Original Article

JHSMR Journal of Health Science and Medical Research

Infection Control Practices Among Thai Medical Students

Ruj Nana, M.D.[1], Sirashat Hanvivattanakul, M.D.[1], Porntita Sae-li, M.D.[1],
Thana Khawcharoenporn, M.D., M.Sc.[2]

[1]Faculty of Medicine, Thammasat University, Klong Luang, Pathumthani 12120, Thailand.
[2]Infectious Diseases Unit, Department of Internal Medicine, Faculty of Medicine, Thammasat University, Klong Luang, Pathumthani 12120, Thailand.

Received 21 October 2025 ● Revised 14 December 2025 ● Accepted 20 December 2025 ● Published online 2 September 2026

Abstract:

Objective: To assess the knowledge, infection control (IC) practices, and antibiotic prescribing practices of Thai medical students in their clinical years

Material and Methods: A cross-sectional anonymous survey was conducted among 4th- to 6th-year medical students at a Thai public university from January 2023 to February 2024. Data were collected on demographics, knowledge about antibiotics and IC, and patient-related IC practices, as well as antibiotic prescribing practices among 6th-year students.

Results: Of the 147 students surveyed, 51% were female, with 35%, 29%, and 36% in the 4th, 5th, and 6th years, respectively. The median knowledge score for antibiotics and IC was 14 out of 18, with 6th-year students scoring significantly higher than the 4th- and 5th-year students. However, only 26.5% reported always washing their hands before patient examinations, and 41.5% always washed their hands after touching patient surroundings. A significantly higher proportion of 4th-year students reported wearing unwashed white coats repeatedly (p-value=0.008). Students from outside Bangkok were more likely to wash their hands consistently before examining patients (odds ratio 6.28; p-value=0.02). Among 6th-year students, 30.2% often or always prescribed antibiotics for asymptomatic bacteriuria, 39.6% empirically prescribed quinolones for urinary tract infections, and 22.7% reported antibiotic resistance in treated patients.

Conclusion: The study identified gaps in IC practices and the application of knowledge among medical students. Interventions to improve IC practices are needed.

Keywords: antibiotic prescribing, infection control, knowledge, medical students, practices, Thailand

Contact: Thana Khawcharoenporn, M.D., M.Sc.
Infectious Diseases Unit, Department of Internal Medicine, Faculty of Medicine,
Thammasat University, Pathumthani 12120, Thailand.
E-mail: kthana@tu.ac.th

J Health Sci Med Res
doi: 10.31584/jhsmr.20261403
www.jhsmr.org

Introduction

Infection control (IC) is essential to reducing the spread of transmissible diseases in healthcare settings. Clinical-year medical students, as active members of patient care teams, must adhere to IC guidelines. Physician knowledge, behaviors, attitudes, and IC practices directly affect patient care and outcomes, with a study in China showing a positive correlation between these factors[1]. Another study reported that physicians with more antibiotic knowledge and better IC adherence were less likely to prescribe antibiotics unnecessarily, suggesting that knowledge and practices in these areas may shape medical students' future prescribing behaviors[2]. The Thai medical curriculum is a six-year program, which does not require a bachelor's degree as a prerequisite. The curriculum is structured into two main phases: the pre-clinical period (Years 1-3) and the clinical period (Years 4-6). The pre-clinical years focus on classroom-based instruction and the fundamentals of medical science with minimal exposure to practical patient contacts. In contrast, the clinical period involves learning in hospital wards. Medical students receive hands-on experience and direct patient interactions, while also encountering antimicrobial-resistance problems.

Studies have shown wide variation in medical students' antibiotic and IC knowledge across countries, as well as regional differences in IC practices[1,3,4]. Although Thai medical students demonstrate adequate IC knowledge, their hand hygiene compliance remains suboptimal and differs by training level and clinical exposure[3-5]. Most Thai studies, however, have focused solely on hand hygiene and overlooked other IC practices such as attire and equipment hygiene[3-5]. While antibiotic prescribing is an important element of IC, most international studies have focused on self-medication among medical students or used clinical scenarios for analysis[4,6,7]. None has evaluated actual prescribing practices, particularly among final-year students who prescribe antibiotics under supervision.

Despite the importance of knowledge and practice, not much is known about Thai medical students' understanding of antibiotics and IC, their adherence to IC measures, and their antibiotic prescribing behaviors. In response to increasing concerns about antimicrobial resistance and transmission due to inappropriate antibiotic use and poor IC adherence in Thailand, this study aimed to assess clinical-year medical students' antibiotic and IC knowledge, their personal and patient-related IC practices, prescribing behaviors, and factors influencing IC compliance.

Material and Methods

Study population and setting

A cross-sectional anonymous survey was conducted among 4^{th}- to 6^{th}-year (clinical-year) medical students from Thammasat University, a large public university in Thailand, from 5 January 2023 to 13 February 2024. Thammasat offers four medical programs: Thai, English, International, and the Collaborative Project to Increase Production of Rural Doctors (CPIRD). This study complied with the amended Declaration of Helsinki and was approved by the Human Research Ethics Committee of by the Human Research Ethics Committee of Thammasat University (Medicine) (approval number 036/2566). An information sheet was provided on the survey's first page, and consent was implied upon survey completion.

Study protocol

Based on a literature review, a structured self-administered survey was developed in Google Forms by an infectious disease specialist and three medical students. Students were requested to complete an anonymous online survey questionnaire, which was distributed through various online platforms such as LINE, university forums, and an exclusive Facebook group for medical students. The survey tool automatically verified that all questions were completed before submission, as all questions needed to be answered on each page prior to proceeding to the next page. The questionnaire included five key sections: demographics (8 items), sources of antibiotic information (5 items), knowledge of antibiotic use/resistance and IC (18 true/false items), self- and patient-related IC practices (12 items), and, for 6^{th}-year students only, antibiotic prescribing practices (12 items) and the related outcomes (5 items). For the antibiotic prescribing practices and related outcomes, the mean score was calculated by averaging the scores derived from all the participants. The scores of 1, 2, 3, 4, and 5 were assigned for each of the following responses: "never", "rarely", "sometimes", "often", and "always", respectively. To ensure data completeness, a response was required for every item. Knowledge scores were calculated from the total number of correct responses to the 18 knowledge items. A pilot study with 20 students confirmed clarity and internal consistency, yielding a Cronbach's alpha of 0.79. Recruitment was conducted via an electronic poster with a survey link and QR code distributed through LINE, Facebook, and Instagram student groups.

Statistical analysis

Data were analyzed using IBM Statistical Package for the Social Sciences (SPSS) Statistics Version 22.0. Descriptive statistics were presented as number (percent) or median (interquartile range, IQR) for data with non-normal distribution. Categorical variables were compared using Chi-square tests, and continuous variables using the Kruskal-Wallis test for data with non-normal distribution. A p-value<0.05 was considered statistically significant. Variables that were present in more than 10% of the students at a significance level of P less than 0.20 were entered into stepwise backward logistic regression models. Significant variables that were thought to be covariates were grouped, and only one variable from each group was chosen for model entry. The model's overall robustness was confirmed by the Hosmer-Lemeshow goodness-of-fit statistic with Bonferroni adjustment. Adjusted odds ratios (aORs) and 95% confidence intervals (CIs) were calculated to determine independent factors associated with each IC and antibiotic prescribing practice.

Results

Participant characteristics

Of the total 498 eligible clinical-year students, 147 participated in the study (response rate, 29.51%): 52 (35%) were fourth-year, 42 (29%) were fifth-year, and 53 (36%) were sixth-year students. The median age was 23 years (IQR 22–24), with nearly equal gender distribution (Table 1). Most students were originally from Bangkok (64.6%), enrolled in the Thai program (51.4%), graduated from Thai high schools (73.5%), rated their English proficiency as average (59.9%), and reported a monthly household income of at least 3000 USD (61.2%). A significantly higher proportion of 4^{th}-year students were from Bangkok and enrolled in the Thai program compared with the 5^{th}- and 6^{th}-year students.

Regarding the information sources on antibiotics and resistance, most students reported using online medical resources (81.6%) and conducting additional research from multiple sources (65.3%). Only 29.9% had family members in the medical profession, and 4.1% reported family-run pharmacies (Table 1). There were no significant differences in information sources by academic year.

Knowledge of antibiotic use, resistance, and infection control

Overall, knowledge scores were good, with a median of 14 out of 18 (IQR 13-15), and increased significantly with advancing academic year (p-value=0.024; Table 2). Nearly all students knew that antibiotics should not be discontinued once symptoms subside (99.3%), identified penicillin as an antibiotic (98.6%), and recognised that antibiotics are ineffective against viral infections (95.9%). Awareness

Table 1 Demographics and knowledge searching behaviors among the participants

Characteristics	All (N=147)	Year 4 (N=52)	Year 5 (N=42)	Year 6 (N=53)	X^2, p^a
Age					<0.001[b]
(Year, Median, IQR)	23 (22-24)	22 (21-23)	23 (22-23)	24 (23-25)	
Gender					
Male	72 (49.0)	26 (50.0)	22 (52.4)	24 (45.3)	0.506,
Female	75 (51.0)	26 (50.0)	20 (47.6)	29 (54.7)	0.776
Domicile					
Bangkok	95 (64.6)	39 (75.0)	20 (47.6)	36 (67.9)	10.114,
Other provinces	51 (34.7)	13 (25.0)	22 (52.4)	16 (30.2)	0.039
Other countries	1 (0.7)	0 (0)	0 (0)	1 (1.9)	
Course					
Thai Program	75 (51.4)	29 (55.8)	20 (47.6)	26 (50)	16.332,
English Program	46 (31.5)	18 (34.6)	9 (21.4)	19 (36.5)	0.012
CPIRD	23 (15.8)	5 (9.6)	13 (31.0)	5 (9.6)	
Foreign Externship	3 (1.3)	0 (0.0)	0 (0.0)	3 (3.9)	
Self-rated English skills					
Very good - good	54 (36.7)	19 (36.5)	11 (26.2)	24 (45.3)	4.231,
Average	88 (59.9)	32 (61.5)	29 (69.0)	27 (50.9)	0.376
Poor	5 (3.4)	1 (2.0)	2 (4.8)	2 (3.8)	
Graduated high school					
International schools	32 (21.8)	11 (21.2)	7 (16.7)	14 (26.4)	4.967,
Thai schools	108 (73.5)	38 (73.1)	35 (83.3)	35 (66.0)	0.291
Abroad	7 (4.8)	3 (5.8)	0 (0.0)	4 (7.5)	
Graduated high school location					
Bangkok and vicinity	106 (72.1)	40 (76.29)	28 (71.7)	38 (71.7)	6.097,
Other provinces	34 (23.1)	9 (17.3)	14 (33.3)	11 (20.8)	0.192
Abroad	7 (4.8)	3 (5.8)	0 (0.0)	4 (7.5)	
Monthly household income					
<1,500 USD	16 (10.9)	6 (11.5)	3 (7.1)	7 (13.2)	5.065,
1,500–3,000 USD	41 (27.9)	14 (26.9)	16 (38.1)	11 (20.8)	0.535
3,000–<6,000 USD	27 (18.4)	9 (17.4)	9 (21.4)	9 (17.0)	
≥6,000 USD	63 (42.8)	23 (44.2)	23 (44.2)	26 (49.1)	
Ever done additional research on antibiotics, such as enrolling in courses or searching the internet					
Yes	96 (65.3)	34 (65.4)	28 (66.7)	34 (64.2)	0.066,
No	51 (34.7)	18 (34.6)	14 (33.3)	19 (35.8)	0.968
Ever done additional research on antibiotic resistance, such as enrolling in courses or searching the internet					
Yes	75 (51.0)	24 (46.2)	26 (61.9)	25 (47.2)	2.798,
No	72 (49.0)	28 (53.8)	16 (38.1)	28 (52.8)	0.247
Ever followed any medical knowledge resources on the internet, such as Facebook page, Twitter account, etc.					
Yes	120 (81.6)	42 (80.8)	31 (73.8)	47 (88.7)	3.495,
No	27 (18.4)	10 (19.2)	11 (26.2)	6 (11.3)	0.174
Family members work in the medical field such as being doctors, pharmacists, or nurses					
Yes	44 (29.9)	14 (26.9)	16 (38.1)	14 (26.4)	1.872,
No	103 (70.1)	38 (73.1)	26 (61.9)	39 (73.6)	0.392
Having a family running a pharmacy business					
Yes	6 (4.1)	1 (1.9)	3 (7.1)	2 (3.8)	1.637,
No	141 (95.9)	51 (98.1)	39 (92.9)	51 (96.2)	0.441

Data are number (%) unless otherwise indicated, Exchange rate used: 1 USD=34 THB (average 2024, Bank of Thailand)
[a]=Comparison of students in each academic year across all groups, [b]=Test statistical value is not available for the Kruskal-Wallis test
CPIRD=Collaborative Project to Increase Production of Rural Doctors, IQR=interquartile range
.

that antibiotics prevent and treat bacterial infections was higher among 6th-year students (83.0%) than among 5th-year (73.8%) and 4th-year students (69.2%), though not statistically significant (p-value=0.485). Notably, 49.7% recognized that antibiotic use in animals contributes to resistance in humans, and 51.0% recognized that resistance can be transmitted from animals to humans, with significant differences between academic years (p-value=0.049) (Table 2).

Recognition of basic IC practices was also high: 96.6% responded that hand hygiene reduces the spread of resistance, and 83.7% identified patient and environmental contact as the most common transmission route. Fewer than half, however, knew that surgical masks worn by healthcare workers do not prevent tuberculosis transmission from patients. Correct identification of metronidazole and azithromycin indications was significantly higher among 5th- and 6th-year students than 4th-year students

Table 2 Responses to statements about antibiotic use, drug resistance, and infection control among the participants

Questions	All (N=147)	Year 4 (N=52)	Year 5 (N=42)	Year 6 (N=53)	X^2, p^a
Penicillin is an antibiotic					1.180, 0.554
Yes*	145 (98.6)	51 (98.1)	41 (97.6)	53 (100)	
No	2 (1.4)	1 (1.9)	1 (2.4)	0 (0.0)	
Uncertain	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Antibiotics are effective for viral infection					6.693, 0.153
Yes	5 (3.4)	4 (7.7)	0 (0.0)	1 (1.9)	
No*	141 (95.9)	47 (90.4)	42 (100.0)	52 (98.1)	
Uncertain	1 (0.7)	1 (1.9)	0 (0.0)	0 (0.0)	
It is appropriate to stop taking the antibiotics (stop antibiotics earlier than prescribed or did not complete the course) once the symptoms have subsided					1.839, 0.399
Yes	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
No*	146 (99.3)	51 (98.1)	42 (100.0)	53 (100.0)	
Uncertain	1 (0.7)	1 (1.9)	0 (0.0)	0 (0.0)	
Gonorrhea is caused by a bacterial infection, and there has not been any evidence of antibiotic resistance found					7.991, 0.092
Yes	46 (31.3)	11 (21.2)	16 (38.1)	19 (35.8)	
No*	68 (46.3)	27 (51.9)	14 (33.3)	27 (50.9)	
Uncertain	33 (22.4)	14 (26.9)	12 (28.6)	7 (13.3)	
Intravenous antibiotics are always better than oral antibiotics					1.864, 0.761
Yes	22 (15.0)	9 (17.3)	6 (14.3)	7 (15.0)	
No*	116 (78.9)	39 (75.0)	35 (83.3)	42 (79.2)	
Uncertain	9 (6.1)	4 (7.7)	1 (2.4)	4 (7.5)	
Antibiotics can be used to treat and prevent bacterial infection					3.456, 0.485
Yes*	111 (75.5)	36 (69.2)	31 (73.8)	44 (83.0)	
No	34 (23.1)	15 (28.8)	10 (23.8)	9 (17.0)	
Uncertain	2 (1.4)	1 (2.0)	1 (2.4)	0 (0.0)	
The use of antibiotics in animal feed, such as pigs, cows, and chickens, can lead to antibiotic resistance in humans					
Yes*	73 (49.7)	29 (55.8)	18 (42.9)	26 (49.1)	5.507, 0.239
No	21 (14.3)	6 (11.5)	4 (9.5)	11 (20.8)	
Uncertain	53 (36.0)	17 (32.7)	20 (47.6)	16 (30.1)	
Taking an inadequate dose of antibiotics or not completing the course as prescribed can lead to antibiotic resistance					3.721, 0.445
Yes*	143 (97.3)	50 (96.2)	41 (97.6)	52 (98.1)	
No	1 (0.7)	0 (0.0)	0 (0.0)	1 (1.9)	
Uncertain	3 (2.0)	2 (3.8)	1 (2.4)	0 (0.0)	

Table 2 (continued)

Questions	All (N=147)	Year 4 (N=52)	Year 5 (N=42)	Year 6 (N=53)	X^2, p^a
Antibiotic resistance can be transmitted from human to human					1.853, 0.763
Yes*	126 (85.7)	45 (86.5)	36 (85.7)	45 (84.9)	
No	15 (10.2)	4 (7.7)	4 (9.5)	7 (13.2)	
Uncertain	6 (4.1)	3 (5.8)	2 (4.8)	1 (1.9)	
Antibiotic resistance can be transmitted from animal to human					9.546, 0.049
Yes*	75 (51.0)	35 (67.3)	17 (40.5)	23 (43.4)	
No	19 (12.9)	5 (9.6)	5 (11.9)	9 (17.0)	
Uncertain	53 (36.1)	12 (23.1)	20 (47.6)	21 (39.6)	
Antibiotic resistance is caused by microorganisms evolving resistance to the medication					1.729, 0.421
Yes*	144 (98.0)	50 (96.2)	42 (100.0)	52 (98.1)	
No	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Uncertain	3 (2.0	2 (3.8)	0 (0.0)	1 (1.9)	
Antibiotic resistance happens only in bacteria					7.583, 0.108
Yes	24 (16.3)	12 (23.1)	7 (16.7)	5 (9.4)	
No*	106 (72.1)	32 (61.5)	29 (69.0)	45 (84.9)	
Uncertain	17 (11.6)	8 (15.4)	6 (14.3)	3 (5.7)	
Washing hands with plain soap and water or alcohol gel can reduce the spread of antibiotic resistance					6.715, 0.152
Yes*	142 (96.6)	50 (96.2)	40 (95.2)	52 (98.1)	
No	2 (1.4)	0 (0.0)	2 (4.8)	0 (0.0)	
Uncertain	3 (2.0)	2 (3.8)	0 (0.0)	1 (1.9)	
Surgical masks worn by healthcare workers can prevent transmission from patients with tuberculosis					1.322, 0.858
Yes	68 (46.3)	23 (44.2)	20 (47.6)	25 (47.2)	
No*	73 (49.7)	28 (53.8)	20 (47.6)	25 (47.2)	
Uncertain	6 (4.1)	1 (1.9)	2 (4.8)	3 (5.7)	
The most common cause of antibiotic resistance transmission is contact with AMR patients and their surroundings					2.792, 0.593
Yes*	123 (83.7)	43 (82.7)	35 (83.3)	45 (83.7)	
No	11 (7.5)	3 (5.8)	5 (11.9)	1 (7.5)	
Uncertain	13 (8.8)	6 (11.5)	2 (4.8)	13 (8.8)	
Pharyngitis caused by *Streptococcus pyogenes* can be treated with metronidazole					23.360, <0.001
Yes	11 (7.5)	7 (13.5)	3 (7.1)	1 (1.9)	
No*	118 (80.3)	31 (59.6)	38 (90.5)	49 (92.5)	
Uncertain	18 (12.2)	14 (26.9)	1 (2.4)	3 (5.6)	
Azithromycin is a broad-spectrum antibiotic used to treat urinary tract infection					28.595, <0.001
Yes	43 (29.3)	21 (40.4)	13 (31.0)	9 (17.0)	
No*	89 (60.5)	19 (36.5)	26 (61.9)	44 (83.0)	
Uncertain	15 (10.2)	12 (23.1)	3 (7.1)	0 (0.0)	
A blood culture must always be obtained before an antibiotic prescription					4.332, 0.363
Yes	42 (28.6)	17 (32.7)	11 (26.2)	14 (26.4)	
No*	101 (68.7)	32 (61.5)	30 (71.4)	39 (73.6)	
Uncertain	4 (2.7)	3 (5.8)	1 (2.4)	0 (0.0)	
Total score (Median, IQR)	14 (13-15)	13.5 (12-15)	13.7 (13-15)	14 (14-16)	0.024[b]

Data are number (%) unless otherwise indicated, AMR=antimicrobial resistance, IQR=interquartile range
[a]=Comparison of students in each academic year across all groups, [b]=Test statistical value is not available for the Kruskal-Wallis test, *Indicates correct response to a particular statement

(p-value<0.001). No other significant differences were observed between academic years (Table 2).

Infection control practices

Compliance with the World Health Organization (WHO) "5 Moments for Hand Hygiene" (always performing) varied by indication. The highest compliance was for moment 3 (after body fluid exposure; 93.2%), while the lowest was for moment 1 (before patient examination; 26.5%) (Table 3). Compliance with moment 5 (after contacting the patient's surroundings) was significantly higher among 4th-year students compared to 5th- and 6th-year students. No other significant differences were found between academic years.

Regarding general IC practices, 85.0% reported proper handwashing in public, but only 22.4% reported always washing their hands correctly in healthcare settings. In addition, 24.5% always cleaned stethoscopes between patients, and 27.2% always removed their white coats after clinic hours. A significantly higher proportion of the 4th-year students reported wearing the same white coat many times without washing it compared with others (p-value=0.008). Living outside Bangkok and its vicinity was the only factor associated with consistent handwashing before patient examination in the univariable analysis (OR 6.28, 95% CI 1.40–28.31: p-value=0.02). No other factors were associated with other IC practices.

Antibiotic prescribing practices and related outcomes among the 6th-year students

Among the 53 final-year students, 77.3% reported often or always evaluating risk factors for antibiotic resistance before prescribing (mean score 3.9), 67.9% reported often or always following antibiotic guidelines (mean score 3.7), and 7.6% reported prescribing antibiotics

Table 3 Infection control practices among the participants

Practices	All (N=147)	Year 4 (N=52)	Year 5 (N=42)	Year 6 (N=53)	X^2, p^a
You wash your hands properly every time you are in a public place, such as a restroom					2.113, 0.348
Yes	125 (85.0)	42 (80.8)	35 (83.3)	48 (90.6)	
No	22 (15.0)	10 (19.2)	7 (16.7)	5 (9.4)	
You always wash your hands before examining the patient					6.909, 0.329
Always (100%)	39 (26.5)	16 (30.8)	12 (28.6)	11 (20.8)	
Often (51-99%)	84 (57.1)	26 (50.0)	27 (64.2)	31 (58.5)	
Sometimes (50%)	19 (12.9)	7 (13.4)	2 (4.8)	10 (18.9)	
Rarely (1-49%)	5 (3.5)	3 (5.8)	1 (2.4)	1 (1.8)	
Never (0%)	0 (0)	0 (0)	0 (0)	0 (0)	
You always wash your hands after examining the patient					11.106, 0.085
Always (100%)	85 (57.8)	35 (67.3)	21 (50.0)	29 (54.7)	
Often (51-99%)	53 (36.1)	12 (23.1)	21 (50.0)	20 (37.7)	
Sometimes (50%)	8 (5.4)	4 (7.7)	0 (0)	4 (7.6)	
Rarely (1-49%)	1 (0.7)	1 (1.9)	0 (0)	0 (0)	
Never (0%)	0 (0)	0 (0)	0 (0)	0 (0)	
You always wash your hands before procedures that use aseptic techniques					7.583, 0.270
Always (100%)	105 (71.4)	33 (63.5)	29 (69.0)	43 (81.2)	
Often (51-99%)	30 (20.4)	13 (25.0)	11 (26.2)	6 (11.3)	
Sometimes (50%)	10 (6.8)	5 (9.6)	1 (2.4)	4 (7.5)	
Rarely (1-49%)	2 (1.4)	1 (1.9)	1 (2.4)	0 (0)	
Never (0%)	0 (0)	0 (0)	0 (0)	0 (0)	

Table 3 (continued)

Practices	All (N=147)	Year 4 (N=52)	Year 5 (N=42)	Year 6 (N=53)	X^2, p^a
You always wash your hands after contacting a patient's body fluid or blood					4.512, 0.608
Always (100%)	137 (93.2)	48 (92.4)	40 (95.2)	49 (92.5)	
Often (51-99%)	6 (4.1)	1 (1.9)	2 (4.8)	3 (5.7)	
Sometimes (50%)	3 (2.0)	2 (3.8)	0 (0)	1 (1.8)	
Rarely (1-49%)	1 (0.7)	1 (1.9)	0 (0)	0 (0)	
Never (0%)	0 (0)	0 (0)	0 (0)	0 (0)	
You always wash your hands after contacting patient's surroundings					17.508, 0.008
Always (100%)	61 (41.5)	29 (55.8)	12 (28.6)	20 (37.7)	
Often (51-99%)	68 (46.3)	16 (30.8)	29 (69.0)	23 (43.4)	
Sometimes (50%)	14 (9.5)	5 (9.6)	1 (2.4)	8 (15.1)	
Rarely (1-49%)	4 (2.7)	2 (3.8)	0 (0)	2 (3.8)	
Never (0%)	0 (0)	0 (0)	0 (0)	0 (0)	
You always wash your hands properly in healthcare settings					6.683, 0.351
Always (100%)	33 (22.4)	11 (21.2)	10 (23.8)	12 (22.6)	
Often (51-99%)	75 (51.0)	22 (42.3)	25 (59.5)	28 (52.8)	
Sometimes (50%)	29 (19.7)	15 (28.8)	6 (14.3)	8 (15.1)	
Rarely (1-49%)	10 (6.9)	4 (7.7)	1 (2.4)	5 (9.4)	
Never (0%)	0 (0)	0 (0)	0 (0)	0 (0)	
You take off the white coat after leaving the hospital					4.452, 0.814
Always (100%)	40 (27.2)	14 (26.9)	10 (23.8)	16 (30.2)	
Often (51-99%)	41 (27.9)	15 (28.8)	13 (31.0)	13 (24.5)	
Sometimes (50%)	36 (24.5)	12 (23.1)	9 (21.4)	15 (28.3)	
Rarely (1-49%)	20 (13.6)	6 (11.6)	6 (14.3)	8 (15.1)	
Never (0%)	10 (6.8)	5 (9.6)	4 (9.5)	1 (1.9)	
You wear the same white coat many times without washing it					20.640, 0.008
Always (100%)	5 (3.4)	4 (7.7)	1 (2.3)	0 (0)	
Often (51-99%)	31 (21.1)	18 (34.6)	7 (16.7)	6 (11.3)	
Sometimes (50%)	18 (12.2)	7 (13.5)	7 (16.7)	4 (7.5)	
Rarely (1-49%)	42 (28.6)	11 (21.2)	14 (33.3)	17 (32.1)	
Never (0%)	51 (34.7)	12 (23.1)	13 (31.0)	26 (49.1)	
You wash your white coat together with other sets of clothes					4.326, 0.827
Always (100%)	51 (34.7)	19 (36.5)	15 (35.7)	17 (32.2)	
Often (51-99%)	26 (17.7)	10 (19.2)	5 (11.9)	11 (20.8)	
Sometimes (50%)	18 (12.2)	7 (13.5)	3 (7.1)	8 (15.1)	
Rarely (1-49%)	17 (11.6)	5 (9.5)	6 (14.3)	6 (4.1)	
Never (0%)	35 (23.8)	11 (21.3)	13 (31.0)	11 (20.8)	
You always clean your stethoscope before examining a new patient					8.390, 0.396
Always (100%)	36 (24.5)	10 (19.2)	15 (35.7)	11 (20.8)	
Often (51-99%)	45 (30.6)	16 (30.8)	14 (33.3)	15 (28.3)	
Sometimes (50%)	34 (23.1)	13 (25.0)	8 (19.0)	13 (24.5)	
Rarely (1-49%)	30 (20.4)	12 (23.1)	4 (9.5)	14 (26.4)	
Never (0%)	2 (1.4)	1 (1.9)	1 (2.4)	0 (0)	
You often place the patient's chart on the patient's bed.					4.834, 0.775
Always (100%)	3 (2.0)	2 (3.8)	0 (0)	1 (2.0)	
Often (51-99%)	16 (10.9)	6 (11.5)	6 (14.3)	4 (7.5)	
Sometimes (50%)	29 (19.7)	8 (15.5)	8 (19.0)	13 (24.5)	
Rarely (1-49%)	56 (38.1)	19 (36.5)	18 (42.9)	19 (35.8)	
Never (0%)	43 (29.3)	17 (32.7)	10 (23.8)	16 (30.2)	

Data are number (%) unless otherwise indicated, [a] Comparison of students in each academic year across all groups for all patients with upper respiratory tract infections (mean score 2.0) (Table 4). Most reported starting antibiotics within 1 hour of diagnosing sepsis and stepping down treatment after culture and susceptibility results. However, 39.6% reported often or always prescribing quinolones empirically for UTIs (mean score 2.8), and 30.2% and 28.3% reported often or always prescribing antibiotics for asymptomatic bacteriuria and positive sputum cultures (mean score 2.6 and 2.5, respectively). No factors were associated with any particular prescribing practices in univariable analysis.

For antibiotic-related outcomes (Table 4), 84.9% reported frequent treatment success (mean score 3.9). However, 32% reported changing antibiotics due to treatment failure (mean score 3.0), and 17% reported

Table 4 Antibiotic prescribing practices and related patient outcomes among the 6th-year medical students

Practices	Frequency (N=53)
You prescribe antibiotics to all patients presenting with upper respiratory tract infections	
Always (100%)	2 (3.8)
Often (51-99%)	2 (3.8)
Sometimes (50%)	9 (17.0)
Rarely (1-49%)	20 (37.7)
Never (0%)	20 (37.7)
Mean score (S.D.)[a]	2.0 (1.0)
You prescribe quinolone as an empiric treatment to patients with urinary tract infection	
Always (100%)	7 (13.2)
Often (51-99%)	14 (26.4)
Sometimes (50%)	10 (18.9)
Rarely (1-49%)	8 (15.1)
Never (0%)	14 (26.4)
Mean score (S.D.)[a]	2.8 (1.4)
You follow the guidelines for antibiotic use before prescribing	
Always (100%)	13 (24.5)
Often (51-99%)	23 (43.4)
Sometimes (50%)	8 (15.1)
Rarely (1-49%)	8 (15.1)
Never (0%)	1 (1.9)
Mean score (S.D.)[a]	3.7 (1.1)
You consult an infectious disease physician before prescribing antibiotics	
Always (100%)	13 (24.5)
Often (51-99%)	23 (43.4)
Sometimes (50%)	8 (15.1)
Rarely (1-49%)	8 (15.1)
Never (0%)	1 (1.9)
Mean score (S.D.)[a]	2.9 (1.2)
You evaluate risk factors for antibiotic resistance in patients before prescribing antibiotics	
Always (100%)	12 (22.6)
Often (51-99%)	29 (54.7)
Sometimes (50%)	7 (13.2)
Rarely (1-49%)	3 (5.7)
Never (0%)	2 (3.8)
Mean score (S.D.)[a]	3.9 (1.0)
You start antibiotic treatment for the patient within 1 hour of diagnosing sepsis	
Always (100%)	25 (47.2)
Often (51-99%)	23 (43.4)
Sometimes (50%)	2 (3.8)
Rarely (1-49%)	1 (1.9)
Never (0%)	2 (3.7)
Mean score (S.D.)[a]	4.3 (1.0)

Table 4 (continued)

Practices	Frequency (N=53)
You start combination antibiotic therapy in patients diagnosed with sepsis with shock	
Always (100%)	11 (20.8)
Often (51-99%)	28 (52.8)
Sometimes (50%)	8 (15.0)
Rarely (1-49%)	3 (5.7)
Never (0%)	3 (5.7)
Mean score (S.D.)[a]	3.8 (1.0)
You step down antibiotics based on treatment response	
Always (100%)	18 (34.0)
Often (51-99%)	19 (35.8)
Sometimes (50%)	10 (18.8)
Rarely (1-49%)	3 (5.7)
Never (0%)	3 (5.7)
Mean score (S.D.)[a]	3.9 (1.1)
You step down antibiotics after knowing the result of blood culture and antibiotic susceptibility tests	
Always (100%)	31 (58.4)
Often (51-99%)	16 (30.2)
Sometimes (50%)	3 (5.7)
Rarely (1-49%)	1 (1.9)
Never (0%)	2 (3.8)
Mean score (S.D.)[a]	4.4 (1.0)
You fill out the DUE form with complete and accurate information for antibiotics that have controlled use	
Always (100%)	26 (49.1)
Often (51-99%)	19 (35.8)
Sometimes (50%)	4 (7.5)
Rarely (1-49%)	1 (1.9)
Never (0%)	3 (5.7)
Mean score (S.D.)[a]	4.2 (1.1)
You start antibiotic treatment for patients with positive sputum culture, but no symptoms of respiratory tract infection, underlying diseases, and normal chest radiograph	
Always (100%)	5 (9.4)
Often (51-99%)	10 (18.9)
Sometimes (50%)	8 (15.1)
Rarely (1-49%)	13 (24.5)
Never (0%)	17 (32.1)
Mean score (S.D.)[a]	2.5 (1.4)
You start antibiotics for patients with positive urine culture, but no symptoms of urinary tract infection	
Always (100%)	4 (7.5)
Often (51-99%)	12 (22.7)
Sometimes (50%)	8 (15.1)
Rarely (1-49%)	17 (32.1)
Never (0%)	12 (22.6)
Mean score (S.D.)[a]	2.6 (1.3)
You expand the spectrum of antibiotics or change the antibiotics if the patient you are treating is not getting better	
Always (100%)	2 (3.8)
Often (51-99%)	11 (20.8)
Sometimes (50%)	5 (9.4)
Rarely (1-49%)	13 (24.5)
Never (0%)	22 (41.5)
Mean score (S.D.)[a]	2.2 (1.3)

Table 4 (continued)

Practices	Frequency (N=53)
Your patient's disease resolves after receiving antibiotics	
Always (100%)	4 (7.5)
Often (51-99%)	41 (77.4)
Sometimes (50%)	6 (11.3)
Rarely (1-49%)	1 (1.9)
Never (0%)	1 (1.9)
Mean score (S.D.)[a]	3.9 (0.7)
You start antibiotics for patients with positive urine culture, but no symptoms of urinary tract infection	
Always (100%)	4 (7.5)
Often (51-99%)	12 (22.7)
Sometimes (50%)	8 (15.1)
Rarely (1-49%)	17 (32.1)
Never (0%)	12 (22.6)
Mean score (S.D.)[a]	
The patient you are treating did not have side effects from antibiotics after receiving antibiotics	
Always (100%)	4 (7.5)
Often (51-99%)	31 (58.5)
Sometimes (50%)	12 (22.7)
Rarely (1-49%)	4 (7.5)
Never (0%)	2 (3.8)
Mean score (S.D.)[a]	3.6 (0.9)
The patient you are treating has developed resistance to the antibiotics they have taken and/or other classes of antibiotics	
Always (100%)	2 (3.8)
Often (51-99%)	10 (18.9)
Sometimes (50%)	13 (24.5)
Rarely (1-49%)	21 (39.6)
Never (0%)	7 (13.2)
Mean score (S.D.)[a]	2.6 (1.1)
The patient you are treating has to receive alternative antibiotics as the original antibiotics are not effective	
Always (100%)	2 (3.8)
Often (51-99%)	15 (28.2)
Sometimes (50%)	18 (34.0)
Rarely (1-49%)	15 (28.3)
Never (0%)	3 (5.7)
Mean score (S.D.)[a]	3.0 (1.0)
The patient you are treating has wasted unnecessary money on antibiotics	
Always (100%)	2 (3.8)
Often (51-99%)	7 (13.2)
Sometimes (50%)	13 (24.5)
Rarely (1-49%)	21 (39.6)
Never (0%)	10 (18.9)
Mean score (S.D.)[a]	2.4 (1.1)

Data are number (%) unless otherwise indicated.
[a] =Mean score was calculated by averaging the scores derived from all participants. The scores of 1, 2, 3, 4, and 5 were assigned for each of the following responses: "never", "rarely", "sometimes", "often", and "always", respectively.
DUE=drug utilization evaluation, S.D.=standard deviation

patients frequently spending unnecessary money on antibiotics (mean score 2.4). A small proportion reported patients experiencing side effects or developing resistance to prescribed antibiotics or related classes (Table 4).

Discussion

This study provides insights into Thai clinical-year medical students' knowledge of antibiotics and IC, their IC practices, and their antibiotic prescribing behaviors. Overall knowledge scores were high (median 14/18; 77.8%) and improved with advancing academic years. In contrast, previous Thai studies reported lower knowledge scores. Rattanaumpawan et al. reported a mean score of 63% among final-year medical students, while Chueonchom et al. reported low scores for resistance mechanisms (1.61/5) and antimicrobial resistance scenarios (3.39/6), although knowledge of IC was relatively high (8.02/10)[6,8]. Variations in scores may be due to the differences in question type, content, and student performance across settings. The improvement in knowledge across academic years in our study suggests that the concepts of antibiotic use, resistance, and IC are effectively reinforced and accumulated throughout medical training.

In this study, only approximately 50% of the participants recognized that antibiotic resistance can be transmitted between animals and humans. In comparison, a study in India found that most students (84%) were unaware that abuse of antibiotics in animals and agriculture was a major contributor to antibiotic resistance[9]. Our findings also highlighted gaps in knowledge regarding the appropriate mask use for tuberculosis prevention and antibiotic selection for specific pathogens, consistent with other studies.[10] These gaps underscore the need to adapt teaching content to address setting-specific deficiencies in knowledge of antibiotics and IC.

IC practices among students varied and were generally suboptimal. Compliance with the WHO's "5 Moments for Hand Hygiene" was lowest before patient examination (moment 1) and after contact with patient surroundings (moment 5). Similar findings were reported in Thailand, where only 31% complied with handwashing protocols[5], and in Saudi Arabia, where 20% and 15% complied with handwashing before and after physical examination, respectively[11]. Suboptimal compliance with moment 5 has also been reported elsewhere[12]. Our study additionally examined practices related to attire and equipment. Although only 3% of students reported reusing their white coats without washing, this contrasts with earlier findings where 17.3% washed coats every 3 days and 30.3% weekly[13]. Stethoscope hygiene was also poor, with only 24.5% cleaning them between patients, consistent with previous studies[14,15]. Placement of charts near patients was uncommon, aligning with prior reports[16]. These findings highlight the need for interventions to improve both hand hygiene and equipment-related IC practices among medical students.

Our analysis found that students from outside Bangkok and its vicinity were more likely to consistently wash their hands before patient examination. This contrasts with previous findings where individuals from metropolitan areas demonstrated higher compliance, likely due to better access to resources and health education[17]. One possible explanation is that students from rural areas may have become more aware of resource disparities during training, prompting greater conscientiousness toward IC. Additional research is required to test this hypothesis.

Concerning antibiotic stewardship, most final-year students reported adhering to antibiotic prescription guidelines, evaluating resistance risk prior to antibiotic selection, stepping down antibiotic treatment when appropriate, and consulting specialists for antibiotic regimens. However, a significant portion continued to prescribe antibiotics inappropriately, particularly for asymptomatic cases, positive sputum cultures, and bacteriuria. Furthermore, a significant proportion of students prescribed fluoroquinolones as empirical therapy for urinary tract infections, despite the high resistance rates in Thailand among *Escherichia coli and Klebsiella pneumoniae*. Similar patterns of inappropriate prescribing have been reported among European medical students[7]. In our study, although treatment success rates were high, students also acknowledged the need to change ineffective antibiotics, unnecessary costs, side effects, and resistance development. Comparable findings in Europe showed that nearly half of inappropriate prescriptions were potentially harmful to the patients[7]. These findings highlight the importance of strengthening antibiotic stewardship education.

There are several limitations in this study. First, being conducted at a single institution may limit the generalizability of the findings to medical students in other universities with different curricula or educational approaches. Second, since the data collection process depended on voluntary participation through a virtual platform, it is possible that only highly motivated individuals with better internet access or those more comfortable with technology chose to participate. This may have resulted in selection bias, thereby limiting the representativeness of the sample. Third, the self-administered survey design may have introduced misunderstanding, recall bias, or misreporting. Fourth, compliance with IC practices was self-reported and may have been under- or over-estimated, and the responses provided by participants may not accurately reflect their actual behaviors or practices in real-life settings. Lastly, the small sample size for the certainly inappropriate IC and prescribing practices could limit the detection of any associated factors.

Conclusion

Thai clinical-year medical students in this study demonstrated strong theoretical knowledge of antibiotics and IC, but important gaps remain in translating knowledge into consistent practice. These findings illustrate broader challenges in medical education and the persistent gap between knowledge and behavior. Implementing comprehensive IC and antibiotic stewardship programs across all clinical years is essential based on the study findings. These programs could be incorporated into the current curriculum or as additional classes, workshops, and hands-on activities to bridge the gap between theoretical knowledge and real-world application. Continuous reinforcement of knowledge, combined with practical training and regular assessment—through both self-reflection and faculty observation—should be integrated into clinical rotations to strengthen students' long-term retention and compliance with best practices.

Acknowledgement

The authors would like to thank all participating students and the faculty members who facilitated data collection. In addition, the authors would like to acknowledge Michael Jan Everts, from the Clinical Research Center, Faculty of Medicine, Thammasat University, for English editorial assistance.

Conflict of interest

The authors declare no conflicts of interest related to this study.

Funding sources

This research received no funding.

References

1. Ai Z, Fang Y, Gao X, Wang L, Yu M. Knowledge, attitude, and practice towards bacterial multidrug-resistance and structural equation modeling analysis among intensive care unit nurses and physicians. PLoS One 2024;19:e0304734.
2. Abejew A, Wubetu G, Fenta T. Antibiotic prescribing behavior of physicians in outpatient departments in hospitals in Northwest Ethiopia: structural equation modeling approach. Interact J Med Res 2024;13:e57285.
3. Alshammari SA, Alrasheed SS, Alruhaimi WA. Knowledge, attitude, and practice of standard infection control precautions

among medical students at King Khalid University Hospital. Cureus 2024;16:e62768.

4. Huang Y, Gu J, Zhang M, Ren Z, Yang W, Chen Y, et al. Knowledge, attitude and practice of antibiotics: a questionnaire study among 2500 Chinese students. BMC Med Educ 2013;13:163.
5. Paotong D, Trakarnchansiri J, Phongsanon K, Churncharoen P, Sitaphong S, Poldee T, et al. Compliance with handwashing in a university hospital in Thailand. Am J Infect Control 2003;31:128.
6. Chuenchom N, Thamlikitkul V, Chaiwarith R, Deoisares R, Rattanaumpawan P. Perception, attitude, and knowledge regarding antimicrobial resistance, appropriate antimicrobial use, and infection control among future medical practitioners: a multicenter study. Infect Control Hosp Epidemiol 2016;37:603–5.
7. van der Voort T, Brinkman DJ, Benemei S, Böttiger Y, Chamontin B, Christiaens T, et al. Appropriate antibiotic prescribing among final-year medical students in Europe. Int J Antimicrob Agents 2019;54:375–9.
8. Rattanaumpawan P, Chuenchom N, Thamlikitkul V. Perception, attitude, knowledge and learning style preference on challenges of antimicrobial resistance and antimicrobial overuse among first year doctors in training and final year medical students. Antimicrob Resist Infect Control 2019;8:142.
9. Saksena R, Parida A, Jain M, Gaind R. Antibiotic use and antimicrobial resistance: knowledge, attitude and practices survey of medical students to evaluate undergraduate training curriculum. Access Microbiol 2025;7:000638.v4.
10. Laurenti P, Federico B, Raponi M, Furia G, Ricciardi W, Damiani G. Knowledge, experiences, and attitudes of medical students in Rome about tuberculosis. Med Sci Monit 2013;19:865–74.
11. Al Kadi A, Salati SA. Hand hygiene practices among medical students. Interdiscip Perspect Infect Dis 2012;2012:679129.
12. Cambil-Martin J, Fernandez-Prada M, Gonzalez-Cabrera J, Rodriguez-Lopez C, Almaraz-Gomez A, Lana-Perez A, et al. Comparison of knowledge, attitudes and hand hygiene behavioral intention in medical and nursing students. J Prev Med Hyg 2020;61:E9–14.
13. Tahir M, Mubasher A, Ilyas M, Irfan H, Khan M, Aamer R, et al. Practices of medical students regarding hygiene in hospital settings. JSPARK [serial on the Internet]. 2023 [cited 2025 Sep 19];2:26-35. Available from: https://journalofspark.com/journal/index.php/JSpark/article/view/145
14. Ali M, Awwad M, Eid M, Jawabreh A, Abu-Tair F, Zarour A, et al. Investigating stethoscope hygiene practices and bacterial contamination among medical trainees: an educational perspective. Sci Rep 2025;15:23444.
15. Jayarajah U, Athapathu AS, Jayawardane BAAJ, Prasanth S, Seneviratne SN. Hygiene practices during clinical training: knowledge, attitudes and practice among a cohort of South Asian medical students. BMC Med Educ 2019;19:157.
16. Chen KH, Chen LR, Wang YK. Contamination of medical charts: an important source of potential infection in hospitals. PLoS One 2014;9:e78512.
17. Kumar S, Loughnan LC, Luyendijk R, Hernandez O, Weinger M, Arnold F, et al. Handwashing in 51 countries: analysis of proxy measures of handwashing behavior in multiple indicator cluster surveys and demographic and health surveys, 2010–2013. Am J Trop Med Hyg 2017;97:447–59.