Knowledge gaps in antimicrobial stewardship in a Japanese hospital: A cross-sectional study highlighting the need for role-specific education for nurses and administrative staff

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Abstract: Knowledge gaps pertaining to antimicrobial stewardship (AMS) among different hospital professions can hinder program effectiveness. This study aimed to identify and comparatively analyze AMS knowledge levels at a Japanese hospital. We conducted a cross-sectional, internet-based survey of all hospital employees ($n = 2,703$) to assess their knowledge of the antimicrobial stewardship team (AST) and programs (ASPs). The survey response rate was 48.4% (1,307 of 2,703). Significantly lower proportions of nurses and administrative staff than medical doctors and pharmacists knew about the AST and ASPs ($p < 0.001$). Critically, a significantly lower proportion of nurses (62.5%) than medical doctors (97.4%) ($p < 0.001$) was aware of the importance of sample collection for bacterial cultivation before antibiotic administration. These findings reveal significant role-specific knowledge gaps and strongly suggest that educational interventions targeting nurses and administrative staff are needed for promoting hospital-wide ASPs and ensuring their effective implementation.

Keywords: antimicrobial resistance, antimicrobial stewardship programs, antimicrobial stewardship team, questionnaire, awareness

1. Introduction

Antimicrobial resistance (AMR) is a significant global threat (*1*). To combat this, antimicrobial stewardship programs (ASPs) are crucial for ensuring the appropriate use of antimicrobials (*2*). In Japan, the establishment of multidisciplinary antimicrobial stewardship teams (ASTs) has been widely promoted since the 2018 Revision of Medical Fees (*3*).

The Infectious Diseases Society of America (Arlington, VA, USA) and the Society for Healthcare Epidemiology's (Arlington, VA, USA) guideline "Developing an Institutional Program to Enhance Antimicrobial Stewardship" states that antimicrobial stewardship (AMS) should be conducted in collaboration with various occupations (*2*). For instance, nurses are involved in many aspects of infectious disease care, from specimen collection to antimicrobial administration (*4*), while administrative staff, though not directly involved in treatment, generate essential data for program evaluation. Therefore, successful AMS implementation requires all hospital staff to understand their specific roles and the importance of stewardship.

However, previous studies have primarily focused on medical doctors and pharmacists, with limited reports focusing on nurses (*5-8*) and virtually none focusing on administrative staff. Therefore, this study aimed to investigate and compare knowledge levels regarding AMS, ASTs, and ASPs across these different professions. We hypothesized that knowledge levels would be significantly lower among nurses and administrative staff than among medical doctors and pharmacists and that a significant awareness gap would exist between doctors and nurses regarding the critical AMS practice of obtaining culture samples before antibiotic administration.

2. Materials and Methods

2.1. Study sample and data collection

A cross-sectional, internet-based survey was conducted at a university hospital in Tokyo, Japan. The AST at the

participating institution was established in 2018 and has since implemented multifaceted ASPs.

The AST's clinical support activities are primarily directed at medical doctors and include: *i*) prospective audit and feedback for patients on broad-spectrum antimicrobials; *ii*) infectious disease management support for patients with positive blood or cerebrospinal fluid cultures or patients with detected multidrug-resistant organisms; *iii*) regular multidisciplinary conferences with departments such as hematology, cardiovascular surgery, and emergency medicine; and *iv*) monitoring of renal function and dose adjustment support for antimicrobials requiring therapeutic drug monitoring. These ongoing activities are supplemented by educational outreach for all staff.

All 2,703 hospital employees were invited to participate between November 1 and December 31, 2023. Recruitment was conducted *via* internal announcements, and the questionnaire was administered using Microsoft Forms. Responses with identical timestamps and duplicate questionnaires from the same individual were excluded. This study was approved by the Ethics Committee of the Tokyo Medical University (approval number: T2023-0073) and conformed to the provisions of the Declaration of Helsinki (as revised in 2013). Written informed consent was obtained electronically from all participants *via* the first page of the online survey.

2.2. Measurements

2.2.1. Knowledge of AST and ASPs

The participants were asked about their knowledge level of the AST and adherence to ASPs by the AST with regard to the following aspects: prospective audit and feedback on antibiotic use, feedback on antibiotic use to departments, feedback on sample collection for bacterial cultivation before antibiotic use, and support for sample collection. All five items were answered using a "yes or no" format. For medical doctors and nurses, an additional survey item was included regarding their awareness of sample collection before antimicrobial therapy. The participants responded using a four-point Likert scale: 1 = "strongly aware", 2 = "somewhat aware", 3 = "not very aware", 4 = "not at all aware", or 5 = "no antibiotic administration". In this study, participants who responded with "strongly aware" or "somewhat aware" were defined as being aware of the importance of sample collection for bacterial cultivation before administering antibiotics, whereas participants who responded with "not very aware" or "not at all aware" were defined as being unaware.

To ensure content validity, the draft questionnaire was reviewed by a panel of in-house experts, including an infectious disease specialist, a certified nurse in infection control, and a Board Certified Infection Control Pharmacy Specialist. The questionnaire was then finalized based on their feedback to improve the clarity and relevance of the items. The translated questionnaire is provided in the Supplemental Material (*https://www.globalhealthmedicine.com/site/supplementaldata.html?ID=109*).

2.2.2. Other measurements

All participants reported their job categories (*i.e.*, medical doctor, nurse, pharmacist, administrative staff, or other); department (medical doctor: internal medicine, surgery, junior resident, or other; nurse: inpatient, outpatient, or other; pharmacist: central, inpatient, or other; administrative staff: involved in the medical billing department or other); and years of experience (*i.e.*, < 2 years, < 5 years, < 10 years, and > 10 years).

2.3. Statistical analysis

The proportion of "yes" responses to questions on the knowledge of the AST and ASPs was calculated for each occupation. Differences between medical occupations were compared using the chi-square test. If significant differences were observed, we conducted post-hoc tests with Bonferroni correction to examine the differences. The proportions of medical doctors and nurses who were aware of the importance of sample collection for bacterial cultivation before antibiotic administration were calculated. For this analysis, the participants who responded with "no administration of antibiotics" were excluded. The proportions were compared using the chi-square test. Statistical analyses were performed using IBM SPSS Statistics for Windows, version 29 (IBM Japan, Tokyo, Japan). Statistical significance was defined as a two-sided *p*-value of < 0.05.

3. Results and Discussion

In total, 2,703 individuals were invited to participate in the study, of whom 1,308 responded. The response rate was 48.4%. The proportions of respondents for each occupation were as follows: 21.3% (163/764) were medical doctors, 68.0% (777/1,143) were nurses, 77.3% (58/75) were pharmacists, 39.8% (128/322) were administrative staff, and 45.4% (181/399) were other. One medical doctor was excluded from the analysis because of duplication. Therefore, the final analysis set comprised 1,307 participants. Table 1 outlines the characteristics of the participants in the analysis set. Nurses constituted the largest proportion of the sample (59.4%). Of these, 71.4% worked in inpatient settings. Administrative staff accounted for 9.8% of the sample, followed by medical doctors (12.5%), pharmacists (4.5%), and others (13.8%).

This study revealed a significant knowledge gap regarding the AST and ASPs among different hospital

professions. This finding is consistent with previous international reports, such as a study from South Africa that also identified differing levels of knowledge among doctors, pharmacists, and nurses (9). As illustrated in Figure 1, significant differences were observed among professions in their knowledge of both the AST (Figure 1A) and ASPs (Figure 1B) (all $p < 0.001$). Post-hoc tests revealed that the knowledge levels of nurses and administrative staff were significantly lower than those of medical doctors and pharmacists (all $p < 0.001$). This study also assessed pharmacists, whose knowledge of AMS was found to be comparable to that of medical doctors. This may reflect the specific context in Japan, where, according to national policy, pharmacists are

often positioned at the center of a given AST (10), which may have contributed to their higher level of AMS knowledge.

Additionally, this study investigated the knowledge levels of the administrative staff. The results showed that the administrative staff had low knowledge levels of AST. This finding, while perhaps unsurprising, likely reflects the structure of our institution's ASPs and may highlight a common dynamic in many institutions where educational interventions for administrative staff are less intensive than those targeted to clinical professionals. Nevertheless, the Infectious Diseases Society of America (Arlington, VA, USA) guidelines for AMS state that all hospital staff should receive education about AMS

Table 1. Participants' characteristics

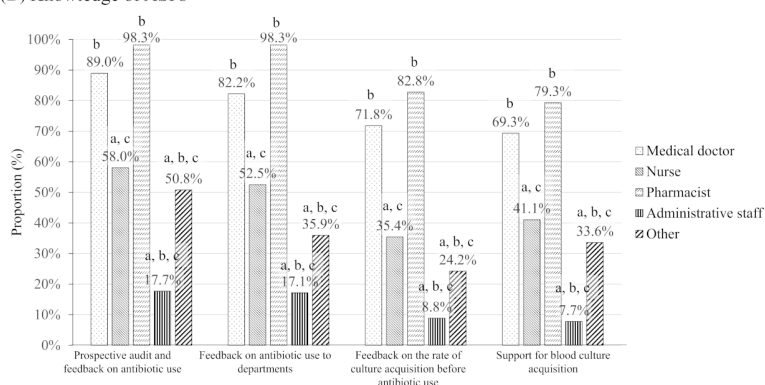|	Total		Medical doctor		Nurse		Pharmacist		Administrative staff		Other	
	n	(%)	*n*	(%)	*n*	(%)	*n*	(%)	*n*	(%)	*n*	(%)
Occupation	1,307	(100)	163	(12.5)	777	(59.4)	58	(4.4)	128	(9.8)	181	(13.8)
Department: Medical doctor												
Internal medicine			61	(37.4)								
Surgery			48	(29.4)								
Junior resident			27	(16.6)								
Other			27	(16.6)								
Department: Nurse												
Inpatient					555	(71.4)						
Outpatient					187	(24.1)						
Other					35	(4.5)						
Department: Pharmacist												
Central							25	(43.1)				
Inpatient							22	(37.9)				
Other							11	(19.0)				
Department: Administrative staff												
Medical billing department									42	(32.8)		
Other									86	(67.2)		
Experience												
Less than 2 years	227	(17.4)	27	(16.6)	137	(18.0)	4	(7.0)	27	(21.1)	32	(17.7)
Less than 5 years	442	(33.8)	16	(9.8)	356	(46.0)	6	(10.0)	27	(21.1)	37	(20.4)
Less than 10 years	215	(16.4)	30	(18.4)	128	(16.0)	14	(24.0)	18	(14.1)	25	(13.8)
More than 10 years	423	(32.4)	90	(55.2)	156	(20.0)	34	(59.0)	56	(43.8)	87	(48.1)
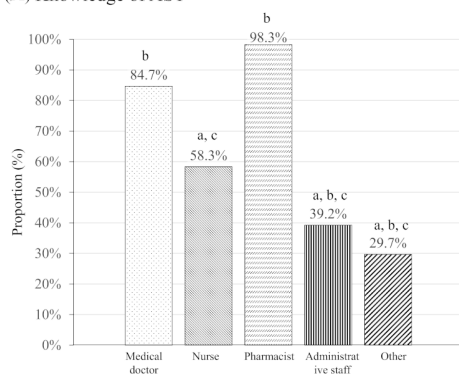
Figure 1. Proportions of respondents with knowledge of the antimicrobial stewardship team (AST) and antimicrobial stewardship programs (ASPs), based on occupation. (A) Knowledge of AST; **(B)** Knowledge of ASPs. [a]$p < 0.001$ versus medical doctors. [b]$p < 0.001$ versus nurses. [c]$p < 0.001$ versus pharmacists. AST: antimicrobial stewardship team; ASP: antimicrobial stewardship program.
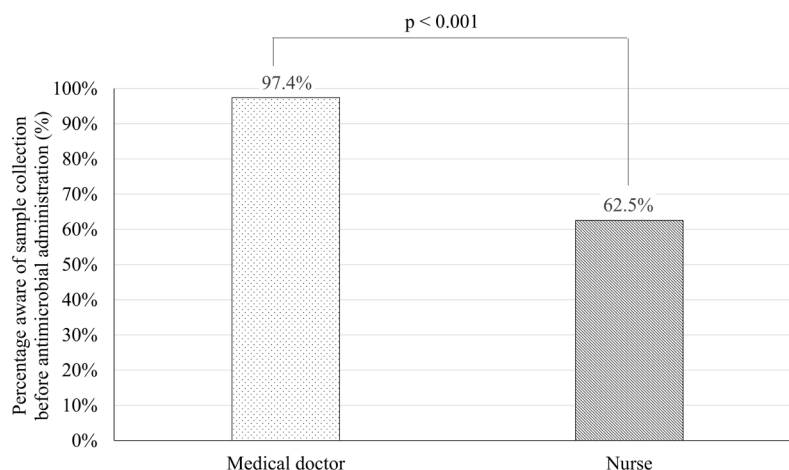
Figure 2. Proportions of medical doctors and nurses who were aware of sample collection for bacterial cultivation before antimicrobial administration.

(*11*). In Japan, administrative data are crucial for evaluating ASPs; for instance, Diagnosis Procedure Combination (DPC) data are widely used to assess antimicrobial consumption and the appropriateness of sample collection (*12*). The administrative department generates these essential data; therefore, the reliance on administrative data underscores why an understanding of AMS principles is important for ensuring data accuracy and, consequently, robust stewardship evaluation. The results of this study suggest that enhancing knowledge levels among administrative staff is important for supporting the accurate utilization of such data by ASTs in Japan, a consideration that may extend to any healthcare system reliant on administrative data for stewardship monitoring.

A critical finding of our study was the disparity in awareness regarding the collection of samples for bacterial cultivation before antibiotic administration. The proportion of nurses who were aware of this crucial practice was significantly lower than that of medical doctors (62.5% *vs.* 97.4%, respectively; $p < 0.001$) (Figure 2). A large-scale, multi-professional survey in South Africa reported a similar, albeit smaller, disparity in antimicrobial knowledge among medical doctors (68.71%), pharmacists (68.59%), and nurses (65.94%) (*12*). In stark contrast, the gap of over 30 percentage points observed between doctors and nurses in our study is particularly pronounced, highlighting the urgent need for targeted educational interventions for nurses at our institution. This knowledge gap is a significant concern because nurses are responsible for important tasks related to AMS, such as administering antibiotics and collecting samples for bacterial cultivation (*4*). Obtaining blood cultures after antibiotic administration significantly reduces the sensitivity of the results (*13,14*). Our results suggest that a lack of knowledge about AMS among nurses, which represents a potential gap between theoretical education and its application in

clinical practice, may contribute to suboptimal practices of obtaining samples for bacterial cultivation. This gap is particularly concerning because previous studies (*5-8*) report that many nurses feel anxious about the lack of AMS education and desire further education on antibiotics, thereby highlighting the need for educational models that better integrate AMS principles into routine clinical workflows.

A strength of this study is its comprehensive inclusion of all hospital staff categories, particularly administrative staff, who are often overlooked in such surveys. However, our study has several important limitations. First, as this was a single-center study, the external validity of our results is limited. The observed knowledge gaps likely reflect the specific context of our institution's ASP, and hospitals with different operational models or educational strategies may yield different results. Therefore, caution is required when generalizing these findings. Second, although we adapted certain questionnaire items from previous studies (*8*) and assessed content validity through an expert review, the survey instrument did not undergo formal psychometric validation, which could have affected the precision of our measurements. Third, the low response rate could have introduced a selection bias, as staff with a greater interest in ASPs may have been more likely to participate, potentially leading to an overestimation of the overall knowledge level. Despite these limitations, to the best of our knowledge, this study is the first to examine AST knowledge among medical professionals and administrative staff in Japan. The results of this study provide useful information for future ASPs.

In conclusion, this study revealed significant role-specific knowledge gaps in AMS, particularly among nurses and administrative staff. These findings strongly suggest that educational interventions targeting these specific professions are essential for promoting hospital-wide ASPs and ensuring their effective implementation.

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