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Abstract (183/200 words): Antimicrobial resistance represents a global health challenge, with Italy among the most affected countries in Europe. In response, the Veneto Region developed governance models to enhance antimicrobial stewardship (AMS) and infection prevention in both hospital and community settings. This study assessed the implementation of these models and explored strategies for improvement. A survey targeting hospital medical and district health management, hospital pharmacies, and primary care pharmaceutical departments was conducted to evaluate governance adherence, resource allocation, training, and reporting practices. Findings were analyzed by a focus group comprising regional experts, infectious disease specialists, microbiologists, and policymakers, which identified critical gaps and proposed actionable recommendations. Results revealed disparities in AMS implementation between hospital and community care, with key challenges including limited multidisciplinary collaboration, inconsistent resource distribution, and gaps in

training. The focus group emphasized the need for stronger governance, standardized protocols, and improved communication to address these shortcomings. This study underscores significant gaps and opportunities within the Veneto Region's healthcare system and provides a framework for enhancing AMS and infection prevention strategies, bridging the divide between hospital and community care to combat antimicrobial resistance effectively.

Keywords: Antimicrobial Stewardship; Infection Prevention and Control; Public Health; Healthcare Governance; Community Healthcare; Multidisciplinary Approach

1. Introduction

Antimicrobial resistance (AMR) is a global health threat with alarming projections for the future [1]. By 2050, it is estimated that infections caused by antibiotic-resistant bacteria will surpass cancer as the leading cause of death worldwide [2]. Italy, in particular, faces some of the highest levels of resistance for critical pathogens like *Klebsiella pneumoniae* and *Escherichia coli*. The country bears one of the heaviest burdens of AMR in Europe, with over 10,000 deaths annually attributed to resistant infections—accounting for more than a third of all AMR-related deaths in the EU. Developing robust antimicrobial stewardship (AMS) programs in hospitals is critical to addressing this issue [3]. However, it is equally important to focus on primary care settings, where 90% of antibiotic prescriptions are made, with two-thirds originating from primary care physicians. This makes primary care a key area for AMS initiatives aimed at optimizing antibiotic use and preventing the spread of resistance [4].

National Action Plans (NAPs) for AMR can serve as a crucial tool in shaping national strategies to combat this growing threat [5]. These plans provide a structured framework for addressing AMR across various sectors, promoting collaboration between healthcare, veterinary, and environmental systems. However, as highlighted in various studies, the existence of NAPs alone is not sufficient to ensure success [6]. In Italy, the first national plan was introduced with the National Action Plan on Antimicrobial Resistance 2017-2020 (updated in 2022), along with its related surveillance system, SPiNCAR (Surveillance and Prevention of Healthcare-Associated Infections and Antimicrobial Resistance), aimed at monitoring the implementation of the NAP [8, 9].

The Italian National Health Service is a decentralized public system with three levels: central, regional, and local. While the national government sets overall health policies and standards, the 21 regions and autonomous provinces have significant autonomy in managing healthcare services. Each region is governed by elected officials who oversee healthcare delivery through hospital trusts and Local Health Authorities (LHAs). LHAs are responsible for providing healthcare within a defined geographic area. They are managed by General Managers appointed at the regional level and are further divided into Local Health Units (LHUs), which integrate hospital and community-based services. Major hospitals often operate as semi-independent public entities known as 'public hospital enterprises' or specialized hospitals [10]. In the Veneto region, north-east of Italy, there are 9 LHAs and 3 specialized hospitals. The 9 LHAs vary in size, with populations ranging from 300,000 to nearly 1 million. The community area of each LHA is divided into one or more territorial areas, each with its own director [11]. Primary care within LHAs is provided by a network of general practitioners, who act as gatekeepers to higher levels of care. Home care services, less complex than those provided in hospitals, are delivered either at the patient's home or in nursing homes. The Community Hospital is a healthcare facility with 20 beds per 100,000 inhabitants, designed for patients requiring short-term, low intensity care [12].

In the Veneto Region the first NAP was adopted in 2019 through a regional decree, which outlined strategies for the proper use of antibiotics in human health and introduced a regional plan for the surveillance, prevention, and control of healthcare-associated infections (HAIs). The Veneto Region's strategy for antimicrobial use includes a comprehensive governance structure for AMS, divided into three levels: the Regional Multidisciplinary Group at the regional level, the Hospital

Multidisciplinary Group at the hub hospitals, and the Community Multidisciplinary Group in territorial health organizations, managing AMS activities at community level [13]. Additionally, the governance model for Infection Prevention and Control (IPC), mandates the establishment of the Hospital Infection Control Committee, chaired by the hospital medical director, to oversee infection control measures. Additionally, a regional coordinating committee ensures alignment and consistency across all healthcare settings, both hospital-based and community-based (Figure 1) [14]. The plan for the surveillance, prevention, and control of HAIs also introduced the role of Link Professionals, healthcare professionals (e.g., nurses, technicians, doctors, etc.) who play a leadership role within their facility on infection risk-related matters [15].
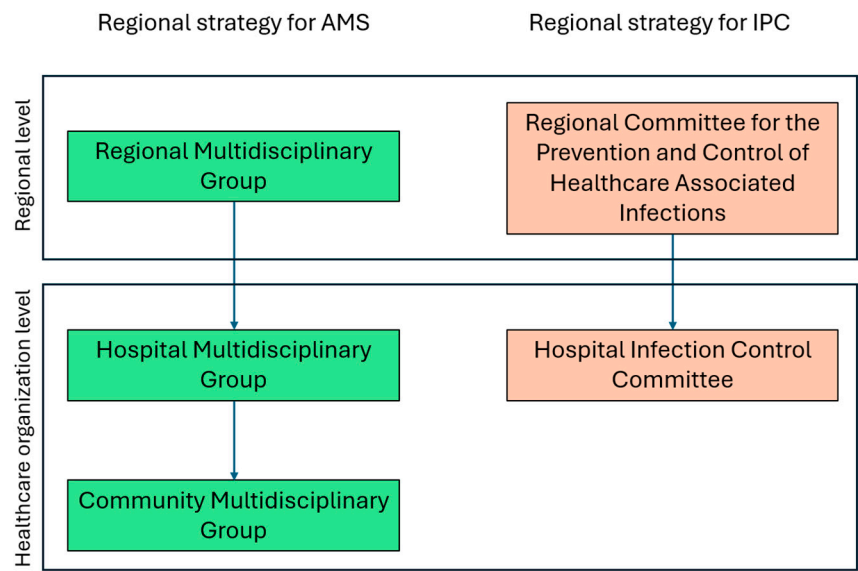
Figure 1. Veneto's Region strategy for AMS and IPC.

This paper presents the findings of the ARCO project (Approcci di Rete per il Contrasto all'Antimicrobico Resistenza Ospedale-Territorio - Network Approaches for Combating Antimicrobial Resistance between Hospital and Community), developed through collaboration among three scientific societies: ANMDO (National Association of Hospital Medical Management), SIFACT (Italian Society of Clinical Pharmacy and Therapeutics), and CARD (Confederation of Regional District Associations). The ARCO working group includes a multidisciplinary team from various healthcare organizations in the Veneto Region, comprising hospital medical directors, hospital pharmacists, infection risk specialists, primary care pharmacists, and coordinators in integrated home care and district functions. The primary objective of the ARCO project is to evaluate the implementation of regional governance models for IPC and AMS across healthcare organizations in the Veneto Region. Additionally, the project involves analyzing data from a focus group of key stakeholders and experts to gain a deeper understanding of current AMS and IPC practices. This analysis will help identify best practices and areas for improvement, contributing to the refinement of AMS and IPC strategies within the region.

2. Materials and Methods

2.1. Survey Design and Distribution.

A cross-sectional survey was conducted to evaluate adherence to regional governance models for IPC and AMS and to explore the integration between hospital and community care settings. The ARCO working group developed four distinct questionnaires targeting Hospital Medical Management (HMM), District Health Management (DHM), Hospital Pharmacies (HP), and Primary Care Pharmaceutical Department (PCPD). The survey collected information on staffing levels for AMS-related activities (pharmacists, nurses, and physicians), the existence and functioning of AMS

programs, training on AMR and AMS, and reporting practices related to antibiotic consumption, protocol adherence, and surveillance data. The survey also explored how healthcare units implemented governance models and the level of coordination between hospital and community settings. The questionnaires were distributed electronically to healthcare units across the Veneto region, supported by a joint communication from the Regional Directorate of Pharmaceutical Services and Medical Devices and the Directorate of Prevention and Food Safety. Responses were collected through Google Forms between November 3 and November 11, 2023, from HMM, DHM, HP, and PCPD. The data collected were analyzed using descriptive statistics in Microsoft Excel.

2.2. Focus Group.

Following the data analysis, a focus group was organized on May 10, 2024, to further interpret the survey results. The participants included members of the ARCO working group, two representatives from the regional directorates, and a panel of experts composed of three infectious disease specialists, a microbiologist, and a hospital hygienist. The discussion centered around three main themes: professional commitment, including staffing and AMS committees; audit and reporting practices; and IPC activities. The focus group discussion provided deeper insights into the current state of AMS implementation in the Veneto region, highlighting strengths and identifying areas for improvement within both hospital and community healthcare settings. This moment of confrontation resulted in statements with the aim of improving practices at the regional level.

3. Results

The survey was completed by healthcare professionals, starting with 21 HMM that represented 34 hospital facilities. These included 26 spoke hospitals, 2 highly specialized hospitals, 4 hub hospitals, and 2 university hospitals, accounting for a total of 12,115 beds. This response represented 100% of the healthcare organizations in the region. Additionally, 22 DHM participated, covering 22 healthcare districts. These districts provide healthcare services to a total of 4,133,010 residents, out of a total population of 4,906,000, also representing 100% of the region's healthcare organizations. Among HP, 16 out of a total of 19 participated, representing 100% of the healthcare organizations in the region. Lastly, 8 PCPD out of a total of 9 responded, representing 89% of the community pharmacies and healthcare organizations in the region, with one community pharmacy per healthcare organization.

3.1. Governance and Organizational Structure

According to HMM, three out of four healthcare organizations reported having a formalized annual plan for IPC. Additionally, one out of two organizations indicated having a formalized antimicrobial stewardship plan in place.

Each respondent could report his or her knowledge in terms of the activation of various company or local committees active in the area of AMS and IPC. These include LHA Committee for IPC, Hospital-based Committee for IPC, Hospital Multidisciplinary Group for AMS, Community Multidisciplinary Group for AMS. All HMM reported that the required committees had been formally established, whereas the other corporate divisions did not provide the same response (Figure 2), even within the same healthcare organization.
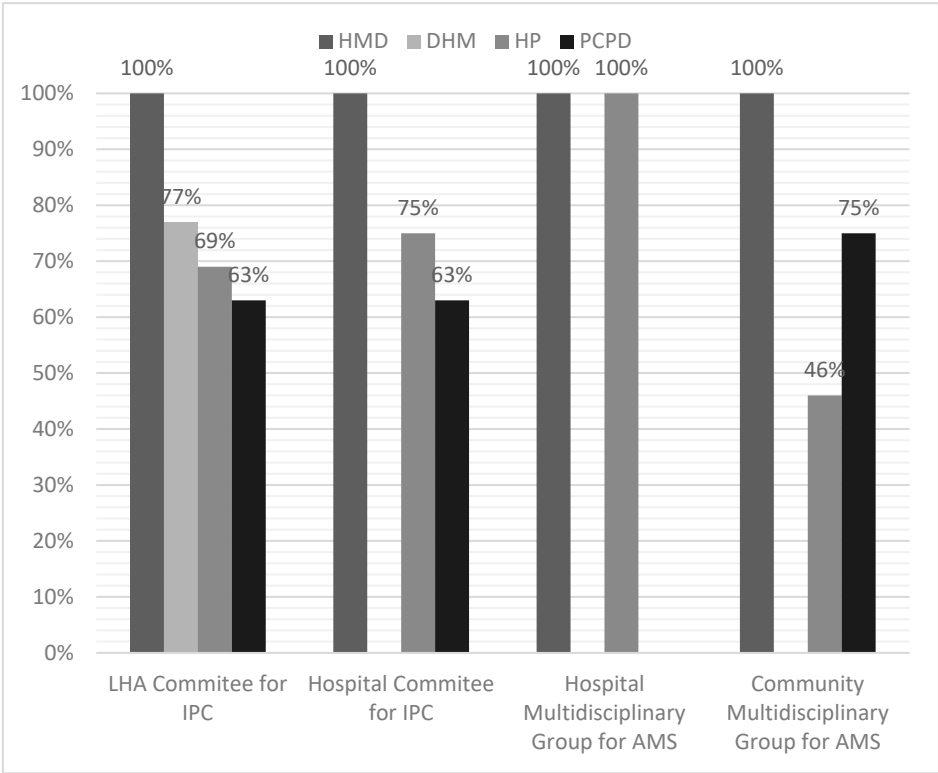
Figure 2. Establishment of Corporate Committees according to Hospital Medical Management (HMM), District Health Management (DHM), Hospital Pharmacies (HP), and Primary Care Pharmaceutical Department (PCPD). LHA: Local Health Authority.

3.2. Human Resources and Link Professional for AMS and IPC

Table 1 presents the allocation of human resources (nurses, physicians and pharmacists) dedicated to IPC and AMS programs across hospital and community care settings. In hospitals, there were 19 fully dedicated infection control nurses (0.25 per 100 beds) and 12 partially dedicated nurses (0.01 per 100 beds). Six public health specialists were fully dedicated (0.04 per 100 beds), while 28 were partially dedicated (0.01 per 100 beds). Hospital pharmacists had only one fully dedicated professional (0.004 per 100 beds), with 16 partially dedicated pharmacists (0.56 per 100 beds).

In community settings, no pharmacists were fully dedicated, though 12 were partially involved (0.004 per 1,000 inhabitants). In primary care, no nurses or physicians were fully dedicated to AMS/IPC programs, but 21 nurses (0.008 per 1,000 inhabitants) and 33 physicians (0.009 per 1,000 inhabitants) were partially involved. Similarly, in community hospitals, no fully dedicated staff were reported, but 41 nurses (6.2 per 100 beds) and 22 physicians (0.10 per 100 beds) were partially involved. In domiciliary care, no fully dedicated staff were present, but 21 nurses (0.022 per 1,000 inhabitants) and 18 physicians (0.005 per 1,000 inhabitants) were partially involved in IPC/AMS activities.

Table 1. Standard of human resources (physicians and nurses) partially and fully dedicated to IPC and AMS programs in hospitals and community care: absolute number and average ratio of professionals per bed in each of the examined facilities.

Human resource for IPC/AMS programs	Fully dedicated		Partially dedicated	
	n	mean	n	mean
Hospital				
IPC nurses	19	0,25 *100 beds	12	0,01*100beds
IPC physicians	6	0,04*100 beds	28	0,01*100beds

6

Hospital pharmacists	1	0,004*100 beds	16	0,56*100beds
Community				
Primary Care Pharmacists	0	-	12	0,004*1000inhab
Primary care				
nurse	0	-	21	0,008*1000inhab
physicians	0	-	33	0,009*1000inhab
Community hospital				
nurse	0	-	41	6,2*100beds
physicians	0	-	22	0,10*100beds
Domiciliary care				
nurse	0	-	21	0,022*1000inhab
physicians	0	-	18	0,005*1000inhab

Table 2 provides data on the identification, training, and involvement of Link Professionals in IPC and AMS programs across both hospital and community settings. In hospitals, 76% of link professionals are formally identified, whereas only 36% are formally identified in community settings, with 50% of link professionals in the community not identified at all.

Table 2. Identification, Training, Service Involvement, and Assigned Objectives of Link Professionals in Hospital and Community Settings.

	Hospitals		Community	
	n	**Percentage**	**n**	**Percentage**
Identification of link professional				
no	0	0%	11	50%
not formally identified	5	24%	3	14%
formally identified	16	76%	8	36%
Training program of link professional				
not provided	4	19%	1	9%
not dedicated	10	48%	8	73%
dedicated	7	33%	2	18%
Identified Services				
Inpatient Wards	21	100%	-	-
Emergency Department	18	86%	-	-
Operating theater	17	81%	-	-
Diagnostic Imaging	15	71%	-	-
Outpatient Services	14	67%	-	-
Day Care Activities	10	48%	-	-
Immunotransfusion Service	6	29%	-	-
Analysis Laboratory	6	29%	-	-
Pathological Anatomy	6	29%	-	-
Primary Care	-	-	10	91%
Integrated Home Care	-	-	6	55%
Intermediate Care Facilities	-	-	4	36%
Residential Facilities	-	-	4	36%

District Management	-	-	2	18%
Territorial Operational Center	-	-	1	9%
Assigned objectives for link professionals				
Auditing/review of documentation	8	38%	5	45%
Procedure/bundle development	10	48%	0	0%
Surveillance data collection	10	48%	2	18%
Checklist application	11	52%	5	45%
HAI/adverse event reporting	13	62%	9	82%
Training/promotion of best practices	16	76%	6	55%
Objectives for link professionals				
Not assigned	4	19%	-	-
Assigned, but not formalized	11	52%	4	36%
Formalized and periodically monitored	4	19%	6	55%
Formalized, monitored, and results shared	2	10%	1	9%

Regarding training, 33% of hospital-based link professionals have received dedicated IPC training, while 48% have participated in non-specific programs, and 19% have not undergone any training. In community settings, these figures are lower: 18% have received dedicated training, 73% have attended non-specific programs, and 9% have not received any training. Link professionals are involved across a range of services. In hospitals, they are present in inpatient wards (100%), emergency departments (86%), operating theaters (81%), and diagnostic imaging services (71%). They also contribute to outpatient services (67%) and day care activities (48%). In community settings, link professionals are primarily engaged in primary care (91%), integrated home care (55%), intermediate care facilities (36%), and residential facilities (36%). The objectives assigned to link professionals vary significantly between hospital and community settings. In hospitals, 76% are involved in training and promoting best practices, 62% participate in HAI reporting, and 52% utilize checklists to ensure IPC measures are followed. In community settings, similar activities are observed, with 82% participating in HAI reporting and 55% focusing on best practices promotion. However, the formalization of these objectives remains limited, with only 10% of hospital-based and 9% of community-based link professionals having formalized, monitored objectives with shared outcomes.

3.3. Infectious Disease (ID) Consultation Services

The survey results indicate that 75% of healthcare organizations have an infectious disease ward, typically located in hub hospitals. Additionally, three out of 12 organizations have established agreements with other institutions to provide infectious disease consultations, while three have hired infectious disease specialists on a freelance basis. Five organizations reported employing infectious disease specialists in departments outside of the infectious diseases unit, ranging from one to three professionals. These specialists are employed in diverse areas, including two in medical management, two in geriatrics, one in internal medicine, and one in pediatrics. This highlights the varied organizational approaches to securing infectious disease expertise across healthcare settings.

As shown in table 3, we highlight the variability in the availability of ID consultation services across healthcare settings. Approximately 5% of facilities reported no access to ID consultation, while the majority have some level of availability. Specifically, 29% of the settings offer consultation services between 1 to 3 days per week, and another 29% provide services for 4 to 5 days. Notably, 38% of settings offer near-daily access, with ID consultation available 6 to 7 days per week. In terms of the number of hours per week that ID consultation is available, nearly half of the healthcare settings (48%) provide access for up to 20 hours per week, while only 14% offer services for 21 to 30 hours per

week. Twenty-four percent of the settings report availability for 31 to 70 hours per week. Continuous, around-the-clock consultation (168 hours per week) is available in 14% of healthcare facilities.

Table 3. Availability of Infectious Disease Consultation Services within hospitals.

Category	n	Percentage
Days per Week with ID Consultation		
No availability	1	5%
1 to 3 days per week	6	29%
4 to 5 days per week	6	29%
6 to 7 days per week	8	38%
Hours per Week with ID Consultation		
0-20 hours per week	10	48%
21-30 hours per week	3	14%
31-70 hours per week	5	24%
Full-time (168 hours per week)	3	14%

3.4. Analysis of Antibiotic Consumption Reports and Indicators in Hospitals and Primary Care Settings

The analysis highlights several key points in the reporting of antibiotic consumption across hospital and primary care settings (Table 4). In hospital reports, almost all (94%) included economic indicators such as expenditure for ATC category J01, while 63% included quantitative indicators measuring consumption in dosage units or pieces. Notably, 75% of hospital reports also incorporated quantitative indicators expressed in Defined Daily Dose (DDD) and qualitative indicators through the AWaRe classification. However, only 25% of the reports included ESAC indicators, showing limited attention to European Surveillance of Antimicrobial Consumption.

In comparison to hospitals, primary care reports demonstrated a lower use of quantitative indicators expressed in DDD (38% versus 75%). However, there was a significant reliance on indicators that measure the number of patients treated, observed in 50% of primary care reports. Similarly, the qualitative AWaRe classification was present in 63% of primary care reports compared to 75% in hospitals, while none of the primary care reports included ESAC indicators.

In terms of infection management guidelines, 38% of primary care reports addressed upper respiratory, lower respiratory, and lower urinary tract infections, with a smaller percentage (13%) covering soft tissue infections.

Table 4. Analysis of antibiotic consumption reports and indicators in hospitals and primary care settings. DDD: Defined Daily Dose; ATC: Anatomical Therapeutic Chemical Classification; PD: patient days; DOT: days of therapy.

	Hospitals		Primary care	
	n	%	n	%
Reports on antibiotic consumption				
Hospital wards	16	100%	-	-
General practitioners	-	-	6	75%
Community pediatrician	-	-	0	0%
General practitioners + community pediatrician	-	-	2	25%
Indicators				

9

Total expenditure for ATC category J01	15	94%	3	38%
Treated (number)	4	25%	4	50%
Dosage units/pieces consumed for ATC category J01	10	63%	3	38%
Total DOT	1	6%	0	0%
DOT/100 PDs or 1000 inhab	1	6%		0%
Total DDD	12	75%	3	38%
DDD/100 PDs or 1000 inhab	14	88%		0%
DDD/100 PDs or 1000 inhab for beta-lactams/enzyme inhibitors	9	56%	2	25%
DDD/100 PDs or 1000 inhab for third-generation cephalosporins	10	63%	2	25%
DDD/100 PDs or 1000 inhab for carbapenems	13	81%	1	13%
DDD/100 PDs or 1000 inhab for fluoroquinolones	13	81%	2	25%
Consumption by AWaRE classes	12	75%	5	63%
ESAC Indicators	4	25%	0	0%
Protocols/guidelines for infections management in primary care				
Management of upper respiratory tract infections	-	-	3	38%
Management of lower respiratory tract infections	-	-	3	38%
Management of lower urinary tract infections	-	-	3	38%
Management of soft tissue infections	-	-	1	13%

3.5. Focus Group Recommendations

The focus group provided a series of detailed recommendations aimed at improving AMS and IPC programs across various healthcare settings. These recommendations, summarized in Table 5, cover key areas such as governance, human resources, link professionals, infectious disease consultation services, and antibiotic consumption reporting in hospitals and primary care. The group emphasized the importance of tailoring AMS and IPC objectives to the specific needs of healthcare organizations, ensuring these goals are incorporated into senior leadership performance evaluations. Additionally, there was a strong emphasis on improving resource allocation, providing standardized training, and formally recognizing link professionals, especially in community settings where these roles are underdeveloped. The focus group also highlighted the need to expand infectious disease consultation services in both spoke hospitals and community care settings to provide continuous support for AMS activities, rather than relying on ad-hoc consultations. These recommendations aim to address existing gaps in resources and governance structures, ensuring a more cohesive and effective approach to AMS and IPC implementation

Table 5. Focus Group Recommendations for Strengthening AMS and IPC Programs in Veneto Region.

Governance and Organizational Structure
1. Integrate AMS and IPC objectives into General Managers' performance targets to ensure accountability and commitment from top management. 2. Align regional objectives with each healthcare organization's specific needs, ensuring consistency with regional healthcare priorities, through collaboration of local health authorities in defining regional AMS and IPC plans . 3. Establish a regional external oversight body to monitor and evaluate AMS and IPC implementation, ensuring alignment with regional and national strategies. 4. Simplify internal governance structures to ensure clear representation of divisions and territorial entities, improving coordination and execution of AMS and IPC programs. 5. Increase transparency by publishing organizational models, plans, and reports on organizations' websites, making them accessible both to healthcare professionals and the general population. 6. Develop standardized regional AMS and IPC toolkits for healthcare professionals, including indicators and minimum standards for organizational plans. 7. Launch public campaigns to raise awareness of conscious use of antibiotics and IPC among the general population.
Human Resources and link professional for AMS and IPC
1. Set clear staffing standards for both hospitals and community care settings, ensuring adequate numbers of healthcare professionals dedicated to AMS and IPC. 2. Expand the network of link professionals, especially in community care settings, including primary and home care. 3. Standardize the profiles and activities of link professionals through structured training programs targeting IPC and AMS practices. 4. Implement formal recognition systems for link professionals, offering financial incentives and continuing education credits. 5. Strengthen collaboration between hospital-based and community-based link professionals to ensure seamless integration of AMS and IPC efforts. 6. Formalize the annual objectives of link professionals, making them measurable and regularly monitored through performance reviews. 7. Improve training and education programs about AMS for Primary Care Physicians.
ID consultation and AMS Support Services
1. Expand infectious disease consultation services in spoke hospitals and community care settings to provide continuous AMS support. 2. Establish permanent AMS reference figures in spoke hospitals and community care facilities to provide leadership on antibiotic use.

3. Strengthen partnerships between spoke and hub hospitals, ensuring consistent access to infectious disease expertise through shared personnel or telemedicine services.
4. Ensure infectious disease support is available for clinical case consultations and broader AMS efforts, such as audits, policy implementation, and staff education.
5. Fully integrate infectious disease services into daily clinical practice, making AMS a proactive component of care.
6. Develop a telemedicine-based remote consultation system to provide timely infectious disease guidance in community settings.

Antibiotic Consumption Reports in Hospitals and Primary Care

1. Create a uniform regional framework for antibiotic consumption reports, utilizing consistent quantitative (DDD) and qualitative (AWaRe) indicators across healthcare settings.
2. Encourage greater use of qualitative indicators in primary care reports, alongside training on interpretation.
3. Promote the use of quantitative indicators like DDD in primary care, alongside patient-centered metrics.
4. Implement regional benchmarking and feedback systems to monitor antibiotic use and improve AMS interventions.
5. Develop empiric antibiotic therapy protocols specifically for primary care to guide appropriate initial treatments.
6. Integrate, through IT systems, antibiotic prescription data with AMR, based on tools used in the veterinary field.

Other recommendations from the focus group

1. Develop and implement comprehensive IPC protocols for primary care and residential facilities, with a focus on infection prevention and MDRO management.
2. Establish real-time microbiology alert systems in hospitals that communicate infection risks and MDRO presence to community care settings.
3. Integrate microbiology alerts into shared IT platforms between hospitals and primary care to enable immediate action across all care settings.
4. Ensure the transfer of microbiology data, including critical infection alerts, during patient discharge from hospitals to community care facilities through a coordinated IT system.
5. Overcome obstacles imposed by italian privacy regulation to share data between institutions, with epidemiological and decision-making for public health.
6. Integrate data from private laboratories into AMR surveillance.
7. Improve standardization of methods for microbiological analysis.
8. Invest in technology to support microbiological laboratories and field epidemiology.

4. Discussion

National action plans are useful but not sufficient for the effective implementation of AMS and IPC measures [5]. The aim of our project was to collect data through surveys and, following a focus group discussion, to identify best practices and approaches within HCAs that could be integrated into regional and local plans.

The ARCO project gathered expert recommendations to strengthen governance within HCAs and enhance leadership commitment by defining clear objectives and allocating resources to incentivize AMS program implementation. Broom et al. highlighted the challenge of prioritizing long-term public health goals, such as AMR, over short-term performance-driven objectives, underscoring the need for clearly defined, long-term objectives aligned with AMS goals to ensure accountability and sustained leadership commitment [16]. Similarly, Jeleff et al. emphasized that AMS compliance must go beyond formal documentation to include meaningful resource allocation and concrete actions that drive real improvements [17]. Further recommendations focused on strengthening local and regional governance. Regional and local AMR committees can tailor interventions to local needs, better aligning efforts with regional epidemiological contexts. These committees foster collaboration across hospitals and community settings, enabling quicker responses to resistance trends [6,18]. However, localized approaches also present challenges, such as the risk of fragmentation and duplicated efforts due to overlapping roles [16]. To address this, minimum operational standards should be established, such as regional toolkits accessible to healthcare professionals, modeled after the AMS Toolkit TARGET and Start Smart Then Focus from the UK NHS [19]. These toolkits should include content for implementation and indicators for organizational plans, ensuring consistent standards across all settings. Additionally, investment in communication and transparency is crucial, ensuring that all healthcare professionals are informed about existing committees and medium- to long-term plans, with key information made accessible via the organization's website.

Our work focuses on the human resources necessary for effective AMS and IPC programs, highlighting the critical importance of adequate staffing for their success and sustainability. Our findings reveal an average of 0.25 IPC nurses and 0.04 IC physicians per 100 beds, which aligns with the national ratio for nurses but falls short of European data, where the average is 0.80 IPC nurses and 0.15 physicians per 100 beds [20, 21]. Italian guidelines from 1980 recommend 0.25–0.4 IPC nurses and 0.1 physicians per 100 beds, while the European Centre for Disease Prevention and Control has recently updated its guidelines to recommend 1 IPC nurse per 100 beds, reflecting the increasing need for specialized personnel [22, 23]. Where national standards are lacking—such as in HP, PCPD, and community healthcare—dedicated personnel are often absent. Our study found a ratio of 0.004 HP per 100 beds, significantly lower than the European average of 0.1221. Several guidelines suggest that a ratio of 1 HP per 100 beds is necessary for effective clinical pharmacy services, particularly in AMS programs [24-26]. The lack of clear roles and organizational structures, especially in community settings, underscores the need for standardized human resource allocation for AMS and IPC programs.

Expanding services and appointing permanent AMS reference figures in primary care would provide the leadership needed to integrate AMS into routine clinical practice, shifting from ad-hoc consultations to continuous support and improving antimicrobial management. The shortage of ID consultation services, especially in spoke hospitals and community settings, further hinders AMS and IPC implementation. A study from another northeastern Italian region found that for a population of 312,000, an AMS program required 4 full-time infectious disease consultants, 0.9 FTE microbiologists, and 0.9 FTE pharmacists, alongside an IPC team [27]. In the Veneto region, larger healthcare organizations, and the absence of central hub hospitals in some areas, require adjusted staffing models, emphasizing the need for tailored strategies to support AMS and IPC efforts.

Link Professionals are crucial to the success of IPC programs. To ensure these roles are valued and supported, a formal system of recognition and incentives is essential. This echoes findings by Jeleff et al., who emphasize the importance of both financial and symbolic recognition for professionals engaged in AMS. Without adequate remuneration and career incentives, attracting and

retaining skilled personnel in these critical roles becomes challenging [17]. Establishing an annual, structured training curriculum would ensure that link professionals, particularly in community settings, are fully equipped to promote best practices, ensure proper surveillance, and implement infection control policies [28]. Formalizing the objectives assigned to link professionals and creating a system of regular performance monitoring would further enhance their impact, fostering commitment and accountability across the healthcare organization.

The survey highlights the need for standardized antibiotic consumption reporting across hospitals and primary care. Primary care reports often emphasize economic indicators rather than clinical metrics like DDD or the AWaRe classification. The focus group recommended standardizing reports to include both economic and clinical data for a comprehensive understanding of antibiotic use. Additionally, specific prescribing guidelines for primary care are necessary to reduce inappropriate antibiotic use. The ARCO Project also identified gaps in monitoring and reporting adherence to AMS and IPC protocols in the Veneto Region. Implementing standardized indicators and transparent reporting, like the governance model in England, could improve accountability, enhance performance tracking, and foster a more consistent approach to stewardship across the region [29].

The focus group reminded the long-standing problem of the application of European Privacy Regulation in Italy, that often represent a barrier to share data between health authorities and interconnection of health informational flows. Quality of data is fundamental to guarantee efficacious health systems governance and disease prevention and control, especially as regards field epidemiology and, consequently, management of HAI and AMR, since these are issues that distress across different healthcare services and spread without taking in account territorial boundaries [30].

The ARCO project may seem similar to SPiNCAR, the tool used to monitor the implementation of the Italian NAP [9]. However, while SPiNCAR focuses on assessing the application of Italian's NAP within HCAs, it does not examine internal organizational models, resource allocation, or regional strategies for managing AMS and IPC. Furthermore, the ARCO project aims to provide a broader perspective by incorporating insights from a wider range of professionals and offering a more detailed analysis of resource allocation and organizational structures. Therefore, results from SPiNCAR and ARCO could be integrated to provide a more comprehensive and multi-faceted approach to governance for AMS and IPC across different levels of the Regional Health Service.

To our knowledge, this is the first study to provide a comprehensive understanding of HCAs' perspectives and actionable measures by combining survey data with focus group insights to identify best practices and areas for improvement. Previous studies have assessed AMS activities through surveys in community healthcare organizations, interviews with hospital managers, or by examining the perspectives of key experts and stakeholders involved in AMR policy [16, 17, 19]. However, no previous study has undertaken such a thorough contextual analysis, administering questionnaires across various structures within local healthcare organizations and subsequently gathering expert recommendations on organizational context, along with insights from regional leadership, in a regional audit approach.

Nevertheless, the study is not without its limitations. A significant challenge is the reliance on self-reported data from healthcare organizations, which could introduce reporting biases [31]. Furthermore, while the study offers valuable insights specific to the Veneto Region, its findings may not be fully generalizable to other regions due to variations in healthcare structures and challenges. Despite these limitations, the study provides actionable insights for optimizing AMS and IPC plans, contributing meaningfully to the broader goal of combating antimicrobial resistance.

In conclusion, while significant progress has been made in establishing governance frameworks for AMS and IPC in the Veneto Region, targeted operational improvements are essential for healthcare units to fully realize the potential of these programs. Strengthening unified governance structures, standardizing antibiotic consumption reports, expanding infectious disease consultation services, and ensuring adequate staffing are critical steps to enhancing the region's response to antimicrobial resistance. The ARCO project provides a valuable foundation for these efforts, offering

actionable recommendations that will be key to driving sustained improvements across both hospital and community care settings.

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