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REVIEW ARTICLE

Management of the health care system in Ecuador to confront the antimicrobial resistance

Manejo del sistema de salud de Ecuador frente a la resistencia antimicrobiana

Gestão do sistema de saúde equatoriano contra a resistência antimicrobiana

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ABSTRACT

Introduction: the Ecuadorian Health System has a National Plan for the Prevention and Control of Antimicrobial Resistance (AMR), which seeks to improve the quality of medical care and, from there, to draw attention to the increase in microbial resistance, which has become a highly relevant problem for the world public health. **Objective:** to systematize knowledge on the management of the Ecuadorian health system in the face of antimicrobial resistance. **Method:** an exhaustive bibliographic review was carried out in bibliographic search engines such as Scopus, Google Scholar and PubMed, with the search for key words. The research was carried out on May 20, 2022. Of the 39 articles, only 20 were selected according to criteria. **Results:** Ecuador has a mixed health system, made up of the public sector of the Ministry of Public Health (MSP), the Ecuadorian Social Security Institute (IESS), the Armed Forces Security Institute (ISSFA) and the National Institute of Police Security (ISSPOL); on the other hand, there is the private sector, integrated by the National Association of Private Clinics and Hospitals of Ecuador. Both are integrated in order to guarantee the integral health development of the entire Ecuadorean population, regulate and control the activities carried out by both public and private entities, without distinction, to face the threat posed by the increase in the indiscriminate use of antimicrobials, with repercussions on human and animal health. **Final considerations:** the inefficient way of combating the health risk due to antimicrobial resistance affects the Ecuadorian population as a consequence of the indiscriminate and inadequate use of antibiotics, and the insufficient use of conventional treatments.

Keywords: national health system; antimicrobial resistance; national health plan; public ministry; Ecuador

RESUMEN

Introducción: el Sistema de Salud del Ecuador cuenta con el Plan Nacional para la Prevención y Control de la Resistencia a los Antimicrobianos, que persigue la mejora en la calidad de la atención en médica y, desde ahí, llamar la atención en el aumento de la resistencia microbiana, que se ha convertido en un problema de suma relevancia para la salud pública mundial. **Objetivo:** sistematizar conocimientos sobre el manejo del sistema de salud del Ecuador frente a la resistencia antimicrobiana. **Método:** se llevó a cabo una revisión bibliográfica exhaustiva en buscadores bibliográficos como Scopus, Google Académico y PubMed, con la búsqueda de palabras clave. La indagación se realizó el 20 de mayo de 2022, de los 39 artículos fueron seleccionados según criterios solo 20 artículos. **Resultados:** Ecuador cuenta con un sistema de salud mixto, constituido por el sector público del Ministerio de Salud Pública (MSP), el Instituto Ecuatoriano de Seguridad Social (IESS), el Instituto de Seguridad de las Fuerzas Armadas (ISSFA) y el Instituto Nacional de Seguridad Policial (ISSPOL); por otro lado, está el sector privado, integrado por la Asociación Nacional de Clínicas y Hospitales Privados del Ecuador. Ambos se encuentran integrados a fin de garantizar el desarrollo integral en salud de toda la población ecuatoriana, regular y controlar las actividades que realizan las entidades tanto públicas como privadas, sin distinción, para combatir la amenaza que representa el incremento en el uso indiscriminado de antimicrobianos, con repercusiones en la salud humana y animal. **Consideraciones finales:** la forma ineficiente de combatir el riesgo sanitario por resistencia antimicrobiana afecta a la población ecuatoriana como consecuencia del uso indiscriminado e inadecuado de antibióticos, y el insuficiente uso de los tratamientos convencionales.

Palabras clave: sistema nacional de salud; resistencia antimicrobiana; plan nacional de salud; ministerio público; Ecuador

RESUMO

Introdução: o Sistema de Saúde equatoriano conta com o Plano Nacional de Prevenção e Controle da Resistência Antimicrobiana, que busca melhorar a qualidade da assistência médica e, a partir daí, chamar a atenção para o aumento da resistência microbiana, que se tornou um problema de grande relevância para a saúde pública global. **Objetivo:** sistematizar o conhecimento sobre a gestão do sistema de saúde equatoriano diante da resistência antimicrobiana. **Método:** foi realizada revisão bibliográfica exaustiva em buscadores bibliográficos como Scopus, Google Acadêmico e PubMed, com a busca por palavras-chave. A consulta foi realizada no dia 20 de maio de 2022, dos 39 artigos, apenas 20 artigos foram selecionados conforme critérios. **Resultados:** o Equador possui um sistema de saúde misto, formado pelo setor público do Ministério da Saúde Pública (MSP), Instituto Equatoriano de Previdência Social (IESS), Instituto de Segurança das Forças Armadas (ISSFA) e Instituto Nacional de Segurança Policial (ISSPOL); Por outro lado, existe o setor privado, formado pela Associação Nacional de Clínicas e Hospitais Privados do Equador. Ambos estão integrados para garantir o desenvolvimento integral da saúde de toda a população equatoriana, regular e controlar as atividades realizadas por entidades públicas e privadas, sem distinção, para combater a ameaça representada pelo aumento do uso indiscriminado de antimicrobianos, com repercussões na saúde humana e animal. **Considerações finais:** a forma ineficiente de combater o risco à saúde devido à resistência antimicrobiana afeta a população equatoriana como consequência do uso indiscriminado e inadequado de antibióticos e do uso insuficiente de tratamentos convencionais.

Palavras-chave: sistema nacional de saúde; resistência antimicrobiana; plano nacional de saúde; Ministério Público; Equador

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INTRODUCCIÓN

The World Health Organization (WHO) indicates that the provision of quality services for the entire population is the main objective of any National Health System (NHS), which is responsible for the management, financing and provision of health services in each country.

Ecuador has a mixed health system, which regulates and controls the activities carried out by both public and private entities, with the aim of guaranteeing comprehensive health development for the entire Ecuadorian population, without distinction.[1]

Its management is divided into:

- Public sector: the Ministry of Public Health (MSP), established by the constitution, acts as the regulatory and governing body that directs the Ecuadorian health system thanks to government contributions. According to the Organic Health Law, the MSP is the National Health Authority and will be in charge of the application, control and oversight of law compliance, with a directorate in each province. In addition, it will be in charge, together with the Comptroller General of the State, of granting operating permits for health companies.[2]

  On the other hand, the Ecuadorian Institute of Social Security (IESS), which operates on the basis of employee contributions, provides insurance to the working population in formal and rural sectors. The Armed Forces Security Institute (ISSFA) and the National Police Security Institute (ISSPOL) are in charge of insuring members and family members of the military and police, using the contributions of the workers of these entities.[3]

- Private sector: the private sector operates on the basis of employer contribution, private medical offices and private insurance.[4] According to the National Association of Private Clinics and Hospitals of Ecuador (ACHPE), this sector acts as a strategic partner of the national system, with a total of 762 facilities during the period 2019-2020.[4]

  The Superintendence of Companies will be in charge of supervising the contribution of prepaid medicine entities, and the Superintendence of Banks and Insurance, which, according to the Social Security Law, will audit the IESS hospital.[5]

With the discovery of penicillin in 1928 by Alexander Fleming, the development of various groups of antibiotics began in order to provide adequate treatment for infections caused by bacteria that affected the world's population. However, this in turn triggered the appearance of resistant bacteria due to the indiscriminate use of these drugs.[6]

Antimicrobial resistance is a natural process defined as the ability of microorganisms to neutralize and/or resist antimicrobial action. This resistance can be natural or acquired.

Natural resistance is specific to each microorganism. In the case of acquired resistance, it appears to be the result of defense mechanisms developed by microorganisms when exposed to antimicrobial agents. The latter mechanism is of concern because it can spread resistance and promote outbreaks at hospitals[7], which is a critical area for any national health system.

METHOD

An exhaustive bibliographic review was carried out in bibliographic search engines such as Scopus, Google Scholar and PubMed, with the search for keywords such as: "National Health System", "Microbial Resistance to Antibiotics", "National Health Plan" and "Public Ministry", taken from DeCS, with the aim of systematizing knowledge on the management of the Ecuadorian health system in the face of antimicrobial resistance.

The search began on May 20, 2022. Of the 39 articles studied, were excluded the ones that were not updated, scientifically relevant, or did not adequately address the topics of interest; 20 were selected because both the title and abstract were properly related to the present article.

In addition, the results and analyses were scrutinized, considering as a priority those that described in detail the management of public health in the face of antimicrobial resistance in Ecuador.

DEVELOPMENT

One of the factors contributing to the spread of resistance mechanisms is the inappropriate and erroneous use of antimicrobials, coupled with poor control of nosocomial infections.[8,9]

It was established at the World Health Organization (WHO) Assembly held in 2015 that all the States Member of the organization would develop and implement the Global Action Plan against Antimicrobial Resistance.[8] In Latin America, Brazil reported the first case of antimicrobial resistance in 2003; Argentina and Colombia reported other cases in 2005; in 2010, Ecuador described a carbapenemase-producing *Klebsiella pneumonia* as its first case of antimicrobial resistance.[8]

The Ecuadorian Health System seeks to achieve health objectives that have an impact on improving the quality of health care:[9,10]

- Raising awareness of antimicrobial resistance through clear, community-based communication.
- Reduce the incidence of infections through effective sanitation, hygiene and infection prevention measures.
- To promote research and strengthen knowledge on the appropriate use of drugs.
- To reduce the unnecessary use of antimicrobial drugs in human and animal health.
- Invest in diagnostic tools, vaccines and other interventions.

It also presents a strategic plan with its respective goals from the global action plan. Retrieved from Contreras, *et al.*[8] (Table 1).

Table 1. Ecuador's strategic plan with strategic objectives from the global action plan

Actions	Objetives
Promote understanding of antimicrobial resistance through communication and education.	• Identify the perception and practices of antimicrobial resistance. • Improve awareness and understanding regarding antimicrobial resistance.
Strengthen the knowledge and scientific base through monitoring and research.	• Implement a national integrated monitoring system for antimicrobial resistance. • Establish a national laboratory system for AMR monitoring in human health, animal health, environmental health and the food chain. • Design and implement a research and a development program for the prevention and control of AMR.
Reduce the incidence of infections with effective sanitation, hygiene and infection prevention measures.	• Establish training and education in infection prevention and control in education programs. • Strengthen supervision in the Monitoring, Prevention and Control of healthcare-associated infections (HAI). • Establish Monitoring, Prevention and Control of HAI at the primary health care. • Introduce prevention and control programs in veterinary settings. • Limit the development and spread of AMR outside healthcare settings through infection prevention and control.
Optimal use of antimicrobial drugs in human and animal health.	• Measure antimicrobial use in humans, farm animals, agriculture, aquaculture and food. • Ensure good practices in the use of antimicrobials in humans and animals. • Certify good practices in the use of antimicrobials in hospitals.
Prepare economic grounds in favor of sustainable investment that takes into account the needs of each country, and increase investment in new drugs.	• Prepare economic information necessary for decision-making in favor of sustainable investment in AMR prevention and control in human health, animal health and environmental health. • Promote the channeling of governmental and non-governmental resources to increase investment in new drugs, diagnostics, vaccines and other interventions in AMR prevention and control.

The National Epidemiological Monitoring Service, with support from the National Drug Resistance Reference Center (CRN-RAM) of the National Institute of Public Health, led this control. The AMR monitoring system network consists of laboratories in each hospital.

There are four private laboratories for AMR monitoring, located in Quito and Guayaquil. Monitoring helps to generate information on the evolution of antibiotic resistance patterns in the microorganisms, develops prevention and control strategies at all levels, and guide public policy decision-making.

To obtain bacterial resistance data, the professionals responsible for each hospital laboratory must complete the microbiology information in the Whonet computer system, provided by the Ministry of Health.[8]

Main resistance genes in health facilities in the country

KPC: This gene is present in *Klebsiella pneumoniae*. KPC is an enzyme produced by bacteria that confers resistance to carbapenem antibiotics, rendering them inactive against the bacteria, mainly found in hospitals in Quito, Ecuador.[8]

ESBL: Extended spectrum beta-lactamase is an enzyme produced by large negative bacilli (mainly *Enterobacteriaceae*), most commonly found in *Escherichia coli* and *Klebsiella pneumoniae*.[11]

CTX-M: Constitutes a new group of Ambler class A ß-lactamases with extended spectral properties. They are encoded in transferable plasmids and most are present in *Enterobacteriaceae* such as *Salmonella typhimurium*, *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus mirabilis*. With resistance to cephalosporin, especially cefotaxime and ceftriaxone, carbapenemics, due to the presence of extended spectrum beta-lactamases (ESBL), it is the most common microbial resistance and crucial matter for public health.[8,12]

vanB: vanB genes are mostly found in *Enterococcus genus*, specifically in *Enterococcus faecium* and *Enterococcus faecalis*; confer resistance to vancomycin.[13]

mcr-1: Found in *Escherichia coli* and *Klebsiella pneumoniae*, it allows the bacteria to resist colistin, wich use is prohibited for animal use or consumption in the country.[14]

OXA-48: Identified in *Klebsiella pneumoniae*, *Escherichia coli*, *Enterobacter cloacae*, *Morganella morganii*, the antibiotics with the highest sensitivity of OXA-48 producing strains include ceftazidime-avibactam, amikacin, tigecycline, meropenem and imipenem.[15]

NDM-1: (New Delhi metallo-beta-lactamase) has resistance to carbapenemics. This enzyme is usually found in Gram-negative bacteria such as *Klebsiella pneumoniae* and *Escherichia coli*.[16]

VIM-1: (Verona integron-encoded metallo-beta-lactamase) has resistance to carbapenemics. It is mostly found in enterobacteria.[17]

CFR: Found in *Staphylococcus aureus*, *Staphylococcus epidermidis* and *Enterococcus faecalis*, it provides resistance to chloramphenicol-florfenicol, linozolid (oxazolidinones).[18]

mecA: Is responsible for methicillin resistance in *Staphylococcus aureus*.[19]

Antibiotic resistance classification of the main microorganisms subject to monitoring

Escherichia coli

In Ecuador, several bacterially expressed resistance genes have been described, such as: KPC and NDM-1 type carbapenemases, which confer resistance to colistin, in addition to the appearance of isolates carrying the mcr-1 gene. In the hospital area, has been observed resistance every year to ceftazidime, ceftriaxone, cefotaxime, cefepime, cephalosporins and imipenem, meropenem and other carbapenemics. Compared to carbapenemics, which have a lower rate of resistance, cephalosporins have a resistance rate of up to 50%.[8]

Resistance to cephalosporins has been observed in *Escherichia coli* strains in isolates from the intensive care unit (ICU), suggesting that cefepime has a lower resistance rate than other antibiotics in this class. Regarding resistance to other antibiotic families such as aminoglycosides, quinolones, sulfonamides, phosphonates, glycylcyclines, and nitrofurans, ICU isolates were more resistant to quinolones.[8]

Resistance to other antibiotic families has been demonstrated in both isolated patients that developed resistance in the hospital and in patients with community-acquired resistance. In both cases, the rates of resistance to sulfonamides and quinolones were the highest.[8]

Klebsiella pneumoniae

Considered an opportunistic pathogen responsible for a large number of HAIs, it has been described as a multidrug resistant microorganism that spreads globally. Carbapenem resistance in *Klebsiella pneumoniae* involves multiple mechanisms, including the production of carbapenemases (KPC, NDM, VIM, OXA).

Similar rates of resistance to cephalosporins have been demonstrated in isolates from hospitalized patients and ICU patients, particularly for cefotaxime and ceftriaxone. *Klebsiella pneumoniae* is part of the flora of healthy individuals and may be the causative agent of infection upon presentation of an immunosuppressed state, often associated with an underlying disease.[8]

This trait and the acquisition of resistance mechanisms mediated by mobile genetic elements lead to the development of HAIs like sepsis, respiratory, urinary and soft tissue and community-acquired infections.

In Ecuador, this microorganism is the most widespread and most associated with HAIs in hospitals nationwide. Resistance mechanisms associated with this pathogen include KPC, NDM and IMP type carbapenemases, and the mcr-1 gene, which provides resistance to colistin. Similar rates of resistance to carbapenemics such as imipenem and meropenem were observed in both hospitalized patients with hospital-acquired infections (20%-35% resistance) and ICU patients with 40%-55% resistance.[8]

Pseudomonas aeruginosa

It is an opportunistic pathogen of major importance because it is closely related to HAIs. Regarding the resistance mechanisms associated with this pathogen, it is known to have both intrinsic and acquired resistance, making it a challenge to develop an understanding of the very diverse therapeutic procedures in isolates of *P. aeruginosa*. The country has described the discovery of *Pseudomona aeruginosa* with carbapenemases such as VIM, IMP, etc. Carbapenems, imipenems and meropenems isolated in hospitals between 2014 and 2017 had resistance rates of up to 30% in infections caused by the bacterium.[8]

Bacterial infections caused by *Pseudomona aeruginosa* have been empirically treated with beta-lactams such as ceftazidime, piperacillin-tazobactam or cefepime; however, during 2014-2017, susceptibility profiles obtained by monitoring networks showed a high percentage of resistance in isolates from several health services, including ICU. As reflected in the analysis, the number of isolates has increased significantly each year; ceftazidime, for example, showed high resistance rates of 23.7% and 18.5% in 2016 and 2017 respectively, making it the most representative of the period, which is directly related to the discovery of extended-spectrum β-lactamases, specifically hydrolyzed CAZ.[8]

Staphylococcus aureus

It has been associated with community and nosocomial infections in humans. Methicillin-resistant *Staphylococcus aureus* (MRSA) is widely studied and distributed at community and hospital levels, and is associated with skin and soft tissue infections and bacteremia. A similarly high rate of resistance was present in ICU isolates, 87% of which were penicillin-resistant. In the four-year study presented, the same pattern was observed, with a slight decrease in *Staphylococcus aureus* resistance rates associated with methylases, the enzymes that confer resistance to clindamycin, for hospital isolates and ICU isolates.

For isolates sent from ICUs by healthcare facilities, fewer samples were observed compared to hospitals, and a 37% decrease in the percentage of oxacillin resistance was also observed from 2014 to 2017, which fell to 26%.[8]

Enterococcus

Among the common causative microbial agents of HAIs and community infections is the genus *Enterococcus*, represented by *Enterococcus faecalis* and *Enterococcus faecium*, the most distinctive species in humans. Linezolid is an antimicrobial agent of the oxazolidinone family used to treat clinically relevant gram-positive bacterial infections. Therefore, resistance to this drug is of concern, given the limited therapeutic options.[18,19]

The UN agenda for the year 2030 has 17 sustainable development goals, of which 7 are related to antimicrobial resistance, supported by the importance of the collection and analysis of data obtained by the WHO, which since 2015 recommended that member countries develop a national plan to fight antimicrobial resistance, using reliable, timely and reproducible microbiological results obtained from the Latin American Network for Antimicrobial Resistance Monitoring (ReLAVRA), created in 1996 with support from the Pan American Health Organization.[20]

ReLAVRA, which is present in Argentina, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay and Venezuela[21], seeks to improve patient care through the establishment of sustainable quality assurance programs[20]. For this reason, a report on the criteria to be used was prepared and also a list of the antibiotics to be included, taking into account that their discovery and marketing has fundamentally changed the prognosis of considerably fatal infections.[22]

Infections caused by drug-resistant bacteria not only result in increased morbidity and mortality, but also generate more complex hospitalizations, longer hospital stays and higher costs for health systems, especially in Latin America[22], where there is no monitoring at the local, national and regional levels to allow adequate measures for the prevention and control of antimicrobial resistance. Therefore, to counteract this dangerous health problem, the following strategies are proposed:

- Stratify the national monitoring of the consumption of priority antimicrobials in ICUs in hospitalized patients in Ecuador, to better understand the impact of efforts to reduce the use of antimicrobials on the levels of resistance observed in hospitals and communities.[23]
- Elaborate, develop and spread awareness campaigns on the rational use of antibiotics for the general population. Aims to raise awareness of antimicrobial resistance and promote changes in habits and behaviors for the responsible use of medicines. Promote a better understanding and awareness of this problem at an early age.[24]
- Monitor and measure antimicrobial concentrations in water, sediments and soil at strategic points. Monitoring for AMR of bacteria in water for human use and consumption, agricultural use, and wastewater reuse. Establish a standardized mechanism for the measurement and analysis of AMR of relevant bacteria with clinical impact in wastewater and purification systems (especially in hospitals, farms and institutions specialized in the production of pharmaceuticals and food.[25,26,27]
- Develop laboratories in larger areas where there is bacterial exposure, such as the agricultural and livestock sector, together with the coordination of the Ministry of Agriculture and Livestock for AMR monitoring in animals and vegetables (fresh unprocessed vegetables).[24]
- Use of an integrated monitoring system with animal health "Una Salud". It is required the creation and development of a national network for AMR monitoring, including human and animal health, made up of specialists representing both sectors. The reports derived from the information processed will contribute to the management of AMR.[25]
- The National Agency for Health Regulation, Control and Monitoring (ARCSA) is a nationally and internationally recognized health regulation and control institution which mission is to guarantee the health of the population by controlling the quality, efficacy and safety of health-related products and establishments.[28] This institution should focus its efforts on strengthening control and compliance of antibiotic sales, and dispensing them to the public in pharmacies strictly with the use of medical prescriptions. Among the factors that affect the misuse of antibiotics are: self-medication, dispensing without prescription and non-compliance with medical indications. Control of the use of antimicrobials is necessary in the fight against resistance, since it provides

information on prescribing habits and behaviors related to their consumption. Generally, the sale units do not include the actual duration of the treatment.[28]

- Propose an electronic prescription system to control the use of antimicrobials in humans.[27]
- Participation in International Antimicrobial Resistance Monitoring Networks, wich is a tool for information exchange and knowledge acquisition that contributes to continuing education. Spreading the results of national monitoring to the scientific community and socializing the knowledge generated by control is a fundamental pillar for understanding the current epidemiological status of the country, in order to determine treatment options and update the approaches of health care providers for the diagnosis of AMR.[28]
- Strengthen the multimodal strategy for hand hygiene and application of biosafety and personal protective equipment.[29]
- Conduct technical training on HCAI and AMR prevention and control issues, to generate national spreading mechanisms for information on content related to the infection prevention and control program.[29]
- Extend epidemiological monitoring of HCAI to secondary and tertiary level hospitals of the public and complementary network of the National Health System.[29]
- Implementation of antimicrobial consumption monitoring module in the current HAI monitoring system. Monitoring antimicrobial consumption is essential to understand the pressure they exert on the emergence of resistance. This effect is of utmost importance at hospital level, where the use of broad-spectrum antimicrobials is often necessary. Implement of a Consumption Monitoring System (in Primary and Hospital Care). Control of antimicrobial use is necessary in the fight against resistance, as it provides insight into prescribing habits and behaviors related to their consumption.[28]
- Implementation of the National Program for the prevention and control of healthcare-associated infections and updating of the biosafety manual (as needed according to scientific advances in the field).[29]
- Implementation of control protocols for surgical chemoprophylaxis.[23]
- Monitor the use of antimicrobials in prisons.[27]
- To include strategies to reduce human STDs transmission, such as prevention campaigns with the help of the HIV/STI department.[27]
- Strengthen vaccination programs to reduce the morbidity of infectious diseases such as hepatitis A and tetanus in populations susceptible to emergencies and disasters.[27]

Actions for the prevention and control of antimicrobial resistance

The government is actively pushing the "National Plan for the Prevention and Control of Antimicrobial Resistance 2019-2023" based on the WHO global action plan on antimicrobial resistance. The plan was developed with representatives from the following government sectors: Agriculture, Livestock, Aquaculture, Fisheries, Education, Environment and Health. Thus, activities for each of these sectors are cemented to achieve the general goal of reducing the risk and spread of antimicrobial resistance emergencies in human, animal, plant and environmental health in Ecuador.[8]

In parallel to the need for the aforementioned plans, it is clear that the country has responsibility in guiding the implementation of interinstitutional strategies for the activities proposed in each sector. Goals are: to propose policies, programs and activities necessary to develop, implement and enforce the National Program for Prevention and Control of Antimicrobial Resistance and to form technical subcommittees and support groups with experts on AMR issues and establish a mechanism for communication and spreading of the activities and results of the committee's management.(8)

It is planned to expand institutional monitoring of AMR in sentinel hospitals through training in the Whonet system by the personnel responsible for microbiology, infection control and epidemiology in these facilities, in order to begin to strengthen sentinel monitoring and expand coverage to 60 hospitals in the country.(8)

FINAL CONSIDERATIONS

The National Health System of Ecuador represented by the Ecuadorian Ministry of Public Health, in compliance with the requirement set forth by the World Health Organization, implements the National Plan for the prevention and control of AMR 2019-2023, in order to fight back the growing antimicrobial resistance that has become a global health problem.

The drawback lies in the fact that although the country has deployed initiatives to address AMR in the last decade, these have been carried out inefficiently. It is expected that until 2023 there will be real progress in terms of facing this health risk that affects the Ecuadorian population both physically and economically, as conventional treatments cannot be used because of the indiscriminate and inappropriate use of antibiotics.

REFERENCES

1. Organización Panamericana de la Salud. Ecuador. www.paho.org. [cited 21 Ago 2022]. Available in: https://www.paho.org/es/ecuador
2. MSP. Reglamento Establecimientos Servicios Funerarios y Manejo Cadaveres. emuce.gob.ec. 2018. Available in: Reglamento Establecimiento de Servicios Funerarios y Manejo de Cadáveres.pdf (emuce.gob.ec)
3. Becerril-Montekio V, Reyes JD, Manuel A. Sistema de salud de Chile. Salud Púb Méx [Internet]. 2011 Ene [cited 21 Sep 2022]; 53:s132-42. Available in: http://www.scielo.org.mx/scielo.php?script=sci_abstract&pid=S0036-36342011000800009&lng=es&nrm=iso&tlng=es
4. Lucio R, Villacrés N, Henríquez R. Sistema de salud de Ecuador. Salud Púb Méx [Internet]. 2011 Ene [cited 28 Sep 2022]; 53:s177-87. Available in: http://www.scielo.org.mx/scielo.php?script=sci_abstract&pid=S0036-36342011000800013&lng=es&nrm=iso&tlng=es
5. Ortiz-Culcay O, Fernández-García C, Pérez-Rico C. Análisis de cobertura de medicina

prepagada en Pichincha (2019-2020). Ciencia UNEMI [Internet]. 2022 [cited 21 Aug 2022]; 15(38):1-13. Available in: https://dialnet.unirioja.es/descarga/articulo/8374923.pdf
6. Vanegas Múnera JM, Jiménez Quiceno JN. Resistencia antimicrobiana en el siglo XXI: ¿hacia una era postantibiótica? Rev Fac Nac Salud Púb [Internet]. 2020 Feb [cited 21 Aug 2022]; 38(1):1-6. DOI: https://doi.org/10.17533/udea.rfnsp.v38n1e337759
7. Mendoza Macías CL. La resistencia bacteriana: estrategias para la optimización de la terapia antimicrobiana. Nat Tecnol [Internet]. 2021 Nov [cited 21 Sep 2022]; (2). Available in: http://148.214.66.42/index.php/nyt/article/view/400
8. Contreras B. Reporte de datos de resistencia a los antimicrobianos en Ecuador (2014-2018). Min Salud Pub [Internet]. 2018 [cited 21 Sep 2022]; 2(1):1-10. Available in: https://www.salud.gob.ec/wp-content/uploads/2019/08/gaceta_ram2018.pdf
9. MSP. Plan Nacional para la Prevención y Control de la Resistencia Antimicrobiana (RAM) 2019-2023. Ecuador: Ministerio de Salud Pública; 2019 [Internet]. [cited 23 Sep 2022]. Available in: https://www.salud.gob.ec/msp-presento-plan-nacional-para-la-prevencion-y-control-de-la-resistencia-antimicrobiana-ram-2019-2023/
10. OPS. Chile: Mesa Intersectorial de RAM lanza segunda versión del Plan Nacional Contra la Resistencia a los Antimicrobianos [Internet]. Organización Panamericana de la Salud; 2021. [cited 28 Sep 2022]. Available in: https://www.paho.org/es/noticias/8-10-2021-chile-mesa-intersectorial-ram-lanza-segunda-version-plan-nacional-contra
11. Miranda García M. Escherichia coli portador de betalactamasas de espectro extendido: resistencia. Sanid Mil [Internet]. 2013 Dic [cited 23 Aug 2022]; 69(4):244-8. DOI: https://dx.doi.org/10.4321/S1887-85712013000400003
12. Rivera-Jacinto M, Rodríguez-Ulloa C, Flores Clavo R, Serquén López L, Arce Gil Z. Betalactamasas de espectro extendido tipo TEM y CTX-M en Klebsiella spp y Escherichia coli aisladas de superficies de ambientes hospitalarios. Rev Perú Med Exper Salud Pública [Internet]. 2015 Oct [cited 23 Sep 2022]; 32(4):752-5. Available in: http://www.scielo.org.pe/scielo.php?script=sci_abstract&pid=S1726-46342015000400018&lng=es&nrm=iso&tlng=es
13. Raza T, Ullah SR, Mehmood K, Andleeb S. Vancomycin resistant Enterococci: A brief review. J Pak Med Assoc [Internet]. 2018 Mayo [cited 24 Aug 2022]; 68(5):768-72. Available in: https://pubmed.ncbi.nlm.nih.gov/29885179/
14. Ugarte Silva RG, Olivo López JM, Corso A, Pasteran F, Albornoz E, Sahuanay Blácido ZP. Resistencia a colistín mediado por el gen mcr-1 identificado en cepas de Escherichia coli y Klebsiella pneumoniae: primeros reportes en el Perú. An Fac Med [Internet]. 2018 Jul [cited 23 Aug 2022]; 79(3):213-7. DOI: http://dx.doi.org/10.15381/anales.v79i3.15313
15. Mora-Guzmán I, Rubio-Perez I, Domingo-Garcia D, Martín-Pérez E. [Infections by OXA-48 carbapenemase-producing Enterobacteriaceae in surgical patients: antibiotic consumption and susceptibility patterns]. Rev Esp Quimioter [Internet]. 2020 Dic [cited 26 Aug 2022]; 33(6):448-52. DOI: https://doi.org/10.37201/req/081.2020

16. Resurrección-Delgado C, Montenegro-Idrogo JJ, Chiappe-Gonzalez A, Vargas-Gonzales R, Cucho-Espinoza C, Mamani-Condori DH, *et al*. Klebsiella pneumoniae nueva Delhi metalo-betalactamasa en el Hospital Nacional Dos de Mayo: Lima, Perú. Rev Perú Med Exp Salud Pública [Internet]. 2017 Abr [cited 21 Aug 2022]; 34(2):261-7. DOI: http://dx.doi.org/10.17843/rpmesp.2017.342.2615
17. Yaffee AQ, Roser L, Daniels K, Humbaugh K, Brawley R, Thoroughman D, *et al*. Notes from the Field: Verona Integron-Encoded Metallo-Beta-Lactamase-Producing Carbapenem-Resistant Enterobacteriaceae in a Neonatal and Adult Intensive Care Unit--Kentucky, 2015. MMWR Morb Mortal Wkly Rep [Internet]. 2016 Feb [cited 23 Sep 2022]; 65(7):190. DOI: https://doi.org/10.15585/mmwr.mm6507a5
18. Rincón S, Panesso D, Díaz L, Carvajal LP, Reyes J, Munita JM, *et al*. Resistencia a antibióticos de última línea en cocos Gram positivos: la era posterior a la vancomicina. Biomedica [Internet]. 2014 Abr [cited 21 Aug 2022]; 34(01):191-208. DOI: https://doi.org/10.7705/biomedica.v34i0.2210
19. Becker K, Denis O, Roisin S, Mellmann A, Idelevich EA, Knaack D, *et al*. Detection of mecA- and mecC-Positive Methicillin-Resistant Staphylococcus aureus (MRSA) Isolates by the New Xpert MRSA Gen 3 PCR Assay. J Clin Microbiol [Internet]. 2016 Ene [cited 21 Sep 2022]; 54(1):180-4. DOI: https://doi.org/10.1128/jcm.02081-15
20. Giono-Cerezo S, Santos-Preciado JI, Rayo Morfín-Otero M del, Torres-López FJ, Alcántar-Curiel MD, Giono-Cerezo S, *et al*. Resistencia antimicrobiana. Importancia y esfuerzos por contenerla. Gac Méd Méx [Internet]. 2020 Abr [cited 23 Aug 2022]; 156(2):172-80. DOI: https://doi.org/10.24875/gmm.20005624
21. Jiménez Pearson MA, Galas M, Corso A, Hormazábal JC, Duarte Valderrama C, Salgado Marcano N, *et al*. Consenso latinoamericano para definir, categorizar y notificar patógenos multirresistentes, con resistencia extendida o panresistentes. Rev Panam Salud Púb. 2019; 43:e65. https://doi.org/10.26633/RPSP.2019.65
22. Allel K, García P, Labarca J, Munita JM, Rendic M, Undurraga EA. Socioeconomic factors associated with antimicrobial resistance of Pseudomonas aeruginosa, Staphylococcus aureus, and Escherichia coli in Chilean hospitals (2008–2017). Rev Panam Salud Púb [Internet]. 2020 Sep [cited 23 Sep 2022]; 44:e30. DOI: https://doi.org/10.26633/RPSP.2020.30
23. Hinestroza D. Plan de accion nacional de lucha contra la resistencia a los antimicrobianos Costa Rica, 2018-2025. www.ministeriodesalud.go.cr. 2018; 7:1–25. Available in: https://bit.ly/3IQYCgf
24. Rodrigez J, Galindo RM. Estrategia nacional de acción contra la resistencia a los antimicrobianos. dof.gob.mx. 2018. Available in: https://dof.gob.mx/nota_detalle.php?codigo=5525043&fecha=05/06/2018#gsc.tab=0
25. FAO. El Plan de acción de la FAO sobre la resistencia a los antimicrobianos (2021-2025). www.fao.org. 2021. Available in: https://www.fao.org/3/cb5545es/cb5545es.pdf
26. Sylvia Santander RD, Contreras Cerda P. Ministerio de Salud. Plan Nacional contra la Resistencia a los Antibióticos [Internet]. Ministerio de Salud; 2017. p. 43. Available in: https://bit.ly/3XcWOTf
27. Alyahya M. Changing organizational structure and organizational memory in primary care practices: a qualitative interview study. Health Serv Manage Res [Internet]. 2012 Feb [cited 23 Aug 2022];

25(1):35-40. DOI: https://doi.org/10.1258/hsmr.2011.011023

28. Lazovski J, Corso A, Pasteran F, Monsalvo M, Frenkel J, Cornistein W, *et al*. Estrategia de control de la resistencia bacteriana a los antimicrobianos en Argentina. Rev Panam Salud Púb [Internet]. 2018 jun. [cited 23 Sep 2022]; 41:e88. DOI: https://doi.org/10.26633/RPSP.2017.88

29. Ross J, Larco D, Colon O, Coalson J, Gaus D, Taylor K, *et al*. Evolución de la Resistencia a los antibióticos en una zona rural de Ecuador. Práct Fam Rural [Internet]. 2020 Feb [cited 27 Aug 2022]; 5(1). DOI: https://doi.org/10.23936/pfr.v5i1.144

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