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Posted Date: 18 July 2025

doi: 10.20944/preprints202507.1519.v1

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Antimicrobial Stewardship at a Tertiary Center in Portugal: Insights from Prescribers

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Abstract

Background/Objectives: Antimicrobial stewardship programs (ASPs) are essential to promote rational antibiotic use and limit resistance. However, their impact depends on how they are perceived and applied in clinical settings. This study aimed to identify areas for improvement in a hospital ASP and to offer a model for assessing prescriber engagement with stewardship activities. **Methods**: We conducted a cross-sectional survey between March and December 2024 among physicians prescribing antibiotics at a 1200-bed tertiary hospital in Portugal. The anonymized questionnaire covered six domains: (1) antibiotic knowledge; (2) awareness and use of local protocols; (3) access to antimicrobial use and resistance reports; (4) awareness of restrictive prescribing policies; (5) use of unscheduled consultations with the stewardship team; and (6) participation in scheduled multidisciplinary case discussions. **Results**: Of 1,539 invited physicians, 154 responded (10%). Most were female (64.3%) and specialists (75.8%). Although 78.6% were aware of institutional protocols, 66.9% rarely or never consulted them, citing poor accessibility and reliance on personal knowledge. Only 25.3% participated in regular case discussions, but these were widely viewed as useful. Awareness of restrictive policies was limited, although 69.5% acknowledged that such measures influenced prescribing. Respondents valued expert consultation, protocols, and feedback on antibiotic use. Interest in regular feedback on antimicrobial use and resistance patterns was high. **Conclusions**: Four main areas for improvement were identified: (1) improving access to protocols, (2) expanding weekly case-based discussions, (3) improving communication on restrictions, and (4) delivering clear, actionable feedback. This approach may serve as a model for aligning ASPs with clinical practice.

Keywords: antimicrobial stewardship; antibiotic prescribing; institutional protocols; antimicrobial resistance

1. Introduction

Antimicrobial resistance (AMR) is a major public health threat worldwide. Various national and international entities have launched initiatives to prevent its emergence and to promote the rational use of antibiotics[1,2]. This concern was most recently reaffirmed in the 2024 United Nations High-Level Meeting on AMR[3], where Heads of State recognized AMR as one of the most pressing global

 doi:10.20944/preprints202507.1519.v1

health threats and emphasized the need to strengthen multisectoral responses through antimicrobial stewardship (AMS) and other coordinated efforts.

In Portugal, the National Program for the Prevention and Control of Infections and Antimicrobial Resistance (PPCIRA) was established in 2013[4] and is considered a national health priority. PPCIRA operates at central, regional (UR-PPCIRA), and local (UL-PPCIRA) levels. As per national legislation, local units must implement an Antibiotic Stewardship Program (ASP) to optimize antimicrobial therapy, prevent unnecessary or prolonged prescriptions, and reduce ecological impact.

While the structural design and objectives of ASPs are well established, their influence on clinical decision-making is less well understood. A recent survey conducted at our institution highlighted significant variability in prescribing practices across departments, shaped by local cultures, hierarchies, and individual attitudes toward stewardship[5]. These findings suggest that ASPs' impact depends not only on protocols but also on contextual and behavioral factors.

At our tertiary center, the UL-PPCIRA, which was created in 2014, leads the implementation of a multidisciplinary ASP. Its key activities include the dissemination of local infection treatment protocols, generation of antimicrobial consumption and resistance reports, post-prescription validation of restricted antibiotics, automatic 7-day stop orders, ad hoc clinical consultations, and weekly multidisciplinary meetings as part of a structured support model for clinical departments. However, despite these efforts, the extent to which specific stewardship initiatives influence prescribing behavior remains largely unmeasured. Understanding how prescribers perceive and interact with ASPs is necessary for identifying areas for improvement. Moreover, such an assessment may provide a useful model for other institutions aiming to align ASP activities with clinical realities.

This study aims to assess physicians' perceptions of the ASP through a structured questionnaire, with the ultimate goal of promoting more rational and evidence-based antimicrobial use. Additionally, beyond its local relevance, this study also aims to illustrate a feasible model for assessing prescribers' perceptions of stewardship programs.

2. Materials and Methods

This was a cross-sectional study conducted between March and December 2024 at Hospital de São João, a tertiary university hospital in Northern Portugal with 1200 beds. The institution is highly differentiated, with active bone marrow, kidney, and heart transplant programs, a dedicated hematology-oncology service, and an advanced intensive care unit (ICU) that includes extracorporeal membrane oxygenation (ECMO) support.

The study population consisted of all the physicians involved in antibiotic prescribing decisions at the institution. A convenience sampling method was employed: all eligible physicians were invited to participate via institutional email. Participation was encouraged through monthly reminder emails sent to all eligible physicians over the course of the study period.

Data were collected using an anonymized online questionnaire developed by the research team and adapted from a French antimicrobial stewardship study[6]. The questionnaire, administered through Microsoft Forms, was designed to capture participants' experiences with, opinions on, and perceived usefulness of the various interventions of the hospital's ASP, as well as to identify potential barriers and facilitators to adherence. It comprised 39 items grouped into six domains: (1) knowledge of antibiotics; (2) awareness of local antibiotic prescribing protocols; (3) use of antimicrobial consumption reports; (4) awareness of the restricted antibiotics program; (5) engagement with unscheduled consultations on antimicrobial therapy; and (6) participation in scheduled weekly multidisciplinary case reviews. The tool was specifically developed for this study and has not been formally validated. Before dissemination, it was piloted with four resident physicians from different specialties at the same institution (not included in the final sample) to assess clarity, relevance, and comprehensiveness. These participants were selected for convenience, based on availability. Feedback from the pilot informed refinements to wording and structure. Additionally, members of

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the hospital's ASP reviewed the final version for content appropriateness. The complete questionnaire can be found in the supplementary materials.

Descriptive statistics were used to summarize participant responses. Missing data were handled using pairwise deletion, excluding only the specific data points that were missing for each analysis. Data analysis was conducted using Microsoft Excel.

This study received prior approval from the hospital's ethics committee. Informed consent was obtained from all participants after providing detailed information about the study objectives, procedures, potential risks, and benefits. Data protection measures included anonymization of all responses and secure storage of data, accessible only to members of the research team. Participation was voluntary, and respondents could withdraw at any time. The study was also conducted in compliance with the General Data Protection Regulation (GDPR).

3. Results

Out of 1,539 surveys sent through institutional e-mail, 154 valid responses were received, yielding an approximate 10% response rate. Most respondents were female (64,3%) and held a specialist positions (75,8%), mostly a medical specialization (64,9%) (Table 1). All predefined age groups were represented, with the highest proportion of respondents aged 25 to 35 years (30.6%).

Table 1. Respondents' Characteristics.

Characteristics	N (%)
Age group	
25-35	55 (30.6)
36-45	31 (17.3)
46-55	35 (19.5)
56 or more	35 (19.5)
Sex	
Female	99 (64.3)
Male	55 (35.7)
Professional Differentiation	
Specialists	116 (75.8)
Residents	37 (24.2)
Specialties	
Medical	100 (64.9)
Surgical	52 (33.8)

3.1. Antibiotic Knowledge

Most respondents reported being able to manage simple infections only (59.6%). In terms of self-assessed knowledge, responses were predominantly classified as good or sufficient, with fewer respondents rating their knowledge as very good or insufficient (Table 2).

Table 2. Self-assessed knowledge and confidence in antibiotic use.

Question	Category	N (%)
Confidence in antibiotic prescribing	Confident and comfortable in choosing antibiotics.	56 (35.9)
	Confident in simple cases only.	93 (59.6)
	Not confident.	5 (3.2)
Self-rated knowledge	Very good	14 (9.0)

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	Good	74 (47.4)
	Adequate	57 (36.5)
	Insufficient	9 (5.8)

3.2. Protocols

Most respondents were aware of the existence of institutional protocols for antimicrobial prescribing (Table 3). However, the frequency of use of protocols was generally low. Among those who rarely or never used the protocols, the most commonly reported reasons included difficulty in locating the documents in the hospital's shared folders (35.7%), reliance on pre-existing knowledge (18.8%), lack of time (13.6%), and a preference for national or international guidelines (9.7%). Other less frequent reasons included the perception that the protocols did not address the specific clinical question (9.1%), and concerns regarding whether the documents were up to date (5.8%).

Table 3. Awareness and frequency of use of institutional protocols.

Question	Response	N (%)
Are there institutional protocols for the management of infectious diseases and antimicrobial prescribing?	Yes	121 (78.6)
	No	1 (0.6)
	I don't know	32 (20.8)
How often do you consult these protocols?	Never	36 (23.49
	Rarely	67 (43.5)
	Monthly	40 (26.0)
	Weekly	7 (4.5)
	More than once a week	4 (2.6)

3.3. Restrictive Measures

Most respondents were not aware of the existence of post-prescription validation of restricted antibiotics (Table 4). Additionally, awareness of which antibiotics were restricted was low. As for the impact of these restrictive measures on clinical practice, most respondents (69.5%) agreed or strongly agreed that the measures influenced their prescribing practices, while 17.3% were neutral or disagreed.

Table 4. Awareness of restrictive measures.

Question	Response	N (%)
Are restrictive prescribing measures implemented in your department?	Yes	69 (44.8)
	No	36 (23.4)
	I don't know	49 (31.8)
If yes: Are you aware of which antibiotics are included in the restricted list?*	Yes	26 (37.7)
	No	13 (18.8)
	I'm unsure	30 (43.5)

* Only respondents who answered yes to the first question were directed to this question.

3.4. Unscheduled Consultations

Situations prompting unscheduled consultation with the antimicrobial stewardship team varied, with the most common reasons being managing unfamiliar infections and seeking expert opinion (Table 5). A significant number of respondents also reported requesting guidance when first-line antibiotics were not viable or when therapy needed to be adapted based on microbiological results.

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Table 5. Clinical situations in which respondents seek unscheduled support from the AMS team.

Clinical situation	N* (%)
Management of infections with which the clinician is unfamiliar.	75 (47.8)
Request for expert consultation.	73 (46.5)
Alternative antibiotic choice when first-line agents are not viable (e.g., allergy or resistance).	45 (28.7)
Adaptation of therapy based on microbiological results.	33 (21.0)
Choice of antibiotic duration.	30 (19.1)
No support usually requested.	34 (21.7)
Empirical antibiotic selection.	18 (11.5)
Treatment of special populations (e.g., pregnancy, renal/hepatic impairment, immunosuppression).	18 (11.5)
Clarification of antibiotic dosing.	11 (7.0)
Transition from intravenous to oral therapy.	2 (1.3)

*Respondents were allowed multiple answers for this question. N = 154.

Regarding the frequency of unscheduled contact with the ASP team, 14.9% of respondents reported never requesting support, 51.3% rarely, 22.1% monthly, 9.7% weekly, and 1.9% more than once per week.

3.5. Scheduled Weekly Multidisciplinary Meetings

Only 25.3% of respondents reported having scheduled case-based discussions on antimicrobial prescription (Table 6). Of those with scheduled meetings, most considered their duration adequate, with only two respondents suggesting the meetings were too brief. Similarly, the frequency of the meetings was deemed appropriate by most participants. Regarding the usefulness of these consultations, the vast majority (37 out of 39) found them beneficial for their clinical practice.

Table 6. Participation in scheduled discussions on antimicrobial prescribing.

Question	Response	N (%)
Are there scheduled meetings in your department for guidance on antimicrobial prescribing?	Yes	39 (25.3)
	No	98 (63.6)
	I don't know	17 (11.0)
If yes: Do you consider the duration of these meetings appropriate?*	Yes	37 (94.9)
	No, too long and detailed	0 (0.0)
	No, too short and general	2 (5.1)
Do you consider the frequency of these meetings appropriate?*	Yes	38 (97.4)
	No	1 (2.6)
	Not applicable	0 (0.0)

* Only respondents who answered yes to the first question in this section were directed to this question.

3.6. Overview of Interventions

When asked about the most useful antimicrobial stewardship interventions, respondents most frequently selected the availability of protocols, unscheduled support for specialties, and regular case discussions. Regarding preferred resources for reinforcement or implementation, the most commonly chosen were the inclusion of prescription recommendations in susceptibility reports, direct contact

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when antibiotic therapy could be improved, and structured training sessions on antimicrobial prescription (Table 7).

Table 7. Perceived usefulness of interventions and suggestions for improvement.

Question	Response	N* (%)
Which interventions do you consider most useful?	Availability of protocols.	112 (72.7)
	Unscheduled support to specialties (phone/email.)	87 (56.5)
	Regular meetings for clinical case discussions.	75 (48.7)
	Feedback on antimicrobial consumption and local epidemiological data.	71 (46.1)
	Automatic stop program (e.g., 7-day empirical or 24-hour surgical prophylaxis).	34 (22.1)
	Restricted antibiotics program (authorization requirement).	22 (14.3)
Which resources would you like to see reinforced or implemented in your department?	Direct inclusion of antibiotic recommendations in susceptibility reports	68 (44.2)
	Direct contact when antibiotic therapy could be optimized	61 (39.6)
	Direct contact when the isolated agent is resistant to the prescribed antibiotic	41 (26.6)
	Direct contact when the isolated agent is multidrug-resistant	41 (26.6)
	Educational sessions on antibiotic use in common infections	41 (26.)
	Dissemination of protocols	34 (22.1)
	Intervention programs to improve prescribing	27 (17.5)
	Department-specific ASP liaison (local contact point)	26 (16.9)
	Training sessions on antimicrobial resistance	21 (13.6)
	Direct contact when a restricted antibiotic is inappropriately prescribed	18 (11.7)
	Narrow-spectrum-first antibiograms	16 (10.4)
	Regular clinical case discussions	17 (11.0)
	Regular meetings to discuss ASP projects and improvement initiatives	8 (5.2)

* Respondents were allowed multiple answers for these questions. N = 154.

3.7. Feedback of Data on Antimicrobial Use or Antimicrobial Resistance

A total of 129 respondents (83.8%) expressed interest in receiving regular updates on antimicrobial consumption within their unit, while 10 (6.5%) were not interested, and 15 (9.7%) reported no opinion. Interest in receiving periodic information on local antimicrobial resistance patterns was reported by 142 respondents (92.2%), whereas 3 (2.0%) were not interested, and 9 (5.8%) had no defined opinion.

4. Discussion

This study explored how physicians perceive and engage with AMS activities at a tertiary hospital. Despite a modest response rate, the sample included a wide range of specialties and seniority levels, offering insight into AMS integration across the institution.

Four key findings emerged: (1) institutional protocols are underused, mainly due to accessibility issues; (2) regular weekly multidisciplinary case discussions are well received and could be expanded; (3) awareness of the hospital's restrictive antibiotic policy is limited; and (4) there is high demand for resistance and consumption data among prescribers. Below, we discuss each of these findings and possible actions.

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Most respondents knew protocols existed but used them infrequently. Barriers included poor accessibility, time constraints, and preference for national or international guidelines. This is consistent with findings from the French national survey our study was based on[6], where 76.7% of prescribers relied on guidelines issued by academic societies compared to 61.5% who used local hospital protocols. Similarly, a study among general practitioners in Germany[7] reported that only 39% frequently used antibiotic therapy guidelines. The survey results indicate that institutional protocols must be made more accessible and easier to navigate. Access to antimicrobial prescription protocols could be improved by reorganizing the hospital's internal system to create a centralized and clearly labelled section that facilitates consultation, highlighting recently updated content. In addition to improving access, protocols may need to be updated and structured in ways that align more closely with clinicians' decision-making and using robust and transparent methodologies.

Scheduled case discussions were viewed positively by respondents who had them within their departments, with the vast majority indicating that the frequency, duration, and clinical usefulness of these meetings were adequate. These results may support expanding scheduled discussions to more departments. While many AMS tools are automated or digital, the value placed on face-to-face, case-based discussions shows that clinicians still rely on personalized, real-time input for complex decisions regarding individual patients. Unscheduled consultations were less frequent and usually occurred when physicians faced difficult cases, which may reflect appropriate, case-driven use of the service rather than systematic integration into routine clinical practice.

Awareness of the hospital's restrictive antibiotic policies was limited. Even among those who knew such measures were in place, many were unsure which antibiotics were affected. While most respondents agreed that these policies influence their prescribing decisions, the results suggest that communication around their scope and rationale could be improved. One possible approach could include sharing an updated and simplified list of restricted antibiotics with clinical departments, accompanied by brief explanations. Opportunities to reinforce this information might include departmental meetings or routine AMS interactions.

Interest in receiving regular feedback on antimicrobial resistance and consumption data was high. These findings support the potential value of systematic feedback strategies. However, previous research suggests that even when this information is available, applying it in clinical practice can be challenging[8,9]. In a recent study[9], only 26.9% of hospitalists reported using antibiogram data more than once a month, and decisions to prescribe antibiotics were often unaffected by susceptibility levels. Therefore, resistance data must be presented with interpretative guidance that is relevant to common clinical scenarios. Integration into existing prescribing tools may also facilitate its use.

The most valued ASP interventions included access to protocols, expert support, and therapeutic guidance embedded in microbiology reports. In general, prescribers tend to support educational and supportive interventions over restrictive measures6. Additionally, team dynamics and autonomy influence prescribing decisions, supporting the idea that ASP strategies should be adapted to local contexts5.

This study has some limitations. The response rate was low, which may introduce selection bias, particularly if those more engaged with stewardship were more likely to respond. The questionnaire was not formally validated, although it was adapted from a previously published tool and piloted locally. Responses were self-reported and may be subject to recall bias. Finally, as a single-center, cross-sectional study, the findings may not be generalizable and do not capture changes over time.

Despite these limitations, the study offers relevant insights for assessing ASP quality as perceived by the medical population and improving implementation. The inclusion of respondents from various specialties and training levels provides a broad perspective on prescribing behavior.

5. Conclusions

Four areas stood out for potential improvement: (1) making protocols easier to access and use; (2) maintaining and expanding scheduled multidisciplinary discussions; (3) improving

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communication around restricted antibiotics; and (4) delivering clear, actionable feedback on resistance and consumption data. In addition to its local relevance, this study offers a practical example of how AMS initiatives can be assessed from the perspective of prescribers. Understanding how they engage with different stewardship components can inform the design of more context-sensitive and effective interventions. By sharing our approach, we aim to contribute to ongoing efforts to integrate behavioral and organizational dimensions into the evaluation and refinement of ASPs in real-world settings. Future research could explore the impact of specific interventions longitudinally and examine behavioral drivers that influence prescribing across clinical areas.

Supplementary Materials: The following supporting information can be downloaded at the website of this paper posted on Preprints.org, FileS1: Survey Questionnaire on Antimicrobial Stewardship Practices and Perceptions.

Author Contributions: Conceptualization, A.V., M.S.M., L.R.D., F.A., M.G., P.A., N.R.P.; methodology, A:V:, M.S.M., L.R.D., F.A., M.G., P.A., N.R.P.; formal analysis, A.V, M.S.M.; writing—original draft preparation, A:V:, M.S.M..; writing—review and editing, A:V:, M.S.M., L.R.D., F.A., M.G., P.A., N.R.P.; supervision, F.A., N.R.P.;. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Ethics Committee of São João Local Health Unit (protocol code nº 113/2024, date of approval May 27th, 2024).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The datasets presented in this article are not readily available due to General Data Protection Regulation restrictions.

Acknowledgments: The authors would like to acknowledge the physicians at Hospital de São João who participated in the survey and contributed their time and perspectives to this study. During the preparation of this manuscript, the authors used ChatGPT (OpenAI, GPT-4, July 2025 version) for language refinement and formatting support. The authors have reviewed and edited the output and take full responsibility for the content of this publication.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

AMS	Antimicrobial Stewardship
ASP	Antimicrobial Stewardship Program
UL-PCIRA	Local Unit for the Prevention and Control of Infection and Antimicrobial Resistance
UR-PCIRA	Regional Unit for the Prevention and Control of Infection and Antimicrobial Resistance
PPCIRA	Program for the Prevention and Control of Infections and Antimicrobial Resistance
AMR	Antimicrobial Resistance
ICU	Intensive Care Unit
ECMO	Extracorporeal Membrane Oxygenation
GDPR	General Data Protection Regulation

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