

# การพัฒนากระบวนการสนับสนุนและส่งเสริมการใช้ยาปฏิชีวนะอย่างเหมาะสมในโรงพยาบาลชุมชน ด้วยเทคนิคการสร้างผังมโนทัศน์ร่วมกับทีมสหวิชาชีพ Development of the Supporting and Promoting System for Appropriate Antibiotics Use in a Community Hospital by Concept Mapping Techniques with a Multidisciplinary Team

นิพนธ์ฉบับ

Original Article

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## บทคัดย่อ

**วัตถุประสงค์:** เพื่อค้นหาปัญหาการดำเนินงานการประเมินความเหมาะสมในการสั่งใช้ยาปฏิชีวนะในโรงพยาบาล และพัฒนารูปแบบการประเมินการสั่งใช้ยาด้วยระบบการสนับสนุนและส่งเสริมการใช้ยาปฏิชีวนะอย่างเหมาะสม โดยการมีส่วนร่วมของทีมสหวิชาชีพ **วิธีการศึกษา:** การศึกษานี้ใช้วิธีวิจัยแบบผสมผสานทั้งเชิงปริมาณและเชิงคุณภาพ กลุ่มตัวอย่างคือ บุคลากรทางการแพทย์จำนวน 22 คน ที่เกี่ยวข้องในการสั่งใช้ยาปฏิชีวนะ meropenem, vancomycin, piperacillin/tazobactam และ amoxicillin/clavulanic acid ที่คัดเลือกแบบเจาะจง ดำเนินการวิจัยโดยใช้กระบวนการจัดผังมโนทัศน์ (Concept mapping) ระหว่างวันที่ 1 มีนาคม 2561 ถึง 31 มีนาคม 2562 ณ โรงพยาบาลชุมชนแห่งหนึ่งในจังหวัดร้อยเอ็ด เครื่องมือที่ใช้ในการวิจัย ได้แก่ แบบบันทึกข้อมูลทั่วไปของผู้ร่วมการวิจัยแบบสัมภาษณ์เชิงลึก และอุปกรณ์สนับสนุนการสัมภาษณ์ ได้แก่ เครื่องบันทึกเสียง และแบบบันทึกภาคสนาม วิเคราะห์ข้อมูลโดยใช้สถิติเชิงพรรณนามultidimensional scaling และ hierarchical cluster analysis **ผลการศึกษา:** จากการสัมภาษณ์เชิงลึกพบปัญหาการดำเนินงานการประเมินการสั่งใช้ยาปฏิชีวนะแบ่งเป็น 3 สาเหตุหลัก ได้แก่ ด้านบุคลากร ด้านนโยบายกับระเบียบปฏิบัติ และด้านการสื่อสารประชาสัมพันธ์ ในการประชุมระดมสมองเพื่อหาแนวทางแก้ไข ปัญหาการดำเนินงานตามขั้นตอนการสร้างผังมโนทัศน์ พบว่าได้ผังมโนทัศน์ประกอบด้วย 7 กลุ่ม ดังนี้ 1. ระบบเทคโนโลยีสารสนเทศ 2. นโยบายและแผนการดำเนินงาน 3. ประชาสัมพันธ์ระบบงานเชิงรุก 4. การมีส่วนร่วมของทีมสหวิชาชีพ 5. กิจกรรมทบทวนปัญหาและนำเสนอผลการปฏิบัติงาน 6. กิจกรรมส่งเสริมและพัฒนาความรู้ความเชี่ยวชาญของบุคลากร และ 7. แนวทางปฏิบัติการประเมินการสั่งใช้ยาอย่างเหมาะสม **สรุป:** การนำผังมโนทัศน์ที่ได้ไปวางแผนการดำเนินงานในระบบสนับสนุนและส่งเสริมการใช้ยาปฏิชีวนะอย่างเหมาะสมในโรงพยาบาลโดยอาศัยความร่วมมือจากทีมสหวิชาชีพในการมีส่วนร่วมควรประกอบด้วย 7 ประเด็นสำคัญที่พบในการวิจัย เพื่อให้ได้แผนการดำเนินงานที่มีคุณภาพต่อไป

**คำสำคัญ:** การประเมินความเหมาะสมในการสั่งใช้ยา, ผังมโนทัศน์, ทีมสหวิชาชีพ, ยาปฏิชีวนะ

## Abstract

**Objective:** To identify problems for drug use evaluation of antibiotics and developing a system to encourage the appropriate antibiotics use in a hospital by the participation of multidisciplinary team. **Methods:** Mixed methods composited of qualitative and quantitative approaches were used in this study. The participants were 22 healthcare professionals involving in the use of antibiotics, including meropenem, vancomycin, piperacillin/tazobactam and amoxicillin/clavulanic acid. The study was conducted between March 1<sup>st</sup>, 2018 and March 31<sup>st</sup>, 2019 at a community hospital in Roi-et province. Tools for data collection included the demographic data record form, interview guides and supporting equipment for interviews including the voice recorder, and field note. Data were analyzed using descriptive statistics, multi-dimensional scaling, and hierarchical cluster analysis. **Results:** From in-depth interviews, problems in drug use evaluation of antibiotics operation were classified into three themes including personnel, policy and regulations, and public relation and communication. Based on brainstorming in order to determine the solutions for problems in operation, one step in concept mapping method resulted in 7 clusters: 1. Information technology system, 2. Policy and action plan, 3. Proactive communication, 4. Participation of multidisciplinary teams, 5. Review of problems and present results, 6. Promoting and developing professional and clinical skill for staff with training programs, and 7. Drug use evaluation guideline. **Conclusion:** The concept map consisting of 7 issues with multidisciplinary teamwork should be taken into the action plan for promoting and supporting appropriate antibiotics use in hospitals to obtain a quality operational plan for the future.

**Key words:** drug use evaluation, concept mapping, multidisciplinary team, antibiotics

### Editorial note

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## Introduction

Communicable or infectious diseases have been an increasing public health problem worldwide including Thailand.<sup>1,2</sup> Communicable diseases have been one of the leading causes of morbidity and mortality when compared with non-communicable diseases including heart diseases and

cancers. Based on 2017 data, death from communicable diseases was the third of all causes of death.<sup>3</sup>

The worse problem of communicable diseases is associated with appropriate drug use especially antibiotics. The problem of inappropriate antibiotics use has put

detrimental effect on various aspects of health system including economic loss due to unnecessary and inappropriate drug use, financial burden according to the expense on high-priced drugs, and emerging poor clinical outcomes, hospital-acquired infection and antibiotic resistance from inappropriate antibiotics use.

Based on the data of antimicrobials resistance management strategy of Thailand from 2017 to 2021, the management on antibiotics resistance has been set as a priority<sup>4</sup> since the resistance has caused an urgent and crucial detrimental effects in a large scale.<sup>2</sup> As a consequence, evaluation and monitoring of antibiotics use in individual patients is highly crucial for correct and appropriate antibiotics prescription. At present, the most effective tool to control and monitor appropriate drug use is Drug Utilization Evaluation (DUE).<sup>5</sup> In the emerging microbial resistance, DUE is in a great need like never before as a strict and continuous measure to reduce the inappropriate drug use especially antibiotics.<sup>2</sup>

In Thailand, one of the measures for appropriate drug use is issuing certain drugs into category D and E in the National Essential Drug List 2013. These are drugs that need evaluation and monitoring for use since they could cause either serious adverse effects, severe microbial resistance, or a high likelihood of inappropriate drug use.<sup>6</sup> At present, many hospitals have initiated the program for appropriate use of antibiotics.<sup>7-13</sup> The core process of antibiotics use evaluation among hospitals is similar, steps of prescription could be different depending on prescription policy of these hospitals.

To be successful, various resource availability must be considered including human, technology and budget.<sup>14</sup> Hospitals with different purposes and expertises face different levels of resource availability and obstacles. Community hospitals, as secondary care setting, are more ready to conduct antibiotics appropriate use evaluation than those higher levels of healthcare setting. With a small number of physicians, it is easier to encourage the staff, to provide information necessary for decision making on prescribing, and to operate the program with a Pharmacy and Therapeutic Committee (PTC).<sup>15</sup> However, drawbacks found in community hospitals may include budget constraint, high personnel turnover rate, and disrupted operation; while in large hospitals, resource of personnel and technology is more available, and other measures to control antibiotics use have been initiated,

for example, Antimicrobial Stewardship Program (ASP)<sup>16,17</sup>, antibiotics prescribing control by infectious expertises<sup>18-21</sup>, and multidisciplinary team for appropriate drug use evaluation.<sup>7,22</sup>

In Phonthong Hospital, a community hospital in Roi-et province, Thailand, there had been an attempt to assess appropriateness of drug use through a DUE program since 2014. In this DUE program, four antibiotics have been subject to assessment. Based on the PTC criteria, these antibiotics include meropenem, piperacillin/tazobactam and vancomycin (Category D), and amoxicillin/clavulanic acid (Category C). The two main indicators of the program were 1) coverage of drug use evaluation and 2) percentage of prescriptions non-compliant to the criteria. The program has been facing certain obstacles including a poor level of cooperation among relevant staff on the set measures of course as reflected by a 45.2% evaluation coverage which was lower than a set criterion of 80% or more of patients with prescribed drugs. Majority of prescriptions were found to have a moderate level of appropriateness (77.9%). The problems could be rooted from a high turn-over rate of physicians, a lack of orientation on work process for new staff members, and ineffective measures to solve the identified inappropriate drug use.

With the existing problems that needed further improvement, this study aimed to determine problems in the operation of appropriate antibiotics use in Phonthong Hospital and to develop the supporting and promoting system for the appropriate antibiotics use among multidisciplinary team using concept mapping technique. We expected to obtain information regarding problems and solution from all relevant members in the multidisciplinary team by brainstorming. This information could be useful in developing a systematic and reliable measures for problem solving for community hospitals.

## Methods

In this mixed method study, quantitative and qualitative approaches were used to determine the problems of inappropriate antibiotics use and to develop the supporting and promoting system for the appropriate use of antibiotics including meropenem, piperacillin/tazobactam, vancomycin and amoxicillin/clavulanic acid among multidisciplinary team using concept mapping technique. The study had been conducted from March 1 to 31, 2019 at Phonthong Hospital, Roi-et province.

Study participants were healthcare personnel associating with appropriate use of the four antibiotics either directly or indirectly at the in-patient department. Specifically, the participants included one individual from administrative office, two internal medicine physicians, one pediatrician, one gynecologist, one surgeon, one family medicine physician, one general practitioner physician, seven pharmacists, and six nurses. In addition, a pharmacist with an extensive experience in supporting and promoting system for the appropriate antibiotics use in a general hospital was recruited. As a result, a total of 22 participants, or 26.25% of all 80 working in-patient department personnels, were included. This sample size of 22 individuals was based on the study of Pakyz and colleagues (2014) of which 21 physicians and pharmacists of a total of 79 staff members (26.58%) were interviewed.<sup>14</sup> Based on the concept mapping theory, a sample of 10 to 40 participants was recommended for the study.<sup>7</sup> Therefore, the sample estimated in our study deemed appropriate. The sample was selected by a purposive sampling technique. We selected individuals from the multidisciplinary team involving directly or indirectly with the antibiotics use evaluation; while the hospital director was selected to represent the administration team.

### Study tools

Three sets of instruments were used in the study. First, demographic questionnaire collected information such as gender, age, job position, education level, length of job position, marital status, and monthly income. Second, a set of opened interview questions was used to interview the participants. The questions were, for example, "what kinds of problems or obstacles in operating the DUE have you encountered?", "what are the reasons that you could not operate the DUE as indicated by the PTC?", "Do you have any recommendation to overcome the obstacles in DUE operation?" Third, the devices used for interviews included voice recorder phone (Iphone®) and field note collection form.

Regarding the interview questions previously described, they were created based on literature review and tested by three experts for correctness and coverage. The questions were revised according to the experts' recommendations.

### Study procedure

In-person interviews were conducted with all 22 participants, which were healthcare providers and administrator involving antibiotics use evaluation, using the

concept mapping technique. Concepts were based on information obtained from brainstorming on the multidisciplinary team, demographic questionnaire and opened in-depth interview questions.

The participants were asked for voice recording before the interview. The in-depth interview took about 15 – 20 minutes for each individual until information about all relevant issues was obtained. The whole interview was terminated once the information was saturated as the information was repetitive. In this study, the information was saturated once all 22 participants were interviewed.

The voice recorded interview was transcribed verbatim. The interview data were analyzed for problems and solutions provided by individual participants using the thematic analysis technique. As a result, major issues of the given problems with their relevant minor issues were determined. Concept mapping was used to summarize and depict problems and solutions for inappropriate antibiotics use. Recommendations were also summarized to apply in the next step of developing the supporting and promoting system for the appropriate use of antibiotics.

In the **second part** of the study, the supporting and promoting system for the appropriate use of antibiotics was developed based on the concept mapping method by the six following steps. First, brainstorming for establishing sound solutions and developing the appropriate drug use evaluation system was operated. The researcher held the meeting by providing the 22 participants objectives and results of the first part of the study. To aid the selection process, the researcher also provided recommendations for developing the supporting and promoting system for the appropriate antibiotics use obtained from literature review<sup>14,24- 26</sup> and experienced individuals, each representing DUE/ASP team of each network hospitals of Roi-et province. The researcher summarized all relevant opinions from the meeting. The summary was then verified for accuracy by the 22 meeting members to be prioritized in the step.

In the second step, opinions were prioritized as 22 participants were asked to rank each of all opinions by writing the number on a card of a size of 3 x 5 inches. Individual participants were allowed to categorize opinions closely relating to each other into a concept with no specific criteria but with their own rationale. All concepts were then named to be relevant to their content.

Categorizing and rating data of concepts were recorded into MS Excel® spreadsheet. Data were analyzed by the two-dimensional non-metric multidimensional scaling using statistical software R. The analysis results were presented as the point map where points close to each other indicated that the majority of the participants categorized such close concepts as a shared cluster. Coordinates of opinions from point map were analyzed by hierarchical cluster analysis with Ward method. The results were presented as cluster tree depicted by coordinates of opinions onto the map using MS Paint® which is a basic painting program of Microsoft™. The resulting graphic was concept mapping as guided by Trochim.

In the third step, each of all concepts was selected by each participants regarding applicability and importance using a five-point Likert-type scale<sup>27</sup> from 5 (the most) to 1 (the least). Scores of each given concept from all participants were averaged. Concepts with average score equal or greater than the average score of all concepts were selected.

In addition, scores of importance and feasibility were analyzed by quadrant analysis where concepts that were selected would appear on the right upper part of the graph called Go-Zone display. Participants were further asked to approve the rejected and retained concepts for the construction of concept mapping.

In the fourth step, retained opinions with their associating clusters of opinions were used in constructing concept mapping as guided by Novak's method using the software CmapTools.

In the fifth step, the concept mapping was interpreted. The second meeting was held to ask the participants to name each of all clusters to represent all opinions in their respective clusters.

In the last step, the developed concept mapping was applied for developing the supporting and promoting appropriate antibiotics use in the hospital with multidisciplinary team.

### Ethical consideration

The study protocol was approved by the Ethics Committee for Human Study of Mahasarakham University (Approval number: 072/2561; approval date: July 3, 2018).

### Data analysis

Demographic characteristics of the participants were presented by descriptive statistics including frequency with

percentage for categorical data and mean with standard deviation for continuous data. Data from in-depth interview were qualitatively analyzed using thematic analysis and content analysis as follows. Verbatim transcription was conducted on the voice records of individual participants by the researchers. The transcribed text was verified with the filed logbook and by the participants for accuracy.

After thorough reading and comprehension, keywords representing major and minor concepts were coded and further clustered according to the study objectives independently by two researchers. Concepts were grouped using quantitative analysis of multidimensional scaling and hierarchical cluster analysis. All statistical analyses were conducted using software program R (available at <https://www.r-project.org/>).

## Results

Demographic characteristics of 22 participants are shown in Table 1. The results of developing the program for supporting and promoting appropriate antibiotics use based on four antibiotics in the hospital with multidisciplinary team using concept mapping method are presented into two parts.

**Table 1** Demographic characteristics of participants (N = 22).

Characteristics	N	%
<b>Gender</b>		
Male	3	13.6
Female	19	86.4
<b>Marital status</b>		
Married	11	50.0
Single	11	50.0
<b>Age (yr) Mean = 37.82, S.D. = 7.78</b>		
≤ 30	4	18.2
31 – 40	12	54.5
41 – 50	3	13.6
≥ 51	3	13.6
<b>Occupation</b>		
Physician	8	36.4
Pharmacist	8	36.4
Professional nurse	6	27.2
<b>Duration of job (yr) mean = 13.77, S.D = 8.32</b>		
≤ 10	10	45.4
11 - 20	8	36.4
≥ 21	4	18.2
<b>Education</b>		
Bachelor's	11	50.0
Higher than Bachelor's	11	50.0
<b>Monthly income (Baht)</b>		
20,001 - 30,000	7	31.8
30,001 - 40,000	4	18.2
≥ 40,001	11	50.0

In the **first part**, problems and solutions of inappropriate use of the four antibiotics were obtained. The information of the DUE program of this community hospital could be categorized into three aspects including personnels, policy and rules, and communications. Novak's concept mapping is depicted in Figure 1 and the details are as follows.

In terms of personnels, the problem of poor cooperation according to the established DUE protocol could be attributable to several factors including understaff, a lack of workflow review, poor and unclear job description among members of multidisciplinary team, a lack of experience in DUE process, and a lack of infectious disease experts. The statements, for example, are as follows.

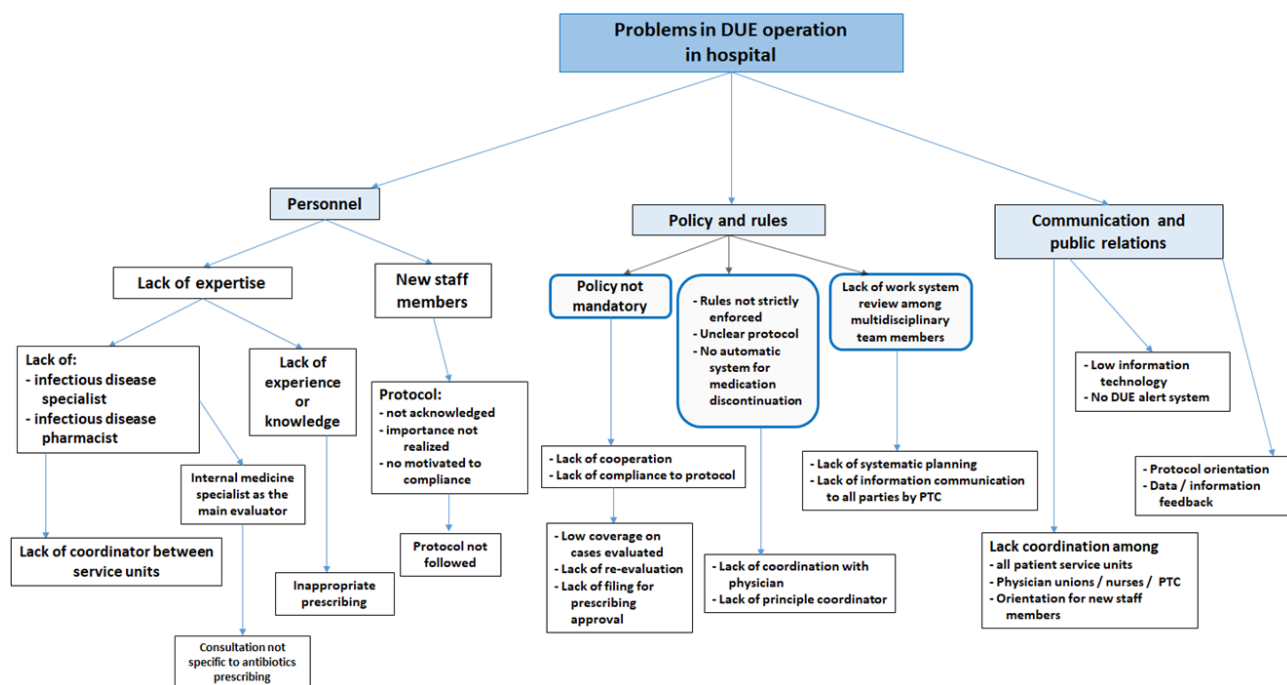
(Administrator) "The success of DUE depends on the actual operation which almost always faces the obstacles. It needs a good system from the beginning to the end from prescribing physician, to dispensing pharmacist to nurse. With a good management system, dedication, clear outcomes evaluation based on DUE concepts and the improvement based on the evaluation results, the appropriate antibiotics use could be achieved."

(Physician #1) "The problem is consulting physicians sometimes are frustrated. They feel no authority for decision making or even giving

opinions or recommendations since primary physicians of the given patients are always the one making decision. Consulting physicians could only provide information and additional opinions for drug selection. Primary physicians are always the one with the ultimate authority since they were the one most familiarizing the patient. Infectious disease specialists could provide a more appropriate and reliable recommendation for antibiotics selection. Unfortunately, such specialists are not available in our hospital."

(Pharmacist #7) "Assigning only one pharmacist to be solely responsible for the whole task or more poses a high risk for failure. With more responsibility but the same amount of time, documentation work is less likely to be done. In addition, whenever the assigned pharmacist is absent, the task is incomplete or completely lost. This problem could be found in almost all assigned tasks which is the major problem in our hospital."

(Nurse #1) "For us nurses, we need to remind the physician to fill the DUE form. It is inconvenient and easy to forget to do. In addition, contacting the specialist for signing of endorsement is burdensome and frustrating. In some cases, nurses forget to contact the specialist; while most new nurses are reluctant to do so. Certain proportion of nurses do not realize this responsibility. The operation of DUE is thus disrupted or delayed. Loss of follow-up of DUE evaluation data in some cases is evident."



**Figure 1** Problems in DUE operation in hospital based on Novak's concept mapping.

The second aspect of the problem, policy and rules, was also of great concern. Based on the policy and rules issued by the hospital PTC, staff faced problems during DUE operation including task management and staff coordination. These problems disrupted the task continuity among the relating service units in the hospital. Some concerns are as follows.

(Administrator) "The policy of the hospital has to comply with those at national level. The administrative team supports the DUE operation. All rules could lead to a better DUE outcomes and a role model for other hospitals."

(Physician #4) "DUE is a tough task to operate since it is voluntary, not mandatory in nature like rational drug use (RDU) which needs to be reported to the regional health administration office. This makes it difficult to mandate the DUE operation or to meet its indicators requirement."

(Pharmacist #1) "The most found problem is coordination at both service units and organization levels to promote a thorough understanding on the DUE protocol. Larger staff and organization with a poor oversight coverage could lead to a disrupted task."

(Nurse #5) "DUE operation has been disrupted because of the habit of not doing it, not seeing how much the benefits or impacts on the service."

Communication, the third aspect of the problems, had been reported as lacking within the multidisciplinary team; hence a lack of cooperation among the team members. Some opinions are as follows.

(Administrator) "DUE task is related to many units including infectious control and drug system. Prescribing physicians need to know the conditions of appropriate drug use. The best way to learn all condition, experience and related issues of DUE operation for all parties is to disseminate through the administrative committee or a conference for knowledge management. The administrator could financially support such conference."

(Physician #1) "Not all physicians know about the DUE especially the new staff members. Some physicians know about the DUE but do not follow or did not want to follow the protocol. Physician association in the hospital does not understand the objectives of DUE or realize the importance of DUE. Multidisciplinary team should know the protocol and carry out the task continuously since DUE could only be successful with a team effort not merely single or group of individuals."

(Pharmacist #1) "Some team members have not performed the task possibly due to a lack of communication on protocol to all involving parties. For example, nurses may not realize the importance of having physicians signing the document, physicians may forget or may not know the need to record prescribing data on the DUE forms, and

pharmacists may not realize to coordinate with prescribing physicians or acquire the prescription documents from the physicians on duty."

(Nurse #5) "Since the hospital has been growing with more personnel hired, turned over, and circulated each year, information dissemination to these diverse groups of expertises could be inadequate. In addition, information could be easily lost."

In the **second part** of the study, based on problems from the brainstorming and the subsequential 100 solutions from the interview analysis in the first part, this information was further presented to the participants for verification. They were also asked to provide opinions not in the first interview. Once redundant opinions were removed, a total of 62 recommendations for appropriate use of four antibiotics were retained as shown in Table 2. Concept mapping from the hierarchical cluster analysis resulted in nine groups of concepts. Quadrant analysis indicated 27 concepts with the highest level of importance (mean score of 4.54 points) and high level of feasibility (mean score of 3.86 points), i.e., those on the right upper quadrant (Table 2). However, there were two concepts outside of but close to the quadrant that we selected (concepts 27 and 48). Therefore, a total of 29 concepts were selected for development of the supporting and promoting system for appropriate antibiotics use (Table 2).

Based on the second meeting, nine groups of concepts based on Trochim method were presented to participants for opinions and names of the groups relevant to the concept content. All participants unanimously regrouped the concepts into seven groups. These seven groups of concepts were ultimately named specifically (1) information technology system, (2) policy and planning, (3) public relation for proactive working system, (4) multidisciplinary teamwork, (5) review of problems and task outcomes, (6) activities for promoting and developing personnel expertises, and (7) guideline for appropriate antibiotics use as shown in Figure 2. Groups of concepts based on Trochim method (Figure 2) were incorporated with 29 concepts with high level of importance and feasibility to form the ultimate concepts based on Novak method. The seven groups of concepts were linked as seen in Figure 3. These concepts were proposed for use in the supporting and promoting system for appropriate antibiotics use in the hospital with the multidisciplinary participation in strategic planning as shown in Table 3.

**Table 2** Sixty-two selected opinions with scores on importance and feasibility for application (N = 22).

Order	Opinions	Mean score		Order	Opinions	Mean score	
		Feasibility	Importance			Feasibility	Importance
1	DUE policy should be passed on from administrator to unit heads for a more in-depth strategic planning.	3.80	4.45	32	Scanning system should be installed for more convenient and faster task; retrospective evaluation could also be completed more efficiently.	3.65	4.60
2	A specific committee for DUE should be appointed so the policy could be clearly communicated and practical outcome indicators could be monitored.	4.30	4.65	33	Multidisciplinary team (physician, pharmacist, nurse and laboratory technician) should be assigned as DUE coordinators.	4.15	4.75
3	DUE system should be incorporated into infectious disease control, patient care team (PCT) and medication system.	4.05	4.80	34	All hospital healthcare personnel needed to know and realize the importance of the protocol of the policy to control the use of 4 antibiotics.	4.10	4.85
4	DUE tasks and conditions for 4 antibiotics prescribing should be developed by the hospital pharmacy and therapeutic committee (PTC).	4.00	4.65	35	Specialists in all expertises should participate in all cases of DUE.	3.80	4.50
5	PTC should reveal antimicrobial resistance and rate of inappropriate antibiotics prescriptions to encourage rationale antibiotics use.	3.95	4.75	36	More nurses especially IC nurses should be assigned in DUE task for a more complete evaluation.	3.55	4.35
6	Policy on appropriate antibiotics use like DUE should be proposed to the hospital administration committee for cooperation and support from all involving service units.	3.60	4.40	37	Pharmacist should be the main coordinator for monitoring and analysis of DUE operation.	4.60	4.80
7	Budget for the four antibiotics should be fixed to limit their expenditure.	2.65	3.55	38	Medication system team hold a DUE orientation annually for new staff.	4.40	4.80
8	Data of antibiotics prescriptions should be analyzed and fed back to administrator and all involving parties every fiscal year so the problems and obstacles are known.	3.90	4.70	39	New tasks should be directly communicated to personnel with direct patient care to inform about the objectives of each task.	4.35	4.65
9	Responsibilities of physicians, nurses, and pharmacists should be clearly specified so tasks at each service unit could be performed.	4.10	4.60	40	There should be more communications about DUE and drugs with prescribing conditions through hospital online media using infographics easy to understand.	3.90	4.45
10	Physicians, nurses, and pharmacists should participate in problem sharing in each of the steps of DUE task.	4.10	4.55	41	Small meetings at the service unit where problems arise so that measures to solve the problem specific the unit context could be carried out.	3.75	4.50
11	Non-compliance to the DUE protocol, if any, should be notified to the related person.	3.15	4.00	42	There is a need to communicate with physician organization on a regular basis since a high turn-over rate of physicians could disrupt the communication.	4.05	4.80
12	Any problems of non-compliance with the protocol or disrupted tasks must be immediately notified to the PTC.	3.40	4.20	43	More channels for communication and reporting cases through Line application could enhance a continuous and fast task.	3.90	4.55
13	Advice from specialist for be readily available for general practitioner in complicate cases, for a more reliable prescription and more chance of learning from the experts.	3.95	4.80	44	Nurse peer teaching system to advise the new nurses allows for first-hand experience, simultaneous practice, and ultimately practice confidence.	4.25	4.65
14	Cases of inappropriate or expensive drug use should be reviewed, in cooperation with patient care team (PCT).	3.65	4.55	45	It is recommended to conduct knowledge management (KM) for multidisciplinary team to learn and share appropriate DUE tasks.	3.95	4.60
15	Consultation with specialists should be encouraged for a more reliable prescribing practice and more concern on the practice.	4.05	4.60	46	Platform for communication and annual task presentation conference should be available for feedback and sharing of the task outcomes to the staff.	3.50	4.50
16	DUE review should be done at day 1 and 7, since the duration is appropriate for therapeutic outcomes assessment and dose de-escalation could be done in some cases.	3.65	4.50	47	Small group for academic conference should be held to emphasize the importance of DUE, and disadvantages, risks or damages if not properly following the protocol.	3.85	4.45
17	Every referred case from the network head hospital should be re-evaluated by DUE protocol with no exception.	3.80	4.55	48	Academic conference is needed to review the protocol update with the infectious control team for controlling antibiotic resistance due to unnecessary antibiotics use.	3.85	4.70
18	Every referred case from the network head hospital should be re-evaluated by specialist for appropriate antibiotics use.	4.10	4.55	49	Case conference should be held regularly for shard learning among multidisciplinary team members.	3.55	4.40
19	To be practical, DUE of given drug should fit in a one-page form to collect only necessary information such as short patient history, cause of illness, reasons for antibiotics prescription, and dosage regimen.	4.50	4.75	50	Case-by-case learning for physicians is more useful than attending large academic conferences or meetings.	3.60	4.40
20	A seal on the doctor order sheet is needed to show that the prescription has been consulted as indicated by the DUE protocol.	4.10	4.35	51	Specialists in each expertise should take part in training new physicians about appropriate antibiotics use.	3.70	4.55
21	A stop-order system must be enforced rigorously.	3.50	4.60	52	DUE form must be completed for all cases for appropriate use with no exception for specialist.	4.00	4.80
22	A system to re-evaluate the ongoing use of drugs prescribed is needed to examine appropriateness of a drug that has been continued longer than the predetermined duration.	3.95	4.70	53	Proactive public relations such as voice public announcement and campaign billboard could disseminate microbial resistance and promote awareness on the problem in the community.	3.75	4.65
23	There should be a warning system to the physician once the drug course is completed.	4.30	4.79	54	Meropenem should be selected for case conference with its large prescribing volume and cost, and induced drug resistance. This should be influential for appropriate antibiotics use among specialists.	3.65	4.50
24	Concurrent DUE is preferred to the others since it is more useful to the patient.	3.50	4.45	55	Case conference could be held in the internal medicine department before the others. The team could consist of primary physicians, specialist, pharmacist, and nurse.	3.80	4.35
25	Data of cases referred from Roi-et Hospital for continuous drug use should be analyzed to determine the higher drug cost and inappropriate drug use.	3.75	4.35	56	DUE data should be analyzed and used for further regular development.	4.20	4.70
26	DUE, the form to notify physician, should be placed in the patient chart. Pharmacist could place additional forms to the chart to collect more data for analysis.	3.95	4.45	57	Compliment is considered a reward and encouragement for the worker.	4.55	4.75
27	It is critical for pharmacy to follow the protocol vigorously when dispensing this group of drugs. If any non-compliance with the protocol, pharmacist must contact the ward and physician in a timely fashion.	3.80	4.55	58	DUE team could be motivated by economic data such as the cost they could save (or cost saving) from the problems they found in the DUE task.	3.55	4.25
28	If any prescriptions after hours, a DUE form must be submitted for evaluation within 24 hours for the next dose prescription to be allowed.	3.70	4.60	59	New staff members should be reminded on task and protocol regularly to prevent noncompliance to the protocol.	4.00	4.65
29	If there is a system for data recording and evaluation on drug use, the problem of under-record cases could be alleviated.	3.05	4.15	60	DUE of comparable hospitals or those with good performance should be learned to adapt to our hospital context.	4.05	4.50
30	Information technology such as Line application and Google form could make the task easier.	3.10	4.25	61	There should be guideline and standard protocol for the 4 antibiotics that need DUE.	3.95	4.45
31	Information technology could prompt the pop-up results of drug-resistant microbials so the time to search history of antibiotics for empiric therapy.	3.65	4.55	62	All personnel in the organization should be concerned about the benefit of following the drug use control policy such as reduction in hospital cost and antibiotic resistance.	4.20	4.70

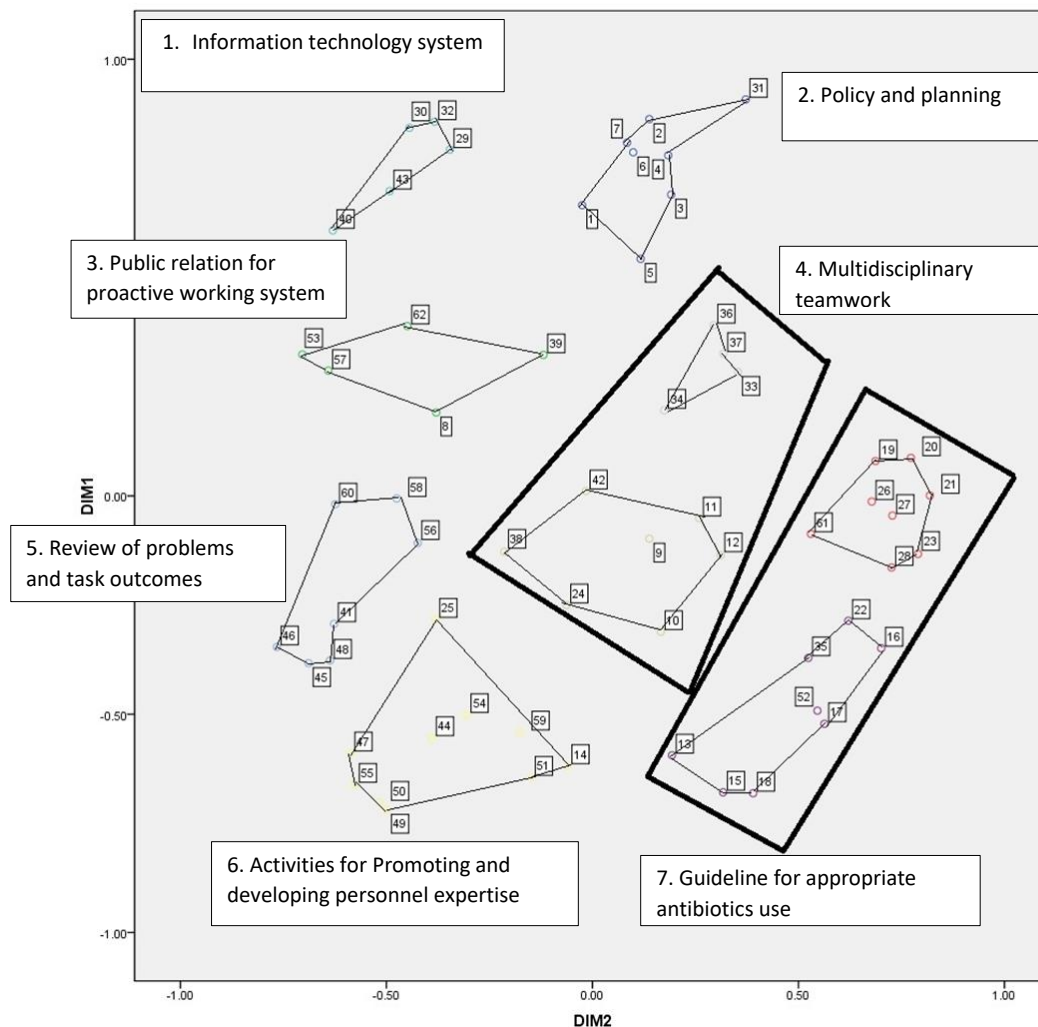


**Table 3** Seven applicable strategies based concept mapping.

Strategies	Methods
1. Policy and planning	- Pharmacy and therapeutic committee determines prescribing protocol, outcomes indicators, and conditions for appropriate antibiotics prescribing in the hospital.
2. Multidisciplinary teamwork	- Practice protocol and related tools are created by the effort of the multidisciplinary team.
3. Guideline for evaluation of inappropriate antibiotics use	- Supervise, monitor and evaluate drug use based on concurrent DUE is done with the cooperation of multidisciplinary team under the hospital's rules.
4. Public relation for proactive working system	- Communication with all involving units and new staff about the plan and task protocol for understanding and cooperation.
5. Information technology system	- Regular communications of plans to control antibiotics prescription and antimicrobial resistance through online media, and the hospital's informatic system, news letter, and academic conference. - Plans for monitoring the process and processing the task results through information technology and electronic database of the hospital.
6. Activities for promoting and enhancing personnel expertises	- Provide experts' advice and knowledge about appropriate antibiotics use, local antimicrobial resistance, and case study reviews.
7. Review of problems and task outcomes	- Analyze and summarize task results quantitatively and qualitatively to submit to the PTC and disseminate such information to all involving parties. - Small group meeting at each service unit to review the process and problems found in the actual work. - Revise and update the criteria for evaluation of drug prescription regularly for more appropriate and accurate evaluation results. - Examine the participation and cooperation of all relevant individuals and the gaps or joints in the work flow.

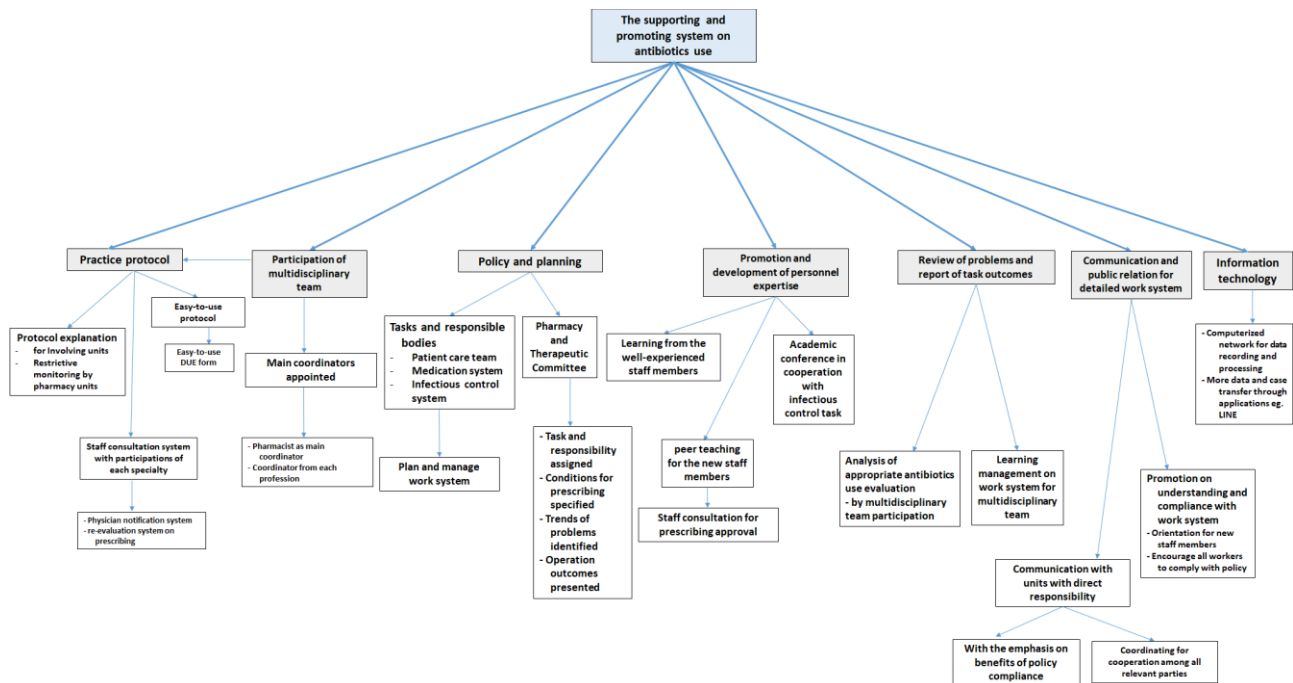
## Discussions and Conclusion

Problems in evaluating appropriate use of 4 antibiotics could be classified into 3 groups, namely 1) personnel, 2) policy and rules, and 3) communication. Our finding was somewhat consistent with the study of Pakyz and colleagues (2014) where mixed method was used.<sup>14</sup> They telephone-interviewed physicians and pharmacists using semi-structured interview questions. Based on thematic analysis, they found that factors affecting the success in appropriate drug use evaluation included communication formats, team member relationship, and conflict management; while availability in human resource, technology and budget supported the success.<sup>14</sup>



**Figure 2** Groups of concepts from hierarchical cluster analysis based on Trochim method.





**Figure 3** The seven groups of concepts for the supporting and promoting system for appropriate antibiotics use based on Novak method.

Hospitals with different levels of care had different availability of resource and obstacles. In our study, the study hospital had 120 beds. Based on human resource database, the hospital had no physicians and pharmacists specializing in infectious diseases to participate in appropriate antibiotics use evaluation. In the antibiotics use evaluation task, participation of the multidisciplinary team in the policy and planning was not emphasized. As a result, the task of antibiotics use evaluation was not fully operated and problem of discontinuity of the DUE program was evident. In the study of Ozkurt and colleagues (2005), with a protocol limiting prescribing antibiotics only for infectious disease specialists, 93% antibiotics prescriptions for specific therapy was found appropriate while only 33.3% of empiric therapy prescription was so with a statistical significance.<sup>20</sup> Thus policy to limit prescriber authority and antibiotics list was critical for achieving a higher level of appropriate use.

In the study of Ananwattanakij and co-workers (2015), they proposed that factors that affected the success of a program to achieve a better antibiotics use included the support from hospital administrators and the enforced policy.<sup>16</sup> Our study thus included the administrator participation in identifying problems and solutions to the task problems. In terms of communications and public relations, there was a lack of clarification of specific responsibility of each involving

party, clear protocol, and realization on the impact caused by antibiotics prescriptions that were unnecessary or non-compliant to the hospital protocol. These problems deserved urgent solutions.

The three aspects of the problems in our study were consistent with the study of Ruengrong and colleagues (2009) where a lack of physician cooperation, a lack of personnel, and a poor task management system were the reasons for the failure in promoting appropriate antibiotics use.<sup>25</sup> In our study, physician-related factors on the success of the program included a limited number of physicians and a continuous annual turn-over of physician which meant that orientation of the program needed to be held every year. These circumstances disrupted the program continuity, the pharmacist's capacity in recommending and evaluating the appropriate drug use, and cooperation from the nurses in evaluating the physician's prescriptions. Team effort on planning and operating the program could strengthen team members' relationship which could improve the chance of program success. The hospital had a guideline on appropriate drug use evaluation as indicated by the National List of Essential Medicine; however, the actual operation was not enforced, promoted or encouraged. Since communication to promote program cooperation was insufficient, the problems persisted and dampened the program success. Participation

from all involving parties was crucial for the success in evaluating the appropriateness of antibiotics use.

These seven groups of concepts found in this study helped form seven strategies namely (1) information technology system, (2) policy and planning, (3) public relation for proactive working system, (4) multidisciplinary teamwork, (5) review of problems and task outcomes, (6) activities for promoting and developing personnel expertises, and (7) guideline for appropriate antibiotics use. The use of information technology system in supporting and promoting appropriate antibiotics use was also found in the study of With and colleagues (2016).<sup>25</sup> The use of advanced and up-to-date information technology system as the major strategy of the Infectious Diseases Association to promote rational antibiotics use should be supported. Electronic document system and electronic prescribing system to alleviate the problem of pre-authorization of antibiotics prescribing and regimen modification based on microbial culture results should be in place.<sup>24</sup>

In terms of human resource, a multidisciplinary team of infectious specialists should be adequately staffed in number and qualification. At least one infectious disease specialist should be on duty. The team should also include pharmacists experienced or trained in infectious diseases, and laboratory microbiology specialists.<sup>25</sup> In the study of Pakyz and co-workers, communication methods that offered fast and precise information dissemination included news letter, information feedback, in-person recommendation, and telephone which was increased in popularity.<sup>14</sup> Information technology could help a fast communication such as in notifying culture results and antibiotics regimen completion to the physicians. Since the protocol or guideline for antibiotics use evaluation, antibiotic resistance and infectious diseases should be revised periodically and communicated to all parties through news letter and/or electronic journal. All cases of inappropriate antibiotics use should be reviewed and shared.<sup>26</sup> In our study, availability of information technology and human resource was limited and considered an opportunity for improvement in the hospital context.

Literature review suggested that structured concept mapping could be a reliable tool for participatory development to apply for health service system.<sup>10,11</sup> The use of concept mapping was also successful in our study with seven strategies for the evaluation of antibiotics use (meropenem, vancomycin, piperacillin/tazobactam and amoxicillin/clavulanic

acid) were discovered. We emphasized the participation of multidisciplinary team in planning and designing the protocol. The members of the team included physicians, pharmacists, professional nurses, and laboratory technician. The evaluation was concurrent DUE so that change in antibiotic regimen could be timely done when inappropriate prescribing was found. Case review with the multidisciplinary team was also conducted.

At present, the task of Antimicrobial Stewardship Program (ASP) to tackle the problem of microbial resistance has been implemented in Thailand and worldwide.<sup>9,12-15</sup> However, studies on ASP in Thailand have been limited. The application of ASP has been almost solely in tertiary care hospitals.<sup>9</sup> A lack of implementation of ASP in community hospitals could be attributable to supporting factors such as infectious disease physicians, pharmacists specialized in infectious diseases, information technology availability, and resource availability.

The community hospital in this study had some advantages. It was a community hospital with six specialties of physicians. The hospital also had a PTC which acted as the core in directing the prescribing policy of the hospital. However, the hospital lacked specialists in infectious diseases and had a high turn-over rate of the physicians. Participation of multidisciplinary team members was not fully achieved to have a program that was suitable to the hospital context. Participation could be enhanced by encouraging realization among the members, supporting activities that were strengths of the hospital such as promoting physician mentoring system using specialists as mentors, creating tools easy to use and revise, identifying working process that facilitated the workers to continuously improve the program quality.

We proposed that future research should test the effectiveness of implementing the concept mapping in the actual work flow. Outcomes of and compliance to the protocol for antibiotics use evaluation among multidisciplinary team should be determined.

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