

## Education on antimicrobials, antimicrobial resistance, and infectious diseases in pharmacy curricula, Thailand

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### ABSTRACT

To compare the number and percentage of subjects, credits, and learning hours with regard to antimicrobials, antimicrobial resistance, and infectious diseases in pharmacy curricula of Faculty of Pharmacy in Thailand. This was a survey study that defined keywords in regard with antimicrobials, antimicrobial resistance, and infectious diseases by physician and clinical pharmacist. The keywords were used to search from course descriptions, and course syllabi in Thai pharmacy curricula in each university. There were 19 universities providing pharmacy curricula in Thailand, which data were completed by 13 out of 19 universities. All universities provided the subjects related to antimicrobials, antimicrobials resistance and infectious diseases. Khon Kaen University had the highest number (36 credits) and percentage of credits (15.79%). Siam University had the highest percentage of lecture hours (57.33%). Mahasarakham University had the highest percentage of laboratory hours (86.67%). In addition, there were 6 out of 19 universities with the infectious diseases clerkship. All 19 universities provided the subjects related to antimicrobials, bacterial resistance and infectious diseases in various types of learning (i.e. lecture, laboratory and clerkship). These could provide pharmacy graduates in promoting appropriate use of antimicrobial agents.

### 1. INTRODUCTION

The problem of antimicrobial resistance (AMR) is rapidly growing and threatens to patient outcomes worldwide which can lead to high rate of mortality and hospitalization, including increased public health costs<sup>1-3</sup>. Importantly, hospital-acquired infections caused by multidrug-resistant (MDR) Gram-negative bacteria, in particular *Pseudomonas aeruginosa* and *Acinetobacter baumannii* become a significant problem that resulted in a rising number of mortality, especially in critically ill patients<sup>4</sup>. The prevalence and severity of resistance vary in different area. Klevens et al. found that

Methicillin-resistant *Staphylococcus aureus* (MRSA) was responsible for mortality rate of 6.3 per 100,000<sup>5</sup>. In Thailand, the reports from National Antimicrobial Resistance Surveillance Center, Thailand (NARST) revealed a high prevalence of MDR which has been shown rising during 2000 and 2016<sup>6</sup>. Incidence of carbapenem-resistant *A. baumannii* (CRAB) was found increasing from 2.1% in 2000 to 46.7% in 2005<sup>7</sup>. The causes of antimicrobial resistance were composed of inappropriate antimicrobial use, prior antimicrobials, and long term hospitalization<sup>8</sup>. Similarly, risk factors for MDR gram-negative infections at Siriraj Hospital,

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Thailand were found as previous antibiotic use within 1 year and inappropriate use of antibiotics<sup>9</sup>. AMR has been dramatically significant problem, where discovery of new antimicrobials are time consuming.

Consequently, The World Health Organization (WHO) has provided a campaign to combat AMR entitled “Antimicrobial Resistance: No Action Today, No Cure Tomorrow”. Likewise, the Infectious Diseases Society of America (IDSA) has developed a policy against AMR by: 1) supporting research and development for new antibiotics at least 10 antibiotics by 2020, including facilitation of new antibiotics approval process; 2) supporting antimicrobial surveillance system; 3) promoting appropriate use of antimicrobials using various measures, such as antimicrobial stewardship programs, clinical practice guidelines, and drug use evaluation<sup>10</sup>. Currently, all faculties of pharmacy in Thailand have changed curricula to doctor of pharmacy (PharmD) program. All 6-year pharmacy curricula complied with the core pharmacy course for professional content mandated by the Pharmacy Council of Thailand. The majority of universities have one program divided into two tracks in the fifth year as pharmaceutical science and pharmaceutical care, while some universities have only pharmaceutical care program. Few universities have been found for both pharmaceutical science program and pharmaceutical care program<sup>11</sup>.

Considering this situation, healthcare providers need to be regarded as appropriate use of antimicrobials with knowledge in selecting the optimal antimicrobials. Therefore, pharmacy education is a core to coordinate with other healthcare professionals to promote appropriate use of antimicrobials. The courses involving in antimicrobials, bacterial resistance, and infectious diseases needs to be provided for promoting rational use of antimicrobials. Thus, assessment and comparison on antimicrobial education in each pharmacy school are required to develop pharmacy curricula in the future.

## 2. MATERIALS AND METHODS

This study was a descriptive survey research. The nineteen universities were included

as follows; Naresuan University, Khon Kaen University, Phayao University, Chiang Mai University, Payap University, Prince of Songkla University, Rangsit University, Siam University, Huachiew Chalermprakiat University, Silpakorn University, Mahidol University, Thammasart University, Mahasarakham University, Ubon Rachathani University, Burapha University, Chulalongkorn University, Eastern Asia University, Srinakharinwirot University, and Walailak University. The fourteen keywords were developed and approved by one infectious diseases physician and clinical pharmacist as follows; antimicrobial drug (agent), antibiotic drug, anti-infective drug (agent), microbial resistance, antibiotic resistance, antimicrobial resistance, bacterial resistance, infectious disease, pharmacology, pharmacotherapeutics, pharmaceutical care, rational drug use, appropriate use of antibiotics, antibiotics stewardship, and infection.

A course description acquired from each university website or by direct sending a letter to each university was searched by using the keywords. A course syllabus was included in this study when we found at least 1 out of 14 keywords in the course description. Then, it was requested by sending the letter to each university for further identify in detail of each subject. In the subsequent step, all course syllabi were searched for the keywords along with the definition of antimicrobials, antimicrobial resistance, and infectious disease to identify credits and learning hours of each subject. The process of this study is shown in Figure 1.

The data were analyzed as the number and percentage of credits in each subject with the keywords, the number and percentage of lecture hours and laboratory hours with the keywords along with the definition of antimicrobials, antimicrobial resistance, and infectious disease in each subject.

## 3. RESULTS

### 3.1. Pharmacy curricula in Thailand

There were 19 universities along with 22 curricula dividing into doctor of pharmacy in pharmaceutical care and pharmaceutical science (Table 1).

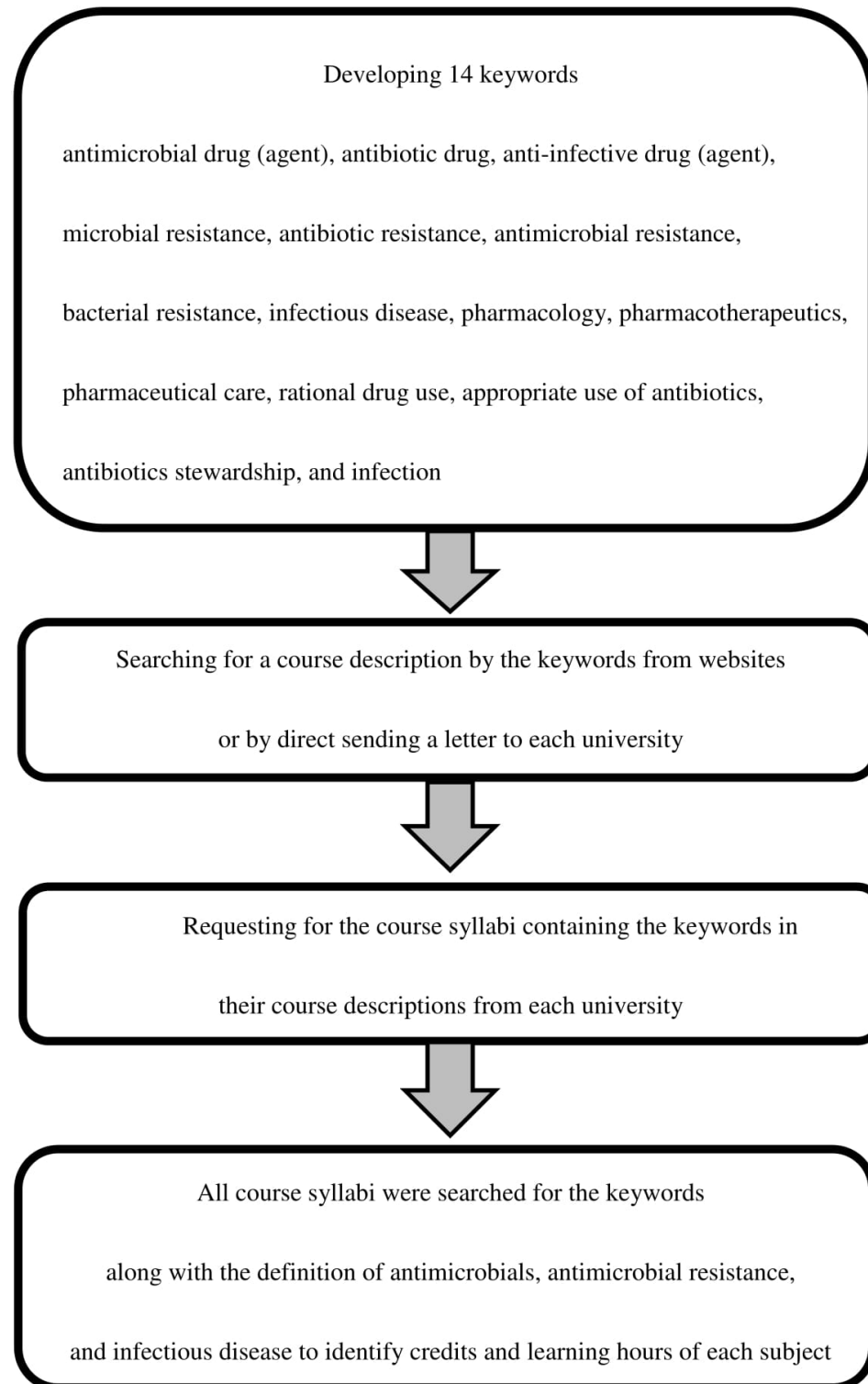


Figure 1. Flow chart of the study process

**Table 1.** Baseline characteristics of the study population (N = 102)

| No. | Universities            | Curricula (years)   | The number of subjects with the keywords from course descriptions | The number of subjects with course syllabi sent back | The number of subjects with the keywords from course syllabi | The number of credits in subjects with the keywords from course syllabi | Total credits in curricula | The percentage of credits in subjects with the keywords from course syllabi |
|-----|-------------------------|---|---|--|--|---|----------------------------|---|
| 1   | Burapha                 | Doctor of Pharmacy Program (2013)                           | 6   | 6  | 4  | 16  | 238                        | 6.72  |
| 2   | Chiang Mai              | Doctor of Pharmacy Program (2010)                           | 30  | 27   | 6  | 21  | 231                        | 9.09  |
| 3   | Chulalongkorn           | Doctor of Pharmacy Program in Pharmaceutical Care (2009)    | 8   | 8  | 7  | 18  | 233                        | 7.73  |
|     |                         | Doctor of Pharmacy Program in Pharmaceutical Science (2009) | -   | -  | -  | -   | 234                        | -   |
| 4   | Eastern Asia            | Doctor of Pharmacy Program (2010)                           | 24  | 10   | 6  | 16  | 236                        | 6.78  |
| 5   | Huachiew Chalermprakiat | Doctor of Pharmacy Program (2012)                           | 16  | 16   | 5  | 10  | 228                        | 4.39  |
| 6   | Khon Kaen               | Doctor of Pharmacy Program (2013)                           | 16  | 16   | 12   | 36  | 228                        | 15.79   |
| 7   | Maharakham              | Doctor of Pharmacy Program in Pharmaceutical Care (2011)    | 14  | 14   | 10   | 32  | 224                        | 14.29   |
| 8   | Mahidol                 | Doctor of Pharmacy Program (2009)                           | 9   | 9  | 9  | 19  | 225                        | 8.44  |
| 9   | Naresuan                | Doctor of Pharmacy Program in Pharmaceutical Care (2008)    | 6   | 6  | 5  | 19  | 226                        | 8.41  |
| 10  | Payap                   | Doctor of Pharmacy Program (2010)                           | 4   | 4  | 4  | 11  | 225                        | 4.89  |
| 11  | Phayao                  | Doctor of Pharmacy (Pharmaceutical Care) (2010)             | 4   | 4  | 4  | 16  | 228                        | 7.02  |
| 12  | Prince of Songkla       | Doctor of Pharmacy (Pharmaceutical Care) (2010)             | 4   | 5  | 5  | 27  | 244                        | 11.07   |
|     |                         | Doctor of Pharmacy (Pharmaceutical Science) (2010)          | -   | -  | -  | -   | 244                        | -   |

**Table 1.** Baseline characteristics of the study population (N = 102) (contd.)

| No. | Universities     | Curricula (years)   | The number of subjects with the keywords from course descriptions | The number of subjects with course syllabi sent back | The number of subjects with the keywords from course syllabi | The number of credits in subjects with the keywords from course syllabi | Total credits in curricula | The percentage of credits in subjects with the keywords from course syllabi |
|-----|------------------|---|---|--|--|---|----------------------------|---|
| 13  | Siam             | Doctor of Pharmacy Program in Pharmaceutical Care (2010)    | 12  | 12   | 5  | 11  | 222                        | 4.95  |
| 14  | Rangsit          | Doctor of Pharmacy Program in Pharmaceutical Care (2012)    | 9   | 9  | 7  | 19  | 233                        | 8.15  |
| 15  | Silpakorn        | Doctor of Pharmacy Program (2012)                           | 16  | 14   | 8  | 21  | 237                        | 8.86  |
| 16  | Srinakharinwirot | Doctor of Pharmacy Program in Pharmaceutical Care (2009)    | 12  | 5  | 5  | 14  | 229                        | 6.11  |
|     |                  | Doctor of Pharmacy Program in Pharmaceutical Science (2009) | -   | -  | -  | -   | 224                        | -   |
| 17  | Thammasart       | Doctor of Pharmacy Program (2013)                           | 10  | 11   | 8  | 25  | 229                        | 10.92   |
| 18  | Ubon Rachathani  | Doctor of Pharmacy Program (2009)                           | 14  | 9  | 5  | 14  | 224                        | 6.25  |
| 19  | Walailak         | Doctor of Pharmacy Program (2008)                           | 17  | 11   | 3  | 13  | 234                        | 5.56  |

### 3.2. Course descriptions with the keywords

The top three universities with the number of subjects with the keywords from the course descriptions were Chiang Mai University (30 subjects), Eastern Asia University (24 subjects), and Walailak University (17 subjects), respectively. Prince of Songkla University, Phayao University, and Payap University had the least subjects with the keywords (4 subjects). The details are presented in Table 1.

### 3.3. Response rate of the course syllabi

All of the course syllabi were sent back to the researcher after sending the letters to each university. However, only 13 universities sent all requested the course syllabi, while 6 universities did not send all the requested course syllabi; Eastern Asia University (14 missing subjects), Srinakharinwirot University (7 missing subjects), Walailak University (6 missing subjects), Ubon Rachathani University (5 missing subjects), Chiang Mai University (3 missing subjects), and Silpakorn University (2 missing subjects). The details are shown in Table 1.

### 3.4. Course syllabi with the keywords

#### 3.4.1. The number of subjects and credits with the keywords

The top three universities with the number of subjects and credits with the keywords from the course syllabi were Khon Kaen University (12 subjects), Mahasarakham University (10 subjects), and Mahidol University (9 subjects), respectively. Walailak University had the least subjects with the keywords (3 subjects). The details are shown in Table 1. The mean  $\pm$  SD of the number and percentage of credits with the keywords were  $18.84 \pm 7.03$  and  $8.18 \pm 3.06$ , respectively. The top three universities with the number and percentage of credits with the keywords were Khon Kaen University (36 credits; 15.79%), Mahasarakham University (32 credits; 14.29%), and Prince of Songkla University

(27 credits; 11.27%), respectively. Huachiew University had the least credits (10 credits; 4.39%). The details are shown in Table 2.

Considering lecture credits, the top three universities with the number of lecture credits with the keywords were Thammasart University (24 credits), Prince of Songkla University (20 credits), and Mahasarakham University (19 credits), respectively. However, Hua Chiew Chalermprakiat University had the least lecture credits (8 credits). Considering laboratory credits, the top three universities with the number of laboratory credits with the keywords were Khon Kaen University (20 credits), Mahasarakham University (13 credits), and Chiang Mai University (8 credits), respectively, and Walailak University had the least laboratory credits (0.5 credits). The details are shown in Table 2.

**Table 2.** The number and percentage of lecture and laboratory hours in the subjects with the keywords

| No. | Universities            | Total credits | The number of credits |            | The number of hours in the subjects of one semester* |            | The number of hours from course syllabi (%) # |             |
|-----|-------------------------|---------------|-----------------------|------------|--|------------|---|-------------|
|     |                         |               | lecture               | laboratory | lecture  | laboratory | lecture                                       | laboratory  |
| 1   | Burapha                 | 16            | 10                    | 6          | 150  | 270        | 46 (30.67)                                    | 61 (22.59)  |
| 2   | Chiang Mai              | 21            | 13                    | 8          | 195  | 360        | 61 (31.28)                                    | 90 (25.00)  |
| 3   | Chulalongkorn           | 18            | 16                    | 2          | 240  | 90         | 117.50 (48.96)                                | 39 (43.33)  |
| 4   | Eastern Asia            | 16            | 15                    | 1          | 225  | 45         | 38.50 (17.11)                                 | 27 (60.00)  |
| 5   | Huachiew Chalermprakiat | 10            | 8                     | 2          | 120  | 90         | 66 (55.00)                                    | 10 (11.11)  |
| 6   | Khon Kaen               | 36            | 16                    | 20         | 240  | 900        | 50 (20.83)                                    | 361 (40.11) |
| 7   | Mahasarakham            | 32            | 19                    | 13         | 285  | 585        | 48 (16.84)                                    | 507 (86.67) |
| 8   | Mahidol                 | 19            | 13                    | 6          | 195  | 270        | 79 (40.51)                                    | 162 (60.00) |
| 9   | Naresuan                | 19            | 14                    | 5          | 210  | 225        | 61.50 (29.29)                                 | 44 (19.56)  |
| 10  | Payap                   | 11            | 10                    | 1          | 150  | 45         | 63 (42.00)                                    | 24 (53.33)  |
| 11  | Phayao                  | 16            | 11                    | 5          | 165  | 225        | 64 (38.79)                                    | 39 (17.33)  |
| 12  | Prince of Songkla       | 27            | 20                    | 7          | 300  | 315        | 73 (24.33)                                    | 26 (8.25)   |
| 13  | Rangsit                 | 19            | 14                    | 5          | 210  | 225        | 60 (28.57)                                    | 84 (37.33)  |
| 14  | Siam                    | 11            | 10                    | 1          | 150  | 45         | 86 (57.33)                                    | 15 (33.33)  |
| 15  | Silpakorn               | 21            | 16                    | 5          | 240  | 225        | 109.95 (45.81)                                | 46 (20.44)  |
| 16  | Srinakharinwirot        | 14            | 13                    | 1          | 195  | 45         | 38 (19.49)                                    | 0 (0.00)    |
| 17  | Thammasart              | 25            | 24                    | 1          | 360  | 45         | 108 (30.00)                                   | 6 (13.33)   |
| 18  | Ubon Rachathani         | 14            | 12                    | 2          | 180  | 90         | 41.50 (23.06)                                 | 4 (4.44)    |
| 19  | Walailak                | 13            | 12.5                  | 0.5        | 210  | 22.5       | 34.50 (18.40)                                 | 15 (66.67)  |

\* One semester was equal to 15 weeks lecture hours = 1 hour per week laboratory hours = 3 hours per week

# The number of lecture hours or laboratory hours from course syllabi/ the total number of lecture hours or laboratory hours in the subject of curricula x 100



### 3.4.2. The number and percentage of hours in the subjects with the keywords

The top three universities with the number of lecture hours with the keywords were Chulalongkorn University (117.50 hours), Silpakorn University (109.95 hours), and Thammasart University (108 hours), respectively. Walailak University had the least lecture hours (34.50 hours). The top three universities with the number of laboratory hours were Mahasarakham University (507 hours), Khon Kaen University (361 hours), and Mahidol University (162 hours), respectively. As the percentage of lecture hours, the top three universities were Siam University (57.33%), Huachiew Chalermprakiat University (55.00%), and Chulalongkorn University (48.96%), respectively. Mahasarakham University had the least percentage of lecture hours (16.84%). As the percentage of laboratory hours, the top three universities were Mahasarakham University (86.67%), Walailak University (66.67%), Mahidol University and Eastern Asia University (60.00%), respectively.

## 4. DISCUSSION

All curricula had average of 12.16 subjects with the keywords from the course descriptions. However, the number of subjects and credits with the keywords from the course syllabi were average of 6.21 and 18.84, respectively. Chiang Mai University had the highest number of subjects with the keywords from the course descriptions (30 subjects) while Khon Kaen University had the highest number of subjects (12 subjects) and credits (36 credits) with the keywords from the course syllabi. All the universities had the average percentage of credits per total credits in the curricula of 8.18. In addition, the highest percentage of credits with the keywords from course syllabi per total credits in curricula was also Khon Kaen University (15.79%). Considering the learning hours in subjects with the keywords, the average number and percentage of lecture and laboratory hours with the keywords were 65.55, 82.11, 32.54, and 32.78, respectively. The proportion of credits and learning hours was appropriate because the current pharmacy

education in Thailand focuses on two tracks as pharmaceutical technology and pharmaceutical care. However, no study has recommended the number or percentage of credits for pharmacy education in antimicrobials, antimicrobial resistance, and infectious disease. Furthermore, advance knowledge and skills in antimicrobials, antimicrobial resistance, and infectious disease need further study after undergraduate study. For instance, Board of Pharmaceutical Specialties for pharmacotherapy in infectious disease, Pharmacy Council of Thailand.

Of the results, most of the universities had the above average number of subjects, credits, and percentage of credits with the keywords per total credits in curricula, including the number of learning hours. The universities were as follows: Naresuan University, Khon Kaen University, Phayao University, Chiang Mai University, Payap University, Prince of Songkla University, Rangsit University, Siam University, Huachiew Chalermprakiat University, Silpakorn University, Mahidol University, Thammasart University, Mahasarakham University, Chulalongkorn University, Eastern Asia University, and Walailak University. These results might imply that those universities have an acceptable pharmacy educations in antimicrobials, antimicrobial resistance, and infectious disease. However, Ubon Rachathani University and Srinakharinwirot University were likely to be underestimated results from incomplete data of course syllabi.

Furthermore, the highest number of lecture hours with the keywords was Chulalongkorn University (117.50 hours), and the highest percentage of lecture hours was Siam University (57.33%). The highest number and percentage of laboratory hours were Mahasarakham University (507 hours; 86.67%). Siam University was ranked at the 10<sup>th</sup> by the number of subjects with the keywords from course syllabus (5 subjects), and was ranked at the 17<sup>th</sup> by the credits with the keywords (11 credits). Chulalongkorn University was ranked at the 7<sup>th</sup> by the number of subjects with the keywords from course syllabus (7 subjects), and was ranked at the 10<sup>th</sup> by the credits with the keywords (18 credits). Nevertheless, these universities had the percentage

of lecture hours per total hours of subjects with the keywords ranked as the first and the third orders, respectively. As the results, universities which have the large number of subjects or credits might not be indicated that those universities have the large number of lecture hours, e.g. Khon Kean University was ranked at the first order in the number of subjects and credits. This means that certain universities have the small number of subjects, but provide a high proportion of learning hours. This is benefits for students focusing on a specific content and contribute to integrate the knowledge when compared with the high number of subjects or credits, but the less percentage of learning hours. Thus, the universities that have separated the learning hours should increase the subject that integrate the knowledge such as drug use evaluation in antimicrobial drugs or clerkships in infectious disease. Mahasarakham University had the number of subjects and credits ranked as second orders but those had the percentage of lecture hours as 19 orders, and laboratory hours as first order. Overall, Mahasarakham University has been remarkable in practice learning, and Siam University has been remarkable in lecture learning.

Considering pharmacy clerkship at the sixth year, there were 6 out of 19 universities that had specific clerkship in infectious diseases as follows; Khon Kaen University, Prince of Songkla University, Rangsit University, Mahidol University, Silpakorn University, and Ubon Rachathani University. This might result from the pharmacy council has focused on producing undergraduate students for practice in pharmaceutical science; patient care for inpatient, ambulatory, and community care, and medication system in hospital. The pharmacy council has taken a mandatory clerkship rotation for all of universities in Thailand, which results in specific clerkship in infectious disease have only alternative practice. Therefore, encouragement of pharmacy clerkship in infectious disease should be focused. However, other tracks, e.g. cardiovascular disease has also been the problem of health care. As present situation, universities that has not clerkship in infectious disease may concentrate on optimizing anti-

microbial therapy in all of the four mandatory clerkship; patient care for inpatient, ambulatory, community care, and medication system in hospital.

There are several limitation. First, the missing data from 6 universities, including Eastern Asia University that had only the third year student, which make a missing data from no course syllabus in 4-year to 6-year students, and that might result error in analysis. Second, a periodical adjustment in Thai pharmacy curricula may not reflect the results since many universities are the previous curriculum for 5-6 year students, but curriculum in early students have already adjusted. Third, our study evaluated the number of lecture and laboratory hours along with the percentage of lecture and laboratory hours. This might not reflect the appropriateness of antimicrobial education. Evaluation of teaching methods should be provided in further study. Finally, the designation of the keywords might not cover an activity related to rational use of antimicrobials, because many activities have used various words. Moreover, there have not been assessed the proportion of examination during learning and pharmacy licensing exam. Therefore, the pharmacy education should be designed for optimal learning proportion for antimicrobial, antimicrobial resistance, and infectious disease, and should be made up date for circumstances of increasing antimicrobial resistances.

## 5. CONCLUSIONS

All pharmacy curricula of 19 universities have included the topic of antimicrobials, antimicrobial resistance, and infectious diseases. Therefore, pharmacy education could provide the knowledge for graduates in accordance with antimicrobial resistance situation.

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## Conflict of interest

None



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