

การพัฒนาระบบการดูแลด้านยาภายใต้การมีส่วนร่วมของเภสัชกรในทีมสหสาขาวิชาชีพ: กรณีศึกษาคลินิกโรคไม่ติดต่อเรื้อรัง โรงพยาบาลดำเนินสะดวก

Development of Drug Therapy Management System by the participation of Pharmacist in Multidisciplinary Team: A Participatory Action Research in the Non-communicable Disease Clinic at Damnoensaduak Hospital

นิพนธ์ฉบับ

Original Article

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บทคัดย่อ

Abstract

วัตถุประสงค์: เพื่อพัฒนาระบบการดูแลด้านยาโดยเภสัชกรในคลินิกโรคไม่ติดต่อเรื้อรังที่มีความเหมาะสมกับบริบทของโรงพยาบาลดำเนินสะดวก **วิธีการศึกษา:** การวิจัยเชิงปฏิบัติการแบบมีส่วนร่วมและกระบวนการพัฒนาแบบต่อเนื่อง เก็บข้อมูลระหว่างพฤศจิกายน 2559 ถึงกันยายน 2560 จากบุคลากรทางการแพทย์ 14 คน ร่วมกันวิเคราะห์ปัญหา ออกแบบและทดสอบระบบ แล้วนำระบบที่พัฒนาขึ้นไปดูแลผู้ป่วยโรคไม่ติดต่อเรื้อรัง ตามแนวคิดองค์ประกอบ CCM และการพัฒนาแบบวงล้อ PDCA **ผลการศึกษา:** ระบบการดูแลด้านยาโดยเภสัชกรที่พัฒนาขึ้นประกอบด้วยการทำงานของเภสัชกร 3 ขั้นตอน คือ 1. การคัดกรองปัญหาด้านยาโดยใช้ระบบเทคโนโลยีสารสนเทศและจากการซักประวัติของเภสัชกร 2. การจัดการด้านยา และ 3. การส่งต่อข้อมูลแก่บุคลากรทางการแพทย์และผู้ป่วย ในการพัฒนาระบบอาศัยทุกองค์ประกอบของรูปแบบการดูแลโรคเรื้อรังโดยมีเป้าหมายและทิศทางเป็นองค์ประกอบเริ่มต้นในการพัฒนา ซึ่งระหว่างการพัฒนาต้องให้ทั้งระบบสารสนเทศ การปรับระบบและกระบวนการบริการระบบการสนับสนุนการจัดการตนเอง และระบบการสนับสนุนการตัดสินใจ พบว่าระบบสารสนเทศมีความสำคัญต่อการพัฒนาระบบการดูแลด้านยามากที่สุด ระบบที่พัฒนาขึ้นสามารถคัดกรองปัญหาที่คาดว่าจะเกี่ยวข้องกับยาก่อนวันนัดได้ร้อยละ 17.8 และในวันนัดคัดกรองได้ร้อยละ 42.7 ปัญหาส่วนใหญ่ที่พบ คือ ผู้ป่วยบริหารยาผิด (ร้อยละ 67.6) พบว่าแพทย์ให้การรักษาสอดคล้องกับข้อมูลที่ส่งต่อให้ร้อยละ 63.6 **สรุป:** บทบาทเภสัชกรในทีมสหสาขาวิชาชีพโดยการทำงานเชิงรุกอาศัยระบบเทคโนโลยีสารสนเทศและการซักประวัติโดยเภสัชกรร่วมกันสามารถสนับสนุนให้การจัดการด้านยาในผู้ป่วยโรคติดต่อเรื้อรังได้เหมาะสมยิ่งขึ้น

คำสำคัญ: ระบบการดูแลด้านยา, วิจัยแบบมีส่วนร่วม, เภสัชกร, ทีมสหสาขาวิชาชีพ, โรคไม่ติดต่อเรื้อรัง, วงจรพีดีซีเอ, โมเดลการดูแลโรคเรื้อรัง

Objective: To develop a drug therapy management system with pharmacist participating in multidisciplinary team suitable for the non-communicable disease (NCD) clinic of Damnoensaduak Hospital. **Method:** This participatory action research (PAR) was performed from November 2016 to September 2017. Fourteen healthcare providers were selected to be in the PAR team to coordinate analysis, design based on the components of Chronic Care Model (CCM) concept, and implementation of the developed system using the Plan-Do-Check-Act (PDCA) cycle. **Results:** The developed drug therapy management system consisted of three roles of pharmacists, namely (1) screening drug related problems (DRP) using information technology and history taking, (2) drug therapy management, and (3) communication of the patient's information to the team and patient. All components of CCM could be implemented. Resource and policy were the initial components for development. During the ongoing process, other components namely clinical information systems, delivery system design, self-care support and decision-making support were applied with the information system component as the most important one. The developed system could screen 17.8% and 42.7% DRPs before and on the appointment day, respectively. Most DRPs were errors in patient's self-administration (67.6%). The physician responded to the DRP in agreement with the information communicated by pharmacist by 63.6%. **Conclusion:** The proactive role of pharmacist using the information technology and history taking in the multidisciplinary team could offer an effective drug therapy in NCD patients.

Keywords: drug therapy management system, participatory action research, pharmacist, multidisciplinary team, non-communicable disease, PDCA cycle, chronic care model

Editorial note

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Introduction

Non-communicable disease (NCD) has become a significant burden on health worldwide since they are the major causes of disability and premature mortality. In addition, NCD related illnesses affect not only the patients, but also family member, either physically, mentally or emotionally, or combined. Overall, NCD could impair the economic and social

development. There has been a trend of increased number of NCD patients annually as well as NCD related deaths and hospitalizations.^{1,2} Since diabetes mellitus and hypertension are the two most prominent NCDs, inadequate treatment and/or poor control on the two NCDs could lead to complications ranging from heart failure, cerebrovascular

diseases, ischemic heart disease, kidney failure, retinopathy and stroke. With these grave consequences of these two NCDs, early screening on these two NCDs could enable an early access to proper treatment, control or modify risk factors, delay the disease progression, and eventually alleviate the healthcare burden, expenditure and loss of health and quality of life.

Recently there has been NCD management system with multidisciplinary team. With its proactive approach, the two core components are as follows. First, the patient and family hold the central role of proactive action for self-care management. The second part is the management system with the multidisciplinary team for the continuity of care.^{3,4} To develop such solid healthcare system, one of the model that several countries have adopted is the Chronic Care Model (CCM) of Wagner and colleagues.^{5,6} CCM consists of 6 related components including 1) health organization policy, 2) clinical informatic system, 3) decision making system, 4) healthcare service system, 5) self-care support, and 6) connection with community. CCM expects healthcare providers to improve their service to fit the mutual expectation, supports collaboration, and encourage a systematic network of care for NCD. In addition, CCM expects that the multidisciplinary team create a proactive interaction between patients and healthcare providers. In accordance with the present concept of quality assurance, individual components of CCM are used to help develop the patient care process through the continuous improvement based on the PDCA quality improvement concept of Deming.⁷ According Deming, the improvement cycle consists of planning (Plan-P), the execution of the plan (Do-D), the examination after the execution (Check-C), and the improvement (Act-A). After a complete systematic cycle of PDCA, a more systematic working process and/or a quality working process could be achieved. In NCD care context, PDCA could bring a quality healthcare management system for NCD patients, providers, family, caregivers, community, and other related parties.

The use of CCM components with the continuous improvement process of PDCA could be done with participatory action research (PAR) which also support the proactive approach for integrated NCD healthcare system. PAR encourages participations of all involving parties. PAR is usually used in developing new system or improving existing system. The process of PAR allows for information from all active parties. This kind of information is more diverse and

applicable for a timely improvement or correction. The PAR process could thus lead to a quality healthcare service process, which could further lead to better clinical outcomes for patients and satisfaction for healthcare providers.⁸⁻¹⁰

In Thailand, the Ministry of Public Health (MOP) requires hospitals under its supervision to establish NCD clinic in 2013.³ However, despite a clear policy and support for execution, all components of CCM have not been clearly implemented in the process of care. In addition, the systems of development and continuous evaluation have not been fully integrated.³

Guided by the MOP, Damnoensaduak Hospital has established an NCD clinic for diabetes and hypertension to offer care by multidisciplinary team. However, the care has been provided mainly by physicians and nurses, not all related professionals. Mainly the passive aspect of care has been provided by pharmacists, specifically solving drug related problems identified and referred by nurses. With the concern on a more involvement of pharmacists in the NCD clinic, this study aimed to develop a proactive drug therapy management system in the multidisciplinary team as guided by the CCM components in the PDCA development cycle. The developed system could be beneficial for the care of NCD patients, especially drug therapy management.

Methods

In this participatory action research (PAR) , the investigators involved in all steps of the research. All professionals in the multidisciplinary team were encouraged to participate in identifying, analyzing and solving drug therapy problems, as well as developing the drug therapy management system with the participation of pharmacists in the NCD clinic of Damnoensaduak Hospital, Ratchaburi province.

This study was approved by the Ethic Committee for Human Research of Faculty of Pharmacy, Silpakorn University (Approval number: 4/2559; approval date: October 3, 2016). The study was conducted from November 30, 2016 to September 15, 2017.

In this study, drug therapy management system was defined as a proactive integrated planning of drug therapy by multidisciplinary system through out the entire duration of disease prognosis, as well as the prevention of drug-related adverse events. The system was expected to provide useful

information both for providers and patients which could be the patient confidence with proper drug therapy.

Study participants

Two groups of participants were recruited namely (1) multidisciplinary team participating the development of drug therapy management system and (2) patients receiving care provided by the multidisciplinary team. Participants were selected by purposive sampling method. The inclusion criteria were providers in the NCD service of Damnoensadua Hospital. This group of providers participated in problem analysis, system development, and implementation of the developed system.

The process of the study was continuous with the PDCA cycle. We divided the study into three phases as follows. First, the planning for drug management system based on the development objectives (Plan-P). Second, the execution of the plan (Do-D) and the evaluation of the execution (Check-C). Third, the modification after the evaluation for further improvement (Act-A). Details are shown in Figure 1.

In terms of healthcare provider participants, they were divided into three phases according to the study phases. In the first phase, 13 providers in the care of NCD patients were included. In the second phase, 9 providers involving in care of NCD patients were included. These were physicians, nurses, health educators, and pharmacist (the first investigator). Of these 9 participants, 4 of them were participants from the first phase. In the third phase, 14 providers in the NCD care were physicians, nurses, health educators and regular staff pharmacists in the NCD clinic. Of these 14 providers, 6 of them were from the second phase (Figure 1).

For patients receiving care provided by the multidisciplinary team, all patients followed up in the NCD clinic during study period of the developed system were recruited. Providers were participants in the development of the drug therapy management system. Details are shown in Figure 1. Components of the drug therapy management system based on the Chronic Care Model (CCM) concept are depicted in Figure 2.

Data collection

Two kinds of data were collected. First, problems, possible solutions, opinions (recommendations, critiques, etc.), and

outputs during the system development were collected at all steps of study conduct. Second, outputs during the system implementation were collected at phase 2 and 3 of study conduct.

Data collection tools differed by phase of study. In phase 1 and 2, electronic database called HOSxP, hardcopy of patient's information receiving care at the out-patient department, video recorders to record all study process, for interviewing multidisciplinary team, screening form for drug related problems by pharmacists, and the form to collect problems and solutions during the development and implementation of the drug therapy management system. In phase 3 where pharmacists regularly responsible in NCD clinic took care of the patients, we used the screening form for drug related problems by pharmacists and the form to collect problems and solutions during the development and implementation of the drug therapy management system. In phase 3, the first investigator only observed the process and participated only when problems arose.

All data were subject to analysis by the investigators with confidential. The results were presented as a summary not individual patient data. No identification information of the patients were presented so no individual patients could be identified.

Data analysis

In the **qualitative analysis** part, inductive summary to reach the important issues was based on the information from interviews with multidisciplinary team, team meeting, the implementation of the drug therapy management system with patients and providers. The results of system development and implementation were presented along with the recommendations for improvement in the format guided by components of CCM concept.

For **quantitative analysis**, frequency with percentage was used to present the numbers of 1) patients undergoing screening for drug related problems, 2) drug related problems identified, the intervention by physicians that were in concordance with pharmacist's suggestions. These results reflected the implementation of the drug therapy management system developed in our study.

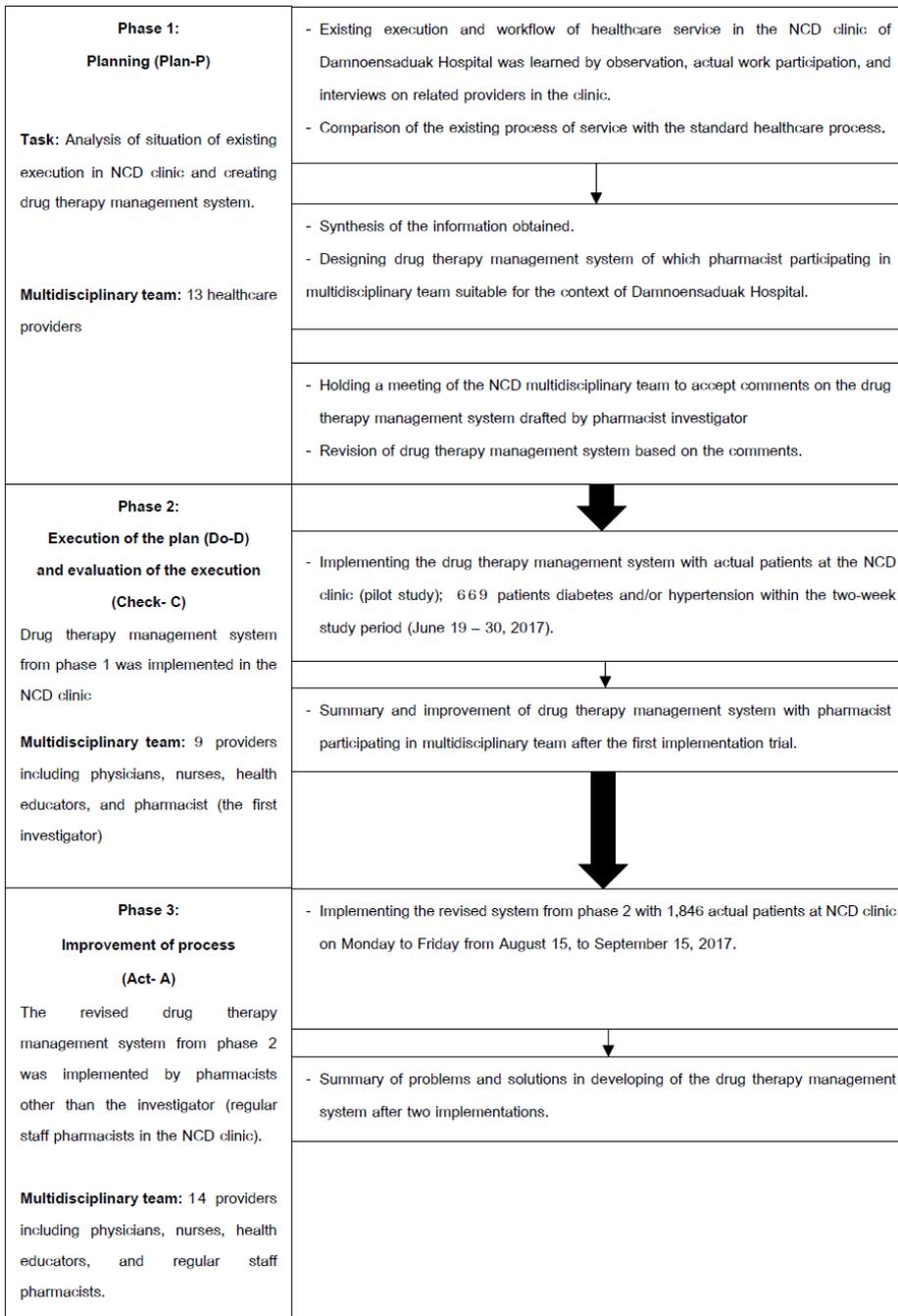


Figure 1 Procedure and participants in 3 phases of study.

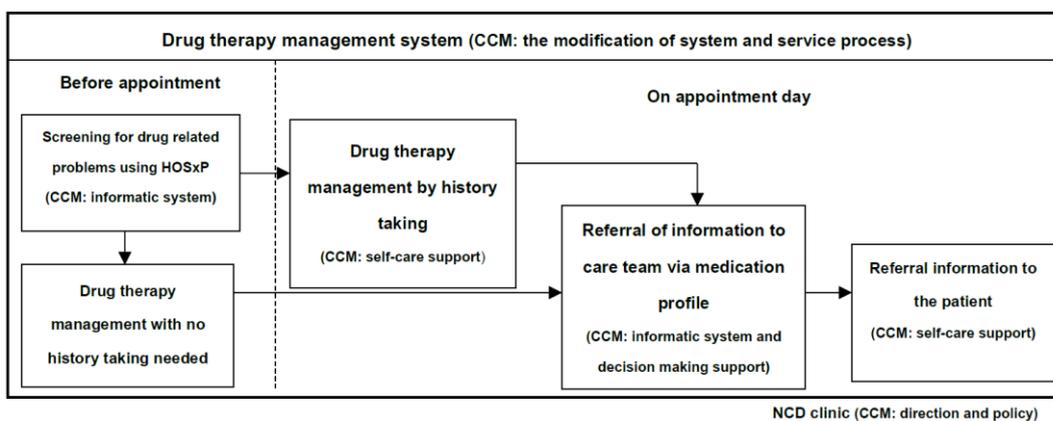


Figure 2 Components of the drug therapy management system based on the Chronic Care Model (CCM) concept.

Results

The study results were divided into two parts. The first part demonstrated the details of related situation and development of the drug therapy management system with pharmacists participating with multidisciplinary team. In the second part, quantitative results after implementing the system were presented.

Part I: Related situation and development of the drug therapy management system with pharmacists participating with multidisciplinary team

The present situation of the existing NCD clinic at Damnoensaduak Hospital

At present, NCD clinic of Damnoensaduak Hospital were providing service 5 days a week. Specifically, diabetes clinic was open on Monday, Tuesday and Friday; while hypertension clinic was on Wednesday and Thursday. On a daily basis, about 50 – 100 patients were taken care of by physicians, nurses, pharmacists, social medicine officers, and laboratory workers. Specifically, three physicians examined the patients, prescribed medications and order laboratory investigations for the next appointment.

Among few nurses (i.e. 2 – 3) on duty at the NCD clinic, one of them was responsible for the direct NCD patient care. This on-duty nurse prepared medical chart a day before the appointment day. At the appointment before the patient could see the physician, the nurse screened for signs and symptoms of other co-morbidities, performed history taking, performed physical examinations especially basic vital signs, and recorded information from the screening into computer system. After the appointment, the nurse recorded all information and laboratory orders for the next appointment into computer system.

The other nurse assistant(s) in the NCD clinic were responsible for preparing the hardcopy medical records. Like the head nurse previously mentioned, these nurse assistants also screened for signs and symptoms of other co-morbidities, performed history taking, performed physical examinations especially basic vital signs, and recorded information from the screening into computer system. After the appointment, these nurse assistants also recorded all information and laboratory orders for the next appointment into computer system.

For pharmacists, there were 2 to 4 of them at the NCD clinic. These pharmacists were responsible for checking for proper prescriptions, dispensing the prescriptions, and providing advice and/or solving drug related problems for all patients transferred from multidisciplinary team.

For two workers in the social medicine team, one was a nurse acting as a case manager of NCD patients with problems. This nurse was responsible for history taking, identifying and solving problems in patients with abnormal laboratory values, and improper drug administration. Another person was a health educator responsible for solving problems and providing advice about lifestyle modification. NCD patients seeing social medicine team were usually transferred from the screening by physicians and/or nurses at the NCD clinic. For laboratory workers, they were responsible for collecting specimens for investigation as ordered by physicians, and reporting the findings to physicians via the electronic system (HOSxP).

In terms of procedures of NCD service, the operations were divided into (1) days before the appointment and (2) on the appointment day. **Before appointment**, the monthly-assigned NCD nurse reviewed medical OPD charts of the appointed patients, and had the planned laboratory works for the next appointment ready on the OPD chart. On the **appointment day**, the appointed patient presented their appointment document at the history taking point to be preliminarily screened by the NCD nurse. Once available, the patient met the physician for physical examination and consultation. Once the session was over, the patient met the nurse for the next appointment document, laboratory order for next appointment, and prescriptions. For some patients with problems, they might be transferred to social medicine team as indicated. The criteria for transferring to social medicine team included (1) blood pressure of > 140/90 mmHg, (2) fasting blood sugar (FBS) > 180 mg/dL, and/or HbA1C > 7%, (3) total cholesterol > 200 mg/dL, and or triglyceride > 150 mg/dL, (4) smoking history, or (5) improper drug administration.

Issues leading to the development of the drug therapy management system

Based on the situation of the existing NCD clinic service mentioned above, four main issues were found problematic and deserved considerations for the development of the new drug therapy management system.

First: roles and responsibilities of the NCD clinic. It was found that the major healthcare providers were teams of physicians, nurses, and social medicine. Roles and responsibilities of other professionals were unclear, including nutritionists and physical therapists were unclear. For pharmacists, they had no proactive roles in identifying drug related problems, only provided pharmacy service to NCD patients like all other OPD ones. These included examining prescriptions, dispensing medications and providing advice on proper drug use.

Second: the communication network and transferal of patient information. It was found that a small card was used to transfer or share information of the NCD patients (diabetes and hypertension). Since the care was relatively small, certain useful information was left out unrecorded especially medications which were briefly recorded as RM shortened for re-medication (i.e, refill for previous prescriptions). As a result, the thread of treatment information was disrupted which could further lead to treatment or medical errors.

Third: the workforce of responsible providers. There was a lack of workforce to serve a relatively large number of NCD patients within a short period of time; hence, not all patients got screened.

Fourth: the importance of drug related information for patient care in the NCD clinic. Multidisciplinary team reported that drug related information was crucial for taking care of NCD patients. Information on the patient's drug use behavior and evaluation on the appropriateness of prescriptions before seeing the physicians, if available, could be highly useful for multidisciplinary team with such as limited service time.

Based on the issues mentioned above, we proposed **three points for the development of the drug therapy management system** as follows. **First**, there was a need to enhance the role of pharmacists in the multidisciplinary team for NCD clinic. Pharmacists should be responsible for identifying drug related problems before the patient met the physician, solving drug related problems, and transferring the information of drug related problems to the multidisciplinary team for a proper treatment plan.

For the **Second point for the system development**, the drug therapy management system with more proactive role of pharmacists should be developed. The system should be managed into three steps. Step 1 involved screening drug related problems. The screening should be done at least one

day before the appointment by pharmacists using the Pharmaceutical Care Network Europe (PCNE) to identify laboratory findings and previous medications from the hospital electronic medical record system (HOSxP). Step 2 should focus on drug therapy management system both with and without history taking. For the drug therapy management system with no history taking, most drug related problems were about the physician prescription orders which the pharmacist could propose options of solution and inform the physician accordingly before the appointment. For problems that needed history taking, they were about the patient's actual use of medications thus history taking at the appointment should be conducted. In step 3, information of identified drug related problems should be transferred to multidisciplinary team through the developed forms. Advice on medication use should be provided to the patients by pharmacists.

Finally, the third point for development involved the development of the clear and continuous transferal of information. The development of patient information forms either hardcopy or electronic, to shared among members of the multidisciplinary team and the information technology team. The form should be ready for collecting the latest medication prescribed shared and printed from the HOSxP program, and drug related problems identified by the pharmacist.

The development of the drug therapy management system based on the Chronic Care Model (CCM)

Based on all three phases of the development, components of the drug therapy management system based on the Chronic Care Model (CCM) were as follows. For the **first component, direction and policy**, it was used to drive and oversee the development to better serve the NCD patients in accordance with those laid out by the Ministry of Public Health.

In terms of the **second component, informatic system**, it was the crucial part of this development project. Informatic system was used to guide the development of the form for transferring patient and medication information linked with the HOSxP software program. The informatics system was also used in identifying drug related problems and sharing the problems among members of multidisciplinary team.

Regarding the **third component, system modification and service process**, we developed a proactive drug therapy

management system as a part of NCD care. It was found that after implementation, the developed system helped identifying drug related problems, managing practical medication administration, and sharing drug information to both providers and patients.

For the **fourth component, self-care support system**, this component was incorporated in the step of drug therapy management system with the patient participating in treatment plan. It was found that pharmacist and patient together could identify drug related problems and adjust drug treatment plan to suit the patient's lifestyle.

For the **fifth component, decision making support system**, the transferal of patient information through the patient information form was developed to aid the physician and multidisciplinary team to timely design treatment plan. Finally, the sixth component, the community networking, had not been incorporated in this study. Details of implemented components based on CCM are shown in Figure 2.

The developed drug therapy management system

The developed system was proactive in identifying and solving drug related problems before the patient could see the physician. The system also helped taking a continuous care of drug use after appointment and the incorporation of the multidisciplinary team. The process was divided into two phases, namely the process before and on the appointment day. In both phases, pharmacists were involved in **three steps**.

In **step 1**, identifying drug related problems was the first step for drug therapy management system. With the availability of the hospital informatic system, two screening methods for identifying drug related problems were implemented. The first preliminary screening was possible with the use of HOSxP program to retrieve information of patients unable to control their blood sugar and blood pressure (FBS > 180 mg/dL and blood pressure > 160/100 mmHg, respectively). The second thorough screening by the pharmacist based on medication history and laboratory results from previous appointment from HOSxP for all patients registered in the NCD clinic.

In **step 2**, drug therapy management was performed after identifying drug related problems in step 1. Drug related problems that did not need history taking were mainly the problems related to physician's prescription pattern. On the

other hand, problems that needed history taking were related to the actual patient's compliance to drug regimen and drug administration.

Finally, step 3 involved a transferal of information. The transferal of patient information to members of multidisciplinary team was done via the transferal form developed in this study. Transferal of information to the patient was done mainly verbally regarding the purpose and administration of each drug as well as any modification in drug regimen. Details are also shown in figure 2.

Part II: quantitative results after implementing the developed drug therapy management system

In the last phase of development, the drug therapy management system with pharmacists participating with multidisciplinary team was implemented. With 5 pharmacists participating in a 5-week period, a total of 1,846 patients were included in the NCD clinic, where 1,035 (56.1%) and 811 (43.9%) of them had diabetes and hypertension, respectively (Table 1).

Of these 1,846 patients, 312 drug related events were screened with HosXP program. However, once screened by the pharmacist, a total of 329 drug related events were found (17.8%). Drug therapy management with no history taking was done in 13 patients (0.7%) with 13 drug related problems found; while 316 patients with history taking for suspected problems were helped with drug therapy management (17.1%) (Table 1).

Table 1 Number of patients screened for drug therapy management at the NCD clinic.

Number of patients registered at NCD clinic by disease (%)			Number of patients before appointment (%)			
Diabetes	Hyper-tension	Total	Screened by HOSxP	Screened by pharmacist		Total number of patients screened
				Number of patients with no history taking	Number of patients with history taking	
1,035 (56.1)	811 (43.9)	1,846 (100.0)	312 (16.9)	13 (0.7)	316 (17.1)	329 (17.8)

Among 13 patients helped with drug therapy management with no history taking before appointment, 13 events of drug related problems were found with untreated indication as the most found problem (10 events or 76.9%) (Table 2).

Table 2 Number of drug related problems managed with no history taking by pharmacy before appointment and the acceptance by physician.

Drug related problems	Number (%)	Acceptance by physician (%)	
		Accepting	Not accepting
1. Drug choice problem			
1.1 Improper drug	0	0	0
1.2 Duplicate drug	0	0	0
1.3 Contraindicated drug	0	0	0
1.4 Untreated indications	10 (76.9)	5 (50.0)	5 (50.0)
2. Dosing problem	2 (15.4)	2 (100.0)	0
3. Drug interaction	0	0	0
4. Prescribing error	1 (7.7)	1 (100.0)	0
Total	13 (100.0)	8 (61.5)	5 (38.5)

For 316 patients screened by pharmacists before history taking on appointment day, 318 events of drug related problems were found (Table 3). The most found drug relation problem was blood sugar > 180 mg/dL (199 events or 62.6%).

On the appointment day, after history taking, of a total of 302 suspected events (drug related and non-drug related events) there were no drug related problems in 162 events (162 of 302 events or 53.6%), and problems other than drug related ones in 11 events of 302 events (3.6%).

After history taking, of the 302 suspected events (drug related and non-drug related events), 129 drug related problems were found (42.7%). The most frequently found problems were erroneous drug self-administration (96 events), dose self-adjustment (23 events), and side effects and short of supply (5 events each) (Table 3).

For drug therapy management with no history taking, pharmacists recorded the problems and recommendations on the information transferal form for the physician. For example, for the case of patient in need of given medications or with

untreated indication as in patients with hyperlipidemia, the pharmacist would state on the form the recommendation for lipid-lowering agents.

Physician's acceptance for pharmacist's drug therapy management recommendation is detailed as follows. It was found that before the appointment day, with no history taking, of the 13 drug related problems notified to the physician, 8 of them were accepted and the regimens were modified accordingly (61.5%) (Table 2). For those management recommendations with history taking by pharmacist before meeting with the physician, drug related problems were recorded on the transferal form along with laboratory findings for the physician. The most frequently found problems were self-administration error by the patient. This problem was mainly caused by the unawareness of the modified administration, thus the former administration method was continued. The pharmacist would inform the physician through the information transferal form.

Of the 129 drug related problems transferred to the physician after pharmacist's history taking, 82 events were accepted and changed according to the pharmacist's recommendation (63.6%) (Table 4).

There were 142 events of drug related problems transferred to the physician which consisted of 13 events without history taking before the appointment day and 129 events with history taking on the appointment day. There were 90 drug related problems that the physician provided the treatment in accordance with the pharmacist's recommendation, specifically 8 events without pharmacist's

Table 3 Number of drug related problems managed with history taking by pharmacy on the appointment day drug related problems found on appointment day (N = 316 patients).

Number of drug related problems	Number of events AFTER history taking								
	BEFORE history taking (%)	Drug related problems (DRP)						Other problems	
		Number of patients with no DRP	Side effects	Self-administration error	Dose self-adjusting	Misunderstanding about drug	Short of supply	Non DRP	Missed appointment
FBS > 180 mg/dl	199 (62.6)	32	2	55	9	0	4	8	25
BP > 160/100 mmHg	23 (7.2)	3	0	8	4	0	1	3	5
Previous dose adjustment	41 (12.9)	7	2	17	5	0	0	0	8
FBS > 180 mg/dl with previous dose adjustment	47 (14.8)	5	0	14	4	0	0	0	3
BP > 160/100 mmHg with previous dose adjustment	8 (2.5)	2	1	2	1	0	0	0	2
Total	318 (100.0)	162	5	96	23	0	5	11	43
					302*				
					129[#]				

* suspected events (drug related and non-drug related events) found after history taking, on the appointment day.

[#] drug related problems found after history taking, on the appointment day.

Note: DRP = drug related problems.

history taking before the appointment day (Table 2) and 82 events with history taking by the pharmacist on the appointment day (Table 4). Therefore 63.4% (or 90 of 142 events) of the transferred events and recommendations were accepted by the physician. Inversely, decisions not in agreement with the drug related events and related recommendations was found to be 36.6% (or 100 – 63.4%).

In addition to quantitative outcomes previously mentioned, pharmacists also recommended the patient to read labels and check for any changes in administration methods. Furthermore, for prescriptions with modified administration methods, pharmacists were instructed to put signs for direction such the up and down arrows for increased and decreased doses, respectively, and the underlined text for new or modified administration methods.

Table 4 Number of treatment provided by the physician in accordance with drug related problems (DRPs) and recommendations transferred by the pharmacist after history taking.

DRPs with recommendation	Number of DRP	Number of treatment by physician (%)	
		in accordance with DRP and recommendation	
		Yes	No
Side effects	5	5 (100.0)	0 (0.0)
Self-administration error	96	63 (65.6)	33 (34.4)
Dose self-adjustment	23	9 (39.1)	14 (60.9)
Misunderstanding about drugs	0	0	0
Incomplete drug list	5	5 (100.0)	0 (0.0)
Total	129	82 (63.6)	47 (36.4)

Discussions and Conclusion

Our study developed the drug therapy management system with pharmacist participating with the multidisciplinary team in the NCD clinic to be suitable for the context of Damnoensadua Hospital, a large-sized community hospital. The study was conducted using the participatory action research and continuous development of PDCA cycle, and the components of the developed system based on the Chronic Care Model (CCM). It was conducted from November 30, to September 15, 2017 with the group of 14 multidisciplinary healthcare providers and 1,846 patients.

The developed system demanded a proactive approach in identifying and solving drug related problems before the patient could see the physician. The system also involved continuous care on drug use after appointment and the participation of the multidisciplinary team. The process was

divided into 2 phases, specifically the operation before appointment day and the operation on the appointment day. Pharmacists involved in 3 steps of execution, namely screening for drug related problems, managing drug therapy, and transferring information to the physician and patient.

It was found that before appointment day, 17.8% of drug related problems could be screened and identified, and additional 42.7% were identified on the appointment day. Of the cases with drug related problems and recommendations transferred to the physician, 63.4% were agreed by the physician and the drug therapy was modified accordingly.

Based on the findings from the execution, **five issues** are worthy of discussion, namely, the implementation of CCM components, role of pharmacists in the multidisciplinary team, screening drug related problems, the outcomes of implementing the system in screening drug related problems, and participatory action research with the use of PDCA cycle. The details are as follows.

In our study, the implementation of CCM components in all steps of development had showed that all components were interconnected and unable to be distinguished from each other. Since only five of the six components of CCM, but not the community networking component, were used in this study, the developed system was only applicable to screening, managing and transferring information to the hospital setting. As a consequence, drug therapy management and information transferal between the hospital and responsible entities in the patient community was lacking. To enhance the efficiency of the drug therapy management system, all six components of CCM should be incorporated.

The crucial interconnectivity of all components of CCM has been evident in previous studies. In the study of Siminerio¹¹ where CCM components were applied for diabetes care, the components of CCM were inseparable and functioned together for a success in diabetes care. In our study, the most crucial CCM components were informatics system, self-care support system, and decision-making support system. These components were crucial for the success because they involved mainly in the ongoing system operation. Our finding was consistent with a systematic review of Davy and colleagues¹² which reported that the most crucial CCM components for the success were self-care support system and decision-making support system. In addition, they stated that components of support among healthcare team members,

clear information transferal system, and the support from administrators were needed for a sustainable success.¹²

In this study, **role of pharmacists in the multidisciplinary team** included screening drug related problems, managing drug therapy and transferring the patient information to the team members, before the patient could meet the physician. This role was critical as also found in the systemic review of Beney and colleagues where they concluded that pharmacist participating in drug management affected physician prescribing pattern in all studies.¹³ The systematic review of Poowaruttanawiwit also stated that one of the crucial roles in drug management was preparing the patient's information before the actual meeting with the physician could help the physician and healthcare team to make a sound decision for continuous care suitable for individual patients.¹² In short, pharmacist participating in the multidisciplinary team to screen and prepare the patient's drug related information before meeting with the physician could help improve the treatment. However, for patients unable to see the pharmacists before physician, the pharmacist consultation could be after the physician session with a longer clinic visit required.

In terms of screening drug related problems screening, we used two methods, the information technology assisted and the actual pharmacist methods. Both methods offered a relatively comparable efficiency; while no previous studies demonstrated such comparisons. A few studies demonstrated only the number of drug related problems identified by pharmacist participation.^{14,15} These two studies used both information technology to review laboratory findings and history taking by the pharmacist to identify and evaluate drug related problems.^{14,15} In our study, HOSxP database program could help screen a large amount of patient data for possible drug related problems with a relatively short period of time. However, the screening was based on almost solely on data of laboratory findings; while more kinds of data, such as medication history and laboratory findings from the past 2 – 3 visits, could be used for manual screening by the pharmacist. In conclusion, drug therapy management system with pharmacist participating in multidisciplinary team should make use of information technology and actual history taking to achieve a better outcome. However, if the workforce of pharmacist is limited, information of patients with suspected drug related problems from the electronic database should be reviewed prior to the actual screening by the pharmacist.

The fourth issue was the outcomes of implementing the drug therapy management system on screening of drug related problems. The system could screen a relative low portion of drug related problems, i.e., 42.9%. This rate was somewhat lower than other studies where 66.3 – 75.1% of the problems were found.¹⁴ The most found drug related problem in our study was self-administration error (67.1%). This was consistent with the work of Lekpet and Pitchayapaibul¹⁴ where 48.2% of drug related problems were non-compliance to drug administration. The agreement of prescribing with the recommendations from the pharmacist was 63.6% was somewhat lower than other studies where the agreement was 86.1 – 90.0%.^{16,17} This low agreement rate could be attributable to a relatively short period of study time (5 weeks) compared to those in other studies of at least of 6 months.

The use of the **participatory action research (PAR)** and **PDCA development cycle** could allow the multidisciplinary team to share opinions and work together in planning and improving the existing system to achieve the drug therapy management system suitable for the hospital context. PAR was also used in the study of Khangsri and colleagues where PAR could help develop working and learning process of personnel in alleviating drug dispensing and advice, as well as reducing drug related problems among diabetes patients.¹⁸ In our study, PDCA development cycle was incorporated in all steps of the development to foster continuous and timely improvement. The effectiveness of PDCA was consistent with the study of Modthong et al where PDCA in the development of OPD service of the medicine department resulted in a more effective and safe care for the patient.¹⁹ PDCA is suitable for continuous development as also found in the study of Srisathitnarakun²⁰ of which service system was one of the systematic problems applicable for cyclical and continuous improvement. Ultimately, to achieve a more effective drug therapy management system, multidisciplinary team with systematic, continuous planning for improvement should be considered the crucial intervention in all settings.

In conclusion, the improvement of drug therapy management system with pharmacist participating in the multidisciplinary team using the continuous PDCA cycle and CCM components offered a service that could improve screening, identifying and solving drug related problems. The transferal of the information related to drug related problems could be done with less disruption. This systematic improvement has been proven to be useful in the service for

NCD patients which comprised the largest portion of OPD patients. It could be useful in improving drug therapy management system in other groups of patients where no pharmacist participation or their participation is limited to achieve a higher level of effectiveness in patient care. The process could also be used to improve the working process such as retrieval of patient information from HOSxP for transferal system. More importantly, with a lack or limit of workforce and/or service time, not all patients with diabetes and hypertension could be served and not both screening system by the pharmacist could be employed simultaneously. Thus, one might start with diabetes patients, and the screening of drug related problems should be mainly aided with the patient informatic system. Future research should be extended for at least 6 months to prove a relatively moderate-term effectiveness and appropriateness of the developed system. Lastly, clinical outcomes evaluation as indicated by the concept of the NCD Clinic Plus of the Ministry of public Health should be carried out to demonstrate the sustainable, real-life clinical outcomes of the developed drug therapy management system.

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