



Integrated medicine management system for malaysian healthcare sector

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ABSTRACT

Medicine management is an approach supported by evidence to prescribe and manage the patient's medicines to protect the safety, tolerability, and potency of the medication. It helps practitioners to achieve the optimum use of medicines for a patient, optimizes the treatment benefits and accomplishes the best results for each patient. The three components of the Medicine Management System (MMS), which are Electronic Health Record (EHR), e-prescription, and Clinical Decision Support System (CDSS) are vastly used. Despite the values of MMS, only 15.2% of public hospitals in Malaysia utilize the system using different features. This paper reviewed the components of the current MMS, the utilization and challenges of MMS implementation in the Malaysian context, and proposed a new integrated MMS. The proposed MMS is grounded on three theories, namely System Theory, Utilization Theory, and Evidence-Based Theory. The main aspects of the integrated MMS are e-prescription, appropriateness of dosage regimen, covering best current evidence, show alerts of any medicine-related issues, and centralization of patient data that will be designed for all healthcare centers. If any issues arise in the prescribed medicine, an alert will be supported by the current foremost evidence that shows on the prescriber's system. However, if no issue is detected, the prescription will be saved in the patient's record and will show on the pharmacy system with direction and cautions related to the medicines. The proposed MMS is postulated to increase the productivity of the healthcare system by reducing medicine-related issues, improve communication among healthcare professionals, enhance patient health, and enhance practitioner operations.

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INTRODUCTION

Medicine management is an approach based on evidence to prescribe and manage the patient's medicines to ensure the safety, tolerability, and effectiveness of treatments. With good medicine management, patients experience more satisfactory, safer and suitable care. It helps practitioners to advise the drug for patients in the best way (Aggarwal, 2018). The main intention of medicine management is to enhance the efficiency of treatments and attain the best consequences for the individual patient (Department of Health Northern Ireland, 2018). Three components of the Medicine Management System (MMS), which are Electronic Health

Record (EHR), e-prescription, and Clinical Decision Support System (CDSS) are widely used. Despite the importance of MMS, the adoption rate of information system in Malaysian hospitals are very low where only 15.2% of the hospitals are using the information system, and all those systems are not integrated and have different features (Ismail *et al.*, 2015). The prime objective of this paper is to scrutinize the factors associated with the current information system utilized by the public and private healthcare sector in Malaysia in an attempt to develop an integrated web-based MMS for future use.

Components of the medicine management system (mms)

Health Information Technology (HIT) comprises several technologies to maintain patient medical information to enhance the operations of practitioners in medical care. HIT is the phrase which is used for storage and usage of patient medical information using electronic media. Information Technology (IT) gives good effects on the protection, cost, and the degree of excellence in the quality of health (Rouse, 2018). HIT is an extensive-phrase for referencing the complete management of patient's health information over computer systems. It is normally considered the more appropriate tool for streamlining the excellence of protection and secure healthcare provision (Laal, 2013). HIT groundwork is helpful for practitioners to make possible competent access of data, communication, and clinical services (Leventhal *et al.*, 2012). In various clinical studies, the benefits of HIT are admirably reported such as reducing healthcare professionals' documentation and time commitments and increasing productivity and regulation with regards to administrative operations (Jamal *et al.*, 2009). HIT is raising as a key aspect in medical care (Werder, 2015).

Electronic Health Record (EHR)

EHR is a data structure that stores well-ordered information regarding patient's demographic data, history of previous and recent treatments in healthcare centers, disease history in the family, possible allergies and oversensitivity, as well as test reports and results of diagnostic testing. It contains data from practitioners and health centers who have previously provided patients with any sort of healthcare services. Although practitioners acknowledge the benefits or strengths of EHRs, they would still prefer competent guarantees about data protection (Entzeridou *et al.*, 2018). It is crucial to maintain that privacy is checked for access to information, whereby only permitted persons can retrieve the patient data (Harman *et al.*, 2012).

EHR systems present remarkably to the degree of

excellence of patient care protection when they contain advanced support of CDSS (Horsky and Ramelson, 2016). According to (Davis *et al.*, 2012), EHR is an important ingredient in the foundation of integrated clinical programs as healthcare organizations are able to change their patient care settings with the adoption of EHR. EHR systems should be appreciated by the public at large as it offers safer prescribing, rehabilitation of drug errors, and disease tracking for public health (Miller and MacGregor, 2011). According to Flores (2013), EHR should be considered not only as a substitute for health record notes but also as a means of facilitating the accessibility and protection of eligible health information, thus providing a significant technology to support and improve health services.

EHRs allow the built and application of information infrastructures that are used to support flexible working environments. It enhances the reciprocity of health records among the medical staffs and has the capability to access remote data repositories (Flores and Vergara, 2013). Computerized systems can enhance the effectiveness of coordination between medical staffs in the medical discipline, whereby the exchange of patient's treatment information verbally can cause information loss and affect patient safety (Collins *et al.*, 2011). Electronic medical records often result in quicker data entry, improved data quality and records that are useful in daily clinical work. However, there is a strong need for further research on the features that may offer EHR more support and increase quality management (Triantafillou, 2017).

Issues with Current EHR

According to a research report by (Smelcer *et al.*, 2009), efficiency loss because of the long training period is an issue with existing EHR systems. The systems are complex, where highly qualified practitioners are required for completion of difficult tasks in a demanding workplace. Notably, practitioners took 30-75 minutes of work a day on EHR; due to the complexity of the system, practitioners had to perform so many steps to complete one simple task. Moreover, the system was intolerable as it had to be adjusted to meet the practitioner's demands. Most efforts on existing healthcare systems are only focused on assessing the success and incompetence of deployments, but not enough to inform detailed design decisions (Bhupatiraju, 2011).

According to (Alqahtani *et al.*, 2017), there are some barriers to the adoption of EHR: (i) Healthcare professionals' lack of experience in computers (18%), (ii) lack of perceived usefulness of healthcare professionals (15%), (iii) lack of perceived ease by

healthcare professionals (15%), (iv) technical limitations of the software system (15%), (v) lack of user support (9%), (vi) confidentiality concerns (9%), (vii) user's resistance to change (6%), (viii) lack of patient information quality (3%), (ix) lack of EHR standards (3%), (x) unreliability about HER vendors (3%), (xi) hospital size (3%), and (xii) hospital's level of care (3%). According to the study by (Khoja, 2013), there are four common barriers to the adoption of HER, which are the cost, adoption of EHR, HIT talent and privacy/security.

ELECTRONIC PRESCRIPTION

Electronic prescription or simplified as e-prescription is the medication instruction or information concerning prescription communication between the medical practitioner who prescribes the medicine and the medicine dispenser via digital media (Dumitru, 2008). The conveyance of safe and successful healthcare remains an existing challenge to clinicians, while more attention is concentrated on the inaccuracies of prescribed medication, in particular. HIT also exhibits efficacy in reducing medication inaccuracies by applying clinical guidelines and care protocols (Bates et al., 1998).

The traditional prescribing process is inherently error-prone and involves issues such as illegible handwriting, unclear abbreviations, the absence/presence of leading/trailing zeros, and confusing, vague, or incomplete directions. Electronic Medication Records (EMRs) and electronic prescription resolve several of these kinds of contemporary problems by providing a structured format for ordering medication. E-prescription allows the standardized ordering process that requires the healthcare professional to provide information on the five basic patient rights: choose the right medication, right medicine dosage, right direction to take medicine, and the right timing to administer the medicine for the right patient (Fox et al., 2011). E-prescription improves prescription quality (Motulsky et al., 2013) and results in a massive reduction of medication errors (Devine et al., 2010).

However, the application of a computer controls the healthcare system with no extensive functionality or accessibility features and processes to ensure a substantial system (Nanji et al., 2011). According to the Institute of Medicine (IOM), approximately 98,000 deaths happen yearly because of medical errors. E-prescription can minimize this medication error (Hoyt and Yoshihashi, 2013). The system is the key for preventing prescription inaccuracies

and enhancing patient care. However, we need to be conscious of their prospects to influence the clinical workflow (Agrawal, 2009).

Drawbacks of E-Prescription

Although e-prescription removes some errors, it amplifies some new errors and reintroduces other problems similar to those experienced by written medication order. Erroneous information, such as the wrong drug selection, inexact patient, and incorrect drug dosage directions are mostly the errors associated with e-prescribing (Ducker et al., 2013). Clarification of imprecision due to inaccuracies increased the processing time of an e-prescribing. The pharmacist took an average of 6.07 minutes per intervention, leading to an increase in the cost per e-prescription rate of \$4.74. Another report exposed that pharmacists intervened in 21 out of 180 e-prescriptions compared to 132 out of 1,498 long-established prescriptions, corresponding to the 11.7% intervention rate versus 8.8%, respectively. Disobedience of legal essential and immoderate quantity or duration of medication were the most common reasons for intervention, resulting in a 4.7-minute intervention and an increase of \$4 per prescription in the cost of dispensing.

These findings show that pharmacists must continue to intervene in e-prescriptions, leading to higher costs and time of dispensing (Warholak and Rupp, 2009; Ducker et al., 2013). According to (Odukoya and Michelle, 2012), there are two main issues related to the use of e-prescription in the pharmaceutical workflow have been classified; first, the challenges arising from the prescription or transmission software which include flawed e-prescribing and time delay in the transmission of e-prescription. The second issue involves pharmacists' lack of formal e-prescription technology training and the effect of software design for e-prescriptions.

According to (Ducker et al., 2013), design features of prescribing software or medicine prescribing application can increase the probability of issues such as drop-down menus, imperfect screen design and auto-suggest functions. In addition, these design features can contribute to the challenges in the workflow because they control the manual entering and editing prescriptions, errors or insufficient clarity. Delays in the new e-prescriptions can lead to anxiety and increase the patient waiting time as patients can reach the drugstore before they receive them. Also, e-prescriptions may impart at different times, not at once. System breakdown and conflicts regarding designs can constitute a problem and result in incompetency in the workflow.

According to (Lander *et al.*, 2013), another issue related to e-prescription technology is cost disadvantages, which include maintenance, start-up costs, and transaction costs. While large-scale pharmacies can negotiate lower transaction costs, smaller pharmacies pay more for the use of prescription software. In addition, not all pharmacies in the community and in the mail order can receive new prescriptions.

Clinical Decision Support System (CDSS)

The Clinical Decision Support System (CDSS) offers clinical and other paramedical personnel with diagnosis and treatment exhortation in real-time (Burney *et al.*, 2010). Problems related to drugs may cause treatment failure, where CDSS improves the performance of practitioners in this regard (Garg *et al.*, 2005). The software for drug interaction examination is an effective tool for helping clinicians identify and manage drug interactions. Clinicians should, however, be aware of the benefits and limits of these programmes (Kheshti *et al.*, 2016).

According to a research, the effect of Computer Provider Order Entry (CPOE) on their jobs was relatively positive and that the drug-drug interaction (DDI) warnings are helpful, but additional work are still required to increase the clinical benefit (Ko *et al.*, 2007). Another research measured that overall, CDSS improved performances in 64% of the 97 studies, but only 13% of the 52 compiled studies reported improvement in the actual patient (Hoyt and Yoshihashi, 2013).

According to the study by (Weingart *et al.*, 2003), the prescription writing program for the online medical record (OMR) has been amplified to include drug interaction and drug allergy. This was done by linking a central database containing information on the drug allergies and intolerances of each patient entered by a nurse, doctor and pharmacist in the hospital, outpatient and home patient environment. The allergy program alerts whether the prescription corresponds to the drug's brand or general name. Warnings for drug interaction were produced by checking the electronic drug list of the patient, which checks the severity of three-drug interaction levels. Figure 1 (Weingart *et al.*, 2003) shows drug allergy and DDI warnings using the OMR system developed by the Boston Clinical Computing Center at Harvard (Weingart *et al.*, 2003)

(Roblek *et al.*, 2015) conducted a clinical study on drug interaction software. Some authors suggest that Micromedex ® Drug-Reax are more accurate and reliable because of its quality of reacting quickly and positively. It provides information on the clinical implications of DDIs and takes into account the

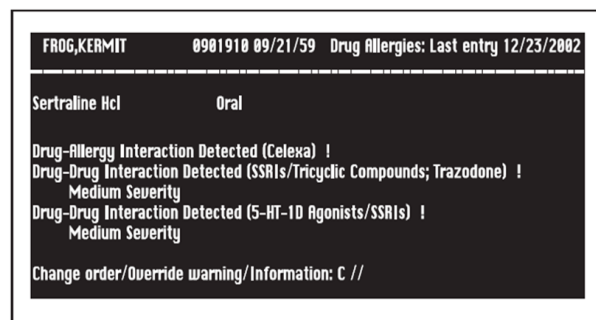


Figure 1: Example of drug allergy and drug-drug integration alerts using OMR

background reasons and the rapid or delayed onset of adverse outcome (fast or delayed) and severity (minor, relatively moderate or significant) with evidences to support this information. Other software that provides these data include Facts ®, Lexi-Interact ® and Pharmavista ®. We also identified that the DDI software are significantly comparable in terms of classification of identification for both commercial and interoperable free software applications. DDI software should be used with prudence to support decisions.

Issues with Current Components of MMS

The main issue with the adoption of current components of MMS includes the high cost to implement EHR. Other issues that have been reported are that people resist adopting the change, it requires computer expertise, security and privacy issues of health records, long training time for a new system, increase time to process the e-prescribing and not user-friendly. CDSS may also be inflexible, which could involve inaccurate drug selection from the drop-down list, inaccurate drug usage direction and prescription against the wrong patient. All these issues with the components of MMS are shown in Table 1.

RESULTS AND DISCUSSION

Mms in Malaysia

According to a healthcare informatics analysis, the Malaysian medical system has developed a way that unites western medical science and traditional health values in numerous places of the country. In 1996, however, the government introduced an ultra-digital media tunnel as a vital tool to improve many industries, including healthcare. In 1997, the government of Malaysia introduced a telemedicine blueprint called telehealth to help the country's future healthcare system (Nguyen *et al.*, 2008). The Multimedia Supercorridor (MSC) inaugurated by the Malaysian government in 1996 was a reform

Table 1: Issues associated with the components of Medicine Management System (MMS)

Compon of MMS	Cost	Adop	Privacy and secu- rity	Long train- ing time	Increase to process	Not user- friendly	Inflexi	Incorrect drug selection	Wrong patient	Incorrect dosage direc- tions
Electronic Health Record (EHR)	✓	✓	✓	✓						
E-prescription	✓				✓	✓		✓	✓	✓
Clinical Deci- sion Sup- port Sys- tem (CDSS)	✓						✓			

agenda designed to set specific long-term emission targets and goals to achieve the designation of a rich nation by 2020 which include enhancing the healthcare system. Malaysia’s Telemedicine Blueprint: Leading Healthcare to the Information Age (1997) is Malaysia’s telehealth development reference document which describes the integrated telehealth solution composition in the MSC Telehealth Flagship Application (Mohan and R.Yacob, 2004). A lot of time and money have been invested in IT in Malaysia as a developing country to improve healthcare services. The government of Malaysia is constantly seeking optimal solutions to enhance the effectiveness of local healthcare without incurring high costs. Unfortunately, the level of IT integration in healthcare isn’t really very intriguing in Malaysia (Lee et al., 2012).

Types of MMS in Malaysia

The Hospital Information System (HIS) has a prominent role in the successful progress of a hospital. Despite the importance of HIS, there is a low adoption rate of this system in Malaysia; only 15.2% of public hospitals in Malaysia have the system enacted in the categories of Total HIS, Intermediate HIS, and Basic HIS (Ismail et al., 2015). The details of the HIS implemented the system in Malaysian hospitals is shown in Table 2 (Ismail et al., 2013). HIS is comprised of at least two of the following Information System (IS) modules: Clinical, Financial, Laboratory, Nursing, Pharmacy, Picture Archiving and Communication System (PACS), and Radiology (Ismail et al., 2013). The functionality of each IS module are as follows: Clinical IS was set up to handle the data

skilfully and to provide important clinical information for the healthcare delivery process. Financial IS handles the hospital’s financial side. Laboratory IS is used for managing laboratory data for all laboratory subfields. Nursing IS is the system used to manage clinical data from different healthcare settings. Pharmacy IS system is designed to address pharmacy prerequisites. PACS is used to define a pair of systems endorsing the digitization, processing, and viewing of electronic radiological photos and related information. Finally, the Radiology IS system is built for the imaging department (Ismail et al., 2013).

There is, however, a lack of medicine management features in implemented modules such as system integration and data centralization, adequacy of the dosage regimen, an alert supported by the current leading evidence for any medicine-related issue such as drug-drug interaction, drug-food interaction, drug-disease interaction by patient type such as pregnant women, senior citizen. A new proposed integrated MMS would support these features.

Each system requires a number of technically trained personnel to operate. In addition, investments in human resources, user-friendliness and adequate training for the end-user will also determine whether or not the system would be implemented smoothly (Ismail et al., 2010). HIS is not highly established in Malaysia, and the adoption rate in small and larger government hospitals is very slow (Ahmadi et al., 2017). The Malaysian Ministry of Health (MOH) reported that 8.51% of the total national budget have been allocated for the system (M.O.H.-Malaysia, 2015). In the initial, only 22

Table 2: Implementation of Hospital Information System(HIS) in Malaysian Hospitals

	Total HIS	Intermediate HIS	Basic HIS
Modules	IHIS + Radiology + PACS + Administration + Financial + Inventory + Personnel Information System	Integration of BHIS + Laboratory + Pharmacy Information System	Patient Management System + Clinical Information System
Hospitals	Hospital Putrajaya, Hospital Selayang, Hospital Serdang, Hospital Pandan, Hospital Ampang, Hospital Sungai Buloh, Hospital Alor Setar, Hospital Sungai Petani	Hospital Keningau, Hospital Lahad Datu.	Hospital Kuala Batas, Hospital Setiu, Hospital Pekan, Hospital Pitas, Hospital Kuala Penyu, Hospital Kunak

out of 137 public hospitals were explicitly or implicitly embedded into the telehealth project (Ahmadi et al., 2017).

Challenges for Implementation of MMS in Malaysia

According to (Mohamadali and Zahari, 2017), the espousal rate of HIS in Malaysia is very low due to the four major challenges in hospitals to execute HIS which are high adoption cost, building the infrastructure, top management involvement and also security issues, as illustrated in (Mohamadali and Zahari, 2017) ,Figure 2.

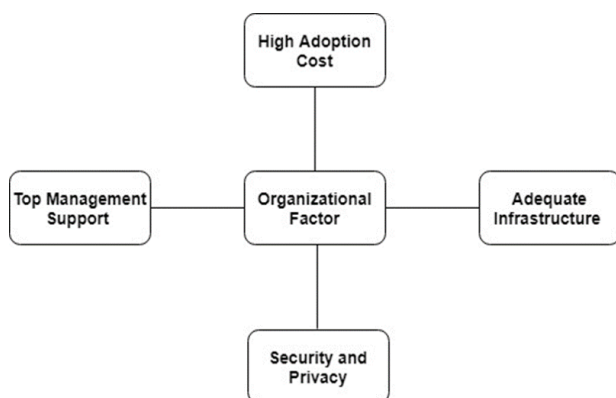


Figure 2: Organizational factor challenges for hospitalsto execute the Hospital Information System (HIS)

Divided the challenges to implementing medicine management into three categories, which are an organizational challenge, human challenge, and technological challenge.

According to (Ismail et al., 2013), there are some issues which effect the implementation of HIS in Malaysian public hospitals such as the limited financial sources, maintenance by different departments, HIS implementation order by the Malaysian Ministry of Health, addition of new systems, confiden-

tiality issues, low acceptance level, low satisfaction level, different vendors, infrastructure issues, system breakdown, and duplication of data.

A crucial challenge in prioritizing healthcare with information on cost efficiency (CE) is when alternatives are more costly but efficient than existing ones. In such a situation, the technology needed an external requirement in the sort of a ceiling that represents the ability to pay for a life-year of quality altered. The insufficiency of an empirical reimbursement threshold in Malaysia could have a consequential reaction on the clarity of healthcare decisions. The estimated CE limit for Malaysia was below the recommended threshold of the World Healthcare centers or healthcare establishments (Lim et al., 2017).

Theoretical modal for integrated mms

The administrator roles and flow of the MMS healthcare system are based on a system theory; when a patient comes to a healthcare registration center, the patient’s name will show on the system’s profile if they have already registered in the system, but if the patient has never registered, then the registration counter staff will enter the demographic information in the system, and it will be saved in the system’s database as a patient’s profile. Then the patient move to see the health practitioner, and after the visitation, the patient will move to the pharmacy to collect the medicine.

The practitioner will search the patient by entering the patient name and Id in the system, the system will show the profile of the patient, then the prescriber will prescribe the medicine, and the system will check drug issues, i.e. drug-drug interaction, drug-food interaction, drug-disease interaction, dosage regimen and dosage direction according to the type of patient, i.e. adult, child, senior citizen, pregnant women and lactating women. The

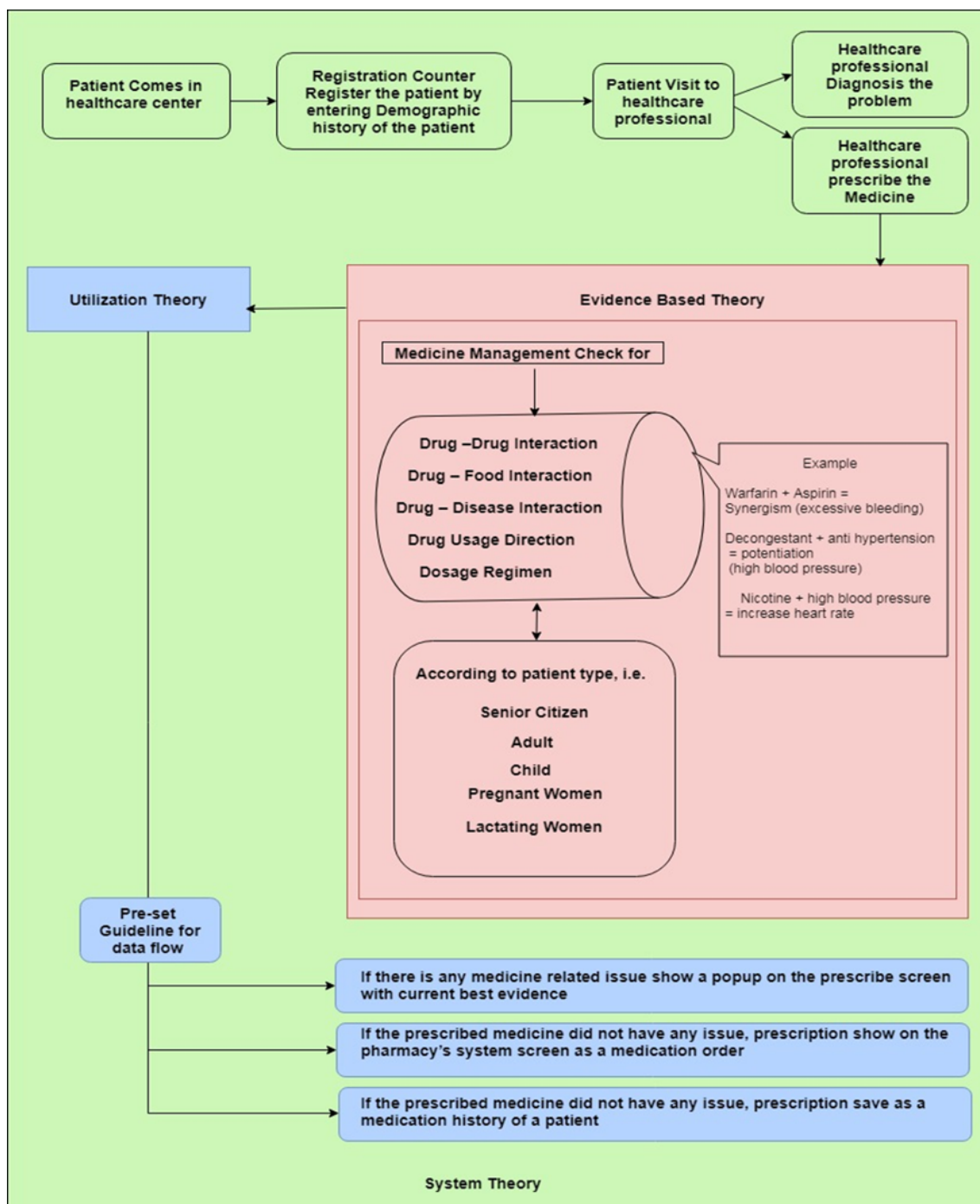


Figure 3: Theoretical Model of the Integrated Medicine Management System (MMS)

prescribed medicine will be evidence-based; if there is any issue, an alert will show on the prescriber’s system. Otherwise, the prescribed medicine will be saved in the system’s database as patient medication history and show on the pharmacy system as a prescription order. The flow of data or instructions are preset as it is a computer-based system; every instruction is preset, so it comes under the utilization management theory which is embedded in the system theory, and this system will be beneficial for both the patients and health practitioners. Figure 3

represents the theoretical model for an integrated MMS.

CONCLUSION

The proposed integrated MMS will increase the productivity of the healthcare system by reducing medicine-related issues. It will also reduce medication errors with the e-prescription features, improve communication among healthcare professionals based on system theory and EHR features

and improve patient care with CDSS. The pharmacy is receiving prescription order electronically; it will also improve the process workflow. It is postulated that the integrated MMS will improve health practitioners' performance and overall health outcomes. It is suggested that the implementation of MMS in the Malaysian healthcare system should integrate the following two important features: (i) appropriateness of dosage regimen, and (ii) an alert will be covered and supported by the current foremost evidence that shows on the prescriber's system in case of any issues related with medicine.

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