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

T. Paiboonvong¹, C. Pummangura¹, P. Tedtaisong², V. Thamlikitkul³, P. Tragulpiankit⁴, T. Suansanae⁴, S. Sukkha⁴, P. Montakantikul*¹

¹ Faculty of Pharmacy, Siam University, Bangkok, Thailand
² Department of Pharmacy, Princess Maha Chakri Sirindhorn Medical Center, Srinakharinwirot University, Nakhon Nayok, Thailand
³ Department of Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand
⁴ Department of Pharmacy, Faculty of Pharmacy, Mahidol University, Bangkok, Thailand

1. INTRODUCTION

The problem of antimicrobial resistance (AMR) is rapidly growing and threats to patient outcomes worldwide which can lead to high rate of mortality and hospitalization, including increased public health costs¹-³. 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 patients⁴. The prevalence and severity of resistance vary in different area. Kleevens et al. found that Methicillin-resistant Staphylococcus aureus (MRSA) was responsible for mortality rate of 6.3 per 100,000⁵. 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 2016⁶. Incidence of carbapenem-resistant A. baumannii (CRAB) was found increasing from 2.1% in 2000 to 46.7% in 2005⁷. The causes of antimicrobial resistance were composed of inappropriate antimicrobial use, prior antimicrobials, and long term hospitalization⁸. Similarly, risk factors for MDR gram-negative infections at Siriraj Hospital,
Thailand were found as previous antibiotic use within 1 year and inappropriate use of antibiotics. 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. 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.

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, 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, Srirakharinwirot 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 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).
Developing 14 keywords

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

Searching for a course description by the keywords from websites

or by direct sending a letter to each university

Requesting for the course syllabi containing the keywords in

their course descriptions from each university

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
<table>
<thead>
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<th>No.</th>
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<th>Curricula (years)</th>
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<th>The number of subjects with course syllabi sent back</th>
<th>The number of subjects with the keywords from course syllabi</th>
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Table 1. Baseline characteristics of the study population (N = 102) (contd.)

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<thead>
<tr>
<th>No.</th>
<th>Universities</th>
<th>Curricula (years)</th>
<th>The number of subjects with the keywords from course descriptions</th>
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</table>

### 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 send 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 sent 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), Chaiang Mai University (3 missing subjects), and Silapakorn 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 ± SD of the number and percentage of credits with the keywords were 18.84 ± 7.03 and 8.18 ± 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, Huachiew 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

<table>
<thead>
<tr>
<th>No.</th>
<th>Universities</th>
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<th>The number of credits</th>
<th>The number of hours in the subjects of one semester*</th>
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* 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), Silapakorn 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 phamacotherapy 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 10th by the number of subjects with the keywords (5 subjects), and was ranked at the 17th by the credits with the keywords (11 credits). Chulalongkorn University was ranked at the 7th by the number of subjects with the keywords from course syllabus (5 subjects), and was ranked at the 10th 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 antimicrobial 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.

6. ACKNOWLEDGEMENTS
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Conflict of interest
None
REFERENCES


