Original Article

The awareness and perception on Antimicrobial Stewardship among healthcare professionals in a tertiary teaching hospital Malaysia

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Abstract

Objective: The engagement with all healthcare professionals involved in antimicrobial use is the key to success for antimicrobial stewardship (AMS) programs. Assessing the awareness and perception of AMS among healthcare professionals is needed to guide the necessary steps required in AMS education. This study primarily aimed to assess awareness and perception of AMS among doctors and nurses across various disciplines in the Universiti Kebangsaan Malaysia Medical Centre (UKMMC). Methods: A cross-sectional study was conducted using a self-administered questionnaire in UKMMC by convenient sampling. The questionnaire consisted of a total of 18 items on demographic data, awareness, perception, and importance on AMS. Results: There were a total of 253 respondents (74 doctors and 179 nurses) with a 74% response rate among doctors and 89.5% among nurses. Doctors (94.6%) were significantly more familiar with the term 'AMS' compared to nurses (28.5%) ($p < 0.001$). Most respondents did not aware of the existence of the AMS program (59.5%) in UKMMC. Institutionalized evidence-based practice guidelines that incorporate local resistance patterns were perceived by the prescribers as the most beneficial (94.6%) and the most-practiced (82.4%) AMS strategy. Doctors (97.3%) were significantly more likely to acknowledge their role in implementing AMS compared to the nurses (52.5%) ($p < 0.001$). They (97.3%) were also significantly aware of the importance of AMS compared to nurses (70.3%) ($p < 0.001$). Conclusion: This study highlighted the low awareness of AMS among nurses in a tertiary teaching hospital, which prompts the need for AMS training for this group of healthcare professionals.

Keywords: antimicrobial-resistant, antimicrobial stewardship, antimicrobial, infectious control

Introduction

The emergence of "superbugs" or antibiotic-resistant strains is one of the alarming global public health threats across the world.[1,2] This threatens the availability of current antimicrobials and consequently, the world is heading towards a post-antibiotic era, in which the common infections are untreatable.[1,2] Antimicrobial stewardship (AMS) has been initiated in the hospitals as a direct response to the rise in antimicrobial resistance.[2] It consists of a set of coordinated interventions to enhance the optimal use of antimicrobials and prevent the spread of infections by multi-resistant organisms, which should be administered by a team of multidisciplinary experts, including infectious disease physicians, clinical pharmacists, clinical microbiologists, and infection control practitioners.[3] AMS requires strong support and collaborative efforts across healthcare professions from various disciplines to be effective and successful.[4,5] Previous studies reported that antibiotic resistance was perceived as a national problem by the majority of the doctors and it was only 55 - 63% viewed antibiotic resistance as an issue within their practice.[6-8] Interestingly, some studies demonstrated that the awareness of antimicrobial resistance was high in teaching hospitals.[9,10] On the other hand, Olans et al. found that the roles of nurses have been under-recognized despite them already being integral components of AMS.[11] The nurses are pivotal in drug administration for patients and their need for education on AMS was supported by Gillespie et al.[12]

In Malaysia, AMS programs have been initiated and implemented in healthcare facilities in the year 2014.[13] Data on AMS in Malaysia is limited. Yap and colleagues reported the first-year experience and the positive outcomes on post-implementation of the AMS approach in a Malaysian district hospital.[14] However, there is a lack of published reports on the awareness and perception of AMS among healthcare

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professionals in Malaysia. Healthcare professionals must recognize the importance of AMS and demonstrate the support in combating antimicrobial resistance. Therefore, this study aimed to investigate the awareness and perception of AMS among doctors and nurses across various disciplines in a tertiary teaching hospital in Malaysia.

Methods

Study design

A cross-sectional study was conducted using a self-administered questionnaire in UKMMC from October 2017 to December 2017. The participants were recruited by convenient sampling following the approval from the Universiti Kebangsaan Malaysia Research Ethics Committee (UKM PPI/111/8/JEP-2017-696).

Study population

The inclusion criteria for the participants include doctors and nurses across various disciplines in UKMMC. The disciplines covered include anesthesiology, medical, obstetrics, and gynecology (O&G), ophthalmology, oncology, orthopedic, otorhinolaryngology (ENT), pediatric, surgical and others. The exclusion criteria include: (1) those who have previously participated in the pilot study, (2) participants who have requested to withdraw from this research study and (3) participants who have answered the self-administered questionnaire incompletely.

Questionnaire

The questionnaire, with a total of 18 items, was adapted and modified from previous studies with permissions.[15-17] The first part of this research questionnaire consisted of 4 items (Q1 – Q4) to compile the demographic data of the participants. The second part was made up of three domains, namely awareness, perception, and importance. The first domain, with a total of 7 items (Q5 – Q11), was to assess the awareness on AMS in general as well as the AMS efforts that were being practiced in UKMMC. The second domain, consisting of 5 items (Q12 – Q16), was to assess the perception of the AMS practices in UKMMC. Lastly, the third domain, comprising of 2 items (Q17 – Q18), was aimed at assessing the awareness on the importance of AMS.

The doctors had to answer all 18 items while the nurses only had to answer 13 items (exempted from Q10 – Q14, which were questions about antimicrobial prescribing practices). This questionnaire had been pre-tested on 20 healthcare professionals (10 doctors and 10 nurses) across various disciplines in UKMMC during the pilot study phase to confirm on the simplicity of language used and to assess the comprehension of the questions. Changes had been incorporated into the questionnaire following the pilot study.

Data collection

Data collection took place in various locations within the setting of UKMMC, namely in the wards, cafeteria, and library. The participants were approached to spend approximately 5-10 minutes on the hard copies of the self-administered questionnaire. An information sheet along with a written consent form was attached to each copy of the questionnaire. The participants had to sign the written consent forms before answering the questionnaires which were then collected on the spot upon completion.

Statistical analysis

Categorical variables were presented as percentages and analyzed using the Statistical Package for Social Sciences (SPSS) version 24.0 (IBM Corporation, Armonk, New York, U.S.). Chi-squared (χ^2) test or Fisher's exact test (when the frequency of respondents was less than 5 for any category) was performed respectively to determine the association between groups (doctors and nurses) for each parameter (on a categorical scale). All p-values reported were two-tailed with a value of < 0.05 being statistically significant.

Results

A total of 253 healthcare professionals (74 doctors and 179 nurses) across various disciplines in UKMMC participated in this study. The response rate was 74% among doctors and 89.5% among nurses. There was no respondent excluded from this study. The demographic data of the respondents were presented in Table 1. On average, the total working experience of the respondents in any given healthcare institute ranges from 0.08 years to 31.00 years with a mean of 9.05 ± 7.36 years. In terms of working experience in UKKMC, the experience of the respondents ranges from 0.08 years to 30.00 years with a mean of 8.22 ± 7.11 years. The distribution of doctors and nurses from the various disciplines in UKMMC was shown in Figure 1.

The responses of the respondents for the questions about awareness of respondents on AMS were tabulated in Table 2. This study revealed that only 47.8% (n = 121) of the respondents were familiar with the term "AMS". A Chi-square test was performed to examine the association between familiarity with 'AMS' and profession. Doctors were found to have a significantly higher rate of familiarity with the term 'AMS' than the nurses ($\chi^2 = 91.68$, $p < 0.000$; Table 2). This familiarity was significantly associated with the AMS training experience, in which 100% (n = 26) of the respondents with AMS training were familiar to the term 'AMS' ($\chi^2 = 31.61$, $p < 0.001$). Across the various discipline or specialties, the anaesthesiology (100%, n = 7) team recorded the highest rate of familiarity with the term "AMS", followed by medical (62.5%, n = 20), surgical (57.6%, n = 19), oncology (51.9%, n = 14), paediatric (48.1%, n = 13), obstetrics & gynaecology (44.4%, n = 12), ophthalmology (44.4%, n = 12) and orthopaedic (36.1%, n = 13) teams. Whereas, the respondents from otorhinolaryngology (30.8%, n = 8) and on rotation among wards (30%, n = 3) were shown to be the least familiar with the term. Chi-squared test was also performed to assess the difference in familiarity with the term "AMS" between the various disciplines studied and it was indicated that there was a significant difference between each discipline ($\chi^2 = 18.35$, $p = 0.031$).

The resources that were being utilized by the doctors in UKMMC for antimicrobial prescribing and their perception of the reliability of multiple resources have been tabulated in Table 3. Prescribers mostly obtained references for antimicrobial prescribing through grand rounds, written guidelines, and e-mail alerts. Most of the prescribers perceived that written guidelines, grand rounds, and journals were the three most reliable resources for them. For other resources, it was also interesting to note that 20.3% of the prescribers found that it was reliable to consult pharmacists before prescribing antimicrobials.

The perception of prescribers on the benefits of each of the 11 AMS strategies studied and subsequently, their perceptions as to whether or not these 11 AMS strategies were being practiced within their respective disciplines in UKMMC were analyzed and the results are depicted in Table 4. Most of the prescribers perceived that the other AMS strategies were beneficial for the prescription and utilization of antimicrobials, except for combination therapy, consultations on infectious diseases before prescribing antimicrobials and conversion of intravenous to oral form for antimicrobials on Day 3. Institutionalized evidence-based practice guidelines and clinical pathways that incorporate local resistance patterns were perceived as the most beneficial AMS strategy were also found to be the most-practiced AMS strategy in UKMMC. Chi-squared test was performed to assess the difference in perception among doctors from the various disciplines studied on the AMS strategies that were being implemented within their respective disciplines. A significant difference in perception of the AMS practice between disciplines was found for several AMS strategies (Table 5).

On the other hand, the respondents revealed that the top three entities that provide active support for the AMS strategies in UKMMC were pharmacists, physicians/prescribers and the infection prevention/control team (Table 6). According to the Chi-squared test, the nurses were significantly more uncertain about the answer as opposed to the doctors for this question ($\chi^2 = 45.07$, $p < 0.001$). Doctors were significantly more likely to acknowledge their role in implementing AMS compared to the nurses ($\chi 2 = 46.55$, $p < 0.001$) and also were significantly aware of the importance of AMS compared to nurses ($\chi^2 = 22.28$, $p < 0.001$) (Table 6). Those who have AMS training experience (n = 26, 100%) were significantly aware on the importance of AMS compared to those without any AMS training (n = 172, 75.8%) ($\chi^2 = 8.05$, $p = 0.005$). However, there was no significant difference in the awareness of the importance of AMS across the various disciplines ($\chi^2 = 8.51$, $p = 0.484$). The majority of the respondents were agreed that AMS would lead to improved patient outcomes, reduced infection rates and reduced antimicrobial resistance (Table 7). Most doctors were reported to significantly agree that AMS will bring about improved outcomes for the 6 indicated parameters as opposed to the nurses (Table 7).

Discussion

This study represents the first awareness study involving doctors and nurses in a tertiary teaching hospital and it provided a clear trend of awareness on AMS and its importance among the doctors and nurses across various disciplines in UKMMC. Although there was a limited number of consultants and specialists enrolled in this study, there was a good distribution among the medical officers and house officers. Similarly, there was also a good distribution of position among the nurses who have responded. In terms of working experiences, there was also a good representation of the two professions in terms of their working experience either in any given healthcare institute or in UKMMC.

Concerning awareness on AMS, it was found that more than half of the respondents were not familiar with the term "AMS". However, there was a good familiarity with the term "AMS" among the doctors. This research study has further confirmed the fact that the awareness of AMS among doctors has been on an increasing trend over the years.[18,19] As for the nurses, there was a rather low familiarity rate with the term "AMS". This finding suggested that the nurses probably had a lower rate of exposure to the knowledge of antimicrobial resistance and AMS as opposed to the doctors. Nurses are under-recognized for their efforts despite having already played integral roles in AMS.[11] Hence, it explains the lack of exposure of nurses to the knowledge of AMS. As such, this data suggested that there is a need for the nurses to be educated on AMS. Several studies have been confirmed that there is a need to empower nurses to acknowledge the significance of their roles and the impact that their daily activities have on AMS.[20,21] Furthermore, this study also revealed that respondents who have had prior AMS training had a significantly higher rate of familiarity with the term compared to subjects who have not undergone any AMS training. It has further proven the significance of training and education in enhancing the awareness of healthcare professionals on AMS. In addition, there was a significant difference in familiarity with the term "AMS" between different disciplines or specialties. This finding suggested that there is a need for a standardized AMS guideline as well as a standardized AMS program that involves a multidisciplinary approach across all the disciplines in the healthcare facilities.[5] A good engagement of hospital leadership will be beneficial in ensuring that good relationships can be fostered among the various disciplines.[22]

Similarly, this study also found that only a minority of the respondents knew about the existence of the AMS program and fellowship training program for Infectious Disease specialty in UKMMC even though it has been started since the year 2014. These findings further confirmed the need for interventions to increase promotion values of AMS that is being practiced in among the healthcare professionals, such as AMS training and education. There was a low percentage of respondents have attended AMS training in the past. Effective training programs on Infectious Diseases have been linked to improved AMS outcomes and the recommendation

was included in the SHEA/IDSA guidelines for the AMS program.[23]

On the other hand, two-third of the prescribers agreed that the practice of antimicrobial prescribing in UKMMC is based on institutionalized evidence-based practice guidelines and clinical pathways that incorporate local resistance patterns. This indicates a pretty healthy level of institutionalized evidence-based practice in this tertiary hospital, although the institution can probably look into further fortifying this practice through grand rounds, the resource which has been identified to be the most-utilized among the doctors in UKMMC for antimicrobial prescribing. In terms of the resources that are being utilized by the doctors for antimicrobial prescribing, it was found that all prescribers agreed that there was at least some form of education provided for the prescription of antimicrobials in UKMMC. It was noticed that the doctors agreed that a couple of resources are less utilized in UKMMC as compared to their perceptions of the reliability of these resources. There was a lack of utilization of reliable references like journals and pocket antibiograms to guide antimicrobial prescribing. Given those less utilized resources, these resources can be introduced to the prescribers on their availability and accessibility during the AMS training program. Also, a pharmacist consultation service was perceived as one of the reliable resources by some of the prescribers. This reflects that the role of pharmacists in optimizing antimicrobial treatment has been recognized by the prescribers in UKMMC.

Since UKMMC is a tertiary teaching hospital, astringent antimicrobial control policy has been practiced.[3] As expected, all the 11 AMS strategies have been practiced by the prescribers. Generally, the perceptions of prescribers on the 11 AMS strategies that were being practiced within their respective discipline corresponded with their perceptions of the benefits of AMS strategies. Noticeably, the prescribers agreed that several AMS strategies were less utilized as compared to their perceptions on the beneficial values of these initiatives, including antimicrobial cycling, antimicrobial order forms, conversion of intravenous to oral form for antimicrobials on Day 3, formulary restriction with pre-authorization, periodic review of antimicrobial prescriptions, prospective audit with feedback and/or intervention and streamlining. Also, there was a significant difference in the perception of prescribers on the AMS practice between disciplines. These findings suggested that further investigations are necessary to evaluate the actual practice of these AMS strategies across the various disciplines in UKMMC. These strategies have been recommended by the MOH Malaysia Protocol on the AMS program in healthcare.[13] Therefore, those core AMS strategies that were found to be practiced much lesser should be adopted as much as possible.[23]

In terms of entities that provide active support for the AMS strategies in UKMMC, doctors were found to significantly agree that almost all entities are involved in the AMS practices, except for nursing leadership. However, fewer nurses agreed on the active involvement and support from those listed entities and more than half of them were uncertain about the answer to this question. This finding correlated closely with data on awareness obtained in this study, where there was better awareness of AMS among the doctors and the nurses lack exposure to AMS. On the contrary, fewer doctors agreed that nursing leadership actively supports AMS practices in UKMMC. This further supports earlier findings which stated that the contributions of nurses towards AMS have been under-acknowledged.[20] Therefore, nurses should be given the necessary support and encouragement to take up leadership roles in pioneering AMS in UKMMC.[24] Although two-thirds of the respondents acknowledged that they have a role in implementing AMS, the nurses were significantly less likely to perceive themselves playing a role in implementing AMS. Similarly, this later made emphasis on the need for education on antimicrobial resistance and AMS among the nurses in UKMMC. Education for the nurses in terms of the importance of avoiding missed antimicrobial doses and proper performance of diagnostic tests will greatly enhance the multidisciplinary AMS program.[25]

Similarly, doctors were reported to have a significantly higher level of awareness on the importance of AMS than the nurses. This study revealed that awareness is significantly associated with the prior AMS training experience, which further confirmed the impact of AMS education for healthcare professionals. Even though there was the only minority of nurses were familiar with the term “AMS”, the majority of them were noticed to agree that AMS is important. This indicates that with proper education, nurses too can grab the opportunity to take charge of AMS since they are well aware that AMS is of importance in the healthcare system.[23] Correspondingly, the majority of doctors were perceived that AMS will lead to improving patient outcomes, reduced infection rates, reduced antimicrobial resistance, and reduced adverse drug reactions, but they were less likely to agree that AMS will reduce expenses for antimicrobials. This suggests that prescribers have a positive perception of AMS, which is one of the important determinants for a successful AMS implementation in healthcare facilities. On the other hand, most nurses were neutral about the potential outcomes of AMS. This could be attributed to a lack of awareness among them. This prompted further interventions on the awareness of nurses in UKMMC on AMS and its importance, particularly focusing on the nursing population in this tertiary teaching hospital.

Since there was a limited number of consultants and specialists enrolled in this study, the results are only reflective of the awareness and perception of medical officers and house officers. Nevertheless, the findings provide a clear trend of awareness among both doctors and nurses. On the other hand, this research study was only conducted in a single tertiary teaching hospital in Malaysia. This is not representative of the practices across the country and the findings would not be able to justify the awareness of AMS and its importance among doctors and nurses across various disciplines nationwide. As such, a longer period should be allocated for

this research study and having its sample scope widened to allow the inclusion of more healthcare institutions in Malaysia and the inflation of sample size to be representative of the total population of healthcare professionals in Malaysia.

Conclusion

Given the increasing trends of antimicrobial resistance, it is undeniable that AMS is of crucial importance to ensure that the existing antimicrobials are preserved while antimicrobial resistance is kept under control. The awareness of AMS and its importance is necessary to ensure that healthcare professionals across various disciplines maintain a high standard of practice of AMS within the particular institution. It was discovered that the awareness of AMS and its importance among doctors has been well established. In contrast, the awareness of AMS and its importance is still low among the nurses, thereby prompting the need for AMS training and education for this group of healthcare professionals. Furthermore, several AMS strategies were reported to be under-utilized in this tertiary teaching hospital. There is a need for increasing promotional activities of AMS strategies that have been implemented among the doctors and nurses across various disciplines in UKMMC.

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Key messages:

Antimicrobial stewardship (AMS) requires strong support and collaborative efforts across healthcare professions from various disciplines to be effective and successful. A survey of awareness and perception on AMS may be useful to determine the engagement of the healthcare professionals and identify their need for education support.

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Table 1: Demographic profile of study respondents (n = 253)

Demographic	n (%)
Profession	
Consultant/specialist	1 (0.4)
Medical Officer	20 (7.9)
Dental Officer	1 (0.4)
House officer	52 (20.6)
Chief Nurse	20 (7.9)
Staff Nurse	159 (62.8)
Working experience in any healthcare institute (year ± s.d.)*	
Doctor (n = 74)	2.32 ± 3.34
Nurse (n = 179)	11.84 ± 6.75
Working experience in UKMMC (year ± s.d.)*	
Doctor (n = 74)	1.57 ± 2.63
Nurse (n = 179)	10.97 ± 6.54

*s.d.: standard deviation

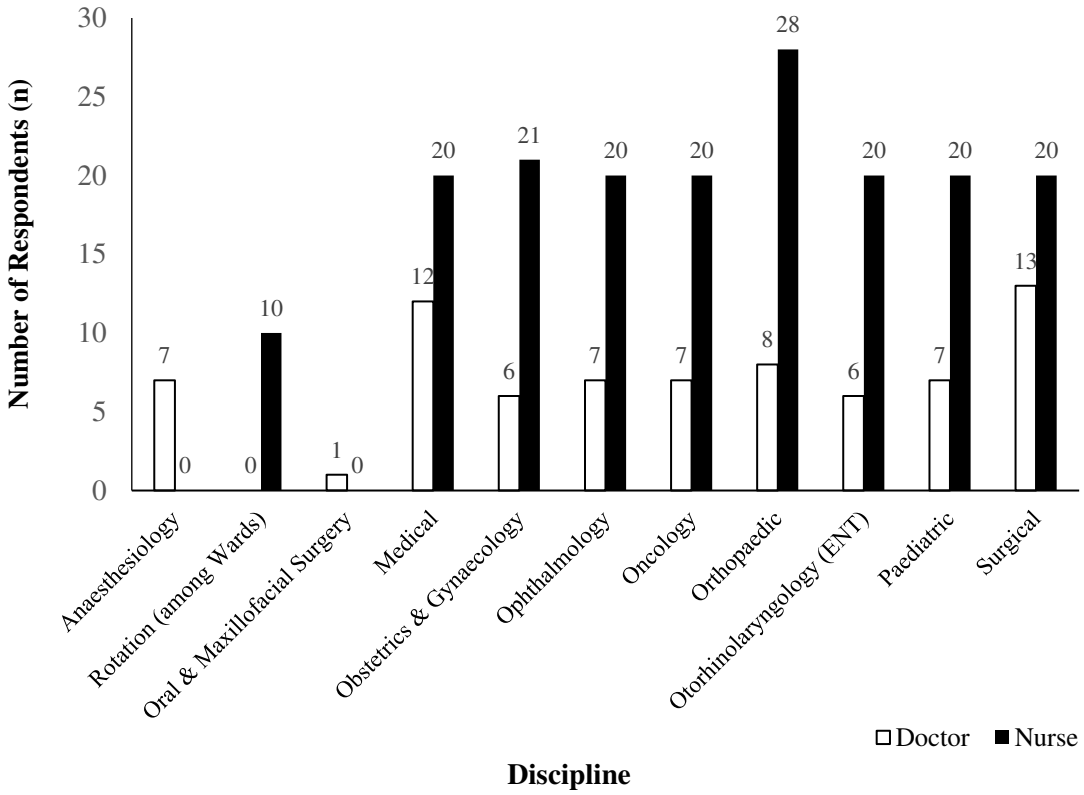

Figure 1: Distribution of study respondents from the various disciplines (n = 253)

Table 2: The awareness of respondents on antimicrobial stewardship (n = 253)

Question/ Response	Doctors (n, %)	Nurses (n,%)	Statistical test (p value)
Are you familiar with the term "Antimicrobial Stewardship"?			
Yes	70 (94.6)	51 (28.5)	< 0.001*
No	4 (5.4)	128 (71.5)	
Is there a formal Antimicrobial Stewardship Program in UKMMC?			
Yes	30 (40.5)	40 (22.3)	0.006†
No	0 (0.0)	6 (3.4)	
I don't know	44 (59.5)	133 (74.3)	
How long has the Antimicrobial Stewardship Program in UKMMC been in place?			
Correct response	2 (2.7)	2 (1.1)	0.583†
Wrong response	72 (97.3)	177 (98.9)	
Does UKMMC have a fellowship training program for the specialty of Infectious Diseases?			
Yes	30 (40.5)	75 (41.9)	0.825†
No	1 (1.4)	5 (2.8)	
I don't know	43 (58.1)	99 (55.3)	
Have you previously attended any program or training regarding AMS?			
Yes	5 (6.8)	21 (11.7)	0.236*
No	69 (93.2)	158 (88.3)	
In UKMMC, are antimicrobials prescribed based on institutionalized evidence-based practice guidelines and clinical pathways that incorporate local resistance patterns?‡			
Yes	51 (68.9)		
No	1 (1.4)		
I don't know	22 (29.7)		

*chi-square test; p<0.05; † Fisher's Exact Test; p<0.05; ‡Nurses were exempted for this question.

Table 3: The multiple resources that being utilized by prescribers for antimicrobial prescribing and their perception of the reliability of these resources (n = 74)

Sources of information	The utilization of resources by prescribers, n (%)	Perception of prescribers on the reliability of resources, n (%)
Conference presentations	33 (44.6)	49 (66.2)
E-mail alerts	48 (64.9)	51 (68.9)
Grand rounds	66 (89.2)	62 (83.8)
Journals	21 (28.4)	57 (77.0)
Newsletters	1 (1.4)	1 (1.4)
Pocket antibiograms	7 (9.5)	38 (51.4)
Webinars	2 (2.7)	5 (6.8)
Written guidelines	56 (75.7)	68 (91.9)

Others	3 (4.1)	15 (20.3)

Table 4: The perception of prescribers on each AMS strategy for antimicrobial prescribing and their practice (n=74)

AMS strategy	Perception of prescribers on benefits of AMS strategies, n (%)			Perception of prescribers on AMS strategies that were being practiced in their disciplines, n (%)		
	Disagree	Neutral	Agree	Disagree	Neutral	Agree
Antimicrobial cycling [a]	1 (1.4)	10 (13.5)	63 (85.2)	1 (1.4)	26 (35.1)	47 (63.5)
Antimicrobial order forms	2 (2.8)	11 (14.9)	61 (82.5)	1 (1.4)	35 (47.3)	38 (51.4)
Combination therapy	3 (4.1)	58 (78.4)	13 (17.6)	2 (2.7)	62 (83.8)	10 (13.5)
Consultations on infectious disease team prior to prescribing antimicrobials	3 (4.1)	50 (67.6)	21 (28.4)	2 (2.7)	51 (68.9)	21 (28.4)
De-escalation [b]	0 (0.0)	10 (13.5)	64 (86.5)	0 (0.0)	24 (32.4)	50 (67.6)
Conversion of intravenous to oral form for antimicrobials on Day 3[c]	1 (1.4)	36 (48.6)	37 (50.0)	1 (1.4)	51 (68.9)	22 (29.7)
Formulary restriction with pre-authorisation [d]	3 (4.1)	25 (33.8)	46 (62.2)	2 (2.7)	42 (56.8)	30 (40.5)
Institutionalised evidence-based practice guidelines and clinical pathways that incorporate local resistance patterns	0 (0.0)	4 (5.4)	70 (94.6)	0 (0.0)	13 (17.6)	61 (82.4)
Periodic review of antimicrobial prescriptions	0 (0.0)	18 (24.3)	56 (75.7)	1 (1.4)	41 (55.4)	32 (43.2)
Prospective audit with feedback and/or intervention [e]	0 (0.0)	27 (36.5)	47 (63.5)	1 (1.4)	51 (68.9)	22 (29.7)
Streamlining [f]	0 (0.0)	17 (23.0)	57 (77.0)	1 (1.4)	43 (58.1)	30 (40.5)

[a] Periodic substitution of a specific antimicrobial class for another. [b] Discontinuing the empirical antimicrobial if the culture turns out to be negative
[c] Conversion of antimicrobials are done in accordance to the "CHANGE" criteria: C – Clinical improvement, H – heart rate < 100, respiratory rate < 20, systolic blood pressure > 90, SPO_2 > 90%, A – Afebrile, N – Normal white cell count, G – Gastrointestinal tract is functioning, E – Exclude specific indications (e.g.: endocarditis); [d] Specific antimicrobials are only prescribed after approval has been obtained; [e] Antimicrobials are prescribed but are subjected to future review with recommendations; [f] Switching to a more targeted, narrow-spectrum antimicrobial once an organism has been identified via culture & sensitivity test

Table 5: The distribution of prescribers who agreed that the listed AMS strategies were being practiced within their respective discipline (n=73)

AMS Strategy	Discipline (%)									
	Anaesthe-siology	Medical	O&G	Ophth-almology	Onco-logy	Ortho-paedic	ENT	Paed-iatric	Surg-ical	p-value*
Antimicrobial cycling	28.6	50.0	16.7	85.7	57.1	87.5	100	85.7	69.2	0.020
Antimicrobial order forms	42.9	58.3	83.3	28.6	14.3	37.5	16.7	100	53.8	0.031
Combination therapy	14.3	25.0	66.7	0.0	0.0	0.0	0.0	0.0	15.4	0.178
Consultations on infectious disease team prior to prescribing antimicrobials	28.6	50.0	66.7	14.3	0.0	0.0	16.7	28.6	30.8	0.020
De-escalation	42.9	58.3	33.4	57.2	85.7	87.5	83.3	71.4	76.9	0.469
Conversion of intravenous to oral form for antimicrobials on Day 3	28.6	50.0	83.4	28.6	28.6	0.0	0.0	14.3	23.1	0.007
Formulary restriction with pre-authorisation	42.9	50.0	66.7	14.3	14.3	37.5	16.7	42.9	46.2	0.001

Institutionalised evidence-based practice guidelines and clinical pathways that incorporate local resistance patterns	71.4	75.0	83.4	85.7	85.7	87.5	66.7	100	76.9	0.205
Periodic review of antimicrobial prescriptions	42.9	66.7	50.0	28.6	28.6	12.5	33.3	28.6	61.5	0.258
Prospective audit with feedback and/or intervention	42.9	25.0	50.0	14.3	28.6	12.5	16.7	14.3	46.2	0.328
Streamlining	57.2	33.3	33.3	28.6	71.4	50.0	66.7	14.3	23.1	0.04

*chi-square test; p<0.05

Table 6: The perception of respondents on the entities that actively support AMS efforts, their role and the importance of AMS (n=253)

Question/ Response	n (%)			p-value
	Total (n=253)	Doctor (n=74)	Nurse (n=179)	
Do the following entities provide active support for AMS efforts in UKMMC?				
Hospital administration	60 (23.7)	22 (29.7)	38 (21.2)	0.148*
Infection prevention/control team	101 (39.9)	50 (67.6)	51 (28.5)	< 0.001*
Medical staff leadership	45 (17.8)	17 (23.0)	28 (15.6)	0.165*
Microbiologists	78 (30.8)	39 (52.7)	39 (21.8)	< 0.001*
Nursing leadership	66 (26.1)	13 (17.6)	53 (29.6)	0.047*
Pharmacists	137 (54.2)	67 (90.5)	70 (39.1)	< 0.001*
Physicians/Prescribers	125 (49.4)	67 (90.5)	58 (32.4)	< 0.001*
None of these entities support AMS	2 (0.8)	0 (0.0)	2 (1.1)	1.00†
I don't know	98 (38.7)	5 (6.8)	93 (52.0)	< 0.001*
Do you have a role in implementing AMS activities in UKMMC?				
Yes	166 (65.6)	72 (97.3)	94 (52.5)	< 0.001*
No	4 (1.6)	0 (0.0)	4 (2.2)	
I don't know	83 (32.8)	2 (2.2)	81 (45.3)	
Do you think that AMS is important?				
Yes	198 (78.3)	72 (97.3)	126 (70.4)	< 0.001*
No	55 (21.7)	2 (2.7)	53 (29.6)	

*chi-square test; p<0.05; † Fisher's Exact Test; p<0.05

Table 7: The perception of respondents on the potential outcomes of AMS (n=253)

Response	n (%)			p-value*
	Total (n=253)	Doctor (n=74)	Nurse (n=179)	
Patient Outcomes				
Worsened	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Neutral	90 (35.6%)	2 (2.7%)	88 (49.2%)	<0.001

Improved	163 (64.4%)	72 (97.3%)	91 (50.8%)	
	Infection Rates			
Worsened	1 (0.4%)	0 (0.0%)	1 (0.6%)	
Neutral	117 (46.2%)	5 (6.8%)	112 (62.6%)	<0.001
Improved	135 (53.4%)	69 (93.2%)	66 (36.9%)	
	Costs of Antimicrobials			
Worsened	1 (0.4%)	1 (1.4%)	0 (0.0%)	<0.001
Neutral	164 (64.8%)	30 (40.5%)	134 (74.9%)	
Improved	88 (34.8%)	43 (58.1%)	45 (25.1%)	
	Antimicrobial Resistance			
Worsened	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Neutral	119 (47.0%)	3 (4.1%)	116 (64.8%)	<0.001
Improved	134 (53.0%)	71 (95.9%)	63 (35.2%)	
	Adverse Drug Reactions			
Worsened	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Neutral	149 (58.9%)	21 (28.4%)	128 (71.5%)	<0.001
Improved	104 (41.1%)	53 (71.6%)	51 (28.5%)	
	Development of Secondary Infections			
Worsened	5 (2.0%)	1 (1.4%)	4 (2.2%)	
Neutral	142 (56.1%)	13 (17.6%)	129 (72.1%)	<0.001
Improved	106 (41.9%)	60 (81.1%)	46 (25.7%)	

*Chi-square test was performed for the responses on 'neutral' and 'improved' except responses on 'worsened' due to the responses were less than 5; $p<0.05$