GLOBAL CORE STANDARDS FOR HOSPITAL ANTIMICROBIAL STEWARDSHIP PROGRAMS

INTERNATIONAL PERSPECTIVES AND FUTURE DIRECTIONS

Report of the Leading Health Systems Network 2018

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FOREWORD

With the evolution of superbugs – microorganisms, such as bacteria, viruses, fungi and parasites, resistant to antimicrobials – and limited developments in the antimicrobial market pipeline, antimicrobial resistance (AMR) is an immense public health threat to every region of the world. If left unchecked, we may be regressing to an era where people die in droves from common infections or routine operations. Current estimates suggest that AMR will lead to more than 10 million deaths and direct healthcare costs of up to $1 trillion annually by 2050.

Tackling AMR requires a multisectoral response spanning the food industry, sanitation, hygiene and the public as well as healthcare providers. Health systems, nevertheless, play a vital role in addressing AMR through infection control measures and the judicious use of antimicrobials, known as antimicrobial stewardship (AMS). However, they need evidence-based tools to make the most impact.

For this report, we partnered with the Center for Disease Dynamics, Economics & Policy (CDDEP) to develop an evidence-based, globally applicable tool to support health systems in the quest to address AMR. Our Checklist for Hospital Antimicrobial Stewardship Programming (CHASP) is designed to help hospitals assess whether their antimicrobial stewardship programs (ASPs) contain core essential elements for success. We then leveraged the Leading Health Systems Network (LHSN) to validate the checklist and also provide a unique insight into the composition of ASPs globally.

While there is still much work to be done, I hope that this report can serve as a starting point for providers to assess and improve their ASPs – ultimately contributing to the fight against AMR.

**Professor the Lord Darzi of Denham,
OM, KBE, PC, FRS**
Executive Chair, WISH, Qatar Foundation
Director, Institute of Global Health Innovation,
Imperial College London

EXECUTIVE SUMMARY

Antimicrobial resistance (AMR) – the reduced effective response of microorganisms to antimicrobials – is a major global public health threat. Without effective interventions, estimates suggest that, by 2050, as many as 10.2 million people will die every year due to antimicrobial resistant infections, 90 percent of which are expected to burden Asia and Africa.[1] Though the causes of AMR are complex and multisectoral, inappropriate use of antimicrobials is one of the major drivers of widespread AMR.

To address this problem, health systems around the globe have implemented antimicrobial stewardship programs (ASPs), defined as a bundled set of interventions managing the judicious use of antimicrobials. Hospital-based ASPs are shown to improve antibiotic use, while also reducing treatment cost, hospital length of stay and AMR, without compromising clinical patient outcomes. However, there is little consensus on a globally applicable essential checklist for ASP design, implementation and assessment.

To address this challenge, we partnered with CDDEP to develop an evidence-based checklist through a comprehensive literature search and review by a group of independent experts – the Checklist for Hospital Antimicrobial Stewardship Programming (CHASP). While CHASP has significant overlap with other high-quality ASP checklists – such as the US Centers for Disease Control's (CDC's) Checklist for Core Elements of Hospital Antibiotic Stewardship – it was designed to be applicable globally for both low- and high-resource settings.

To improve the applicability of CHASP and compare the composition of ASPs internationally, we asked members of LHSN – an international group of health systems and providers, hosted at Imperial College London in conjunction with WISH – to complete the checklist for their institutions.

Within our sample, institutions had implemented between 11 and 29 of the 29 checklist items, with only one institution maintaining all 29. Using these results, combined with expert interviews and a literature review, we identified five primary barriers that hospitals face in implementing ASPs as well as a number of potential strategies to address these (see Table 1).

Table 1. Summary of potential strategies for addressing barriers to antimicrobial stewardship program success

BARRIER	POTENTIAL STRATEGY
Lack of expertise	**1.** Adopt a pharmacist and nurse-led stewardship model **2.** Use the 'train the trainer' model and ensure capacity building across clinicians **3.** Participate in regional and global stewardship networks
Limited financial resources	**1.** Consider a dedicated ASP financing model **2.** Make use of available national or regional funding sources **3.** Engage with global AMS funding initiatives
Absence of hospital leadership commitment	**1.** Integrate stewardship functions into job descriptions and annual performance reviews **2.** Incorporate stewardship outcomes into key performance indicators **3.** Galvanize commitment through a formal statement of management support
Insufficient collaboration	**1.** Incorporate unit-based specialists into broad-based multidisciplinary ASP teams **2.** Monitor and adapt ASPs for improved culture and interdisciplinary team dynamics
Lack of prescriber support	**1.** Engage prescribers by persuasive methods **2.** Improve prescribers' access to data
Suboptimal engagement and support of nurses	**1.** Integrate nurse leaders into ASP decision-making **2.** Provide nurse-focused training for stewardship competencies and behavioral support of nurses **3.** Tailor communication on nurses' stewardship involvement
Suboptimal use of IT	**1.** Participate in the Global Antimicrobial Resistance Surveillance System (GLASS) **2.** Disaggregate and share unit-specific data **3.** Integrate IT-assisted signaling for priority action **4.** Invest in IT integration and consider adopting electronic health records (EHRs) with an integrated clinical decision support system (CDSS)

While improving ASPs at the provider level is an essential step, governments, regulators and policymakers also have an important role to play at the regional and national level in guiding stewardship activities and establishing consistent, evidence-based standards.

Building on the actions to overcome hospital-level barriers, we recommend the following actions for policymakers to improve AMS and address the looming crisis of AMR:
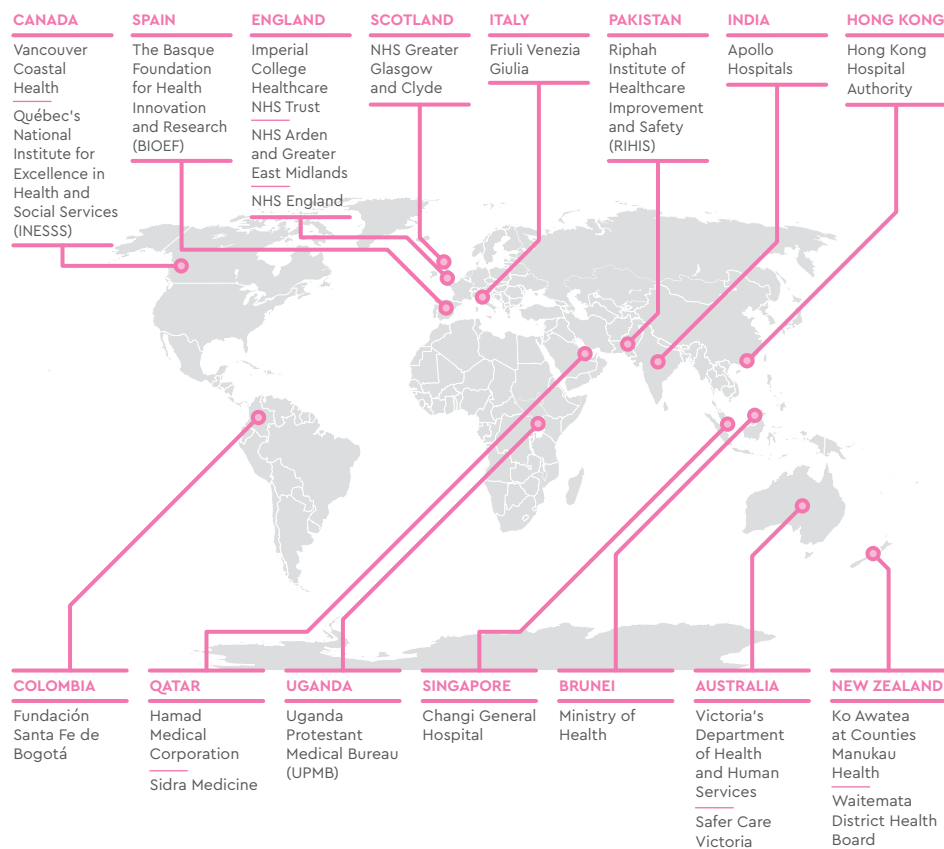
1. **Use CHASP as a model for developing national guidelines.** In response to the World Health Organization's (WHO's) global action plan, several lower- and middle-income countries (LMICs) are in the process of developing national AMS guidelines for hospitals. National policymakers should consider incorporating CHASP items to ensure that minimum standards are consistent across all hospitals.

2. **Ensure macro-level governance is aligned with key hospital ASP objectives.** For LMICs, national initiatives should ensure well-co-ordinated AMR surveillance systems. It is imperative to ensure that antimicrobials are good quality, systematically regulated and equitably priced. Countries worldwide would benefit from adopting elements of a network healthcare governance approach to better facilitate the multilevel and multisector engagement that the One Health framework has urgently called for.

3. **Initiate robust research on ASPs.** To improve hospital ASPs, more high-quality evidence on program structure, process and outcomes as well as macro-level AMS policy outcomes is essential. Lack of evidence fundamentally undermines strategic healthcare decision-making toward safeguarding antimicrobials.

4. **Establish minimum staffing standards for hospital ASPs.** Ensuring the availability of dedicated, adequately staffed stewardship teams across all hospitals is crucial. To do so, we must generate national or regional consensus on the composition, quantity and requirements of staff. Based on this consensus, policymakers should enact and reinforce regulatory measures, delineating minimum standards for sufficiently equipped and well-trained AMS teams.

SECTION 1. INTRODUCTION

About LHSN

LHSN – established in 2009 and previously known as the Leading Systems Network while based at McKinsey & Company – is a collaborative network of healthcare leaders and organizations dedicated to improving healthcare delivery (see Figure 1). Currently based at Imperial College London, and in part-nership with the World Innovation Summit for Health (WISH), LHSN brings together the best ideas, models of care, and strategies to drive sustained improvement to meet health priorities.

Figure 1. LHSN membership map

CANADA
Vancouver Coastal Health

Québec's National Institute for Excellence in Health and Social Services (INESSS)

SPAIN
The Basque Foundation for Health Innovation and Research (BIOEF)

ENGLAND
Imperial College Healthcare NHS Trust

NHS Arden and Greater East Midlands

NHS England

SCOTLAND
NHS Greater Glasgow and Clyde

ITALY
Friuli Venezia Giulia

PAKISTAN
Riphah Institute of Healthcare Improvement and Safety (RIHIS)

INDIA
Apollo Hospitals

HONG KONG
Hong Kong Hospital Authority

COLOMBIA
Fundación Santa Fe de Bogotá

QATAR
Hamad Medical Corporation

Sidra Medicine

UGANDA
Uganda Protestant Medical Bureau (UPMB)

SINGAPORE
Changi General Hospital

BRUNEI
Ministry of Health

AUSTRALIA
Victoria's Department of Health and Human Services

Safer Care Victoria

NEW ZEALAND
Ko Awatea at Counties Manukau Health

Waitemata District Health Board

In 2018 LHSN dedicated its annual program to AMS, as AMR continues to be a serious public health problem globally.[2] Throughout the year, LHSN brought together senior decision-makers and experts to share insights and strate-gies to drive sustained improvement to meet AMS priorities. Network activity has comprised: a dedicated webinar series; network discussions; exchange of resources and promising practices; and participation in the CHASP survey assessing the core elements of hospital ASPs – the focus of this report.

More information on LHSN can be found on the LHSN website: www.leadinghealthsystemsnetwork.org

Antimicrobial resistance

AMR refers to the ability of microorganisms (such as bacteria, virus, fungi and parasites) to overcome the effect of antimicrobials (antibiotics, antivirals, anti-fungal and antiparasitic agents) and continue to proliferate. AMR is recognized as a major global public health threat, with many commonly used treatments for routine infections on the verge of becoming obsolete. As highlighted in previous WISH work, AMR affects health systems around the globe and across income levels.

Figure 2. *Escherichia coli* (*E. coli*) resistance to third-generation cephalosporins (2007–2011)
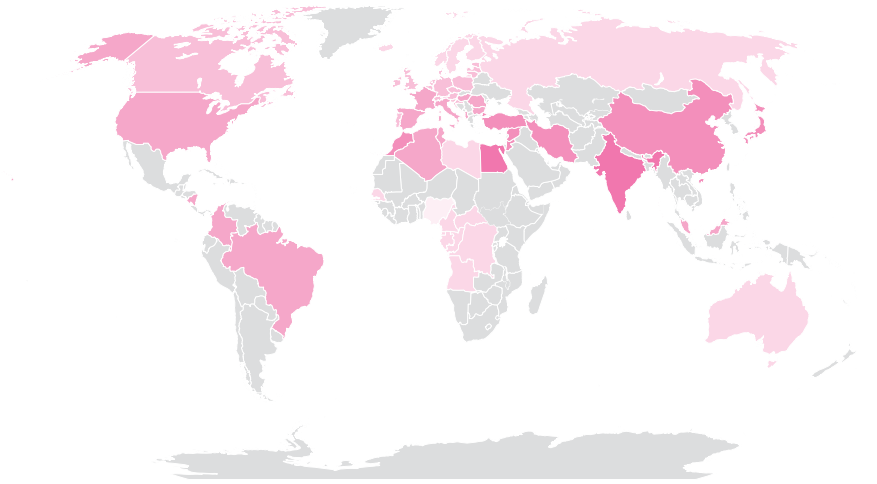

Source: McKenna M (2013)[3]

By 2050, it is estimated that AMR will cause 10 million deaths every year, which will lead to a reduction of 2 percent to 3.5 percent in gross domestic product (GDP) worldwide, costing up to $100 trillion.[4]

The causes of AMR are complex and multisectoral, spanning sanitation and hygiene, livestock practices, public awareness and activity, as well as health system action.[5] Within the provider setting, inappropriate prescribing is a key contributor to AMR, often driven by patient demand, misaligned economic incentives, lack of knowledge of appropriate antimicrobial prescribing and/or delayed laboratory results.[6]

Inappropriate use (either misuse or overuse) reduces the efficacy of antimi-crobials and results in the selection and spread of resistant strains.[7] The 2017 Organisation for Economic Co-operation and Development (OECD) report *Tackling Wasteful Spending on Health* considered this issue the "most threatening

form of wasteful clinical care". It indicated that, within hospital tertiary care settings, inappropriate use constituted just under 80 percent of all antimicrobial consumption – as shown in Figure 3.[8]

Figure 3. Estimated proportion of inappropriate antimicrobial use by type of healthcare service
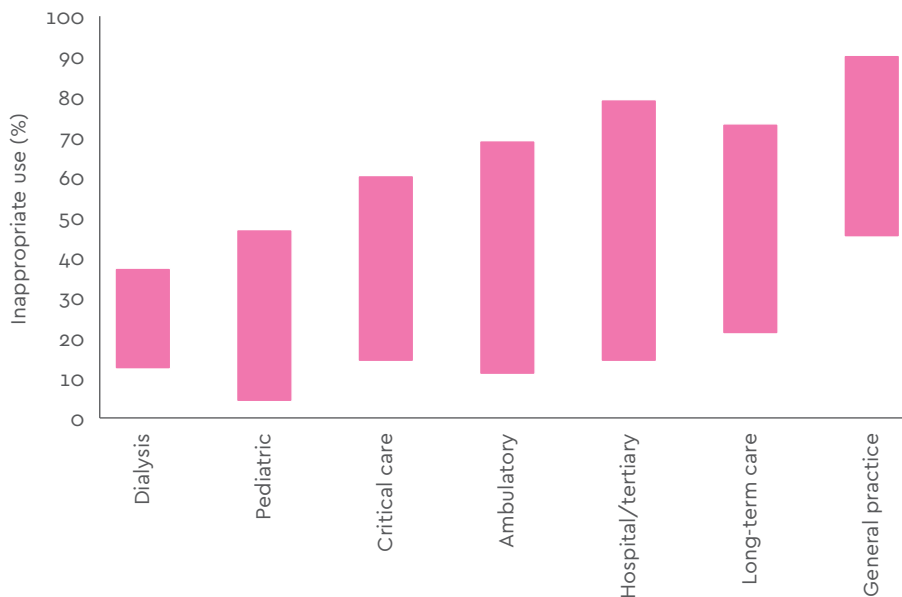
Source: OECD (2017)

Hospital-based ASPs

Hospitals and health systems employ ASPs, programs that encompass the management of the judicious use of antimicrobials, as a key tool to combat AMR.[9] The main objective of stewardship programs is to promote responsible antimicrobial use to ensure sustainable access to effective therapies for all who need them.[10] As antibiotic conservation is a complex issue, there is no one-size-fits-all approach to creating ASPs. Their composition varies based on resource availability, local context and setting (primary care, secondary care, or regional level, for example), but can span representatives from infection control, infectious disease, clinical microbiology, pharmacy, nursing, IT and clinical champions. Activities also vary, but range from encouraging or enforcing antimicrobial conservation, to implementing diagnostic protocols, to raising awareness among clinicians and patients.[11]

These programs are acutely necessary and fairly widespread among hospitals due to the prevalence of antibiotic use, susceptible patients and high rates of infection transmission in the inpatient setting.[12] Although not all hospitals have a dedicated program,[13, 14] ASPs have been shown to reduce treatment costs,[15] hospital length of stay and AMR without compromising clinical outcomes of the patients.[16, 17]

SECTION 2. CHECKLIST FOR HOSPITAL ANTIMICROBIAL STEWARDSHIP PROGRAMMING (CHASP)

Why a checklist?

While ASPs vary widely, successful programs contain a number of core elements. Checklists outlining these elements provide a practical way for providers to assess their programs and ensure that best practices are followed at scale. Internally, detailed checklists can also help all relevant stewardship personnel to align expectations and provide a useful addition to program auditing. When checklists are adopted at scale, a more reliable and accurate method of monitoring ASP performance can be achieved across multiple facilities. More importantly, evidence shows us that adopting AMS-related checklists has led to optimized antibiotic use in hospitals[18, 19] and improved healthcare overall.[20, 21]

Overview of existing checklists

AMS resources recommend the use of baseline checklists to guide the prioritization and deployment of different stewardship interventions within hospitals.[22] The CDC Core Elements of Hospital Antibiotic Stewardship Programs is among the most cited standard sets of interventions for co-ordinated multidisciplinary ASPs.[23–25] The CDC checklist based on these core elements was later launched to allow for a more systematic evaluation of the elements and activities initially recommended to enable improved antibiotic prescribing in hospitals. Many other baseline frameworks exist, including the National Institute for Health and Care Excellence (NICE) baseline assessment tool.[26]

The CDC checklist is thorough and evidence-based. However the CDC acknowledges that implementing all components may not be feasible in all hospital contexts, as the checklist was developed for high-resource settings (mainly in the US).[27]

In partnering with CDDEP to develop a checklist for this report, we sought to leverage a baseline set of program elements and interventions that would be feasible to adopt widely in all healthcare facilities, including those in low-resource settings. The differentiated value of CHASP is that it offers priority interventions for establishing ASPs in LMICs and identifying program improvement areas. At the same time, CHASP provides a broadly applicable standard set of elements and interventions, which allows for tailored implementation and adaptation to higher-resource settings. CHASP would help to set an international baseline for ASP design and implementation standards and provide a practical assessment framework from which to compare programs around the world.

CHASP development

We partnered with CDDEP to develop a checklist of the core components for successful ASPs, applicable to hospitals globally, regardless of resource level. Researchers began with a comprehensive literature review to identify references to AMS practices worldwide. This was cross-referenced with websites of relevant agencies and organizations (WHO, for example) to identify an initial list of core elements and checklist items. A core element was defined as a broad category of actions or a strategy within an ASP (for example, education), whereas checklist items described specific actions or interventions within a core element.

Researchers then convened an independent group of AMS experts from 13 countries to review the initial list and provide two rounds of feedback to confirm a final list using a Delphi consensus procedure.[28] The final checklist includes seven core elements (outlined in Figure 4) and 29 supporting checklist items, providing a comprehensive checklist of essential components for ASPs (see Figure 5).

Figure 4. The seven core elements of CHASP

ACCOUNTABILITY AND RESPONSIBILITY

Formalized program structure – including clear roles and responsibilities, delineated program protocols and action plans – ensures accountability and measurable outcomes.

SENIOR HOSPITAL MANAGEMENT AND LEADERSHIP

Support from hospital executives is crucial to ensure the success of ASPs. Leadership buy-in and governance initiatives secure critical resources for staffing, program infrastructure and IT/monitoring to achieve sustainable outcomes.

EDUCATION AND PRACTICAL TRAINING

Educational programs should be in place for all health professionals with antimicrobial prescribing responsibilities. This training ensures that staff are aware of, and able to meet, the most up-to-date prescribing standards.

AVAILABLE EXPERTISE ON INFECTION MANAGEMENT

Access to microbiology laboratory and imaging services is key for promptly identifying and tracking AMR trends, while infectious disease and clinical microbiology expertise helps guide clinicians in responsible prescribing.

MONITORING AND SURVEILLANCE

Effective stewardship requires reliable data. Ongoing monitoring and surveillance of structure, process and outcome indicators provides valuable insight on key program areas for improvement.

REPORTING AND FEEDBACK

Regular sharing of antimicrobial monitoring data, both of antimicrobial resistant infections and program components, helps to reinforce institution-wide learning and improvement. This iterative process may also help motivate staff participation in new activities to address gaps in performance.

ACTIONS AIMED AT RESPONSIBLE ANTIMICROBIAL USE

Stewardship programs should comprise fundamental activities and tools to support evidence-based practice. These include components such as adequate IT services, an established antimicrobial formulary and up-to-date infection management guidelines.

CHECKLIST FOR
HOSPITAL ANTIMICROBIAL
STEWARDSHIP PROGRAMMING*

_____

1. Senior management leadership towards AMS

1.1 Has your hospital management formally identified AMS as a priority objective for the institution and included it in its key performance indicators?

☐ Yes ☐ No

1.2 Is there dedicated and sustainable budgeted financial support for AMS activities (eg support for salary, training or IT)?

☐ Yes ☐ No

1.3 Does your hospital follow any (national or international) staffing standards for AMS activities (eg number of full-time equivalent per 100 beds for the different members of the AMS team)?

☐ Yes ☐ No

2. Accountability and responsibilities

2.1 Does your hospital have a formal, written ASP or strategy accountable for ensuring appropriate antimicrobial use?

☐ Yes ☐ No

2.2 Does your hospital have a formal organizational multidisciplinary structure responsible for AMS (eg a committee focused on appropriate antimicrobial use, a pharmacy committee, a patient safety committee or other relevant structure)?

☐ Yes ☐ No

2.3 Is there a healthcare professional identified as a leader for AMS activities at your hospital and responsible for implementing the program?

☐ Yes ☐ No

2.4 Is there a document clearly defining roles, procedures of collaboration and responsibilities of the AMS team members?

☐ Yes ☐ No

2.5 Are clinicians, other than those part of the AMS team (eg from the intensive care unit, internal medicine and surgery) involved in the AMS committee?

☐ **Yes** ☐ **No**

2.6 Does the antimicrobial stewardship committee produce regularly a dedicated report which includes, for example, antimicrobial usage data and/or prescription improvement initiatives, with time-committed short-term and long-term measurable goals for optimizing antimicrobial use?

☐ **Yes** ☐ **No**

2.7 Is there a document clearly defining the procedures of collaboration of the AMS team/committee with the infection prevention and control team/committee?

☐ **Yes** ☐ **No**

3. Available expertise on infection management

3.1 Do you have access to laboratory/imaging services and timely results to be able to support the diagnosis of the most common infections at your hospital?

☐ **Yes** ☐ **No**

3.2 In your hospital are there, or do you have access to, trained and experienced healthcare professionals (medical doctor, pharmacist, nurse etc) in infection management (diagnosis, prevention and treatment) and stewardship willing to constitute an AMS team?

☐ **Yes** ☐ **No**

4. Education and practical training

4.1 Does your hospital offer a range of educational resources to support staff training on how to optimize antimicrobial prescribing?

☐ **Yes** ☐ **No**

4.2 Do the AMS team members receive regular training in antimicrobial prescribing and stewardship?

☐ **Yes** ☐ **No**

5. Other actions aimed at responsible antimicrobial use

5.1 Is a multidisciplinary AMS team available at your hospital (eg more than one trained staff member supporting clinical decisions to ensure appropriate antimicrobial use)?
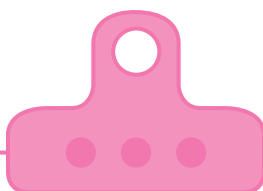
☐ **Yes** ☐ **No**

5.2 Does your hospital support the AMS activities/strategy with adequate information technology services?

☐ **Yes** ☐ **No**

5.3 Does your hospital have an antimicrobial formulary (that is, a list of antimicrobials that have been approved for hospital use, specifying whether the drugs are unrestricted, restricted – approval of an AMS team member is required – or permitted for specific conditions)?

☐ **Yes** ☐ **No**

5.4 Does your hospital have available and up-to-date recommendations for infection management (diagnosis, prevention and treatment), based on international/national evidence-based guidelines and local susceptibility (when possible), to assist with antimicrobial selection (indication, agent, dose, route and duration) for common clinical conditions?

☐ **Yes** ☐ **No**

5.5 Does your hospital have a written policy that requires prescribers to document an antimicrobial plan (includes indication, name, dosage, duration, route and interval of administration) within the medical record or during order entry for all antimicrobial prescriptions?

☐ **Yes** ☐ **No**

5.6 Does the team review or audit courses of therapy for specified antimicrobial agents or clinical conditions at your hospital?

☐ **Yes** ☐ **No**

5.7 Is advice from AMS team members easily available to prescribers?

☐ **Yes** ☐ **No**

5.8 Are there regular infection and antimicrobial prescribing-focused ward rounds in specific departments in your hospital?

☐ **Yes** ☐ **No**

6. Ongoing monitoring and surveillance

6.1 Does your hospital monitor the quality of antimicrobial use at the unit and/or hospital-wide level?

☐ **Yes** ☐ **No**

6.2 Does your stewardship program monitor compliance with one or more of the specific interventions put in place by the stewardship team (eg indication recorded in the medical notes for all antimicrobial prescriptions)?

☐ **Yes** ☐ **No**

6.3 Does your hospital monitor antibiotic susceptibility rates for a range of key bacteria?

☐ **Yes** ☐ **No**

6.4 Does your hospital monitor the quantity of antimicrobials prescribed, dispensed or purchased at the unit and/or hospital-wide level?

☐ Yes ☐ No

7. Regular reporting and feedback

7.1 Does your stewardship program share hospital-specific reports on the quantity of antimicrobials prescribed, dispensed or purchased with prescribers?

☐ Yes ☐ No

7.2 Does your stewardship program share facility-specific reports on antibiotic susceptibility rates with prescribers?

☐ Yes ☐ No

7.3 Are results of audits and reviews of the quality or appropriateness of antimicrobial use communicated directly with prescribers?

☐ Yes ☐ No

* Translations – Arabic, Mandarin, Portuguese and Spanish – are available online at the LHSN website: www.leadinghealthsystemsnetwork.org/chasp

Source: Pulcini C et al. (2018)[29]

SECTION 3. APPLYING CHASP ACROSS LHSN MEMBERSHIP

Approach

We surveyed an international group of LHSN member institutions to test the ASP checklist for usability and also gather insight on a variety of international ASP configurations. The survey sample comprises a diverse geographic community of leading healthcare institutions representing nine countries (as shown in Figure 5).

Ten institutions are based in high-income countries, while two are in LMICs. Ten institutions are public and two are private. The sample size includes teaching and non-teaching hospitals with various ASP team models. More information on participants can be found in the online appendix available on the LHSN website.

We distributed CHASP as an internet-based questionnaire to ASP leaders or pharmacist prescribers from March to April 2018. Each question had a space for respondents' comments. After careful review of the 12 survey responses, clarification was requested regarding the question on funding for ASP activities, since three institutions responded with 'no'. Those who responded to this question with 'yes' also commented that there was a dedicated budget allocation, although it was insufficient for all ASP activities. Therefore, respondents indicating 'no' were able to clarify whether this also applied to their local ASP. Two confirmed that they have dedicated, yet insufficient, funding. Based on this feedback, the word 'sufficient' was removed from the initial checklist item. When participants were requested to indicate if additional essential items should be considered, they did not recommend any additional items.

Results

This section provides an overview of CHASP responses from our sample of LHSN member institutions, broken down across each of the seven core elements.

Figure 5. CHASP participants
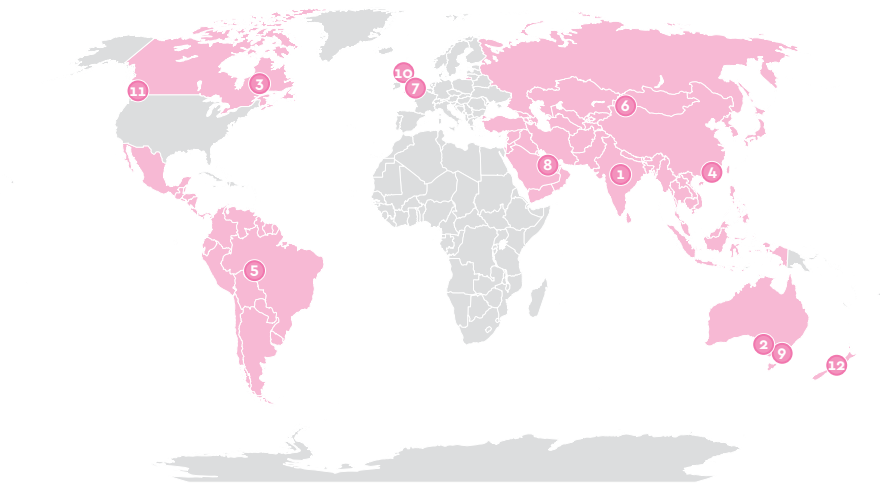
1 Apollo Hospitals, India (units at Delhi, Chennai and Hyderabad as participants in this report)

Based in India, Apollo Hospitals is a private integrated healthcare provider, with 70 hospitals, over 100 primary care clinics and 3,000 pharmacies. Other services in the spectrum include primary care, diagnostic clinics, telemedicine, health insurance, research, medical education and nursing education.

2 Ballarat Health Services, Australia

Ballarat Health Services is a public hospital serving the Ballarat and Grampians region of Victoria, Australia, offering acute care, sub-acute care, residential care, community care, psychiatric services, and rehabilitation services. It encompasses the base hospital, the nearby Queen Elizabeth Centre, and 13 off-site facilities in the surrounding area.

3 CIUSSS de l'Estrie – CHUS, Canada

The Sherbrooke University Hospital Center (CHUS) is the fourth largest hospital in Quebec and the local hospital for Sherbrooke residents. It provides specialized and ultra-specialized care to the entire population of the Eastern Townships. In addition, CHUS has provided ultra-specialized care in cardiology, neurosurgery, medical and surgical oncology, and neonatology to people from the Centre-du-Québec and part of the Montérégie regions. CHUS offers services to about one million people.

4 Hong Kong Hospital Authority, Hong Kong

Hong Kong Hospital Authority (HKHA) manages Hong Kong's public hospitals and is responsible for delivering people-centered preventative, curative and rehabilitative healthcare services.

5 Hospital A, Latin America

Hospital A is a public hospital based in Latin America, providing care to a population of approximately 1.4 million.

6 Hospital B, Asia

Hospital B is a public hospital based in Asia and provides over 23 medical services, including general surgery, internal medicine, cardiology, otorhinolaryngology and orthopedic surgery. It encompasses six specialist centers.

7 Imperial College Healthcare NHS Trust, UK

Imperial College Healthcare NHS Trust (ICHNT) provides acute and specialist healthcare for a population of nearly two million people in North West London, and more beyond. It encompasses five hospitals – Charing Cross, Hammersmith, Queen Charlotte's & Chelsea, St Mary's and Western Eye – as well as a growing number of community services.

8 Sidra Medicine, Qatar

Sidra Medicine is a private academic medical center based in Doha, Qatar, specializing in care for women and children. It was formed as an initiative of the Qatar Foundation and is affiliated with the Weill Cornell Medical College in Qatar.

9 St Vincent's Hospital Melbourne, Australia

St Vincent's Hospital Melbourne (SVHM) is part of the St Vincent's Health Australia group of companies, Australia's largest not-for-profit Catholic health and aged care provider, operating in six public hospitals, nine private hospitals and 17 aged care facilities in Queensland, New South Wales and Victoria. SVHM encompasses the Fitzroy campus, St George's Hospital and Caritas Christi. Areas of expertise include neurosurgery, cardiothoracic surgery, renal transplantation, inflammatory bowel disease, cancer, critical care and emergency services, drug and alcohol services and palliative care.

10 University Hospitals of Leicester NHS Trust, UK

University Hospitals of Leicester NHS Trust (UHL) serves the one million residents of Leicester, Leicestershire and Rutland – and provides increasingly specialist services over a much wider area. Specialist treatment and services in cardiorespiratory diseases, extracorporeal membrane oxygenation, cancer and renal disorders reach a further two to three million patients from the UK.

11 Vancouver Coastal Health, Canada

Vancouver Coastal Health (VCH) is a publicly funded regional health authority in British Columbia (BC) with a network of hospitals, primary care clinics, community health centers and residential care homes. VCH provides healthcare services in Vancouver, Richmond, North and West Vancouver and along the Sea-to-Sky Highway, Sunshine Coast and BC's Central Coast.

12 Waitemata District Health Board, New Zealand

Waitemata District Health Board (DHB) serves the communities of Rodney, North Shore and Waitakere. With more than 580,000 people, it is the largest New Zealand DHB by population. It provides secondary hospital and community services from North Shore and Waitakere hospitals and 30 community sites throughout the district.

1. Senior management leadership towards AMS

Figure 6. Aggregated responses of 12 institutions on hospital management and leadership

	AMS as key performance indicator	Dedicated funding	Staffing standards for ASP
Apollo Hospitals	✓	✓	✓
Ballarat Health Services	✓	✗	✗
CIUSSS de l'Estrie – CHUS	✓	✓	✓
HKHA	✓	✓	✗
Hospital A	✓	✓	✗
Hospital B	✓	✗	✓
ICHNT	✓	✓	✗
Sidra Medicine	✓	✓	✗
SVHM	✓	✓	✗
UHL	✗	✓	✗
VCH	✗	✗	✗
Waitemata DHB	✓	✓	✗

Within our sample, we found an overall high level of support for ASPs from hospital leadership across two of the three core elements. All but two institutions (83 percent) indicated that AMS is a key performance indicator in their institution, and nine out of 12 (75 percent) have dedicated funding for their ASP. Uninterrupted financial support allows for smooth implementation of ASP activities. However, it is important to note that the minimum or ideal level of financial support is unknown.[30]

Only three of the institutions sampled (Apollo Hospitals, CIUSSS de l'Estrie – CHUS and Hospital B) have staffing standards for ASPs, representing an area for improvement. Among all 29 checklist items, following staffing standards was the least common component across all institutions surveyed. Despite their key role in optimizing the management of infections, this finding is consistent with trends in most countries, where stewardship program teams are commonly not formed or remain understaffed.[31]

2. Accountability and responsibilities

Figure 7. Aggregated responses of 12 institutions on accountability and responsibilities of ASP teams

	Formal ASP strategy	Multidisciplinary structure for ASP	Identified ASP leader	Document defining roles of ASP team members	Other specialty clinicians in ASP committee	Report from ASP committee	Document defining collaboration of ASP with infection control committee
Apollo Hospitals	✓	✓	✓	✓	✓	✓	✓
Ballarat Health Services	✓	✓	✓	✗	✗	✓	✓
CIUSSS de l'Estrie – CHUS	✓	✓	✓	✗	✗	✓	✗
HKHA	✓	✓	✓	✓	✓	✓	✓
Hospital A	✓	✓	✓	✗	✓	✗	✗
Hospital B	✓	✓	✓	✗	✗	✓	✗
ICHNT	✓	✓	✓	✓	✓	✓	✓
Sidra Medicine	✓	✓	✓	✓	✓	✓	✓
SVHM	✓	✓	✓	✓	✓	✓	✓
UHL	✗	✓	✓	✓	✓	✗	✗
VCH	✗	✓	✓	✓	✗	✗	✓
Waitemata DHB	✗	✓	✓	✓	✓	✗	✗

Five institutions in our sample (Apollo Hospitals, HKHA, ICHNT, Sidra Medicine and SVHM) maintain all of the checklist items for accountability and responsibilities, while six hospitals maintain only four of the seven.

Nine out of 12 institutions maintain a formal ASP strategy, though these results do not indicate the extent to which strategies are implemented. Formal ASP strategies should include a regularly updated document with planned activities and monitored activity findings to ensure appropriate antimicrobial use.

While all institutions (100 percent) indicated that they have a multidisciplinary structure for their ASP committee and an ASP leader for implementing the stewardship activities, some gaps remain. About two-thirds of institutions indicated possessing:

1. a document defining the roles of ASP team members, healthcare professionals other than those part of the antibiotic stewardship team (for example, from the intensive care unit, surgery or nursing personnel) involved in the antibiotic stewardship committee; and

2. a dedicated report produced by the ASP committee.

Only slightly more than half of participants maintain a document defining procedures to guide collaboration between the stewardship team and the infection prevention and control (IPC) team. Having clearly defined procedures between the ASP team, including surgeons and the IPC team, is imperative to prevent gaps in antibiotic decision-making. Ambiguity of responsibility in the perioperative phase of surgery can also lead to poor choice, timing and dose of prophylaxis, resulting in poor health outcomes.[32]

3. Available expertise on infection management

Figure 8. Aggregated responses of 12 institutions on availability of expertise on infection management

	Access to diagnostic services	Access to trained healthcare professionals in infection management
Apollo Hospitals	✓	✓
Ballarat Health Services	✓	✓
CIUSSS de l'Estrie – CHUS	✓	✓
HKHA	✓	✓
Hospital A	✗	✓
Hospital B	✓	✓
ICHNT	✓	✓
Sidra Medicine	✓	✓
SVHM	✓	✓
UHL	✓	✓
VCH	✓	✓
Waitemata DHB	✓	✓

With the exception of Hospital A (which does not have access to diagnostic services), our sample institutions all maintain both items in the core element of expertise on infection management. Having sufficient numbers of healthcare professionals with appropriate education and training is crucial to provide ASP services, as is access to laboratory services to support the timely diagnosis of infections. While LHSN member participants perform well in this dimension, it is worth noting that resource-constrained hospitals and those in remote areas may not have ready access to these items.

4. Education and practical training

Figure 9. Aggregated responses of 12 institutions on education and practical training

	Educational resources for optimizing antimicrobial prescribing	ASP team receives regular training in antimicrobial prescribing
Apollo Hospitals	✓	✓
Ballarat Health Services	✗	✗
CIUSSS de l'Estrie – CHUS	✓	✓
HKHA	✓	✓
Hospital A	✗	✗
Hospital B	✓	✓
ICHNT	✓	✓
Sidra Medicine	✓	✗
SVHM	✓	✗
UHL	✓	✗
VCH	✗	✓
Waitemata DHB	✓	✓

Comprehensive and up-to-date education is essential to influence prescribing behavior and also increases the support for, and acceptance of, stewardship strategies. Within our sample, nine out of 12 (75 percent) institutions confirmed that educational resources for optimizing antimicrobial prescribing are available to their prescribers, whereas only seven out of 12 (58 percent) indicated that their ASP team members receive regular training in infection management and antimicrobial prescribing. It is important to note that regular training is often not offered by individual hospitals but rather by regional, national or international authorities. It is therefore critical for hospital leadership to support and encourage employees to regularly attend these sessions.

5. Other actions aimed at responsible antimicrobial use

Figure 10. Aggregated responses of 12 institutions on actions aimed at responsible antimicrobial use

	Multidisciplinary ASP team	Have adequate information on technology services	Antimicrobial formulary	Up-to-date recommendations for infection management	Policy on documenting an antimicrobial plan	Auditing by ASP team	Advice from ASP team available to prescribers	Ward rounds focused on antimicrobial prescribing
Apollo Hospitals	✓	✓	✓	✓	✓	✓	✓	✓
Ballarat Health Services	✓	✗	✓	✓	✓	✓	✓	✓
CIUSSS de l'Estrie – CHUS	✓	✓	✓	✓	✗	✓	✓	✗
HKHA	✓	✓	✓	✓	✓	✓	✓	✓
Hospital A	✗	✗	✓	✗	✓	✗	✗	✗
Hospital B	✓	✓	✓	✓	✓	✓	✓	✓
ICHNT	✓	✓	✓	✓	✓	✓	✓	✓
Sidra Medicine	✓	✓	✗	✓	✗	✓	✓	✓
SVHM	✓	✓	✓	✓	✓	✓	✓	✓
UHL	✓	✗	✓	✗	✓	✓	✓	✓
VCH	✓	✗	✓	✓	✗	✓	✓	✗
Waitemata DHB	✓	✓	✓	✓	✗	✓	✓	✗

Overall, the institutions in our sample maintain many of the actions aimed at responsible antimicrobial use, with five of the 12 hospitals having all eight checklist items. Nearly all (92 percent) institutions indicated having multidisciplinary ASP teams, auditing by an ASP team, easy access to the ASP team and an antimicrobial formulary. A large majority (83 percent) of institutions reported having up-to-date recommendations on infection management for common clinical conditions, whereas eight out of 12 (67 percent) reported having ward rounds focused on antimicrobial prescribing, policies on documenting antimicrobial plans by prescribers and adequate IT services to assist AMS activities. These items, particularly ward rounds focused on antimicrobial prescribing, represent an opportunity for ASP champions to raise the profile of AMS and provide informal training to supplement formal educational resources.

As echoed in the previous section, our sample is also skewed towards high-resource environments. Hospital A, one of two institutions located in LMIC, has only two of the items in this core element.

6. Ongoing monitoring and surveillance

Figure 11. Aggregated responses of 12 institutions on monitoring and surveillance

	Monitor quality of antimicrobial use	Monitor compliance with specific intervention determined by ASP team	Monitor resistance rates of key bacteria	Monitor quantity of antimicrobials prescribed
Apollo Hospitals	✓	✓	✓	✓
Ballarat Health Services	✓	✓	✓	✓
CIUSSS de l'Estrie – CHUS	✓	✓	✓	✓
HKHA	✓	✓	✓	✓
Hospital A	✗	✗	✓	✓
Hospital B	✓	✓	✓	✓
ICHNT	✓	✓	✓	✓
Sidra Medicine	✓	✓	✓	✓
SVHM	✓	✓	✓	✓
UHL	✓	✓	✗	✓
VCH	✓	✗	✓	✓
Waitemata DHB	✗	✗	✓	✓

Eight of the 12 institutions in our sample maintain all checklist items related to monitoring and surveillance. Also, all institutions monitor the quantity of antimicrobials prescribed, and 11 out of 12 monitor resistance rates of key bacteria. This finding is unsurprising, given that many institutions are required, either by state or national regulations, to report on these items.

Interestingly, however, fewer institutions (75 percent) monitor compliance with specific interventions designated by their ASP teams. Monitoring program compliance along with other process indicators allows hospitals to ensure that they are meeting their goals, while identifying areas for program improvement.

7. Regular reporting and feedback

Figure 12. Aggregated responses of 12 institutions on reporting and feedback

	Quantity of antimicrobials prescribed in hospitals are shared with prescribers	Hospital antibiotic resistance rates are shared with prescribers	Feedback to prescribers on antimicrobial audit
Apollo Hospitals	✓	✓	✓
Ballarat Health Services	✓	✗	✓
CIUSSS de l'Estrie – CHUS	✓	✓	✓
HKHA	✓	✓	✓
Hospital A	✗	✗	✗
Hospital B	✓	✗	✓
ICHNT	✓	✓	✓
Sidra Medicine	✗	✓	✓
SVHM	✗	✓	✓
UHL	✗	✗	✓
VCH	✓	✓	✓
Waitemata DHB	✗	✗	✓

While most (11 out of 12) hospitals share individual feedback from audits and reviews on the quality of antimicrobial prescribing directly with prescribers, only seven out of 12 institutions share hospital-specific reports on antimicrobial susceptibility rates and the quantity of antimicrobials prescribed in their hospital.

As shown in Figure 11, all of the hospitals in our sample already monitor the quantity of antimicrobials prescribed in their institutions; reporting this information to prescribers represents an easy, low-cost way to raise awareness of AMS.

Key findings

Figure 13. Number of checklist items present at each institution that participated in the survey
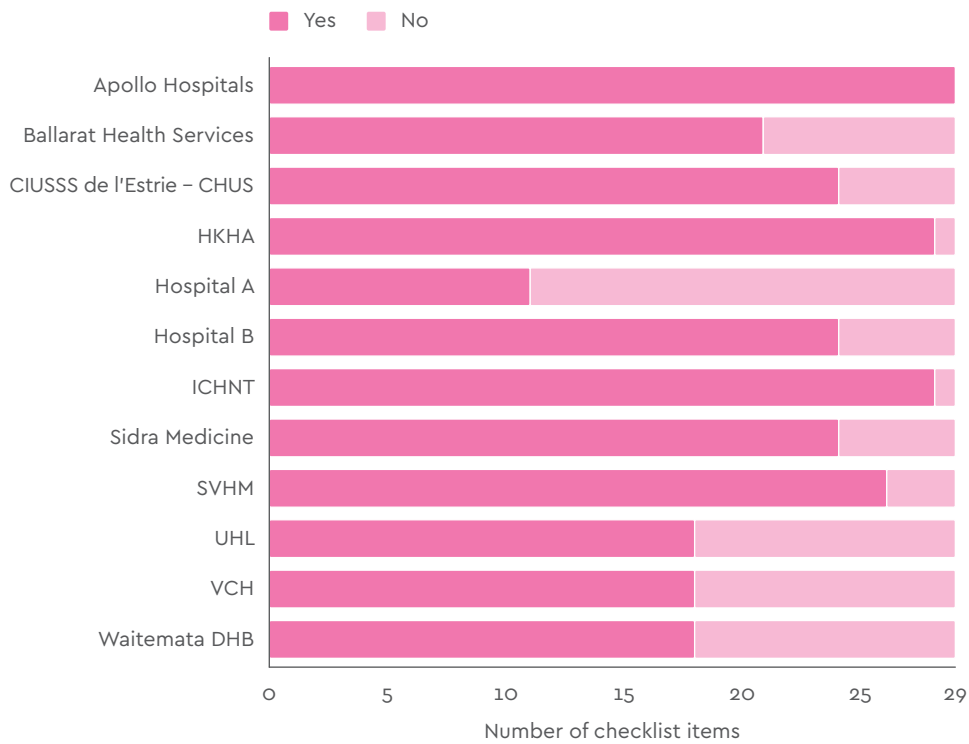
Four checklist items were present in all institutions that participated in the survey:

1. Multidisciplinary structure for ASP

2. Identified leader for ASP

3. Access to trained healthcare professionals for infection management

4. Monitoring of the quantity of antimicrobials prescribed.

In contrast, no single checklist item was absent in all institutions that participated in the survey, indicating that these checklist items are practical and could be implemented in hospital ASPs worldwide.

Overall, 11 checklist items were identified to be absent in at least one-third of the institutions that participated in this survey (Figure 14), highlighting key areas for potential improvement. The presence of staffing standards was the least common element in the survey, highlighting a need for a wider consensus on the ideal structure for antimicrobial stewardship teams. Similarly, documents that clearly define roles within teams and ways of working across teams were also absent in a number of institutions. Other gaps relate to a number of factors, including IT services, information sharing and training.

Figure 14. Checklist items absent in at least one-third of the institutions in the survey
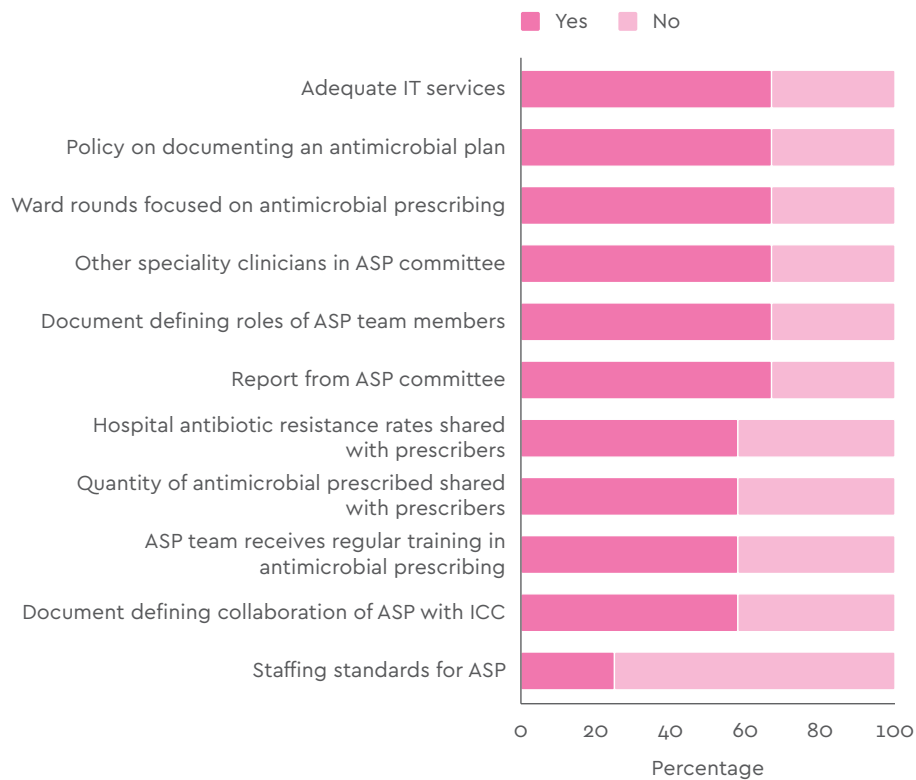
Several interlinking factors contribute to program development and the feasibility of implementing a comprehensive antimicrobial stewardship strategy, from resource availability to access to a well-trained workforce. Hospitals, particularly with limited resources, face a number of barriers to implementing evidence-based, comprehensive ASPs. We explore these issues in the next section (Section 4. Improving antimicrobial stewardship at the hospital level) and provide some suggested actions to overcome these barriers.

Limitations

There are some limitations that should be considered when interpreting the survey results. First, although the participating institutions were from nine different countries, the sample size of 12 institutions is small. A different panel composition could always lead to contrasting results. Therefore, a more robust process with a larger sample size could have led to differences in the final modification of the recommended checklist items and wider variation in ASP structure. Second, it was not possible to independently verify the accuracy of all responses provided by the participating institutions. The extent to which there is fidelity in the implementation of certain checklist items is unknown. It is also important to recognize the limited representation of LMICs among the surveyed institutions.

SECTION 4. IMPROVING ANTIMICROBIAL STEWARDSHIP AT THE HOSPITAL LEVEL

Overview

AMS is one of the key tools healthcare providers can employ in the fight against AMR. While there is no 'perfect' model for ASPs, it is clear that we must improve if we are to stem the spread of AMR.

Building on the data from the LHSN member survey, we discussed results with participants and probed on reasons why key components of hospital-level ASPs are not fully implemented. We uncovered a series of implementation barriers, common across systems and geographies, and complemented these findings with insights from a literature review. Finally, we collected evidence for addressing the barriers, at the hospital level, from the literature and LHSN participating institutions. The result is a summary of the common barriers to comprehensive ASP implementation and an action plan to overcome them.

Figure 15. Barriers to hospital-based ASP success
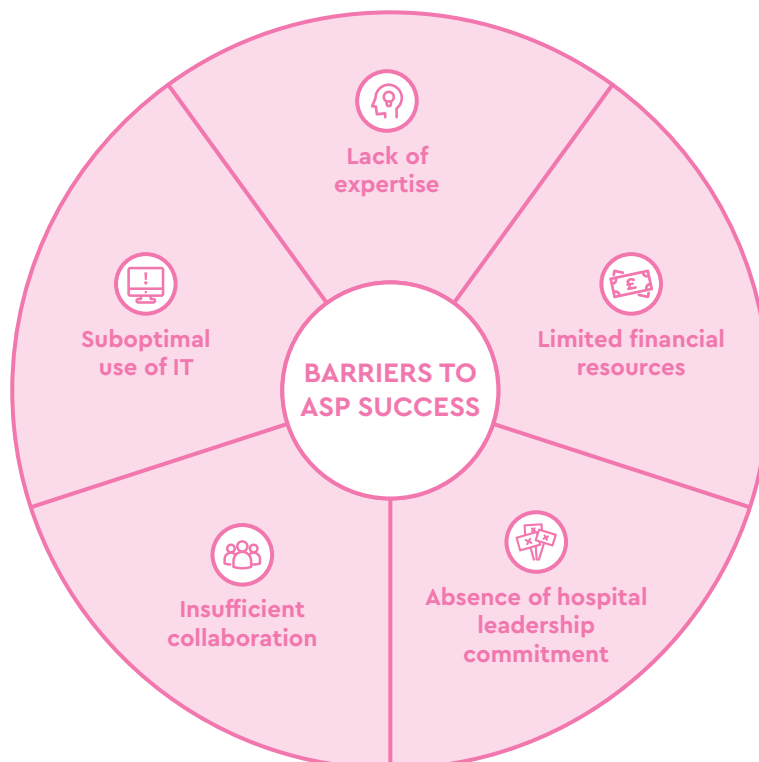
Table 2. Action plan to tackle ASP barriers

BARRIER	POTENTIAL STRATEGY
Lack of expertise	1. Adopt a pharmacist and nurse-led stewardship model 2. Use the 'train the trainer' model and ensure capacity building across clinicians 3. Participate in regional and global stewardship networks
Limited financial resources	1. Consider a dedicated ASP financing model 2. Make use of available national or regional funding sources 3. Engage with global AMS funding initiatives
Absence of hospital leadership commitment	1. Integrate stewardship functions into job descriptions and annual performance reviews 2. Incorporate stewardship outcomes into key performance indicators 3. Galvanize commitment through a formal statement of management support
Insufficient collaboration	1. Incorporate unit-based specialists into broad-based multidisciplinary ASP teams 2. Monitor and adapt ASPs for improved culture and interdisciplinary team dynamics
Lack of prescriber support	1. Engage prescribers by persuasive methods 2. Improve prescribers' access to data
Suboptimal engagement and support of nurses	1. Integrate nurse leaders into ASP decision-making 2. Provide nurse-focused training for stewardship competencies and behavioral support of nurses 3. Tailor communication on nurses' stewardship involvement
Suboptimal use of IT	1. Participate in the Global Antimicrobial Resistance Surveillance System (GLASS) 2. Disaggregate and share unit-specific data 3. Integrate IT-assisted signaling for priority action 4. Invest in IT integration and consider adopting electronic health records (EHRs) with an integrated clinical decision support system (CDSS)

Addressing barriers

Barrier 1. Lack of expertise

Lack of available experts is one of the greatest barriers to running an ASP.[33] Although having an infectious disease (ID) specialist and ID pharmacist may be ideal, they are not always available at healthcare facilities around the world. Improvements to antimicrobial use is difficult to achieve without well-trained experts. ID professionals lead the development of hospital guidelines[34] and provide clinical guidance on diagnostic evaluation and treatment of infectious

diseases, including difficult-to-treat pathogens, complicated infections and AMR. Poor quality data also largely inhibits ASP teams and relevant clinicians from developing an adequate level of expertise.

Actions

1. **Adopt a pharmacist and nurse-led stewardship model**

   Though many institutions only target medical prescribers in training initiatives,[35] it is important to optimize the contribution of nursing and pharmacy professionals within AMS activities, especially in resource-limited settings. As attested in South Africa's Netcare Group model involving 'quick wins', a pharmacist and nurse-led stewardship model has promising potential for scaling up across other LMICs facing limited expertise in urban and rural settings.[36,37] However, commitment from public authorities, hospital senior management and clinicians is essential for making this shift successful.

2. **Use the 'train the trainer' model and ensure capacity building across clinicians**

   'Train the trainer' models, wherein staff are not only given training within a discipline but also the tools to independently train others, have been successfully employed to support the development of ASP leaders.[38] Involving other health professionals, including nurses, in these programs is also particularly useful in environments with limited human resources. Extending training activities on AMR and stewardship competencies to all clinical staff will maximize existing resources and collaboration to more effectively meet stewardship needs.

   To bridge gaps in expertise, stewardship training should link learning to ward rounds, interventions in clinical settings and available resistance data.[39] This will allow AMS teams in resource-limited settings to better analyze the existing data to identify areas for data quality improvement and continued targeted data training.[40] Open-ended online courses[41] on stewardship designated for healthcare professionals are an important resource[42] for complementing, rather than replacing, targeted training using local data and context.[43,44]

3. **Participate in regional and global stewardship networks**

   Access to AMS networks presents a valuable opportunity.[45,46] Comparison of international responses and exchange of experiences can help stewardship leaders gain new practical insights and achieve a better mix of ASP interventions that are more conducive to sustainable and resilient programs.[47] Cross-national networks and collaborations have served to catalyze formalized global mentoring programs,[48] such as the UK's Fleming Fund which addresses surveillance issues.

Barrier 2. Limited financial resources

As reported by most LHSN participating institutions, ASP funding was largely not considered to be sufficient. Limited financial resources are among the top challenges to developing sustainable hospital stewardship, especially in LMICs.[49] Achieving sustainable implementation of ASPs requires financial support to provide adequate human resource, laboratory infrastructure,[50] IT tools, reporting mechanisms and educational resources.[51–53] Sufficient numbers of well-qualified stewardship personnel are essential for day-to-day performance. Investment in IT is critically important to track ASP interventions and outcomes and enable evidence-based decision-making. Investment in additional resources, including education and training, is also valuable. However, allocating additional resources, either through new or existing funding, is often difficult.

Actions

1. **Consider a dedicated ASP financing model**
   Traditionally, stewardship financing, resources and programming have merged into existing institutional structures and mechanisms for infection control. However, stewardship programs in the US and Canada have sought separate, dedicated program budgets to ensure the prioritization of stewardship needs within overall resource allocation.[54, 55] As Canada's Alberta Health Services' experience demonstrates, pitching a robust business case[56] for dedicated funding can positively sway financial decision-making. Making the case for individual institutions, rather than relying solely on region-wide funding can also be helpful.[57]

2. **Make use of available national or regional funding sources**
   While availability varies by country and setting, there are often regional- or national-level budgets available to hospitals and individual providers to support key strategic targets. In the UK, for example, to combat the rise of AMR and *Clostridium difficile* (*C. difficile*) infections,[58, 59] the Department of Health granted a three-year funding initiative of £12 million for hospital pharmacies to update anti-infection guidelines, introduce joint ward rounds, establish surveillance and audits, and expand education opportunities.[60] Applying for this type of funding allows hospitals to expand or improve their program activity without directly allocating more resources at the institutional level.

3. **Engage in global AMS funding initiatives**
   Hospitals and health systems in LMICs should explore financing opportunities provided by the Fleming Fund, a UK Government aid program supporting LMICs to address priorities in tackling AMR through country and regional grants and a fellowship scheme. The fund supports surveillance and capacity-building for human resources and laboratory infrastructure.

AMS funding initiatives such as this bring benefits to countries collectively, as they share surveillance data to better understand the scale and scope of AMR globally.

Barrier 3. Absence of hospital leadership commitment

The robustness and long-term sustainability of stewardship programming is greatly compromised by limited commitment of senior hospital management leaders, including hospital executives and board trustees. These personnel play a pivotal role in securing critical stewardship resources, such as human, financial and IT resources. Lack of buy-in from ASP committee leaders can also derail program success, as these figures exert a great deal of influence over the staff responsible for implementing ASP initiatives. Vocal and clear support from hospital and AMS committee leaders is essential for the success of any stewardship program in any setting.

Actions

1. **Integrate stewardship functions into job descriptions and annual performance reviews**
   As advocated by the CDC, clearly delineating stewardship tasks within job descriptions and evaluation criteria of key leaders is one concrete structural strategy to increase staff awareness, responsibility and accountability for ASP objectives.[61] However, hospital leaders must balance this accountability while still encouraging involvement from those that may be less directly accountable for ASP activity. As staff are likely faced with multiple commitments, it is critical to incentivize meaningful involvements in ASP design and implementation.[62]

2. **Incorporate stewardship outcomes into key performance indicators**
   Regularly reporting on stewardship program inputs, processes and outcomes at hospital board meetings will help leaders[63] prioritize stewardship activities and draw more attention to gaps in performance. Similarly, regular ASP progress briefings at senior management meetings may help incentivize leaders to support and prioritize the establishment of new policies for new ASP components.[64] This should ultimately lead to incorporating stewardship into accountability documents, technology initiatives and plans for budgets, infection prevention, performance improvement and strategy.[65]

3. **Galvanize commitment through a formal statement of management support**
   The CDC also recommends formal statements in support of ASPs.[66] They can complement other leadership commitment initiatives by reinforcing the magnitude of strategic importance hospitals place on aligning institution-wide leaders for rational antimicrobial use.

Barrier 4. Insufficient collaboration

Including a multidisciplinary ASP team is an important stewardship program standard. However, multidisciplinarity alone has not always by default generated a broad-based, collaborative, committed and interdisciplinary team dynamic.[67] Traditional top-down ASP governance approaches can create distrust and tension among different hospital stewardship personnel. As noted by WHO and the CDC, cross-disciplinary engagement[68,69] and awareness of the AMS agenda continues to be lacking among international non-infection specialist prescribers who are accountable for high rates of antimicrobial use.[70] These issues can fail to produce an optimal supportive organizational climate for effective program performance.[71–73]

Actions

1. **Incorporate unit-based specialists into broad-based multidisciplinary ASP teams**
Providers from high-resource settings reported that including unit-based specialists within ASP team leadership better facilitates the dissemination and adoption of ASP guidelines.[74] As key contributors to stewardship program committees, members are more likely to feel ownership of, and commitment toward, stewardship implementation and outcomes, ultimately serving as champions for the program in hospital ward units.

2. **Monitor and adapt ASPs for improved culture and interdisciplinary team dynamics**
Well-functioning relationships between clinicians, laboratory staff and facility management are imperative to the success of any multidisciplinary program, including ASPs. Insights into the perceptions, attitudes and interactions of all staff should help guide and shape improvement interventions.[75]

   ASP leaders should aim to improve collaboration across teams by incorporating elements of program regulation with persuasion and 'nudge' policies (to encourage best practice), as opposed to focusing on dictating rules and monitoring compliance.[76–78] To complement this, providing space for debates that allow ASP members to revisit and re-evaluate evidence and guidelines can help improve cross-functional engagement.

   In high-income settings, organizational leaders should consider employing more staff than necessary, (organizational slack) in different forms, as it allows leaders to learn and adjust the ways the stewardship program integrates into existing priorities, structures and team dynamics to attain its objectives.[79] For example, high-quality hospitals in high-resource settings have often demonstrated a tendency to use organizational slack compared to low-quality hospitals. This 'slack resource' can help improve trust and encourage a consistent culture.[80]

Barrier 4.1 Lack of prescriber support

Certain prescriber groups have struggled with their involvement in ASP protocols and activities,[81] which has led to limited compliance with ASP guidelines.[82, 83] This is partially due to perceiving stewardship programs as restrictive, heavy-handed and 'pushed' from an external agenda.[84, 85]

Actions

1. Engage prescribers by persuasive methods

Both persuasive and restrictive approaches to improving hospital-based antibiotic prescribing practices have been shown to alter prescribing habits and reduce total hospital infections.[86] However, qualitative evidence demonstrates comparative advantages to engaging prescribers through persuasive methods. Persuasive techniques used in Japan, for example, include voluntary surveillance, education, training, a local consensus process, advice, auditing and feeding back.[87]

Within hospital settings, appointing or actively involving prescribers from a range of specialties, such as surgery and critical care units, to contribute to key stewardship measures ensures appropriate buy-in and greater likelihood of adherence to these standards.[88, 89] To complement this strategy, stewardship leaders may also consider implementing a regular mechanism of consultation with hospital unit specialists for promoting agreement on unit-specific guidelines.[90] Appointing a dedicated and engaged ASP leader to work closely with prescribers is another important strategy to consider for incentivizing prescribers to improve long-standing prescribing practices.

2. Improve prescribers' access to data

Prescribers are likely to become more engaged when given greater access to routine clinical and laboratory data.[91–94] By using an infection intelligence platform, prescribers in Scotland, for example, were able to examine the effects of the stewardship program and adjust activity to improve.[95] Organizational leaders should closely examine prescribers' level of awareness and access to data within their local stewardship programs. Similar recommendations have emanated from LMIC contexts, such as Vietnam, where quality data is not available to demonstrate an association between ASP initiatives and patient care improvements.[96]

Barrier 4.2 Suboptimal engagement and support of nurses

In several health settings, AMS strategies often miss an important opportunity to optimize the role of nurses in AMS interventions.[97] As prescribers and professionals routinely involved in essential care and management relevant to AMS objectives, a nurse-focused approach can help reduce antimicrobial use while also ensuring compliance with quality care standards.[98] They play pivotal roles in ensuring that prescribers review daily antimicrobials once specimen results

become available and suggesting the review of the daily dose requirements for devices, such as urinary catheters.[99, 100] However, several barriers inhibit nurses in optimizing the use of antimicrobials, ultimately restricting their ability to efficiently and effectively influence program objectives and health outcomes.

1. Nurses are excluded from ASP teams and antimicrobial therapy decision-making, despite their demonstrated contribution to stewardship objectives.[101-103]

2. Nurses are inhibited or unmotivated to improve relevant antimicrobial outcomes as they may not recognize AMS-associated tasks as being within their remit.[104]

3. Nurse stewardship evolves into a siloed, parallel AMS team, restricting synergetic, efficient and complementary efforts to achieve ASP goals.[105]

While the role of nurses may not be regularly acknowledged in ASP guidelines, nurses fundamentally contribute to stewardship activities and outcomes.[106-109]

Actions

1. **Integrate nurse leaders into ASP decision-making**
Enabling regular consultation or representation of nurses within a broad-based multidisciplinary AMS team is essential to ASP improvements. Integrating nurse leaders in the stewardship team is one strategy that can strengthen the overall interprofessional and interinstitutional dynamic of the program, as their role is well-positioned to address any fragmented stewardship efforts.[110]

2. **Provide nurse-focused training for stewardship competencies and behavioral support of nurses**
Identifying and addressing gaps in stewardship competencies among nurses[111] would help to incentivize and justify wider training of nurses within stewardship programs.

For nursing roles, in particular, behavioral support activities and tools such as scripted dialogue support can improve discussions with prescribers on guideline compliance. By promoting awareness of these types of training and tools among the wider ASP, prescribers can also better align their expectations and receptiveness to accept proactive nurse behaviors. In the long term, these initiatives can incentivize institutional cultures that welcome more assertive and empowered nurse behavior and, ultimately, improve quality.[112]

3. **Tailor communication on nurses' stewardship involvement**
   ASP leaders should also consider adopting messages about AMS and AMR tailored to the variety of ASP professionals.[113] To improve receptiveness among nurses, they should position ASP tasks as supporting nurses' unique contribution to optimal quality person-centered care.[114]

Barrier 5. Suboptimal use of IT

Limited data analysis support restricts tracking antibiotic use, feedback to prescribers and reporting meaningful outcomes.[115–117] Stewardship software programs alone have not always delivered the necessary quality data to meet provider needs. In the US, physicians and pharmacists reported that the data on antimicrobial use produced at their facility was often among the most difficult to read as it did not readily offer essential, unit-specific insight on the effects of antibiotics on AMR outcomes.[118]

Providers have also struggled to adapt and integrate multiple sources of IT effectively to meet the contextual, timely, interprofessional and interinstitutional demands of stewardship programming.[119, 120] Limited interoperability across software systems has directly impacted on the quality of communication and cross-ward collaboration. Dedicated software programs for clinical microbiology, pharmacy, AMS, CDSS and EHRs often fulfill distinct stewardship needs independently or with limited interoperability.[121]

Actions

1. **Participate in the Global Antimicrobial Resistance Surveillance System (GLASS)**
   LMICs with laboratory infrastructure and reporting mechanisms may stand to benefit from joining GLASS. In a collaboration supported by WHO, GLASS provides a standardized approach to the collection and analysis of AMR data by enabling the creation of national AMR surveillance systems capable of monitoring AMR trends and producing reliable and comparable data.[122]

2. **Disaggregate and share unit-specific data**
   Some programs have greatly benefited from using datasets tailored to each unit of AMS practitioners or individual prescribers, as opposed to aggregated hospital data. The ward-specific datasets can provide a critical picture of process, performance and outcome measures while also delivering a comparative benchmark of prescriber performance.[123]

3. **Integrate IT-assisted signaling for priority action**
   An innovative use of stewardship IT in American healthcare settings involves adopting live reminders, which rapidly identify and signal suboptimal management of antimicrobials, and prompt timely communication among relevant practitioners.[124] The alerts are used to announce microbiological

results, which require increased antimicrobial use, as well as flagging infectious disease syndromes. Frontline providers suggest that the IT-assisted signaling delivers gains in efficiency. However, large numbers of reminders have been associated with 'alert fatigue'. Therefore, monitoring and adapting alert priorities to team dynamics would be required.

4. **Invest in IT integration and consider adopting EHRs with an integrated CDSS**

When possible, adopting an all-in-one IT system or customizing the integration of existing IT systems may be the ideal solution to allow for more efficient sharing of key clinical decision-making information.[125] Various studies conducted in the US reveal the benefit of adopting EHRs with an integrated CDSS, given that it demonstrates improvement to ASP in daily tasks, patient care and cost savings.[126–131] Implementation requires sizeable funding, skilled IT staff, leadership commitment, AMS team acceptance, lengthy system customization and IT integration. However, team training can improve usability.[132]

For lower resource settings in particular, mobile app technology offers opportunities to improve data linkage and access data immediately.[133] However, a robust governance framework with data security considerations and careful assessment of applications under review is required. This is because many apps risk patient safety and privacy if the information is outdated, inaccurate or insecure. It may also lead to fragmentation of clinical practice when too many apps are involved in an ASP.[134]

SECTION 5. RECOMMENDATIONS FOR POLICYMAKERS

While improving antimicrobial stewardship programs at the provider level is an essential step, hospitals do not operate in siloes, and individual provider action is not sufficient. Sanitation and hygiene, livestock practices, public awareness and other health system actors, such as primary care providers, all affect the progression of AMR. Within the health sector, governments, regulators and policymakers have an important role to play at the regional and national level in guiding stewardship activities and standards to support hospital activities.

Building on the actions to overcome barriers at the hospital level, in concert with wider One Health initiatives, we recommend the following actions for policymakers to aid in addressing the looming crisis of AMR:

1. **Use CHASP as a model for developing national guidelines**
   In response to WHO's global action plan, several LMICs are in the process of developing national AMS guidelines for hospitals. National policymakers should consider incorporating CHASP items to ensure that minimum standards are consistent across all hospitals.

2. **Ensure macro-level governance is aligned with key hospital ASP objectives**
   For LMICs, national initiatives should ensure well-co-ordinated AMR surveillance systems. It is imperative to ensure that antimicrobials are good quality, systematically regulated and equitably priced. Countries worldwide would benefit from adopting elements of a network healthcare governance approach to better facilitate the multilevel and multisector engagement that the One Health framework has urgently called for.

3. **Initiate robust research on ASPs**
   To improve hospital ASPs, more high-quality evidence on program structure, process and outcomes as well as macro-level AMS policy outcomes is essential. Lack of evidence fundamentally undermines strategic healthcare decision-making toward safeguarding antimicrobials.

4. **Establish minimum staffing standards for hospital ASPs**
   Ensuring the availability of dedicated, adequately staffed stewardship teams across all hospitals is crucial. To do so, we must generate national or regional consensus on the composition, quantity and requirements of staff. Based on this consensus, policymakers should enact and reinforce regulatory measures, delineating minimum standards for sufficiently equipped and well-trained AMS teams.

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About CDDEP

CDDEP produces independent, multidisciplinary research to advance the health and wellbeing of human populations in the US and around the world. CDDEP was founded in 2010 with the objective of using research to support better decision-making in health policy. CDDEP researchers employ a range of expertise – including economics, epidemiology, disease modeling, risk analysis and statistics – to conduct actionable, policy-oriented research on malaria, antibiotic resistance, disease control priorities, environmental health, alcohol and tobacco, and other global health priorities. CDDEP projects are global in scope, spanning Africa, Asia and North America, and include scientific studies and policy engagement. The CDDEP team is experienced in addressing country-specific and regional issues, as well as the local and global aspects of global challenges, such as antibiotic resistance and pandemic influenza. CDDEP research is notable for innovative approaches to design and analysis, which are shared widely through publications, presentations and web-based programs. CDDEP has offices in Washington, DC and New Delhi, and relies on a distinguished team of scientists, public health experts and economists around the world.

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