Monitoring and Evaluation of the Global Action Plan on Antimicrobial Resistance (AMR): Regional Expert Consultation on Monitoring and Evaluation of AMR Interventions

Washington, DC, 26-27 January 2017

Contents

Acronyms

AMR	Antimicrobial Resistance
AMS	Antimicrobial Stewardship
ARC	Antibiotic Resistance Coalition
CDC	Centers for Disease Control and Prevention (United States)
CIDEIM	International Center for Medical Training and Research (Colombia)
DDD	Defined Daily Doses
FAO	Food and Agricultural Organization
FIU	Florida International University
GAP	Global Action Plan (on antimicrobial resistance)
HAI	Health Actions International
ICU	Intensive Care Unit
M&E	Monitoring and Evaluation
MRSA	Methicillin resistant *Staphylococcus aureus*
NAMCS	National Ambulatory Care Survey
NAP	National Action Plan
NHAMCS	National Hospital Ambulatory Medical Care Survey
OIE	World Organization for Animal Health
PAHO	Pan American Health Organization
SDG	Sustainable Development Goal (UN)
SO	Strategic Objective
STAG	Steering and Technical Advisory Group
UN	United Nations
UNGA	United Nations General Assembly
UTI	Urinary Tract Infection
WASH	Water, Sanitation and Hygiene
WHA	World Health Assembly
WHO	World Health Organization

Introduction

The Regional Action Plan on Antimicrobial Resistance for the Americas was adopted by the Pan American Organization's (PAHO) 55th Directing Council in September 2016. The Plan is aligned with the global process initiated by the governing bodies of the World Health Organization (WHO), the Food and Agriculture Organization (FAO), and the Organization of Animal Health (OIE). Following the 68th World Health Assembly of the WHO (WHA), Member States agreed to develop national plans of action on resistance to antimicrobials (AMR) consistent with the Global Action Plan (GAP), and to implement pertinent policies and plans to prevent, control, and monitor AMR. In response, the WHO has committed to developing a global consensus on an approach to AMR monitoring, with predefined measures of impact and outcome, i.e., key indicators.

This meeting is the result of a joint effort by the Golbal Health Consortium at the Florida International University (GHC/FIU) and PAHO. The purpose of the meeting is to contribute to the process initiated by the WHO and other United Nations agencies, by analyzing, discussing, and proposing an antimicrobial monitoring framework focused on the Caribbean and Latin America.

The objectives of the meeting were:

- to discuss efficient monitoring and evaluation strategies to include in national plans of actions in countries of the Caribbean and Latin America;
- to provide guidance for national capacity building for AMR surveillance, and tools for monitoring and evaluation of AMR containment interventions;
- and to develop a preliminary list of Regional and national indicators consistent with those to be used globally.

The Global Health Consortium of the FIU provides technical cooperation in education, policy, and applied research in several global health areas, among them, surveillance of AMR, stewardship in public health, international health, communicable and non-communicable diseases, vaccinations, access to medicines and innovation, health and migration, universal health access and coverage, and climate change as it relates to health. The work carried out by the FIU, and its public health centered programs make the University a valuable PAHO/WHO partner in its work to monitor, contain, and control AMR.

The meeting was conducted at the FIU Washington DC campus.

The list of participants and agenda for the meeting are annexes 1, and 2, respectively.

Opening Session

Dr. Carlos Espinal, Director, Global Health Consortium/FIU, welcomed participants, and expressed his appreciation of their participation in the meeting, while highlighting the

importance of AMR, and the relevance of discussing indicators to monitor the implementation of interventions for AMR containment, and control.

Dr. Marcos Espinal, Director, Communicable Diseases and Health Analysis Department, PAHO, provided an overview of PAHO's history and its relationship to the WHO. He underscored the importance of discussing and recommending indicators to monitor AMR activities, especially in the current climate, in which various international organizations and other partners are willing to move this initiative along. Until recently, very few countries worldwide had developed or implemented programs to contain AMR, therein the need to develop a global plan. Such a global plan was adopted and approved in 2015 by the WHA, and it calls for countries to develop their own national plans. In the Americas, PAHO has already had a Regional plan adopted by Member States. Both the Global and Regional plans have five strategic objectives, for which results (outcome) indicators need to be developed. This is the task of this meeting's participants, in addition to proposing sources of data for indicator numerators and denominators. The five strategic objectives are:

- To improve awareness and understanding of antimicrobial resistance through effective communication, education and training.
- To strengthen the knowledge and evidence base through surveillance and research.
- To reduce the incidence of infection through effective sanitation, hygiene and infection prevention measures.
- To optimize the use of antimicrobial medicines in human and animal health.
- To develop the economic case for sustainable investment that takes account of the needs of all countries and to increase investment in new medicines, diagnostic tools, vaccines and other interventions.

Dr. Pilar Ramon-Pardo provided a summary of the road traveled so far by PAHO/WHO in recent years, underlining the words of the Director General of WHO (2011), who made an urgent call to fight AMR, as "no action today means no cure tomorrow."

Based on a global AMR surveillance report published in 2014, it was determined that: resistance to antimicrobials was widespread around the world; there was an acute lack of data to determine the magnitude and scope of the problem; and no harmonized standards for data collection, sharing, and coordination existed. In 2015, the WHO's Worldwide Country Situation Analysis reported on the weak response to AMR around the world, where only a few countries had comprehensive national plans to detect resistance to antimicrobial drugs, and in many, poor laboratory capacity, infrastructure and data management resources were preventing effective surveillance.

By 2015, the Organization had developed a global action plan on AMR, which was approved by the WHA that same year. The following year, the United Nations General Assembly (UNGA) endorsed the WHO's Global Action Plan on Antimicrobial Resistance as the blueprint for action, including the Plans' five overarching strategic objectives listed above. The Global Plan, which reflects current global scientific expertise, and includes national experiences and contributions,

was subsequently adopted by the Food and Agriculture Organization, and the World Organization for Animal Health. The goal of the global action plan is to ensure, for as long as possible, continuity of successful treatment and prevention of infectious diseases with effective and safe medicines that are quality-assured, used in a responsible way, and accessible to all who need them. It is expected that countries will develop their own national action plans on antimicrobial resistance in line with the global plan.

On the other hand, PAHO's work in AMR which began in the mid-1990s, has included supporting countries of the Americas to strengthen laboratory-based surveillance of AMR; promote the appropriate use of antimicrobials; strengthen infection prevention and control practices; promote integrated AMR surveillance; and improve regulatory processes. The actual responsibility for those endeavors falls to the countries, with the support of many partners, mainly WHONET, the United States Centers for Disease Prevention and Control, the United States Agency for International Development (USAID), and others.

PAHO's Member States committed to developing national action plans by May 2017, for the upcoming WHA. Currently, most countries in Latin America and the Caribbean are in that process. As part of the plans, and for their implementation, monitoring and evaluation indicators will be required to manage the process, to identify and address barriers, and to inform appropriate responses to arising challenges. The target being to increase the impact, and cost-effectiveness of the plans. Monitoring and evaluation will also be crucial to report progress to the global health community, including to the WHA (May 2017); the UNGA, regarding its Declaration on AMR (2018), and its Ad Hoc Interagency Coordination Group on resistance to antimicrobial drugs. Above all, monitoring and evaluation data and indicators will support countries, and provide feedback to national public health authorities on their achievements.

WHO/HQ is currently leading a global consensus process to develop outcome and impact measures. We expect the conclusions and recommendations of this meeting will contribute to that process, from of the Region of the Americas' perspective.

Following a review of the objectives, Dr. Ramon-Pardo indicated that defining indicators was, in general, a difficult task for public health professionals, as it requires technical knowledge of the specific subject matter, as well as familiarity with results based management, for which monitoring and evaluation indicators are crucial. Furthermore, it was not an easy task to select a group of experts who met both requirements. Fortunately, however, participants in this meeting include scholars and specialists from non-governmental organizations, members of professional associations, academics, and government agency staff, all of whose contributions will buttress the work being done in the Americas.

The meeting consisted of plenary sessions followed by group discussions. Plenary sessions were dedicated to presentations by experts with a diverse background in the fight against resistance to antimicrobials, from developing global plans at the international level, to working in infection control and drug prescription at country level. All presentations are summarized in the following pages.

Part I. Plenary Session and Background Presentations

Global, Regional and National Action Plans – Defining Indicators[1]

This presentation provided an update on the progress made by WHO regarding monitoring and evaluation of the GAP.

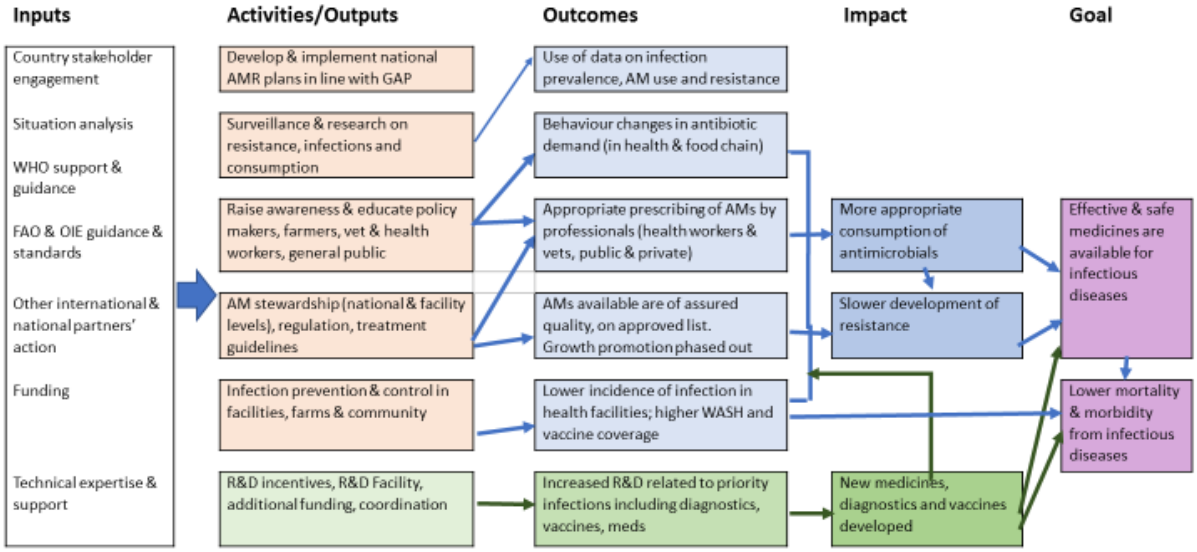
As of February 2017, the World Health Organization was developing a monitoring and evaluation (M&E) approach for the AMR Global Action Plan, which aims to learn from experience; limit the burden on countries; recognize countries at different stages; harmonize global, country and regional M&E, and focus on *one health*, as far as possible.

A monitoring and evaluation approach paper has been developed with contributions from WHO (regions and HQ), FAO, OIE, Steering and Technical Advisory Group (STAG), and informal consultation with experts. It was endorsed by the STAG in November 2016, and included recommendations on indicators. An AMR Global Monitoring Questionnaire, adapted from the International Health Regulation's capacity questionnaire, has been developed as well, and circulated among Member Countries. Its purpose is to determine the national preparedness to implement monitoring and containment of antimicrobial resistance.

Figure 1 illustrates the framework for M&E the Global Action Plan, which clearly separates process monitoring (activities and outputs) from the evaluation of outcomes, impact, and goal. She will also present the questionnaires. Presents a diagram of inputs, activities/outputs, outcomes, impact and goal.

[1]Presentation by Dr. Verónica Walford, on behalf of WHO/HQ.

Figure 1. Framework for monitoring AMR Global Action Plan



At the national level, countries will decide their inputs, outputs and outcomes, as well as the corresponding indicators. The proposed approach to the GAP's process monitoring and evaluation is intended to measure countries advances toward developing and implementing national action plans on AMR. Outcomes would be measured by countries, ideally with standard indicators; these would serve as inputs for research and development.

It is expected that national action plans (NAPs) will include targets, progress indicators, and monitoring and review mechanisms. At the present time, completed NAPs suggest limited focus on monitoring and evaluation. It will be for countries and regions to define activities and outputs, with global guidance. WHO has been working on the development of a core set of outcome and impact indicators. In addition, WHO will have responsibility for monitoring country progress at the global level, and summarizing and reporting on the status of key outputs, capacities and outcomes to implement an AMR response. Figure 2 shows a draft framework for monitoring and evaluation at the national level. The outcome of this Regional Consultation meeting will provide input for further development of the framework in figure 2.

In terms of selecting indicators, the use of standardized indicators is recommended, as well as their relevance in communicating the importance of AMR. An effort should be made to use existing indicators. Some sources might be those already in use by PAHO; Water, Sanitation and Hygiene (WASH) related to SDG 6; the U.S. Centers for Disease Control and Prevention (CDC) and WHO surveillance indicators, standard health facility surveys and household surveys, antimicrobial consumption surveys, and data provided by the global monitoring questionnaire on AMR. WHO is currently working on survey protocols for antimicrobial use in hospitals and community facilities, and on availability, and price.

It is expected that after a period of about 5 years, it will be possible to assess WHO performance in implementing the GAP; learn lessons from countries that achieved results, including unintended effects; and assess progress on the research and development agenda, including its influence on new initiatives.

Figure2. Draft framework for M&E of NAPs – updated draft

Planning	Input	Process	Output	Outcome	Impact and Goals
GAP strategic objective 1	Communication programme targeting people in food practice prepared Funding for developing media kit on AMR secured	Participation in global antibiotic awareness week Partnerships with professional associations, private medical and veterinary groups to address AMR	Proportion of medical and veterinary workforce in public and private sectors who have received education on AMR	AMR awareness levels in target populations Proportion of those treated with antibiotics who took the full course	Access to diagnostics and treatment in public and private sectors Resistance to penicillin in Streptococcus pneumoniae Resistance to 3rd gen cephalosporins among Esch coli and Klebsiella HIV drug resistance rate for people about to start anti-retroviral therapy ESBL levels in poultry production Total human use of antimicrobials in DDD per capita and in hospitals per 1000 admissions Weight of antimicrobials used for animal growth promotion by species, weight used in fish farming Prevalence of hospital acquired infections (MRSA, CLABSI, SSI, VAP, C difficile) Number of MDR TB cases Incidence of catheter-associated urinary tract infections Mortality rate associated with bloodstream infections caused by carbapenem-resistant Enterobacteriaceae (CRE)
GAP strategic objective 2	Terms of reference for a national coordinating centre for AMR surveillance prepared Operational plans for implementing and strengthening surveillance of resistance and consumption	National laboratory quality assurance programme organized and implemented in all laboratories participating in AMR surveillance Data collected to assess total antimicrobial consumption in humans and animals	National report on surveillance of AMR and antimicrobial consumption published Proportion of AMR surveillance sites that submitted surveillance reports to the national coordinating centre on time Data submitted to global level on antimicrobials used in animals National AMR research agenda developed	How AMR surveillance data has been used for decision making	
GAP strategic objective 3	Curriculum and training materials for continuing education on infection prevention and control for health care workers available Hygiene and infection prevention and control included in undergraduate curricula for animal health professionals	Enhance vaccination program in low performing districts Standard operating procedures developed and distributed for infection prevention and control in hospitals Number of train-the-trainers courses on hygiene and infection prevention in agriculture conducted	Proportion of hospitals implementing infection prevention and control programmes Proportion of animal health facilities implementing infection prevention and control programmes	Hib vaccine coverage rate Percentage of hospitals with hand hygiene compliance rates > 75% Percentage of health facilities with improved water supply and sanitation on the premises	
GAP strategic objective 4	List of critically important antibiotics prepared National quality standards for antimicrobials set	Number of antimicrobial agents authorized for marketing (for human and animal use) Regulations introduced to phase out use of antimicrobials for animal growth promotion	Percentage of hospitals with specific treatment recommendations based on local antimicrobial susceptibility for common clinical conditions Number of veterinary workers trained in responsible use of antimicrobials Veterinary oversight required for use of medically-important antibiotics in the feed or water of food-producing animals Enforcement of regulations on antimicrobial licencing and quality of imports in human and animal health	Availability of antimicrobials on the essential medicines list in public facilities Percentage of hospitals prescribing antimicrobials for surgical prophylaxis with >80% compliance with guidelines Availability of unauthorised and sub-standard antimicrobials in the local market	
GAP strategic objective 5	Funding secured for creation and functioning of national multisectoral coordination mechanism and for NAP activities	AMR NAP budget updated and funding gaps identified Number of new public–private partnerships created to encourage research and development related to AMR	Financing sources for the NAP identified Research funding focused on national priorities related to AMR	Research findings applied Uptake of new products developed with global incentives	

On example of an outcome might be the change in antimicrobial demand, which could be measured by the awareness levels about appropriate antibiotic use among target groups, and an indicator on behavior change, for example, in the reasons for using antibiotics in animal production. Among other issues, difficulties in obtaining reliable data to feed the indicators needs to be considered, as well as how data will be used for decision making, and standards of quality for antibiotics, and reserve medicines.

Other issues in measuring outcomes are related to the definition of the outcome itself. In addition, methods are needed for measuring outcomes related to awareness and appropriate use by patients and farmers; the use of surveillance data, whether for policy or clinical use; the assessment of rational prescribing, both in the private and public sectors; compliance with preventive measures in health and livestock production, and access to diagnosis and treatment. Also, there is a need to decide if standard tools are needed, whether measurements can be built into existing assessments, such as service quality assessments or household surveys, and how to measure levels of resistance for so many combinations of drugs.

For illustration purposes, and keeping in mind that the purpose of this meeting is to work on outcome indicators, table 1, below, includes core impact measures, and global measures of GAP goals.

Table 1. Possible Core Impact Measures and Global Measures for the Global Action Plan Goals

Impact	Possible measure
More appropriate use of antimicrobials (appropriate medicines are accessible, inappropriate use has reduced)	Total consumption of antimicrobials in humans, in defined daily doses (DDD) per inhabitant per day, per 1000 inpatients. Volume of antimicrobials used in food production: total volume (by class) used in animals; volume/weight used for growth promotion; etc. Volume of antibiotics on critically important antibiotic list for human use that were sold for use in animals. Access to diagnosis and treatment in public and private sectors; % with prescriptions.
Slower development of resistance	Trends in resistance rates for priority pathogens and drug combinations including: a) resistance to penicillin in *Streptococcus pneumoniae* isolates; b) resistance to 3rd-generation cephalosporins among *Escherichia coli* and *Klebsiella* sp. Resistance mechanisms, e.g. ESBL in *E. coli* in humans, animals, food, and the environment Antimicrobial residues in wastewater

Discussion

Following the presentation, there was a discussion around the need for harmonized indicators across regions, especially for comparison purposes; issues need to considered when developing tools and standards for data collection, and analysis.

Other topics of discussion were a) the need to make available data more transparent (pharmacy or research and development data), which are hard to obtain. The new WHO assessment questionnaire might help collect these data from countries; b) data on antibiotic use in animals, which countries do not want to make public to prevent impact on commerce or tourism; c) the urgent need to work on vaccine development, as the goal should be to reduce infections, as well as mortality.

Impact of Regulating Antibiotic Sales: Challenges and Achievements --- Chile[2]

Appropriate use of antibiotics should be the aim of any AMR program. The use of these medicines must be linked to medical prescriptions, as they can generate adverse reactions in patients, and increase bacterial resistance. The relation between antimicrobial consumption in the community, and the surge and spread of resistance to antibiotics has been established. Regulating antibiotic prescription has been shown to impact sales, and should be a target of national efforts. Interventions in this area should address health care personnel, the patient community (parents, in the case of children), and policy makers. Figure 3 shows the degree of

[2] Presentation by Dr. Luis Bavestrello, Clinica Reñaca, Viña del Mar, Chile.

non-prescription antibiotic use in several countries. AMR resistance rates by country are correlated with non-prescription antibiotic consumption.

In Latin America, antibiotic use measured in defined daily doses (DDD) per 1,000 population is underestimated, and data focuses mainly on consumption in the private sector. However, those the rates of total consumption are low when compared to that of Europe, and the United States of America.

Figure 3. Non-Prescription Use of Antibiotics, Selected Countries

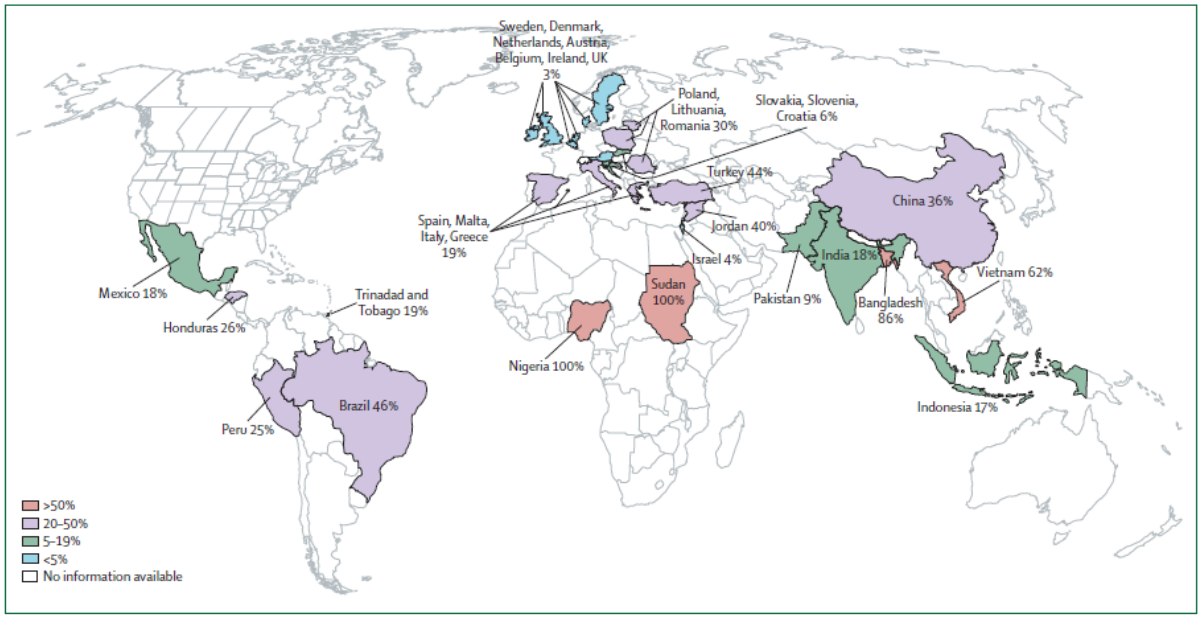


Figure 2: **Frequency of non-prescription use of antimicrobials in the general population based on published works**
In small areas, countries with similar frequency of non-prescription antimicrobial use have been grouped.

Study of Antimicrobial Consumption in Chile

Starting in July 1998, a study of antimicrobial consumption in hospitals and the community was conducted in the country. Sales data indicated a significant increase in consumption between 1988 and 1997. The results of the study, were delivered to the Ministry of Health in December 1998.

Methodology: Data were obtained from the national population census, gathered by the National Statistical Institute; and data on antibiotic sales from 1988 to 1997, from the IMS.

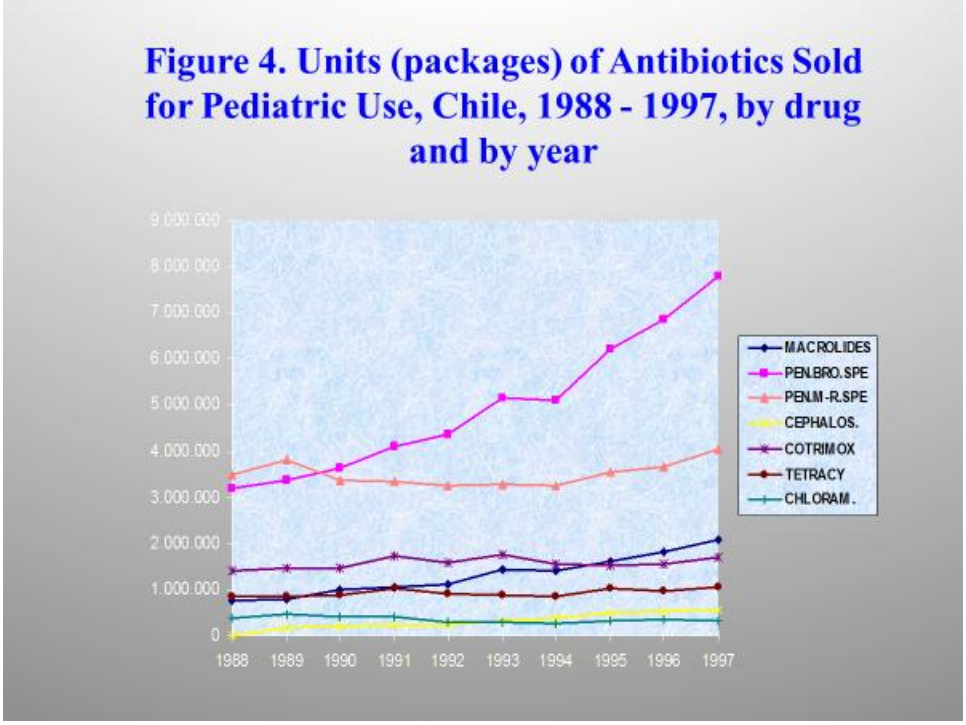
The unit of consumption was defined as DDD/1,000 population per day, and a calculation was done as follows:

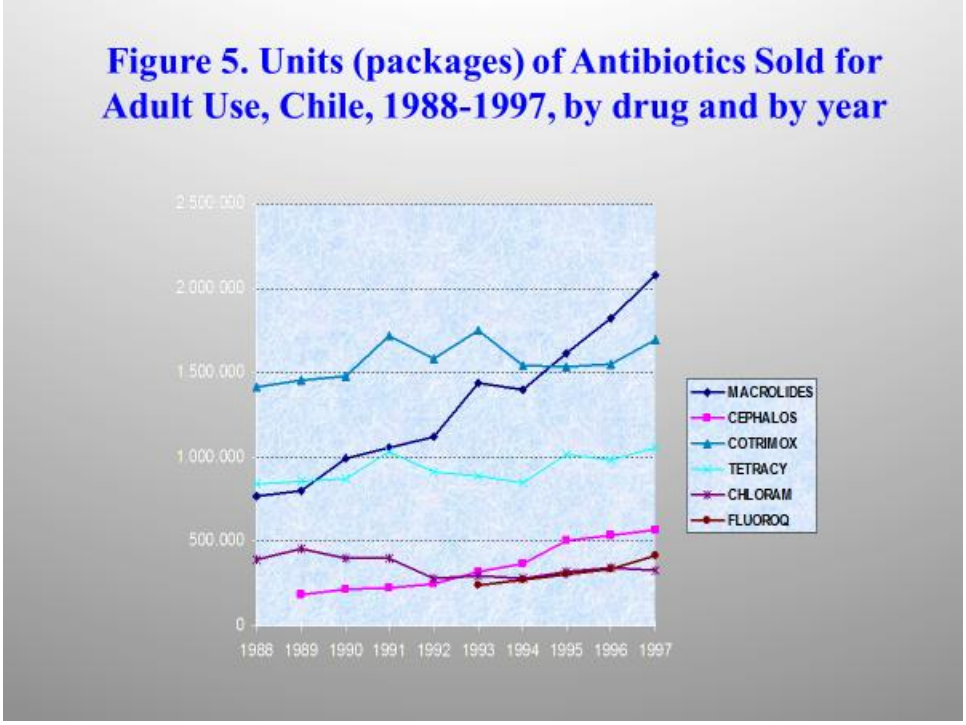
$$\text{DDDs per person/day} = \frac{\text{Grams sold x 1000}}{\text{DDD x number of days x population}}$$

Results

Figure 4 illustrates the number of units (packages) sold between 1988 and 1997 for pediatric use. Data show that the rate of pediatric consumption more than doubled for broad spectrum penicillin, doubled for macrolides, and remained stable for reduced spectrum penicillin and cephalosporins, cotrimoxazole, tetracycline, and chloramphenicol.

On the other hand, figure 5 shows the number of units sold during the same period for the treatment of adults. While the sales of cephalosporins, and chloramphenicol remained below or around 500,000 units throughout the period, consumption of macrolides more that doubled.





In summary, data showed a significant annual increase in the consumption of antimicrobial drugs, in general, and in the community. The greatest increase was in broad-spectrum penicillins, such as amoxicillin. A large proportion of antimicrobial drug consumption is presumed to be for pediatric infections. Newer generation antibiotics showed a high use pattern.

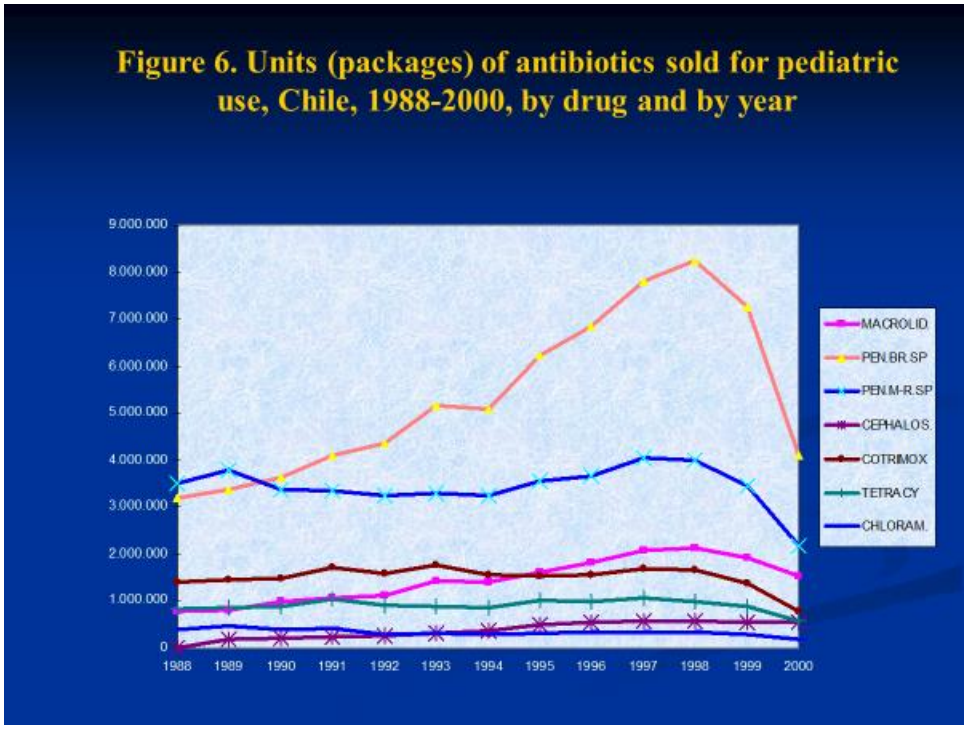
In 1999, the authors of the study shared their results and conclusions in meetings with the Drug Unit of the Ministry of Health, the Chilean Congress's Health Commission, and the National Department of Consumer Affairs, as well as with health professional societies, including the Chilean Infectious Diseases Society, Microbiology Society, and the Institute of Public Health; and other professional physician and chemist organizations.

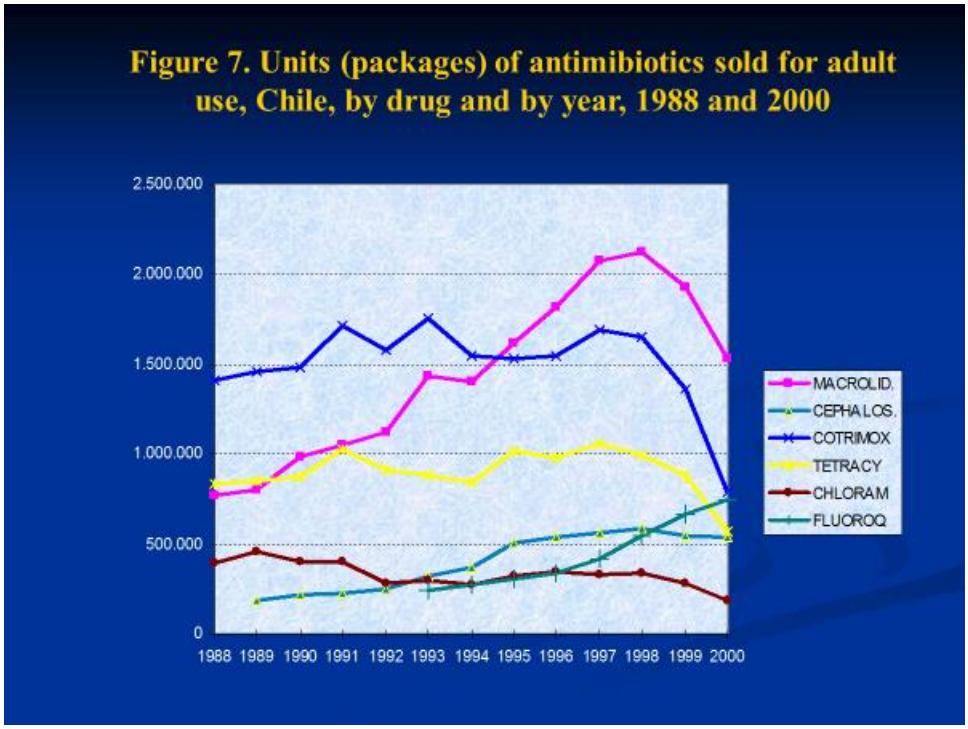
From the above, the need for regulatory measures was determined, and an official document was developed by the Ministry of Health in the form of an Action Plan to Assure the Rational Use of Antimicrobials. The main issues addressed by the Action Plan were:

- Restriction of sales of antimicrobials by demanding preparation by chemists and/or by prescription.
- Population awareness, by providing information through leaflets and posters in all private pharmacies.
- Extensive coverage on radio and television news programs regarding the implementation of these regulations.
- Education campaign.
- Testing of compliance with sale restrictions.

- Sanctions for violation of restrictions.

A follow-up study was conducted to determine consumption post-regulations (Figures 6 and 7).





Available data reflect significant changes in consumption of most classes of antibiotics for pediatric use; the largest drop was for penicillins, both broad and reduced spectrum. However, the use of cephalosporins showed a steady increase. Regarding adult use, sales of all classes of antibiotics declined during the period, with the exception of fluoroquinolones.

Unfortunately, the above success was not permanent. After the initial drop in consumption of antibiotics, trends are currently toward an increase in use at the community level. Of special concern is the increase in consumption of new macrolides and fluoroquinolones. This finding is alarming; and it should be a call to insist on efforts to control the use of antimicrobials, mainly through education campaigns among the population, and other education activities geared to health professionals, mainly, prescribers.

Defining Indicators to Monitor Interventions[3]

CARA stands for Conscience of Antimicrobial Resistance Accountability, an alliance of independent organizations whose purpose is to monitor global progress toward the goals set forth in the UNGA's political declaration (see Introduction section of this document). CARA currently has around 60 member organizations. The final structure is currently being finalized, as are operational aspects of the organization. Leadership will be drawn from the non-profit sector.

CARA will operate through at least three main branches: human, animal, and environment. The human branch has five sub-branches, i.e., stewardship, innovation, surveillance, access and effectiveness, and education. Each branch and sub-branch will have a lead organization in charge of data collection and reporting. Reporting will consist of a two-year cycle for each and all branches. Transparency will be emphasized as much as possible, with data validation, and public accessibility.

To meet its commitments, CARA branches will track a set of indicators keyed directly to political declarations and documents from other relevant entities, such as WHO, OIE, and FAO.

The final list of indicators will be selected based on relevance, validity, reliability, and feasibility of data collection. Potential accountability indicators will measure progress regarding AMR resistance; use and misuse; and infection prevention/public health/water and sanitation in human, animal, environment, development, and other relevant areas. Table 2 shows a list of potential indicators by subject area.

Table 2. CARA's list of potential indicators, by area

Resistance
– National and subnational level blood, cerebrospinal fluid (CSF)
– National and subnational level hospital resistance data from other sources (WHO, PAHO, other)
– Community level outpatient isolates

[3] Presentation by Dr. Hellen Gelband, Center for Disease Dynamics, Economics &Policy.

- Resistance in animals – farms
- Resistance/residues in food
- Resistance and residue from wastewater (factories)
- Resistance and residue from or related to farming

Use and misuse

- Human: hospital and retail sales; over the counter sales; proportion of hospital and outpatient prescriptions considered appropriate
- Animal: overall consumption; prescription sales

Policies and guidelines

- Existence of
  - national policy in place, by country
  - national policy addressing animal use
  - regional AMR network, coalition or alliance
- Enforcement of national policies
- Availability of
  - national clinical guidelines, both for human and animal use
  - hospital infection control plans and policies
  - list of restricted animal antibiotics, by country
  - animal growth promoter ban
  - policy incentives for appropriate use
  - manufacturing wastewater control policies
  - farm and aquaculture residue control policies

Infection prevention/public health/water and sanitation

- Human immunization rates
- Primary health care> physicians, hospital beds per capita
- Sanitation: proportion of population with access to improved water sources
- Clean water: proportion of population with access to improved water sources
- Mortality of children under 5 years of age (diarrheal diseases, pneumococcal infections)
- Animal immunization rates
- Farm sanitation laws
- Hospital-acquired infection rates
- Use of diagnostics: changes in empirical use, appropriate de-escalation rates

Public awareness/education

- Public national awareness campaign conducted (frequency, success)
- AMR coverage in medical, nursing, pharmacist, veterinary education
- Continuing medical/clinical education on AMR

The next steps for CARA include selecting branch and sub-branch leader organizations; final indicator selection; onset of data collection; and ongoing member recruitment.

Setting National Targets to Reduce Unnecessary Antibiotic Prescribing[4]

The PEW Charitable Trust recently established an Antibiotic Resistance Project, with tree lines of action: use in humans, use in food animals, and innovation. The Project has developed a partnership with CDC, and brought together people from different institutions, and with a range of expertise.

Among the main challenges in defining national targets is the definition of *quality* and *appropriate use*, as well as the need for data to measure annual progress. In addition, to set national targets, it will be necessary to: 1) establish the methodology for measuring antibiotic use; 2) develop the ability to assess appropriateness, i.e., the quality of antibiotic prescribing, not just data to quantify antibiotic use; 3) obtain data that are replicable on a year-to-year basis, for which progress tracking mechanisms are required; 4) utilization of a comprehensive data source, with nationally representative data; and 5) consensus among experts.

Within this Project, the methodology for setting national targets included the definition of data sources, in this case, the National Ambulatory Medical Care Survey (NAMCS), and the National Hospital Ambulatory Medical Care Survey (NHAMCS), which includes a national representative sample of office-based visits, and visits to emergency rooms and hospital outpatient departments. It also has demographic, medication and diagnosis data.

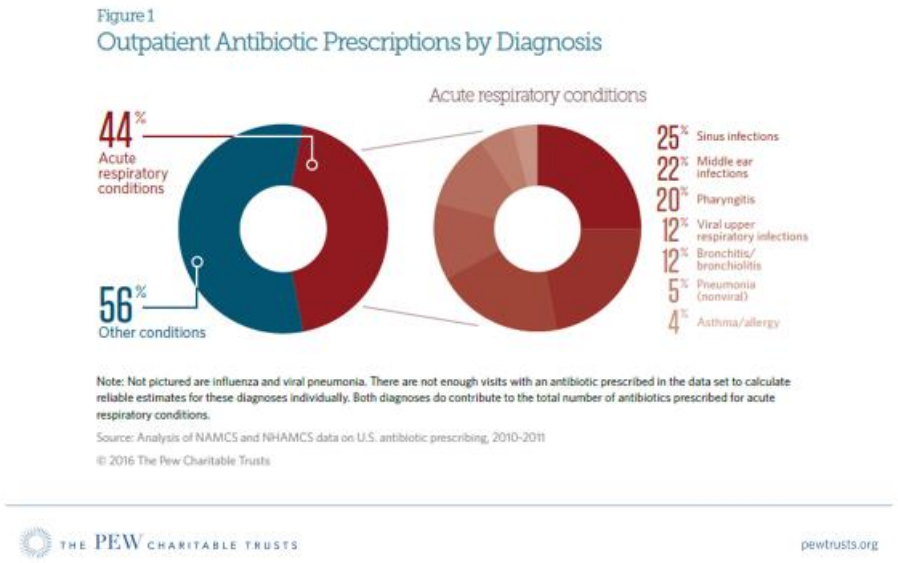
Data are analyzed based on two outcomes:

- Outcome 1: Based on diagnoses, percentage of antibiotics prescribed that are unnecessary
- Outcome 2: For three diagnoses, percentage of prescriptions with inappropriate selection of antibiotics

Figure 8, below, illustrates the results of the analysis of NAMCS and NHAMCS antibiotic prescription data, by diagnosis, from 2010-2011.

[4] Presentation by Dr. David Hyun, The PEW Charitable Trust.

Figure 8. Outpatient Antibiotic Use in the United States



An estimated 30% of outpatient oral antibiotic prescriptions in the U.S. in 2010-2011 may have been inappropriate. This finding supports the need for establishing a goal for outpatient antibiotic stewardship, according to a study appearing in the May 3 issue of JAMA.

Antibiotic-resistant infections affect 2 million people and are associated with 23,000 deaths annually in the United States, according to the Centers for Disease Control and Prevention (CDC, US). Antibiotic use is the primary driver of antibiotic resistance, and leads to adverse events ranging from allergic reactions to *Clostridium difficile* infections. In 2011, in the United States, 262 million outpatient antibiotic prescriptions were dispensed. However, the fraction of antibiotic use that is inappropriate and amenable to reduction is unknown.

Dr. Katherine E. Fleming-Dutra, of the CDC in Atlanta, and colleagues used the 2010-2011 NAMCS and NHAMCS to estimate the rates of outpatient oral antibiotic prescribing by age and diagnosis, and the estimated portions of antibiotic use that may be inappropriate in adults and children in the United States.

Of the 184,032 sampled visits, 12.6 percent resulted in antibiotic prescriptions. Sinusitis was the diagnosis associated with the most antibiotic prescriptions per 1,000 population (56 prescriptions), followed by suppurative otitis media (ear infection; 47 prescriptions), and pharyngitis (common cause of sore throat; 43 prescriptions). Collectively, acute respiratory conditions per 1,000 population led to 221 antibiotic prescriptions annually, but only 111 antibiotic prescriptions were estimated to be appropriate for these conditions. Per 1,000 population, among all conditions and ages combined in 2010-2011, an estimated 506 antibiotic prescriptions were written annually; of those, 353 were considered appropriate.

"Half of antibiotic prescriptions for acute respiratory conditions may have been unnecessary, representing 34 million antibiotic prescriptions annually. Collectively, across all conditions, an estimated 30 percent of outpatient, oral antibiotic prescriptions may have been inappropriate. Therefore, a 15 percent reduction in overall antibiotic use would be necessary to meet the White House National Action Plan for Combating Antibiotic-Resistant Bacteria goal of reducing inappropriate antibiotic use in the outpatient setting by 50 percent by 2020," the authors write.

"This estimate of inappropriate outpatient antibiotic prescriptions can be used to inform antibiotic stewardship programs in ambulatory care by public health and health care delivery care systems in the next 5 years."

Antimicrobial Stewardship Programs: One Size Does Not Fit All[5]

Objectives and requirements

The main objective of antimicrobial stewardship is to optimize clinical outcomes by minimizing undesirable effects of using antibiotics, such as, the selection of other resistant bacteria; the emergence of resistance during treatment; and toxicity. Its secondary objective is to reduce costs without compromising the quality of health care.

To achieve positive results, antimicrobial stewardship must combine its efforts with those of an infection control program. The goal of the program should be to coordinate interventions to improve the use of antimicrobials, by promoting selection of the optimal drug, optimal dose, optimal route of administration, and optimal duration of therapy.

An AMR stewardship team (Figure 9) should include, as a minimum, a microbiologist and a pharmacist, and/or physician, preferably with formal infectious diseases training. The team's responsibilities involve education, guidelines development, pre-prescription approval or post-prescription review, with feedback, and other strategies, depending on the specific hospital's strategies.

[5] Presentation by Dr. Maria Virginia Villegas, Scientific Advisor on Bacterial Resistance and Nosocomial Infections, International Center for Medical Training and Research, Colombia (CIDEIM)

There are seven core elements for successful hospital antimicrobial stewardship programs:

- Leadership commitment: Dedicating necessary human, financial, and information technology resources.
- Accountability: Appointing a single leader responsible for program outcomes. Experience with successful programs has shown that a physician leader is effective.
- Drug expertise: Appointing a single pharmacist leader responsible for working to improve antibiotic use.
- Action: Implementing at least one recommended action, i.e., "antibiotic time out" after 48 hours or only 5-7 days of treatment for IAI and UTI.
- Tracking: Monitoring antibiotic prescribing and resistance patterns.
- Reporting: Regular reporting information on antibiotic use and resistance to doctors, nurses and relevant staff members.
- Education: Educating clinicians about resistance and optimal prescribing.

The most important element of those listed above is, by far, leadership. A good leader will work with other experts to implement the stewardship program, as well as to monitor antibiotic prescription practices and resistance patterns. She or he would also need to provide feedback to other medical professionals about their antibiotic prescription practices (e.g., optimal drug, according to the hospital's guidelines, as well as dose, duration, and de-escalation); report monthly about the AMS and antibiotic use; and educate about resistance and optimal prescribing. However, the success of a stewardship program will depend on the selection of an achievable goal (few antibiotics to follow, the most critical patients), and the sharing of results with hospital staff and physicians, so that they may appreciate the positive effects of the program.

Establishing an antimicrobial stewardship program

To implement an AMS program, the first step is to develop antimicrobial treatment guidelines, both for prophylactic and therapeutic use. Adherence to said guidelines must be measured, as should other outcomes, such as the economic impact of their implementation.

It is important to begin the program with the most common infections in the subject hospital, for example, empiric antibiotic selection in the ICU; urinary tract infections; community-acquired pneumonia; healthcare-associated pneumonia; catheter-related infections; intra-abdominal infections; skin and soft tissue infections; central nervous system infections; surgical site infections; intensive care unit (ICU) empiric therapy; and *C. difficile* infections.

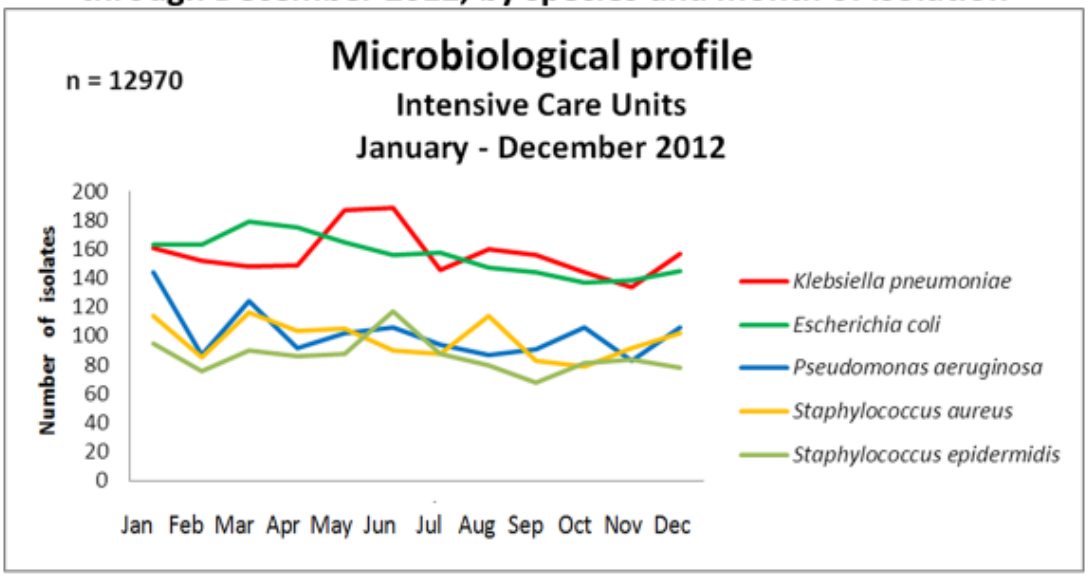
Creating Therapeutic Antibiotic Guidelines

Following are step-by-step recommendations for developing antibiotic treatment guidelines:

1. Chose one infection, for example, ICU initial antibiotic selection and complicated urinary tract infections (UTI).
2. Review the epidemiology of resistance for the most recent 6 month or 1 year period of most common bacteria in the ICU causing UTI (Figure 10).
3. Develop antibiotic guidelines, based on the local epidemiology; resistance mechanisms; selective pressure; stratification of the infection by risk factors for multidrug resistant bacteria, and potential de-escalation.
4. Look for consensus among physicians (including specialists); explain the antibiotic treatment guidelines, and why were certain antibiotics selected.
5. Listen to staff concerns regarding difficulties related to guidelines' implementation. Negotiate!
6. Once consensus has been reached, implementation can begin, followed by monitoring of adherence, measuring other easy to use outcome indicators, and feedback to physicians.

Figure 10. Example of local bacteria epidemiology in an intensive care unit

Frequency trends of the first five microorganisms in ICUs, January through December 2012, by species and month of isolation



Considerations to Select the Best Empirical Antibiotic Therapy in Intensive Care Units

- Therapy must address potential infections with *Pseudomonas aeruginosa*, because of its major importance in the ICU.
- Any anti-pseudomonal antibiotic may be used, as the species has high susceptibility: 70-80%, **but**
  if the initial treatment is cefepime or piperacillin/tazobactam, how would ESBLs be treated? 34 % and/or KPCs: 12% given their broad-spectrum hydrolysis
- Treat with carbapenem (high dose and prolonged infusion), and, depending on the infection's severity, add polymyxin and/or fosfomycin (for septic shock), or tigecycline.
- Should an aminoglycoside be added? Always? Sometimes?
- At what point is de-escalation an option?
- Should methicillin resistant *Staphylococcus aureus* (MRSA) always be covered by adding vancomycin? Or only for sepsis of unknown origin in patients with central venous catheters?

The choice of antibiotic treatment in the ICU should be based on additional data, and the local epidemiology.

Cost Effectiveness of Antimicrobial Stewardship Programs

A study was conducted in three high complexity hospitals in Colombia[6] on the advantages of implementing a stewardship program. Two of the hospitals were teaching institutions, one private (400 beds) and one public (900 beds); the third hospital had 250 beds, and was not a teaching institution. The study was implemented in medical-surgical intensive care units, and general wards. All three hospitals had empirical antibiotic guidelines based on the local epidemiology, and staff monitored prospectively the AMS program; however, every participating hospital had a different way of conducting its AMS program.

Conclusions

- The antibiotic consumption in ICUs decreased post-implementation.
- The average cost of the AMS program implementation was US$ 4,305 per month.
- There was a clear decrease of multidrug resistant bacteria.

The study outcomes confirm the importance, and economic advantages, of implementing AMS programs in healthcare institutions. Nevertheless, when establishing an AMS program, a hospital should tailor its strategies to its needs and resources.

In conclusion, antimicrobial stewardship programs have been shown to reduce morbidity and mortality, bacterial resistance, collateral damages, adverse effects, and treatment costs. A few recommendations are:

- Start by development and implementing antibiotic treatment guidelines.
- Consider using a syndrome-specific approach.
- Consider selecting one syndrome at a time.
- Emphasize that the goal is improving treatment outcomes.
- Encourage a team approach.
- Share the benefits with individual patients and the hospital.
- Streamline rather than complicate practice.
- Carry out transparent evaluations (and reevaluations) of successes and failures with all team members.

The Role of Civil Society in Ensuring Accountability in Addressing AMR: Lessons from the Antibiotic Resistance Coalition[7]

ReACT-Action on Antibiotic Resistance is a global network formed in 2005; it covers five continents, and has three key networking areas: Generation and Translation of Evidence (GATE);

[6] Cristhian Hernández-Gómez, Christian Pallares, Kevin Escandón-Vargas, Sergio Reyes, Soraya Salcedo, Lorena Matta, and Maria Virginia Villegas. Economic Impact of an Antimicrobial Stewardship Program Implementation Three High-Complexity Hospitals in Colombia. Open Forum Infect Dis. 2016; 3 (suppl 1): doi:10.1093/ofid/ofw172.726.

[7] Presentation by Dr. Reshma Ramachandran, ReAct-Action on Antibiotic Resistance Strategic Policy Program; IDEA Initiative, Department of International Health, Johns Hopkins Bloomberg School of Public Health.

Strategic Policy Program (SPP); and Empower, Engagement and Network Extension (EEE). ReACT's approach to antimicrobial resistance is multisectoral.

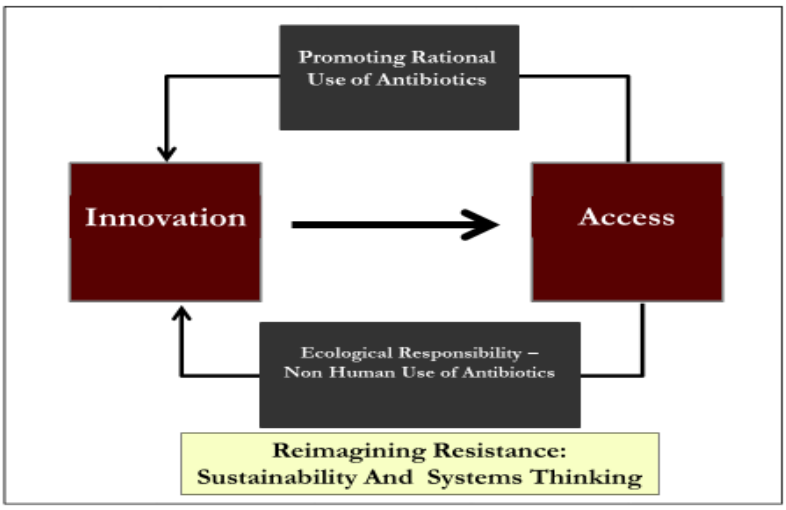
Several years ago, ReACT recognized the importance of bringing together groups working on the use of antibiotics in human health and animal husbandry. The early focus on antibiotic innovation helped generate awareness of these issues, initially from the Innovation + Access movement, which had been focused on drugs for HIV disease, tuberculosis, malaria, and other neglected tropical diseases.

Antibiotics are used to treat diseases in both the northern and southern hemisphere, yet the focus on said drugs presented a case where the research and development pipeline showed a market failure. That generated concerns about how to bring novel antibiotics forward, and how to influence how these drugs would be accessed. Also, how these drugs are used will influence needed innovation.

As antibiotics are used for growth promotion, and as a substitute for tackling non-hygienic conditions, they have markets in animal husbandry, and aquaculture, which can pose risks of cross-species resistance.

Considering that antibiotics affect the microbiome—the bacteria within us and around us—, it might be useful to apply that understanding, and take an ecosystem approach to antibiotic resistance. Also, to effectively address AMR, a three-pronged response is needed, one that includes innovation, access, and stewardship across human and animal health (Figure 11).

Figure 11. Taking a Multisectoral Approach to AMR



- The Antibiotic Resistance Coalition, or ARC, was established by 20 founding members, among them leading consumer groups in the United States, the United Kingdom, and India, as well as 40,000 physicians in training. Its thematic area is *ensuring access* to, *not excess* of antimicrobial drugs, based on the following principles:

- Securing access for everyone is as vital as curbing overconsumption; needs monitoring access, as well as conservation.
- Stewardship practices should be translated through improved, independent training of healthcare professionals.
- Strengthening of health systems is needed to ensure both development and implementation of strong regulatory policies.
- Treatable infectious diseases claim the lives of 5.7 million people annually.
- Pneumonia + diarrhea – 1 out of 4 children under 5 years of age
  - With antibiotics universally available, 75% of deaths among children 1-4 years of age might be averted. Fewer than a third of patients with suspected pneumonia receive antibiotics globally, i.e., lack of access, partially due to antimicrobial resistance.
  - Less than 4 in 10 children receive appropriate treatment for diarrhea [excess].

Monitoring Affordability and Availability

Governments need reliable information on price, availability and affordability of medicines to develop sound medicine pricing policies, and to evaluate the impact of policy implementation. Health Action International (HAI) offers standardized methodology to monitor drug prices and access along the value chain. Said methodology pulls together and analyzes data on medicine prices for patient out-of-pocket expenses and for government procurement across sectors, and country regions. It also assesses medicine availability, affordability and price components, such as taxes and mark-ups.

Curbing the Use of Antibiotics by a Multi-Pronged Approach

Engaging Health Professionals on Stewardship

Ecumenical Pharmaceutical Network/ReAct Africa: through this alliance, work is being done to establish and promote hand-washing practices (Christian Health Association of Malawi); to raise general awareness through media (Zimbabwe Association of Church-related Hospitals), and by improving adherence to standard treatment guidelines (Gertrude's Children's Hospital in Kenya).

Reducing Non-Therapeutic Antibiotic Use in Food and Agriculture

Across the food supply chain, industry and consumers have their role in curbing the non-therapeutic use of antibiotics. This is not without challenge, but the global community would welcome initiatives that could be emulated. For instance, Europe has taken important steps to curb the use of antibiotics for growth promotion, and in places like the Netherlands, the world's second largest agricultural exporter, they have done so, and have remained profitable.

Another area for policy intervention might be to ensure both the collection of and public access to data on antibiotic sales, prescriptions, and use along the food supply chain, as well as resistance patterns. Data to be collected would depend on the local context.

Clear and verifiable labeling of food animal products might help drive consumer demand for products raised without routine use of antimicrobials, and thereby shift the market supply. It

will be necessary to find a way to encourage food retailers and others to change their procurement policies, such that they procure meat and fish produced for which no non-therapeutic antimicrobials have been used.

In addition, consumers must be encouraged to demand food animal products raised without routine use of antimicrobials. In recent years, consumer advocacy groups have begun campaigns to hold food retailers accountable in this regard. These demands have called for clear timetables for implementation, and for third-party independent audits for verification. Shifting consumer demand may be one of the most powerful forces to shape the supply chain, globally and locally.

Engaging Health Professionals

Doctors, nurses, and other health care professionals are an influential voice in stopping the overuse of antibiotics in the meat industry. According to a poll conducted by the Public Interest Research Group (PIRG) and Consumer Reports, 93% of doctors said they were concerned about the use of antibiotics on healthy animals for growth promotion and disease prevention. That's a powerful consensus.

An effective way for health professionals to use their voice is to call on major restaurants to buy meat only from farms that don't raise their animals on routine antibiotics. PIRG has built a network of 25,000 health professionals calling on major restaurants to use their immense purchasing power to stop the overuse of antibiotics in the meat industry.

Catalyzing Innovation to Address Antimicrobial Resistance

Figure 12 summarizes this area of work, and the types of research needed to move forward.

Figure 12. Thematic Area: Catalyzing Innovation to Address AMR

Research need	Human Use	Animal Use
Innovation of Technology	Drugs, vaccines, diagnostics and other health technologies	Vaccines and diagnostics for animals
Innovation of Practice (Stewardship)	Practices that encourage access, but not excess in Healthcare Delivery	Practices that encourage Sustainable Agriculture, curbing non-therapeutic use of antibiotics

We must recognize that in the past few years there has been progress in addressing antimicrobial resistance. Cooperation among various agencies, both national and international, as well as consumer groups and industry, has been very important. Nonetheless, much remains to be done to curb the use of these drugs in human prophylaxis and treatment, as well as in animal husbandry, and other food production industries.

Indicators of Progress toward Sustainable Investment in Drugs, Diagnostics, Vaccines, and Other Actions Tackling Antimicrobial Resistance[8]

This presentation addressed the selection of indicators for WHO's Global Action Plan objective 5, i.e., prepare economic arguments for sustainable investment that takes into account the needs of all countries, and increase investment in new drugs, diagnostic tools, vaccines, and other actions.

A first step for countries regarding that objective is the assessment of investment needs for the implementation of national action plans. This is also a measure of effectiveness, as without sustainable investment, very little can be done to control or prevent antimicrobial resistance.

Other potential measures (indicators) of effectiveness are:

- Prioritizing and supporting basic scientific research on infectious diseases.
- Promoting partnerships among research institutions in developed and developing countries.
- Collaborating in the investigation of natural sources of biodiversity and biorepositories as sources for the development of new antibiotics.
- Piloting innovative ideas for financing research and development, and for adopting new market models to encourage investment, and ensure access to new antimicrobial products.

Following are some considerations set forth in this presentation. These add to the complexity of selecting indicators for various areas requiring measurement of progress in AMR:

- Is it more strategic for the indicator to focus on the magnitude of the problem or the progress made--the gap or the gain?
- How do we ensure that underuse is captured, not just overuse—ensuring access, but not excess?
- Is the indicator finding actionable? And, at what interval would such a change in the indicator be meaningfully so?

[8] Presentation by Dr. Anthony So, Anthony D. So, MD, MPA, ReAct—Action on Antibiotic Resistance, IDEA (Innovation+Design Enabling Access) Initiative, The Johns Hopkins Bloomberg School of Public Health.

- Is the indicator meant to diagnose a problem, set a floor for performance, allow comparison across countries or localities, motivate specific actions, or hold a specific stakeholder accountable?

Antibiotic stewardship is essential to advance the search for solutions to antimicrobial resistance. Figure 13 illustrates stewardship mechanisms and their relationship to accountability in industry, and among health care providers and consumers.

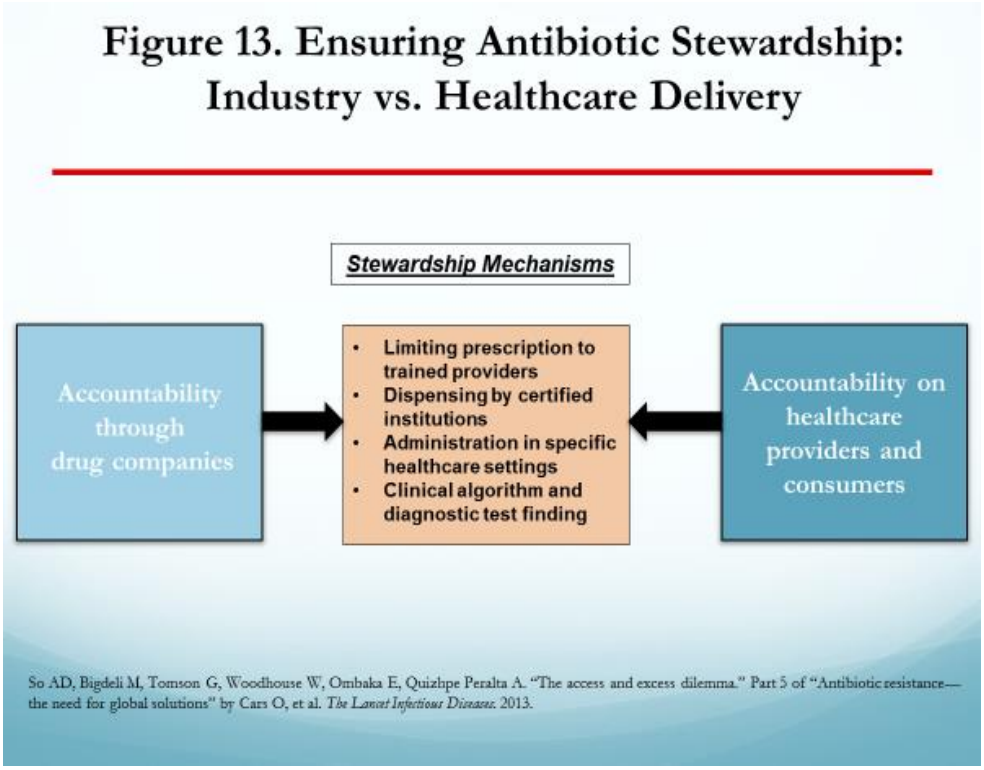
The need for indicators of accountability regarding strategic objective 5 (economic arguments for sustainable investment) are explained as follows:

- Assessment of investment needs for NAP implementation
- Return on investment: Health burden of AMR per year in terms of AMR infections, additional length of hospitalization, deaths due to AMR infections, and the associated Economic costs
- Resource commitments:
    - Prioritizing and supporting basic scientific research on infectious diseases
    - Promoting partnerships between research institutions in developed and developing countries
- Enabling environment:
    - Collaboration, based on fair and equitable benefit sharing as mutually agreed, in the investigation of natural sources of biodiversity and biorepositories as sources for the development of new antibiotics
    - Piloting innovative ideas for financing research and development, and for the adoption of new market models to encourage investment and ensure access to new antimicrobial products [delinkage]

Other actions:

- Innovation of technology in agriculture
- Innovation of practice in healthcare delivery system
- Innovation of practice in animal husbandry and aquaculture

Figure 13. Ensuring Antibiotic Stewardship: Industry vs. Healthcare Delivery



So AD, Bigdeli M, Tomson G, Woodhouse W, Ombaka E, Quizhpe Peralta A. "The access and excess dilemma." Part 5 of "Antibiotic resistance—the need for global solutions" by Cars O, et al. *The Lancet Infectious Diseases*. 2013.

Part II. Conclusions of Working Group Discussions and Proposed Indicators

Group discussions were organized following the PAHO/WHO strategic objectives, and to propose outcome indicators for each:

- To reduce the incidence of infection through effective sanitation, hygiene and infection prevention measures;
- To optimize the use of antimicrobial medicines in human and animal health;
- To develop the economic case for sustainable investment that takes account of the needs of all countries, and to increase investment in new medicines, diagnostic tools, vaccines and other interventions.

Strategic Objective 1: To improve awareness and understanding of antimicrobial resistance through effective communication, education and training.
Outcome: Increased awareness and knowledge of AMR among health care personnel.
Outcome indicators:

Health care personnel

- Proportion of health sciences schools (medicine, dentistry, nursing, other) that include antimicrobial resistance in their curricula.
- Proportion of primary health care personnel who understand that acute upper respiratory tract infections do not systematically require antibiotic treatment.*
- Proportion of primary health care personnel who understand that diarrhea does not systematically require antibiotic treatment.*
- Proportion of primary health care personnel who understand that asymptomatic bacteriuria does not systematically require antibiotic treatment.*

General population

- Percent of patients attending a health care service who are aware that antibiotic treatment is not always necessary.*
- Percentage of public communications that promote the appropriate use of antibiotics.
- Proportion of the general population and farmers who know that antibiotics should not be obtained without a prescription*
- Number of basic education programs that include AMR as a topic.

Other

- Number and type of institutions having participated in the most recent World Antibiotic Awareness Week

*An awareness baseline needs to be determined both for health care professionals and the general population.

Strategic Objective 2: To strengthen the knowledge and evidence base through surveillance and research.
Outcome 1: Assessed quality-assured data from the national resistance surveillance system.

Indicators:

- Pathogen/antibiotic combinations reported by the AMR surveillance system.
- Proportion of pathogen/antibiotic combinations outlined in the Global Antimicrobial Resistance Surveillance System (GLASS).
- Proportion of pathogen/antibiotic combinations defined in ReLAVRA's Regional Program.

Data sources for all preceding indicators: annual reports.

- Proportion (%) of culture based microbiology laboratories in each province included in the national surveillance system. Data source: Ministry of Health or other government database.
- Proportion (%) of all laboratories in the country participating in external quality assurance (EQA) programs. Data sources: external reference laboratory; WHONET database.

Outcome 2: Increased multisectoral surveillance and research efforts.
Indicator: Type of institution (public health, animal, agricultural, academic organizations) with established subcommittees that include these various institutions are producing integrated data. Data source: published report with integrated data.

Outcome 3: Antimicrobial resistance data used for decision making.
Indicators:
Proportion of guidelines based on collected data throughout the national network.

Outcome 4: Antibiotic use in animal production monitored.
Indicators:

- Sales of antibiotics for veterinary use. Data source: custom or proxy measure.
- Veterinary use of antibiotics by purpose: prophylaxis, growth promotion, treatment.
- Animal antibiotic contents in animal food samples.
- Antibiotic contents in farm animals for consumption prior to processing.

Strategic Objective 3: Reduce the incidence of infections through effective sanitation, hygiene, and preventive measures.

Outcome 1: Established strategies to boost national capacities to contain, treat, prevent, monitor, and communicate the risk of diseases caused by multidrug resistant organisms in health care settings.
Indicators:

- Proportion (%) of healthcare facilities with established infection prevention and control (IPC) programs that collect, analyze, and use data on healthcare associated infections (HAI), by level of care. Data source: National IPC programs.
- Proportion (%) of hospitals with hand hygiene compliance above 75%. Hospital IPC program, IPC epidemiologist. Data source: Surveys
- Proportion (%) of health care facilities with quality water supply and in-premise sanitation facilities. Data source: Survey and monitoring visits
- Number of IPC staff per XX patient population and/or per XX hospital beds.
- Rate of vaccination of health care facility staff for relevant infections (e.g., influenza, pneumonia, other).

Outcome 2: National HAI surveillance system in place. Source of data: published data on selected local HAI rates based on standard definitions HAI case definitions.
Outcome 3: Decreased incidence of prioritized health care acquired infections caused by multidrug resistant organisms. Source of data: ICP programs; ministries of health.

Strategic Objective 4: Optimize the use of antimicrobial drugs in human and animal health.
Outcome 1: Improved rational use of antibiotics in hospital settings.
Indicators:

- Proportion (%) of hospital antibiotic prescriptions used in surgical prophylaxis that comply with local guidelines (Target: 80%).
- Proportion (%) of hospital antibiotic prescriptions consistent with diagnosis and known local susceptibility of selected pathogens.
- Proportion (%) of hospital empirical antibiotic prescriptions that comply with local guidelines for three selected diseases (Target: 80%).
- Overall antibiotic consumption level (DDD) for key classes of antibiotics.
- Proportion (%) of hospitals with antimicrobial stewardship programs.
- Proportion (%) of hospitals with local treatment guidelines based on local antimicrobial susceptibility.

Outcome 2: Improved use of antibiotics in community settings.
Indicators:

- Overall antibiotic consumption level (DDD) for key classes of antibiotics.
- Proportion (%) of prescriptions in compliance with national guidelines for three selected diseases. (Target: 80%).
- Proportion of antimicrobials sold by prescription from trained and authorized health care professional.

Outcome 3: Improved use of antibiotics in agriculture and animal health.
Indicators:

- Proportion (%) of antibiotics sold by veterinary pharmacies for animal use in the absence of a disease diagnosis, by species.
- Proportion (%) of antimicrobials sold by prescription from a trained and authorized health veterinary professional.

Outcome 4: Improved access and appropriate use of antibiotics.
Selected population-affordable antibiotics are available at ≥ 80% of health facilities.

Strategic Objective 5: Prepare economic arguments for sustainable investment that takes into account the needs of all countries, and increase investment in new drugs, diagnostic tools, vaccines, and other actions.
Outcome 1: Systematized national evidence generated to document the economic impact of antimicrobial resistance in the country.
Indicators:

- National data available that estimates the economic impact of antimicrobial resistance at national level in all relevant sectors: morbidity and mortality data; infections averted as a result of interventions.
- Increased national investment in research and development to address AMR and prevent multidrug resistant infections.
- Number of new public-private national partnerships established to encourage research

and development of new antimicrobial agents.

- Number of national agreements or new regulatory measures to evaluate efficiency in the development, introduction, regulation, and use of new antimicrobial drugs, diagnoses, and vaccines.

Annex 1 – List of Participants

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Annex 2 - Agenda

AGENDA

Expert Consultation on Monitoring and Evaluation of Antimicrobial Resistance (AMR) Interventions

January 26, 2017

8:30	Registration.	
9:00	Opening session - Objectives - Review of agenda – Nomination of Chairperson.	M. Espinal, PAHO/WHO C. Espinal, FIU
9:15	**Session 1**: Introduction. AMR: Global, regional, national action plans – Scope for monitoring and evaluation.	P. Ramon-Pardo, PAHO/WHO
	Defining indicators needed to monitor interventions. Impact, output and process indicators – for AMR. Discussions from the WHO Strategic Technical Advisory Group.	V. Walford, WHO HQ

9:45	**Session 2:** Bases for the development of efficient monitoring and evaluation strategies on AMR (national) action plans.	
	- Burden of multidrug resistant bacterial infections in low – middle income countries.	V. Thamlikitkul, WHO Collaborating Center on AMR, Thailand.
	- Impact of regulation on antibiotic sales: challenges and achievements. The experience of Chile.	L. Bavestrello, Chile.
10:30	*Coffee Break*	
11:00	**Session 3**: Defining the indicators to monitor interventions.	
	Conscience of Antimicrobial Resistance Accountability (CARA)	H. Gelband, CDDEP
	Setting national targets to reduce unnecessary antibiotic prescription	D. Hyun, PEW Charitable
	Antimicrobial Stewardship Programs: one size does not fit all. Measuring their effectiveness	M.V. Villegas, CIDEIM

	Role of civil society in monitoring AMR. The experience from the Antibiotic Resistance Coalition	R. Ramachandran, ReAct
12:30	*Lunch Break*	
13:30	**ROOM 1 - Session 4:** Improve awareness and understanding of antimicrobial resistance through effective communications, education, and training **Moderator:** A. P. Celi, Asociación Panamericana de Infectología	**ROOM 2 - Session 5**: Strengthen knowledge and scientific grounding through surveillance and research **Moderator**: M. Galas, PAHO/WHO
15:00	*Coffee Break*	*Coffee Break*
15:30	**ROOM 1 - Session 6**: Reduce the incidence of infections through effective sanitation, hygiene, and preventive measures **Moderator**: D. Vanderende, CDC, USA	**ROOM 2 - Session 7**: Optimize the use of antimicrobial drugs in human and animal health **Moderator:** A. Dreser, INSP, Mexico.
17:00	**End of day 1**	

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9:00	**Session 8:** Prepare economic arguments for sustainable investment that takes into account the needs of all countries, and increase investment in new drugs, diagnostic tools, vaccines, and other actions	**Moderator:** Anthony So, ReAct
10:00	**Session 9: Plenary discussion** Presentation of indicators under each strategic line of action Questions and comments *Coffee break*	***Rapporteurs (Sessions 4 to 7)***
11:15		
11:30	**Session 10:** Conclusions and recommendations	P. Ramon-Pardo, PAHO/WHO
12:00	**Closing remarks**	C. Espinal, FIU
12:30	*Lunch*	