE prescription in building A of Dr Cipto Mangunkusumo Hospital

Statistical analysis revealed a significant difference in the response time of medication prescribing – packaging based on the type of prescription, $p = 0.0001$. the odds ratio = 2.7, revealed that CPOE prescriptions are 2.7 times more likely to have longer response times compared to hand-written prescriptions (Table 3). In-depth interview of primary nurses

highlighted the additional standard operating procedures for the administration of medications patients with national insurance that further lengthens the response time of pharmaceutical services in RSCM. According to the nurses, administration of medication to these patients requires approval from the building A management.

No	Characteristic	Short		Long ($\geq 1:35$)		Total		p*	OR
		n	%	n	%	N	%		
1	Prescription type								
	Hand-written	154	77,0	46	23,0	200	100,0	0,0001	1
	CPOE	110	55,0	90	45,0	200	100,0		2.74 (1,78– 4,22)

*Chi-square test, 95% CI

Table 3. Correlation between response time of the prescribing – packaging phase and the type of prescriptions in building A of Dr Cipto Mangunkusumo

Discussion

A. Analysis of the difference in medication errors between hand-written and CPOE prescriptions in Building A

Observation of hand-written vs. CPOE medication prescriptions was analysed with every dependent and independent variables. Results show that there is no correlation between patient characteristics, including age and gender, with the occurrence of medication errors in both, hand-written and CPOE prescriptions.

In general, very few studies have tried to correlate the occurrence of medication errors with patient age and gender. One study, Dabaghzadeh *et al* (2013) reported on patient age and medication errors. There was a significant difference in the occurrence medication errors associated with varying patient age; though the average patient age in that study was 51 and 58 years. Contrastingly, CPOE has been proven to effectively reduce medication errors in the pediatric population, as compared to hand-written prescriptions (Potts, 2004)

Observation of prescribers showed that illegible hand-writing is one main cause of medication errors. This has been reported in several studies and has been summarized in a meta-analysis on the factors that cause incorrect medication administration (Keers *et al*, 2013). The analysis revealed that a significant number of medication errors occur due to illegible hand-writing

Observation of the nursing staff on floors 1, 3, and 7 in building A of Dr Cipto Mangunkusumo hospital reveal their excess workload. It is hoped that this research may form the basis for the addition of nurses for the in-patient ward. According to the report by Keers *et al* (2013), workload and work culture has significant effects on the occurrence of medication errors, thus necessitating additional consideration and further evaluation.

B. Analysis of the difference in response times between hand-written vs CPOE prescriptions in Building A

The study by Keers *et al* (2013) revealed that workload,

mental and physical condition, as well as work cultura are various factors that affect the response times in healthcare institutions. The number of medicines prescribed, on hand-written or CPOE prescriptions, contribute to the time required to package the medications, lengthening the reponse time.

In-depth interview with the head of building A of Dr Cipto Mangunkusumo hospital highlighted the lack of manpower available for delivering the medications that have been packaged, which influences the response time on both, hand-written and CPOE prescriptions. This is because packaged medications are collected on the trolley prior to delivery, waiting for the availability of a porter to deliver the medications to the ward.

Statistical analysis ($p=0.0001$) revealed significant difference in the response time from prescribing to packaging based on the type of medication order. The OR = 2.7, showing that CPOE has 2.7 times the odds of having a longer response time compared to hand-written prescriptions. Longer response times associated with CPOE prescriptions was also reported by Shu *et al* (2001). It was stated that the response time increased by 5% in CPOE compared to hand-written prescriptions. In-depth interview of the primary nurses revealed that there are various factors that contribute to the long response times for pharmaceutical services in the hospital, primarily due to the protocols of the national insurance system

C. Analysis of the factors influencing CPOE implementation in Building A

As reported by Keers *et al* (2013), various prescriber factors affect the occurrence of errors in prescriptions. One interesting finding is the larger number of errors found in prescriptions written by attending physicians compared to the residents, especially considering residents have lesser work experience in comparison. However, a previous study by Kopel *et al* (2005) revealed a similar result which also highlighted the various challenged in CPOE implementation, including the need for prescriber adaptation to the new prescribing system.

In-depth interview with a group of the attending physicians highlighted their resistance in using CPOE as they consider the system to be complicated and they have not received training on usage of the CPOE system. In addition, some attending physicians were ignorant of their access to the CPOE system. Their hope is that CPOE use may be increased as they believe it may reduce the occurrence of medication errors.



Figure 1. Process for medication orders until delivery to the nurse’s station in building A of Dr Cipto Mangunkusumo Hospital

Following launch of the CPOE system in building A of Dr Cipto Mangunkusumo Hospital, a variety of responses and opinions were received from the different stakeholders involved, including the physicians, nurses, and pharmacists. Several informants welcomed the CPOE system well. In addition, some have mentioned that CPOE makes their work faster and helps in reducing the occurrence of avoidable medication errors. The CPOE system is accompanied with lexicomp, an software that detects duplicate prescriptions and medication interactions.

D. Factors influencing CPOE implementation

In general, physician perception of CPOE is one the main determining factors of its implementation in building A of Dr Cipto Mangunkusumo hospital. Physicians are not accustomed to the system and are not ready to use the new technology available, and have never received training with regard to this system. These are the few reasons underlying their resistance to use CPOE. The limited number of computers available is another factor inhibiting the widespread use of CPOE. In addition, the informants also express that the lack of training causes them to be hesitant to shift from hand-written prescriptions to using the CPOE system.

In-depth interview with primary nurses highlighted that though many physicians have begun using CPOE for medication orders, the attending physicians, especially the more senior physicians, are still adamant on hand-written prescriptions.

In-depth interview with the group of attending physicians reveal that they find the CPOE system to be complicated. Additionally, as they have other responsibilities to fulfil, they often lack time to wait for a computer to type in the prescription and prefer the practicality a hand-written prescription. Other factors such as the lack of computers available to input prescriptions may lengthen response times as they have to take turns in typing the prescription into the CPOE.

In-depth interview with the head of information technology systems showed that CPOE has been implemented for 8 years, but evaluation of the system has never been conducted. Evaluation has been planned in 2016 under the instruction of the Director of Development and Marketing of Dr Cipto Mangunkusumo Hospital. In addition, all applications integrated in the EHR will be evaluated from various aspects, primarily with respect to patient safety, but the results have yet to be attained.

Conclusion and Recommendations

A. Conclusion

Based on the results and discussion with regard to evaluation of the computerized prescribing order entry (CPOE), the following conclusions are drawn:

- 1) CPOE may reduce the number of medication errors, though the errors are avoidable even in hand-written prescriptions as the nurses and pharmacists are able to re-confirm the prescribed medications to the attending physician if the hand-writing is illegible
- 2) The number of medicines prescribed in hand-written and CPOE prescriptions affects the response time. Physician status of the prescriber (attending/resident) influences the response time as well. Longer response times are also found where there is a lack of human resources available to deliver the medications back to the nurse’s station.
- 3) Majority of the attending physicians still use hand-written prescriptions as they are not accustomed to using the CPOE system and have not received the required training.

B. Recommendation

Based on the results and discussion with regard to evaluation of the computerized prescribing order entry (CPOE), the following recommendations are given:

- 1) Dr Cipto Mangunkusumo Hospital management:
 - a. Provide mass education, training, and draft policies for the implementation of CPOE for medication prescribing
 - b. Add computers so the attending physicians do not have to take turns to prescribe medications
 - c. Add manpower to deliver medications to the nurse’s station
- 2) Department of Pharmaceutical Services:
 - a. Collaborate with the information technology team to update the list of medications
 - b. Collaborate with the information technology team to improve the dosing unit for prescribed medications
- 3) The Information Technology Team:
 - a. Periodic training, monitoring and evaluation of the use of CPOE for medication orders
 - b. Provide a “help desk” or a person-in-charge to assist the attending physicians with CPOE
 - c. Collaborate with the pharmacy to update data

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