



## Committee Report

## Essential human resources for antimicrobial stewardship teams in Japan: Estimates from a nationwide survey conducted by the Japanese Society of Chemotherapy



Masayuki Maeda <sup>a, b, \*</sup>, Yuichi Muraki <sup>a, c</sup>, Tadashi Kosaka <sup>a, d</sup>, Takehiro Yamada <sup>a, e</sup>, Yosuke Aoki <sup>a, f</sup>, Mitsuo Kaku <sup>a, g</sup>, Masafumi Seki <sup>a, h</sup>, Yoshinari Tanabe <sup>a, i</sup>, Naohisa Fujita <sup>a, j</sup>, Yoshihito Niki <sup>a, k</sup>, Kunihiko Morita <sup>a, l</sup>, Katsunori Yanagihara <sup>a, m</sup>, Koichiro Yoshida <sup>a, n</sup>, Tatsuya Kawaguchi <sup>a, o</sup>

<sup>a</sup> The Antimicrobial Stewardship Committee of Japanese Society of Chemotherapy, Japan

<sup>b</sup> Division of Infection Control Sciences, Department of Clinical Pharmacy, School of Pharmacy, Showa University, 1-4-5 Hatanodai, Shinagawa-ku, Tokyo, Japan

<sup>c</sup> Department of Clinical Pharmacoepidemiology, Kyoto Pharmaceutical University, Kyoto, Japan

<sup>d</sup> Department of Pharmacy, Kyoto Prefectural University of Medicine, Kyoto, Japan

<sup>e</sup> Department of Pharmacy, Hokkaido University Hospital, Hokkaido, Japan

<sup>f</sup> Department of Infectious Disease and Hospital Epidemiology, Saga University Hospital, Saga, Japan

<sup>g</sup> Department of Infection Control and Laboratory Diagnostics, Tohoku University Graduate School of Medicine, Miyagi, Japan

<sup>h</sup> Division of Infectious Diseases and Infection Control, Tohoku Medical and Pharmaceutical University Hospital, Miyagi, Japan

<sup>i</sup> Department of Internal Medicine, Niigata Prefectural Shibata Hospital, Niigata, Japan

<sup>j</sup> Division of Infection Control & Laboratory Medicine at University Hospital, Kyoto Prefectural University of Medicine, Kyoto, Japan

<sup>k</sup> Division of Clinical Infectious Diseases, Department of Medicine, School of Medicine, Showa University, Tokyo, Japan

<sup>l</sup> Department of Clinical Pharmaceutics, Faculty of Pharmaceutical Sciences, Doshisha Women's College of Liberal Arts, Kyoto, Japan

<sup>m</sup> Department of Laboratory Medicine, Nagasaki University Hospital, Nagasaki, Japan

<sup>n</sup> Division of Infection Control and Prevention, Department of Medical Safety Management, Kindai University Hospital, Osaka, Japan

<sup>o</sup> Department of Medical Technology, Kumamoto Health Science University, Kumamoto, Japan

## ARTICLE INFO

## Article history:

Received 5 March 2019

Received in revised form

5 April 2019

Accepted 16 May 2019

Available online 7 June 2019

## Keywords:

Antimicrobial stewardship

Human resource

Full-time equivalent

Medical fee

## ABSTRACT

Implementation of antimicrobial stewardship programs (ASPs) with multidisciplinary antimicrobial stewardship teams (ASTs) is critical for appropriate antimicrobial use at healthcare facilities. Although the Japanese medical reimbursement system was revised to allow fees for ASP implementation, several concerns remain, including understaffing and enforcement of the recommendations on ASTs and ASPs in practice. Furthermore, there are no recommendations on full-time equivalents (FTEs) of the core members in ASTs in Japan. This committee report presents our recommendations on ASTs based on an analysis of the nationwide survey on implemented ASPs and staff FTEs at 1358 healthcare facilities conducted by the Japanese Society of Chemotherapy. Our report provides a directive for structural and financial support of ASTs and should aid in planning for the enhancement of AST practices and the organization of new ASTs.

© 2019 Japanese Society of Chemotherapy and The Japanese Association for Infectious Diseases. Published by Elsevier Ltd. All rights reserved.

*List of abbreviations:* ASP, antimicrobial stewardship program; AST, antimicrobial stewardship team; FTE, full-time equivalent; ID, infectious diseases; IDSA, The Infectious Diseases Society of America; JSC, The Japanese Society of Chemotherapy.

\* Corresponding author. Division of Infection Control Sciences, Department of Clinical Pharmacy, School of Pharmacy, Showa University, 1-4-5 Hatanodai, Shinagawa-ku, Tokyo, 142-8555, Japan.

E-mail address: [m-maeda@pharm.showa-u.ac.jp](mailto:m-maeda@pharm.showa-u.ac.jp) (M. Maeda).

## 1. Introduction

Antimicrobial stewardship requires structural prerequisites for implementation of antimicrobial stewardship programs (ASPs), such as the presence of a multidisciplinary antimicrobial stewardship team (AST), to ensure appropriate antimicrobial use at healthcare facilities [1].

In 2018, the Antimicrobial Stewardship Committee of the Japanese Society of Chemotherapy (JSC) reported data of a nationwide survey on the implementation of ASPs and staff resources in Japan [2]. The survey revealed a shortage in manpower at most Japanese hospitals based on the analysis of staff full-time equivalents (FTEs) for ASPs, demonstrating a high demand for the FTEs of both pharmacists and physicians. The Infectious Diseases Society of America (IDSA) has recommended that an AST should include an infectious diseases (ID) physician and ID-trained pharmacist as core members [1]. The core members play an integral role in the effective implementation of ASPs.

Despite their important role in implementing ASPs, ASTs remain understaffed in not only most Japanese hospitals but also most countries. Several countries have emphasized the importance of sufficient human resources in their recommendations for ASPs [3–6]; however, whether these recommendations are enforced in practice following the recommendations remains unclear.

In 2018, the Japanese medical reimbursement system was revised to allow fee for the implementation of ASPs (1000 yen per admission) in addition to reimbursement for infection prevention and control costs (3900 yen per admission plus 1000 for regional collaboration) [7]. This medical fee for ASP implementation requires the following structure: organization of an AST comprising at least one physician, pharmacist, microbiology technologist, and nurse, with each having more than 0.5 FTE. Additionally, one of the AST members should have more than 0.8 FTE to perform ASPs. However, there are no recommendations regarding FTEs of each healthcare worker who is allocated to AST in an appropriate manner in Japan. This paper reports the potential staffing structures for ASTs proposed based on a nationwide survey conducted by JSC.

## 2. Materials and methods

### 2.1. Data analysis

Data on implemented ASPs and staff FTEs at 1358 healthcare facilities, which were collected by the nationwide ASP survey of JSC in 2018, were analyzed [2]. Multivariate analysis was performed to evaluate whether physician and pharmacist FTEs were associated with the number of implemented ASPs (maximum 29), defined as the number of responses to the following queries in the JSC survey [2]: prospective audit and feedback, preauthorization, optimization, diagnostic stewardship, measurement, and intervention for special populations and education.

### 2.2. Statistical analysis

Correlations were calculated using Pearson correlation coefficient. Linear multiple regression analysis was performed to identify factors associated with the number of implemented ASPs. Middle-to-large hospital (with  $\geq 301$  beds), additional reimbursement for infection prevention, presence of an on-site microbiology laboratory, AST organization, physician FTE, and pharmacist FTE were selected as covariates. FTEs were calculated in increments of 0.5 [3]. Multicollinearity was assessed using Pearson correlation coefficient and variance inflation factor. All statistical analyses were two-tailed, and  $p < 0.05$  was considered significant. Statistical analyses were performed using the SPSS statistics software version 23.0 (IBM Japan, Tokyo, Japan).

### 2.3. Determination of recommended FTEs by bed size ratio and estimation of personnel expenses

The results of the survey were discussed in a face-to-face consensus meeting of the JSC Antimicrobial Stewardship

Committee in February 2019. Based on the results of the previous survey [2], the current analysis, recommended FTEs by IDSA [3] and additional reimbursement standards, a recommended FTE for AST core members was developed that might be sufficient for effective and sustainable implementation of ASPs.

Based on the recommended FTEs, we estimated personnel expenses. The calculation was performed using data of the Basic Survey on Wage Structure 2017 conducted by the Ministry of Health, Labour, and Welfare, which stated 849,000 and 360,800 yen per month as physician and pharmacist salaries, respectively [8].

## 3. Results

### 3.1. Correlation between ASP implementation and combined physician and pharmacist FTEs

Fig. 1 presents the scatterplot showing a strong correlation between the number of implemented ASPs and the current combined FTEs of the physicians and pharmacists ( $r = 0.599$ ).

### 3.2. Factors associated with ASP implementation

Table 1 presents independent factors related to the number of implemented ASPs. Middle-to-large hospitals, additional reimbursement for infection prevention, presence of an on-site microbiology laboratory, AST organization, physician FTE, and pharmacist FTE were significantly associated with the increased number of implemented ASPs. Additional reimbursement was the strongest contributor for the implementation of ASPs (standardized partial regression coefficient, 0.33). Among factors regarding staff resources, the contribution of pharmacist FTE to the implementation of ASPs was stronger than that of physician FTE (standardized partial regression coefficient, 0.09 vs. 0.14).

### 3.3. Minimum essential human resources for ASTs and estimated costs of personnel expenses

Table 2 shows suggested essential FTEs for core members in ASTs stratified by bed size. Additionally, estimated costs of personnel expenses calculated based on the suggested FTEs using physician and pharmacist salaries are also presented in Table 2.

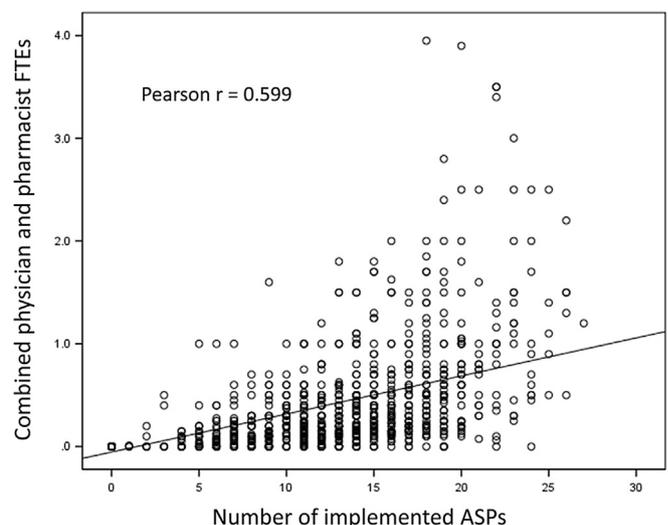


Fig. 1. Scatterplot showing the association between the number of implemented antimicrobial stewardship programs (ASPs) and current full-time equivalents (FTEs) of physicians and pharmacists in combination, revealing a strong correlation ( $r = 0.599$ ) between the number of implemented ASPs and FTEs.

**Table 1**

Factors associated with antimicrobial stewardship program implementation by linear multiple regression analysis.

Factors	$\beta$ (95% CI)	Standardized $\beta$	<i>p</i> value
Constant term	0.6 (0.0–1.3)	–	0.065
Number of beds ( $\geq 301$ )	2.5 (1.8–3.3)	0.16	<0.001
Additional reimbursement <sup>a</sup>	6.3 (5.5–7.1)	0.33	<0.001
Microbiology laboratory (on-site <sup>b</sup> )	3.0 (2.2–3.7)	0.19	<0.001
AST organization	4.2 (3.4–5.1)	0.22	<0.001
Physician FTE, 0.5 increase	1.3 (0.7–1.9)	0.09	<0.001
Pharmacist FTE, 0.5 increase	2.1 (1.4–2.7)	0.14	<0.001

$R^2 = 0.537$ , Durbin-Watson = 2.005.

$\beta$ , partial regression coefficient; CI confidence interval; AST, antimicrobial stewardship team; FTE, full-time equivalent.

<sup>a</sup> For infection prevention.

<sup>b</sup> On-site vs. outsourcing.

#### 4. Discussion

The current analysis of the first nationwide survey of ASPs in Japan revealed that both FTE support and reimbursement of medical fee might have a beneficial impact on ASP implementation.

Recommendations on staffing standards in ASTs were provided for various geographical areas previously [9]. IDSA task force has recommended a physician-to-pharmacist ratio of 1:3 (e.g., 1.0 FTE for physicians and 3.0 FTE for pharmacists per 1000 beds) in ASTs [3]. Similar recommendations were reported for France [4] and Canada [10]. We found an independent association between physician and pharmacist FTEs and enhancement of ASPs, which reinforces the integral role of both physicians and pharmacists in ASTs for the implementation of effective ASPs. However, there is a shortage of both ID physicians and ID-trained pharmacists in Japan. Because most Japanese hospitals desire more FTE support for both physicians and pharmacists as revealed in the survey, the development and securement of these staffs are needed urgently.

We propose that the essential staff resources in ASTs should be stratified by bed size. This suggestion is based on feasible human resources in Japan that involve needed FTEs from our survey, health policy of additional reimbursement and this analysis and intends to provide useful benchmarks to establish effective ASPs in most Japanese hospitals with limited human resources. In multivariate analysis, a strong contribution of pharmacist FTEs was observed in the implementation of ASPs, suggesting the necessity to prioritize staff resources. In addition, we estimated the cost of personnel expenses based on the suggested FTEs. Hospital cost efficiency may be estimated based on salary and benefits of the ASPs such as improved patient outcome, reduced antimicrobial resistance, saving on antimicrobial costs, and additional reimbursement for implementation of ASPs.

Our finding that both additional reimbursement for infection prevention and presence of an on-site microbiology laboratory were independently associated with the implementation of ASPs reinforces the importance of health policy. Ministry of Health,

Labour and Welfare revised additional reimbursement standards in 2018 and approved additional reimbursement for implementation of ASPs. This health policy will aid in the implementation of comprehensive ASPs and securing any resources. Outsourcing microbiology laboratories for cost-saving is increasingly preferred at Japanese hospitals, especially those that are small-to-medium sized. A microbiology laboratory functions to order, perform, and report diagnostic and microbiological tests. The present study suggested an on-site microbiology laboratory working with an AST via a microbiology technologist would be the best approach to implement antimicrobial and diagnostic stewardship [11]. A nationwide survey of the ASPs will be required to monitor the efficacy of the current health policies.

Several important limitations in this study should be noted. First, we did not weigh the core strategies of ASPs such as prospective audit and feedback and preauthorization. Categorization of ASPs akin to the Centers for Disease Control and Prevention core elements may be needed [12]. Another limitation is related to the recommendation of human resources other than physicians and pharmacists, which did not include microbiology technologist or nurse FTEs. It is possible that the previous survey of microbiology technologist and nurse FTEs includes routine work of microbiology tests and infection prevention practices due to reliance on a self-reported survey. Further investigation by surveys is needed to determine the recommendations related to microbiology technologists or nurses in ASTs.

In conclusion, our nationwide survey analysis revealed that pharmacist and physician FTEs were significantly associated with the implementation of ASPs after adjustment for several confounders. Our previous survey and the current findings reveal the human resources for core members of ASTs that are required for the implementation of functional and sustainable ASPs at Japanese hospitals. This study provides a directive for structural and financial support of ASTs and should aid in planning for the enhancement of AST practices and the organization of new ASTs.

#### Funding

This work was supported by the Japanese Society of Chemotherapy.

#### Conflicts of interest

Masafumi Seki received speaker honoraria from Astellas Pharma, Inc., Daiippon Sumitomo Pharma Co., Ltd., Daiichi Sankyo Co., Ltd., Taisho Toyama Pharmaceutical Co., Ltd., Meiji Seika Pharma Co., Ltd., MSD Japan, Pfizer Japan, Inc., research grants from Astellas Pharma, Inc., Nippon Boehringer Ingelheim Co., Ltd., Daiichi Sankyo Co., Ltd., Taisho Toyama Pharmaceutical Co., Ltd., Meiji Seika Pharma Co., Ltd., MSD K.K., Shionogi & Co., Ltd.

Katsunori Yanagihara received speaker honoraria from Pfizer Japan, Inc., Daiichi Sankyo Co., Ltd., Astellas Pharma, Inc., Taisho

**Table 2**

Suggested minimum essential human resources for antimicrobial stewardship teams and estimated cost of personnel expenses by bed size.

	Licensed bed size			
	$\leq 100$	101–300	301–500	>500
Physician FTE	0.5	0.5	0.8	0.8
Pharmacist FTE	0.5	0.8	1.3	1.6
Total FTE	1.0	1.3	2.1	2.4
Physician expense (yen/year)	5,094,000	5,094,000	8,150,400	8,150,400
Pharmacist expense (yen/year)	2,164,800	3,463,680	5,628,480	6,927,360
Total expenses (yen/year)	7,258,800	8,557,680	13,778,880	15,077,760

FTE, full-time equivalent.

Toyama Pharmaceutical Co., Ltd., Asahi Kasei Pharma Co., Ltd., and BD Japan, research fees from Taisho Toyama Pharmaceutical Co., Ltd., Meiji Seika Pharma Co., Ltd., Kyorin Pharmaceutical Co., Ltd., and Roche Diagnostics K.K., and research grants from Dainippon Sumitomo Pharma Co., Ltd., MSD K.K., Daiichi Sankyo Co., Ltd., Astellas Pharma, Inc., Pfizer Japan, Inc., Taisho Toyama Pharmaceutical Co., Ltd., and Biofermin Seiyaku Co., Ltd.,

Koichiro Yoshida received speaker honoraria from Dainippon Sumitomo Pharma Co., Ltd., MSD K.K., Meiji Seika Pharma Co., Ltd.

Yoshihito Niki received speaker honoraria from Pfizer Japan Inc., Astellas Pharma Inc., Taisho Toyama Pharmaceutical Co., Ltd., MSD K.K., Dainippon Sumitomo Pharma Co., Ltd., Asahikasei Pharma Corporation, Meiji Seika Pharma Co., Ltd., Daiichi Sankyo Co., Ltd. and research grants from Daiichi Sankyo Co., Ltd., Taisho Toyama Pharmaceutical Co., Ltd., MSD K.K., Astellas Pharma Inc., Shionogi & Co., Ltd., Yoshihito Niki is endowed chairs and funded by Shionogi & Co., Ltd., Meiji Seika Pharma Co., Ltd., Fujifilm Co., Ltd., Daiichi Sankyo Co., Ltd., Astellas Pharma Inc., Kyorin Pharmaceutical Co., Ltd., and Toyama Chemical Co., Ltd.

#### Authorship statement

All authors meet the ICMJE authorship criteria.

#### Acknowledgments

We thank Mari Kusakabe (School of Pharmacy, Showa University) for assistance with data collection and analysis.

#### References

- [1] Dellit TH, Owens RC, McGowan Jr JE, Gerding DN, Weinstein RA, Burke JP, et al. Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America guidelines for developing an institutional program to enhance antimicrobial stewardship. *Clin Infect Dis* 2007;44:159–77. <https://doi.org/10.1086/510393>.
- [2] Maeda M, Muraki Y, Kosaka T, Yamada T, Aoki Y, Kaku M, et al. The first nationwide survey of antimicrobial stewardship programs conducted by the Japanese Society of Chemotherapy. *J Infect Chemother* 2019;25:83–8. <https://doi.org/10.1016/j.jiac.2018.11.001>.
- [3] Doernberg SB, Abbo LM, Burdette SD, Fishman NO, Goodman EL, Kravitz GR, et al. Essential resources and strategies for antibiotic stewardship programs in the acute care setting. *Clin Infect Dis* 2018;67:1168–74. <https://doi.org/10.1093/cid/ciy255>.
- [4] Le Coz P, Carlet J, Roblot F, Pulcini C. Human resources needed to perform antimicrobial stewardship teams' activities in French hospitals. *Med Mal Infect* 2016;46:200–6. <https://doi.org/10.1016/j.medmal.2016.02.007>.
- [5] de With K, Allerberger F, Amann S, Apfalter P, Brodt HR, Eckmanns T, et al. Strategies to enhance rational use of antibiotics in hospital: a guideline by the German Society for Infectious Diseases. *Infection* 2016;44:395–439. <https://doi.org/10.1007/s15010-016-0885-z>.
- [6] Ten Oever J, Harmsen M, Schouten J, Ouwens M, van der Linden PD, Verduin CM, et al. Human resources required for antimicrobial stewardship teams: a Dutch consensus report. *Clin Microbiol Infect* 2018;24:1273–9. <https://doi.org/10.1016/j.cmi.2018.07.005>.
- [7] Ministry of Health, Labour and Welfare, Japan. The fiscal year 2018 Revision of Reimbursement of Medical Fees. <https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/0000188411.html>. [Accessed 28 January 2019].
- [8] Ministry of Health, Labour and Welfare, Japan. Basic survey on wage structure. 2017. <https://www.mhlw.go.jp/toukei/list/chinginkouzou.html>. [Accessed 22 January 2019].
- [9] Pulcini C, Morel CM, Tacconelli E, Beovic B, de With K, Goossens H, et al. Human resources estimates and funding for antibiotic stewardship teams are urgently needed. *Clin Microbiol Infect* 2017;23:785–7. <https://doi.org/10.1016/j.cmi.2017.07.013>.
- [10] Morris AM, Rennert-May E, Dalton B, Daneman N, Dresser L, Fanella S, et al. Rationale and development of a business case for antimicrobial stewardship programs in acute care hospital settings. *Antimicrob Resist Infect Control* 2018;7:104. <https://doi.org/10.1186/s13756-018-0396-z>.
- [11] Morgan DJ, Malani P, Diekema DJ. Diagnostic stewardship-leveraging the laboratory to improve antimicrobial use. *JAMA* 2017;318:607–8. <https://doi.org/10.1001/jama.2017.8531>.
- [12] Pollack LA, van Santen KL, Weiner LM, Dudeck MA, Edwards JR, Srinivasan A. Antibiotic stewardship programs in U.S. Acute care hospitals: findings from the 2014 national healthcare safety network annual hospital survey. *Clin Infect Dis* 2016;63:443–9. <https://doi.org/10.1093/cid/ciw323>.