



مرکز تحقیقات عوامل اجتماعی مؤثر بر
سلامت

مرکز مدیریت بیماریهای واگیر

National Action Plan of the Islamic Republic of Iran for combating antimicrobial resistance

(IRIAMR) 2016 - 2021

Ministry of Health and Medical Education

Center for Communicable Diseases Control

December 2016

List of members contributing to the formulation of the national action plan

Authors:

Ghobad Moradi ¹

Bakhtiar Piroozi ²

Leila Mollaeipour ³

Supervisors:

Mohammad Mehdi Gouya ⁴

Babak Eshrati ⁵

Technical team members (in alphabetical order):

Masomeh Ebrahimi Tehrani

Shirin Afhami

Farzam Bidarpour

Nader Pourghassem

Alireza Pirestani

Farzad Payravian

Mohammad Mehdi Tadaion

¹ Assistant Professor, PhD in Epidemiology, Social Determinants of Health Research Center, Kurdistan University of Medical Sciences, Sanandaj, Iran.

² Assistant Professor, PhD in Health Policy, Social Determinants of Health Research Center, Kurdistan University of Medical Sciences, Sanandaj, Iran.

³ MS in Epidemiology, Iran University of Medical Sciences, Tehran, Iran.

⁴ Professor, Infectious disease specialist, Center for Communicable Diseases Control, Ministry of Health and Medical Education.

⁵ Associate Professor, PhD in Epidemiology, Center for Communicable Diseases Control, Ministry of Health and Medical Education.

Sayed Hossein Torabi

Nahid Jafari

Mahbobeh Hajabdulbaghi

Ranandehpour

Nahid Rahimifard ⁶

Marjan Rahnami Farzami ⁷

Fatemeh Soleimani

Siamak Mehrab Samii ⁸

Bitra Sangestani

Fatemeh Golchobian

Mino Mohrez

Taibeh Moradi

Farnaz Mostofian

Majid Mesbahian

Taha Mousavi ⁹

Mahmoud Nabavi ¹⁰

Masomeh Nejatifar

List of Organizations contributing to the formulation of the action plan:

Deputy of Health, Ministry of Health and Medical Education

Deputy of Treatment, Ministry of Health and Medical Education

Food and Drug Administration, Ministry of Health and Medical Education

Health Reference Laboratory, Ministry of Health and Medical Education

⁶ Associate Professor, PhD in Microbiology, PhD in Clinical Laboratory Medicine, Food and Drug Administration, Ministry of Health and Medical Education.

⁷ Assistant Professor, PhD in Pathology, Health Reference Laboratory.

⁸ Assistant Professor, PhD in Biotechnology, Health Reference Laboratory.

⁹ Officer of Antimicrobial Resistance Program, Center for Communicable Diseases Control, Ministry of Health and Medical Education.

¹⁰ Infectious disease specialist, Center for Communicable Diseases Control, Ministry of Health and Medical Education.

Reference Laboratory for Food and Drug Control, Ministry of Health and Medical Education

Center for Reference Laboratories for Food and Drug Control, Food and Drug Administration, Ministry of Health and Medical Education

Iran Veterinary Organization

Iran Health Insurance Organization

Abstract:

Antimicrobial agents and drugs are valuable resources that are used every day around the world to treat infections in humans and animals. They save millions of lives in the world each year. However, with the emergence of strains resistant to the antimicrobial agents and drugs, the efficacy of these valuable resources has decreased, and they have become a public health threat which cause economic losses. As a result, from the perspective of the World Health Organization, antimicrobial resistance has become one of the most important public health issues. Therefore, the WHO have invited the countries around the world to work together to inhibit antimicrobial resistance; thus, in the World Health Assembly (May 2014), the WHO adopted a resolution to develop a global action plan for tackling antimicrobial resistance. The WHO expects that by 2017 all the member states prepare a national document for combating antimicrobial resistance based on the suggested framework. In line with this goal, the Islamic Republic of Iran has prepared a national document for combating antimicrobial resistance. For the preparation of this national document, the literature and strategic plans for the inhibition of resistance designed by pioneer countries were reviewed and the views of the experts and key stakeholders in the field of antimicrobial resistance were obtained. As a result, this document reflects the opinions and views of experts and key stakeholders working in the fields of human health, animal health, agriculture, and food production in Iran. In addition, this document supports the regional and global efforts to inhibit antimicrobial resistance. This document covers five main objectives, including:

1. Raise public awareness and promote the trainings and educations for professional groups
2. Monitor antimicrobial resistance continuously, monitor the use of medications and antimicrobial drugs, and identify the signs of change and the expansion of antimicrobial resistance
3. Prevent the spread of microorganisms resistant to antimicrobial agents and drugs via implementing appropriate control and prevention programs
4. Promote the appropriate use of antimicrobial agents and drugs in the fields of health care, livestock production and poultry farming and aquaculture
5. Promote research and development activities in the field of antimicrobial resistance

After designing and implementing operational plans for this national document in the country, this action plan is expected to provide a proper response for combating antimicrobial resistance.

Vision:

"The Islamic Republic of Iran is a country where antimicrobial agents and drugs are considered and managed as valuable resources. Iran is determined to take actions at national and international level to reduce the emergence and spread of resistant microorganisms and facilitate continuous and permanent access to antimicrobial agents and drugs which are effective in the prevention and treatment of diseases".

Foreword

After the discovery of penicillin and streptomycin in the fourth decade of the last century, the world observed a drastic reduction in morbidity and mortality from infectious diseases. It increased the hope to control infectious diseases and caused a public delight. However, it gradually became clear that microbes generating infectious diseases are able to produce genes which deteriorate antimicrobial effects and cause antimicrobial resistance. In recent years, misuse of antibiotics has led to a quick and strong increase in antimicrobial resistance. Consequently, antimicrobial resistance has become a significant public health issue. The emergence of some strains of bacteria that are resistant to multiple antibiotics has made the situation more complicated and difficult. Antimicrobial resistance imposes a high economic burden on patients and the community. It can lead to prolonged hospitalization, unresponsiveness to treatment, and other problems. Now, scientists and international organizations are introducing this problem as a serious health crisis which needs urgent responses. Continuous monitoring, prevention, and control of antimicrobial resistance are dependent on efforts and commitment of public and private groups who are in charge of this program in the community. This program requires advocacy and financial support to be provided by the highest levels of policymaking. Health officials are trying to convince policymakers that combating antimicrobial resistance will ultimately reduce the costs of disease and treatment and protect human from future potential risks.

According to the WHO's 2014 report on the global antimicrobial resistance surveillance system, antimicrobial resistance is no longer a forecast for the future and it is now occurring all around the world and is a serious threat associated with common infections in communities and hospitals. Without urgent and coordinated action, the world can be traced to the pre-antibiotic era when common infections and minor injuries will be fatal once again.

In order to detect, prevent, and control diseases and death caused by drug-resistant microbes, some countries are implementing actions to reduce the emergence and spread of antimicrobial drug-resistant strains. Accordingly, most of these countries are developing national strategic plans to combat antimicrobial resistance. Antimicrobial resistance is a global problem which needs global solutions and cooperation; moreover, it is necessary for the community and all the sectors of government to adopt the required actions. With the passage of time without taking proper steps for the protection of antimicrobial drugs, it will become more difficult and expensive to address drug resistance and the ability to control infectious diseases will weaken in the future.

The WHO in 2015 published a document entitled "Global Action Plan on Antimicrobial Resistance". This document contains five strategic objectives as follows:

1. Improve awareness and understanding of antimicrobial resistance
2. Strengthening the knowledge through surveillance and research

3. Reduce the incidence of infection diseases
4. Optimize the use of antimicrobial medicines
5. Ensure sustainable investment for combating antimicrobial resistance in different fields, including investment in research, production of new medicines, vaccines, and tools

On the basis of the aforementioned document, the WHO is expecting all member states to prepare a national document for combating antimicrobial resistance based on the proposed framework by 2017. In view of that, the Islamic Republic of Iran decided to develop its national document for combating antimicrobial resistance via cooperating with relevant stakeholders and organizations.

Table of contents

Introduction

Current state of antimicrobial resistance in Iran

A review of studies conducted on antimicrobial resistance in Iran

Efforts made to combat antimicrobial resistance in Iran

Surveillance system for health care-associated infections in the country

Surveillance system for prescribing and use of drugs – National committee for rational prescribing and use of drugs

Veterinary Organization's program for monitoring the residues of drugs, hormones, toxins, and heavy metals

Patient Safety Program

Hospital waste management

Antimicrobial Resistance Surveillance System

Developing a strategic plan for combating antimicrobial resistance in the Islamic Republic of Iran (IRIAMR)

Steps of developing national action plan for combating antimicrobial resistance, 2015-2021

Objective 1: Raise public awareness and promote education and trainings for related professional groups

- 1.1. Promote activities to raise awareness in the community about antimicrobial resistance
- 1.2. Promote education and training for professionals in the fields related to antimicrobial resistance

Objective 2: Continuously monitor resistance and the use of antimicrobial drugs and on-time diagnosis of the signs of change and spread of antimicrobial resistance

- 2.1. Strengthen antimicrobial resistance surveillance system in health care centers and medical institutions (hospitals, limited surgery centers, day care, medical offices and clinics)
- 2.2. Monitor the trend of prescribing and use of antimicrobial drugs in inpatient and outpatient service centers
- 2.3. Strengthen the surveillance and monitoring of antimicrobial resistance in the fields of veterinary medicine, livestock production and poultry farming, and aquaculture

2.4. Standardize laboratory tests and strengthen the performance of antimicrobial tests for diagnosis in laboratories

2.5. Implement integrated health care system for three sectors including human, animals, environment and foods

Objective 3: Prevent the spread of microorganisms resistant to antimicrobial drugs via implementing appropriate control and prevention programs

3.1. Prevent and control infections in healthcare services and promote intersectoral cooperation

3.2. Promote the prevention and control of infections in livestock production, aquaculture, veterinary medicine, and food chain

3.3. Strengthen the capacity to response to antimicrobial resistance outbreaks

Objective 4: Promote the appropriate use of antimicrobial drugs in the fields of healthcare, livestock production, and poultry farming, aquaculture

4.1. Promote antimicrobial drugs and materials stewardship in medical institutions

4.2. Ensure prudent use of antibiotics and antimicrobials in the fields of veterinary medicine, livestock production, poultry farming, and aquaculture

Objective 5: Promote research and development in the field of antimicrobial resistance

5.1. Promote research to reveal the mechanisms of emergence and transmission of antimicrobial resistance and its socioeconomic effects

5.2. Promote research on public awareness / training in the field of antimicrobial resistance, prevention and control of infections, and antimicrobial drugs stewardship

5.3. Promote clinical research on the optimization of existing methods of prevention, diagnosis, and treatment of infectious diseases

5.4. Promote research and development activities in the fields of new methods of prevention, diagnosis, and treatment and promote cooperation between universities, industry, and related sectors

5.5. Promote international collaboration for conducting research on antimicrobial resistance and promote research and development for introducing new methods of prevention, diagnosis, and treatment of antimicrobial resistant infections

Outcome indicators for national action plan of the Islamic Republic of Iran for combating antimicrobial resistance

List of references

Part one

Introduction and problem statement

Current state of antimicrobial resistance in Iran

A review of studies conducted on antimicrobial resistance in Iran

Efforts made to combat antimicrobial resistance in Iran

Steps of developing national strategic plan of the Islamic Republic of Iran for combating antimicrobial resistance

Strategic planning on the basis of SWOT matrix

Introduction and problem statement

Antimicrobial resistance is one of the most important threats to the health worldwide. Antimicrobial resistance or drug resistance is the reduction of the pharmaceutical effects of a drug against a disease or reduction of its effectiveness in improving the clinical signs of a disease. Antimicrobial resistance occurs naturally but misuse of antibiotics in human and animals significantly accelerates the process of developing antimicrobial resistance. In fact, antimicrobial resistance refers to the resistance of a microorganism to one or more antimicrobial drugs which had been previously sensitive to these drugs. Antimicrobial resistance can occur in a wide variety of pathogens including bacteria, parasites, viruses, fungi, and cancer cells and may threaten the life of every person, in every age, and in every country (1, 2).

Nowadays, antimicrobial resistance has become one of the major challenges facing health systems all around the world. Because of the emergence of new types of antimicrobial resistance and their spread in the world, the human ability to treat common infectious diseases has been severely threatened. Antimicrobial resistance leads to a decrease in the effectiveness of antimicrobial agents, increases the risk of the spread of resistant microorganisms, increases health care costs, increases the duration of treatment and hospitalization, decreases the ability to control the outbreaks of infectious diseases, and subsequently increases mortality from curable infectious disease such as tuberculosis, malaria, diarrhea, and acute respiratory diseases including pneumonia. In addition, the global prevalence of resistant strains of human immunodeficiency virus (HIV), drug-resistant TB, and malaria especially drug-resistant plasmodium falciparum has increased the concerns (2, 3).

The results of the studies by the European Center for Disease Prevention and Control in 2009 showed that bacterial antimicrobial resistant infections alone were responsible for 25 million deaths in Europe annually. In addition to the common causes of deaths, the estimated healthcare costs and productivity losses in European countries were about at least 5.1 billion euros; in addition, the estimated costs imposed to the health system in the United States of America was between 21 to 34 billion dollars. Given the growing trend of antimicrobial resistance, it is clear that its subsequent damages have significantly increased (4, 5). Moreover, the emergence of antimicrobial resistance in drugs used in veterinary medicine has caused public health risks and hazards in the food industry and food hygiene, resulted in environmental risks, and weakened the world economy (2). It is estimated that approximately 50% of antimicrobials in Europe are used for animals (4). The effects of antimicrobial resistance go beyond the health sector, as during the past 10 years it has resulted in a decline in GDP of the United States of America and reduced it from 0.4% to 1.6% (5).

Antimicrobial resistance is one of the important problems in the health care sector which is more evident in developing countries. Widespread poverty, lack of resources and the subsequent state of poor hygiene, hunger and poor diet, impaired immune system, poor access to appropriate medications, and the use of expired and low quality drugs are the predisposing factors of antimicrobial resistance in countries with low and middle income. In general, increased incidence of

immunosuppressive diseases and subsequent incidence of opportunistic infections, changes in weather and climate patterns, increasing number of natural disasters, rapid growth of human population, and growing trends of trade and international exchanges are among the main causes of the spread of drug-resistant infections and microorganisms. However, the most important aspects of the spread of antimicrobial resistance which can be managed and controlled include the followings:

1. Consumer-related factors: such as self-treatment, failure to complete the course of treatment, lack of enough information, poor immune status, erroneous beliefs and thoughts, treatment expectations, and advertising pressures imposed by pharmaceutical companies.
2. Factors related to the people who are involved in the field of health-service delivery: lack of proper supervision over the performance of pharmaceutical institutions, lack of proper training, unprofessional behavior, lack of proper diagnostic tools, and incorrect choice of antimicrobial agents.
3. Health care service providers: hospitals, health-care centers
4. Use or misuse of antimicrobials in animals

Current state of antimicrobial resistance in Iran

Antimicrobial resistance is a global threat and the available evidence suggests that Iran is not insusceptible to the risks of resistant microorganisms; the increasing incidence of bacterial resistance has become a concern and a major challenge for the health system of Iran. The Islamic Republic of Iran with a population of 79926270 people, with an urbanization rate of 74%, is located in Southwest Asia in the Middle East region and its area is 1,648,195 square kilometers. Iran is bordered by Azerbaijan, Armenia, and Turkmenistan to the north, by Afghanistan and Pakistan to the east, by Turkey and Iraq to the west. It is also bordered by the Caspian Sea to the north and by the Persian Gulf and Oman Sea to the south. Considering the six divisions proposed by the WHO, Iran is located in the Eastern Mediterranean region. According to the reports by the WHO, there are many evidences indicating the emergence of antimicrobial resistance in a wide geographical area of the countries in the region. However, there is no accurate estimates of the size of problems and economic burden caused by antimicrobial resistance.

In a survey, the WHO has urged countries in the world to report the data on seven bacteria which are considered as major international concerns. The bacteria include the followings:

- *Escherichia coli* (resistant to third-generation cephalosporin and fluoroquinolones)
- *Klebsiella pneumoniae* (resistant to third-generation cephalosporin and carbapenems)
- *Staphylococcus aureus* (resistant to methicillin (MRSA))
- *Streptococcus pneumoniae* (non-sensitive or resistant to penicillin)
- Non-typhoid salmonellae (resistant to fluoroquinolones)

- *Shigella* species (resistant to fluoroquinolones)
- *Neisseria gonorrhoeae* (resistant to third-generation cephalosporin)

According to the WHO, Iran is classified among the countries with more than five multi-drug resistant bacteria (Figure 1) (5).

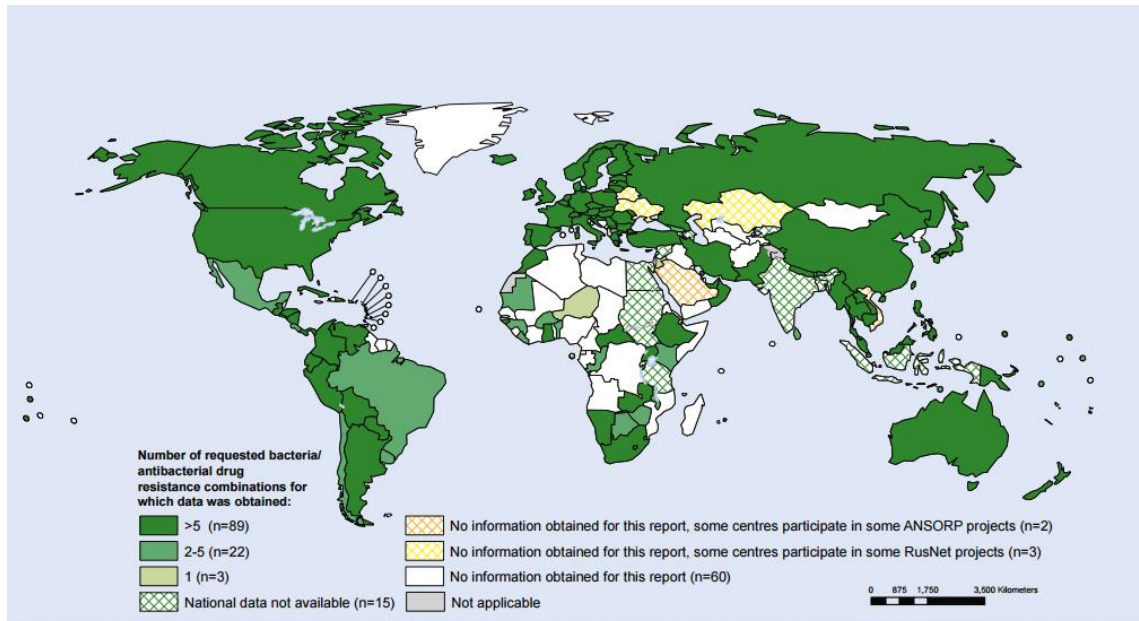


Figure 1. Available data about the multidrug-resistant bacteria (selected bacteria) based on the WHO's 2013 Report

Based on the provided national data, Iran is observing a considerably high the prevalence of antimicrobial resistance in the selected bacteria. In general, the resistance of *Escherichia coli* to third-generation cephalosporin is 41%, the resistance of *Escherichia coli* to fluoroquinolones is 54%, the resistance of *Klebsiella pneumoniae* to third-generation cephalosporins is 48%, the resistant of *Klebsiella pneumoniae* to carbapenems is 54%, the resistance of *Staphylococcus aureus* to methicillin is 53%, the resistance of *Streptococcus pneumoniae* to penicillin is 33.9%, the resistance of nontyphoidal salmonella (NTS) to fluoroquinolones is 6.3%, and the resistance of *Shigella* species to fluoroquinolone is 2.7% (5).

Moreover, based on a report by the National Committee for Rational Prescribing and use of Drugs (NCRUD), affiliated to Food and Drug Administration, Ministry of Health, a review of prescriptions recorded in pharmacies or insurance organizations showed that more than 50% of patients in 2015 received antibiotics. Of the top 10 most prescribed antibiotics in 2015, which were identified based on the "mean number of most prescribed medications" indicator, cefixime was ranked the first among

antibiotics, followed by amoxicillin and azithromycin which, respectively, ranked the next among most prescribed medications (6).

The indicator of the mean number of prescribed drugs in Iran is higher than the global index. The mean number of prescribed drugs varies in different regions of the country. Based on the report by the National Committee for Rational Prescribing and use of Drugs (NCRUD), the highest mean number of prescribed drugs in 2015 was observed in Dezful University of Medical Sciences (Khuzestan province) with 3.44 drugs and the lowest mean number of prescribed drugs was observed in Rafsanjan University of Medical Sciences (Shiraz province) with 2.66 drugs. Although the drug prescription patterns and the mean number of prescribed drugs in each prescription have had a decreasing trend in the country, the review of top 10 prescribed drugs shows that at least one broad-spectrum antibiotic is prescribed for outpatients. A comparison between Iran and other countries in terms of Defined Daily Dose (DDD) of prescribed antibiotics indicates that this group of drugs are excessively prescribed in Iran (6).

A review of studies conducted on antimicrobial resistance in Iran

In general, the current state of the county indicates a variation in the pattern and severity of antibiotic resistance in various provinces of Iran. This section presents a review of some of the studies conducted on top seven antibiotic resistant bacteria in Iran.

A meta-analysis study investigated the prevalence of resistance in several antimicrobial drugs used for patients with urinary tract E. coli infection in Iran in 2016. The results of the study of 10247 patients with urinary tract infection showed that the overall resistance of E. coli to antimicrobial drugs was 49.4%. The results of the study showed that the overall prevalence of antimicrobial resistance in different provinces of the country ranged from 10 to 79.2%. Moreover, the prevalence of antimicrobial resistance in the provinces of Tehran, Fars, and Esfahan (Kashan) was more than 70% (7).

In a study by Moeini et al. in 2015 which was conducted on 250 patients (134 cases with E. coli and 116 cases with pneumonia) admitted to different hospital wards (intensive care unit, pediatric, internal medicine, surgery, and infectious diseases) of Shahid Beheshti Hospital in Kashan, the researchers investigated E. coli and Klebsiella pneumoniae multidrug resistance. The results of the study showed that the resistance of E. coli to different drugs was as follows: amikacin (44.8%), ampicillin (97%), ceftazidime (55.2%), ceftriaxone (38.8%), ciprofloxacin (38.8%), co-amoxiclav (46.3%), and gentamicin (68.7%). Moreover, the resistance of Klebsiella pneumoniae to different drugs was as follows: amikacin (48.1%), ampicillin (96.3%), ceftazidime (50%), ceftriaxone (51.9%), ciprofloxacin (46.3%), co-amoxiclav (46.3%), and gentamicin (59.3%) (8).

Sadeghabadi et al. in 2014 conducted a study in Isfahan on 1086 suspected cases with symptoms of diarrhea to investigate the antimicrobial resistance in shigella and E. coli bacteria. In 58 patients with shigella or E. coli infection (with a positive test result), high resistance to antimicrobials was observed. Shigella and E. coli resistance to different drugs, respectively, were as follows: co-trimoxazole (100% and 80%), azithromycin (70.4% and 44.0%), ceftriaxone (88.9% and 56%), cefixime (85.2% and 68%). In addition, based on the results of the study, 88.3% of shigella sonnei cases and 56% of E. coli cases were resistant to at least three antimicrobial drugs (9).

In a meta-analysis study that was conducted by Askari et al. in 2011, the relative frequency of methicillin-resistant staphylococcus aureus was investigated in the country. This study reviewed the results of 48 studies conducted in Ahvaz, Falavarjan, Fasa, Golestan, Hamadan, Isfahan, Kashan, Mashhad, Sanandaj, Shahrekord, Shiraz, Tabriz, Tehran, and Tonkabon. The overall estimates showed that of a total of 7464 cases of staphylococcus aureus, 52.7% were resistant to methicillin. The level of resistance to methicillin varied in different cities, ranging from 20.48% in Isfahan to 90% in Tehran (10).

Pourabbas et al. in 2015 conducted a study in seven teaching hospitals in Shiraz, Tabriz, Sari, Mashhad, Sanandaj, Ahvaz, and Isfahan. They carried out their study on 858 samples isolates from blood and other sterile body fluids of patients. Of a total of 858 isolates, 224 were infected with staphylococcus aureus, 148 cases with klebsiella, 105 cases with serratia, 146 cases with E. coli, 67 cases with acinetobacter, 38 cases with enterobacter, 95 cases with pseudomonas strains, 71 cases with pseudomonas aeruginosa, 35 cases with stenotrophomonas, and 8 cases with other organisms. In this study, antimicrobial resistance staphylococcus aureus to methicillin was 37.5% (11).

Kopani et al. in 2016 conducted a study to determine the prevalence of staphylococcus aureus antimicrobial resistance in 1000 hospitalized patients admitted to Millad Hospital in Tehran. The results showed that of a total of 220 patients with S. aureus strains isolated from their urine or scars, 47.72% were resistant to methicillin, 99.5% to penicillin, 47.72% to ceftiofur, 18% to ciprofloxacin, 10% to co-trimoxazole, 47.5% to tetracycline, 38% to erythromycin, and 37% to clindamycin (12).

In a meta-analysis study that was conducted in 2016 by Pourhajibagher et al., the prevalence of imipenem-resistant acinetobacter baumannii in Iran was studied. The results of the study showed that 55% of acinetobacter baumannii cases were resistant to imipenem. Furthermore, 74% of the cases with the bacteria were resistant to multiple drugs (multidrug resistance) (13).

Rahmani et al. in 2012 studied 37 species of salmonella (enterica: 75% and enteritidis: 25%) isolated from broiler chickens in three northern provinces (Gilan, Golestan, and Mazandaran). The results showed that a total of 94% of cases with salmonella enterica and salmonella enteritidis were resistant to ciprofloxacin and nalidixic acid (14).

In a meta-analysis study, Hosseini et al. assessed the prevalence of streptococcus pneumoniae and antimicrobial resistance in children under seven years of age. The results of this study showed that

the prevalence of nasopharyngeal streptococcus pneumoniae in children under seven years, in general, was 18% and the resistance of streptococcus pneumoniae to erythromycin, penicillin, and tetracycline, respectively, was 30%, 26%, and 34% (15).

Alian et al. conducted a study to determine the prevalence of Staphylococcus aureus antimicrobial resistance in 348 samples isolated from raw milk of cow, sheep, and goat during the years 1390 to 1391 in the provinces of Fars, Chaharmahal Bakhtiari, and Qom. The results of the study showed that 13.2% of the isolated samples were infected with Staphylococcus. The researchers investigated the sensitivity of isolated Staphylococcus aureus strains to 11 antimicrobial drugs. Bacterial resistance to one or more antimicrobial agents was observed in 82.6% of the samples. Of all, 13% of Staphylococcus isolates were resistant to one antibiotic and 34.8% were resistant to two antimicrobial agents. Multiple drug resistance was observed in 34.8% of staphylococcus aureus isolates. The resistance of Staphylococcus to different drugs was as follows: ampicillin (54.3%), oxacillin (28.3%), tetracycline (26.1%), penicillin (23.9%), erythromycin (23.9%), sulfamethoxazole (17.4%), and cephalotin (2.2%) (16).

Rahimi et al. conducted a study which aimed to assess the prevalence of bacterial resistance in E. coli O157 strains in 290 samples (120 samples of fresh cheese, 50 samples of yogurt, and 120 samples of traditional ice cream) obtained from provinces of Isfahan, Chaharmahale-Bakhtiari, and Khuzestanin 2010. E. coli O157 strains were isolated from 3.1% of the samples. The researchers investigated antimicrobial resistance in nine E. coli O157 isolates. Of all, 44.4% were resistant to gentamicin and ampicillin, 33.3% to erythromycin, 11.1% to amoxicillin, 11.1% to tetracycline, and 11.1% to nalidixic acid (17).

Safaeian et al. in 2010 investigated antimicrobial resistance of gram-negative bacteria isolated from the intestines of wild carp. A total of 126 gram-negative bacteria were isolated from the intestines of fish and the researchers tested the resistance of bacteria to six antibiotics including ampicillin, streptomycin, tetracycline, chloramphenicol, gentamicin, and amikacin. Based on the results, the resistance of gram-negative bacteria to different antibiotics were as follows: ampicillin (93.5%), streptomycin (51.15%) and tetracycline (46.5%). In addition, the resistance of these bacteria to chloramphenicol was 12.15% while their resistance to gentamicin and amikacin was 0.00%. The study of bacterial resistance to antibiotics showed that 80% of the bacteria isolated from the intestines of fish were resistant to multiple antibiotics (18).

Efforts made to combat antimicrobial resistance in Iran

Surveillance system for health care-associated infections in the country

Surveillance system for health care-associated infections in the country was established in 2007 by the Center for Communicable Disease Control, Health Deputy, to regularly collect data on the four

main types of health care-associated infections in the country (urinary tract infections, surgical site infection, pneumonia, and blood infection) and analyze and publish periodic reports and provide feedbacks to the authorities at all levels in all public and private hospitals. The target group of the program includes all patients who are hospitalized for more than 24 hours in a hospital; the program does not include peoples receiving outpatient services and those who develop infections after discharge from hospitals. Since the early 2015, the number of hospitals in the country covered by the scheme has increased to 491 hospitals. Public and private hospitals, except for emergency centers and clinics, are required to provide data on health care-associated infections in the country in accordance with the diagnostic algorithm of the program and the recommended standard definitions. The collected data must be registered in NNIS software and reported to the health center at the end of each month.

Based on the results of the national surveillance system for health care-associated infections in the country in 2015, urinary tract infections and respiratory infections, respectively, with a prevalence of 27.9% and 23.8% had the highest prevalence among health care-associated infections in the country (Figure 2). Furthermore, *Escherichia coli*, *Acintobacter*, and *Klebsiella*, respectively, with an incidence of 17.8%, 16.6%, and 12% accounted for the highest percentage of health care-associated infections in the country (Figure 3).

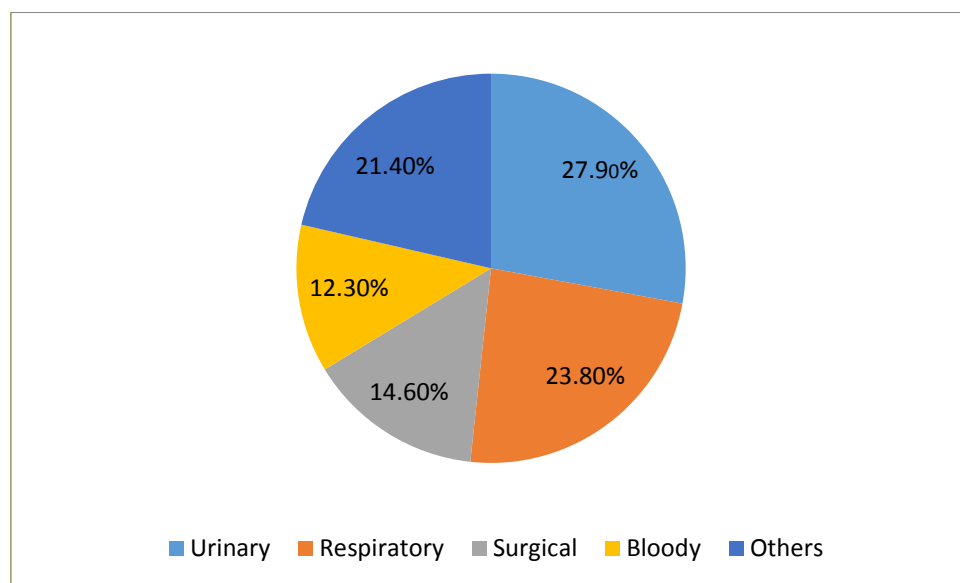


Figure 2. Percentage of the incidence of nosocomial infections by type of infection (*Escherichia coli* and *Pseudomonas dictate*, coagulase, other coagulase-negative staphylococci, other gram-negative bacilli, other gram-positive cocci) based on data reported to the surveillance system for health care-associated infections in the country collected from 491 hospitals in 2015

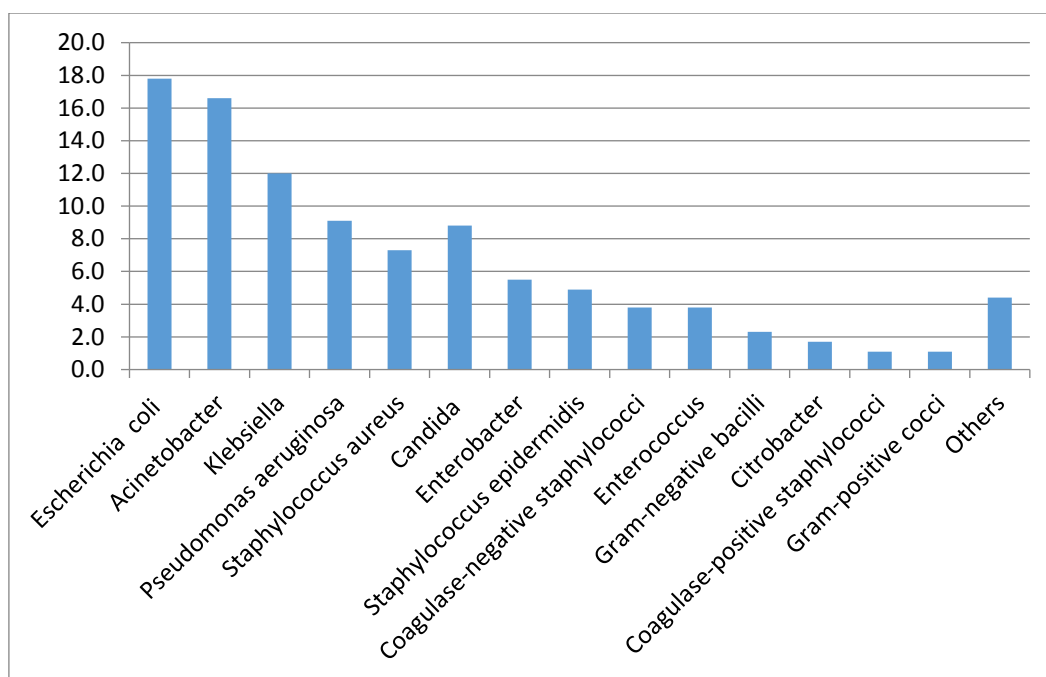


Figure 3. Percentage of microorganisms based on data reported to the surveillance system for health care-associated (nosocomial) infections in the country collected from 491 hospitals in 2015

Surveillance system for prescribing and use of drugs – National committee for rational prescribing and use of drugs

In all countries a large part of government efforts are focused on the health and wellbeing of the people; rational prescribing and use of drugs is one of the things that has always been emphasized. The emergence of wide-range antimicrobial resistance to antimicrobial drugs, life-threatening effects of excessive use of injectable and non-steroidal anti-inflammatory drugs, increased incidence of complications related to irrational and unnecessary use of corticosteroids, increased incidence of complicated drug interactions as a result of prescribing multiple drugs in one prescription, etc. represent only a small portion of the irreparable damages to the health and economy of the community which are caused due to irrational prescribing and use of drugs.

Considering the consequences and outcomes of irrational prescribing and use of drugs, the WHO in 1985 formed a committee in Nairobi and proposed a comprehensive definition of rational prescribing and use of drugs. As the definition states "rational use of drug means prescribing right drug, in adequate dose, for the sufficient duration, and appropriate to the clinical status of the patient. It should also impose the lowest possible cost to patients and the community."

Several different studies were conducted to develop interventions and strategies to improve and amend the current state. The results of some of the field studies indicated the significant

effectiveness of the interventions in reduction and prevention of unintended outcomes (death or damage to organs in a group of diseases such as cardiovascular diseases).

In Iran, the Ministry of Health and Medical Education is the main organization in charge of providing health services to the people. The health services and medical education as two integrated items are provided by the universities of medical sciences. Iran has 31 provinces. In Iran, each province has at least one university of medical sciences which is responsible for providing health services for the people and monitoring health services. Universities of medical sciences are under the supervision of the Ministry of Health and Medical Education. The important role of rational prescribing and use of drugs in promotion of people's health is proved by policy-makers, hence, over the past several decades many efforts were made to introduce and promote this issue. Ministry of Health and Medical Education, as the main custodian of health protection and promotion, in order to achieve its organizational objectives in 1996 established a national committee and several sub-committees in universities for reviewing prescriptions and medical services. In order to enhance the efficiency of activities and develop educational and research activities, in 2000 the national committee was renamed to the National Committee on Rational Use of Drugs and the sub-committees were renamed to Subcommittees on Rational Use of Drugs in Universities of Medical Sciences.

The committee collects data on insurance copies of physicians' prescriptions and registers the data on a national central server; then, it processes the data and identifies drug prescription patterns in the country and supervises the application of the right principles of prescribing by physicians. In addition, the committee runs education and research need assessments to promote the culture of drug use among the members of medical community and the public. The objectives of this committee are as follows.

- improve the quality of rational prescribing and use of drugs in the country
- prevent injuries and unnecessary costs caused by irrational prescribing and use of drugs
- utilize information technology for prescribing and use of drugs in the country
- promote rational prescribing and use of drugs via utilizing all research and training capacities and participating in the design of health care and pharmaceutical plans in the country
- promote health literacy and a culture of rational drug use in the community

Veterinary Organization's program for monitoring the residues of drugs, hormones, toxins, and heavy metals

Use or misuse of antimicrobials in livestock production and poultry farming is a major cause of the spread of microbial resistance worldwide. Following the industrialization of communities, there have been a dramatic increase in the use of drugs and pesticides, considerable climate change, and an interest in the use of new technologies; all these items have raised major concerns about the potential and real chemical and microbial hazards in food products and in the field of health around

the world. Most of the systems used to establish food safety are based on the legal definitions of unhealthy foods and implement programs to collect and remove unhealthy foods from consumption cycle, however, taking preventive measures can address and provide an appropriate response to new challenges which have emerged in the field of microbial resistance in recent decades. Hence, in order to manage the quality safety of food products in terms of food-borne hazards, the veterinary organization in 1999 developed and implemented the comprehensive program for the management of health hazards caused by the residues of drugs, toxins, and raw animal materials. The program is aimed to address public health concerns, set the maximum residue limit (MRL), set per capita drugs, hormones, toxins, and heavy metals in raw animal materials, and pave the ground for surveillance. Now, the veterinary organization is annually running this program nationwide in a four-item matrix including milk, meat, eggs, and farmed trout.

Patient Safety Program

Patient safety is one of the international health concerns which affects patients in all domains of health in all countries, both developed and developing countries. The results of a study that was conducted in 2009 in six countries in the Eastern Mediterranean Region showed that 18% of patients admitted to hospitals suffered from harms caused by medical interventions. Accordingly, the WHO recognized the importance of patient safety and introduced it as an international concern (19).

Because of the importance of patient safety, the WHO initiated the Patient Safety Friendly Hospital Initiative (PSFHI) to help medical institutions to start a comprehensive program for patient safety in different countries. In line with this initiative, the countries in EMRO were also pledged to take action (19). In Iran, Patient Safety Friendly Hospital initiative was confirmed in 2009 and since 2010 it was piloted in 10 hospitals of the country. After the end of the pilot stage, all parts of the health system, from the highest ranks of ministerial institutions to the lowest levels of peripheral health care centers, are expected to take actions to protect health and safety of patients.

Patient safety standards are a set of requirements that are vital for the implementation of patient safety initiative in hospitals. Standards are defined at three levels:

1. The mandatory standards: must be fully realized (100%) to recognize a hospital as a Patient Safety Friendly Hospital.
2. The basic standards: include minimum standards for patient safety that a hospital should follow. Basic standards are an important tool for internal benchmarking and documenting the progress over time.
3. Advanced standards: are the requirements which must be fulfilled by a hospital, depending on the available capacity and resources, to strengthen safety services.

In order to avoid haphazard or potential harms associated with healthcare services, this program suggests nine solutions for the challenges of patient safety which include the followings: providing standard guidelines for proper diagnosis of patients, safe injection, hand hygiene, safe surgery, drugs with similar shapes and names, electrolyte solutions with high viscosity, patients turnover, and avoiding incorrect connections and pharmaceutical synthesis.

Hospital waste management

Hazardous health-care waste are characterized by toxicity, corrosiveness, explosibility, flammability, and reactivity. It includes a wide range of wastes including sharp, infectious, chemical, pharmaceutical, genotoxic, and radioactive materials. Infectious diseases such as AIDS, hepatitis B, and hepatitis C are easily and directly transferred by hospital waste. On the other hand, improper management, collection, and disposal of hospital wastes water and sludge pollutes local water sources with pathogens. This can cause multiple water-borne diseases like malaria and filariasis or facilitates the spread of parasites through the creation of spawning grounds for the carriers. *Campylobacter*, cholera, hepatitis A and E, schistosomiasis, and typhoid are some of the diseases and infections caused by medical wastewater. Substances existing in wastewater of healthcare centers include a wide range of chemical, pharmaceutical, and radioactive materials, hence its quality is highly variable and should be well and carefully treated and managed. Thus, in 2007 the Ministry of Health and Medical Education, the Environmental Protection Agency, and the Commission of infrastructure, industry, and the environment adopted a proposal by the Environmental Protection Agency, and following the Article 11 of the Law on waste management, ratified a set of criteria and methods for the management of medical wastes and related waste with the aim of achieving the following objectives:

1. Protect public health and the environment against the adverse effects of medical wastes
2. Ensure the proper and systematic management of medical wastes
3. Create appropriate and systematic procedures for production, transportation, storage, treatment, annihilation, and disposal of medical wastes

According to Article 4 of the law, the implementation of the approved criteria and methods is mandatory for all natural and legal person who, in any form, is involved in the production, separation, storage, transportation, treatment, disposal, or management of medical wastes. Furthermore, according to Article 5 of the medical waste management law, waste management administrators must adopt measures, based on the criteria and regulations set by the Ministry of Health, to ensure and protect the health and safety of the staffs under their supervision. According to Article 3 of this law, the Ministry of Health and Medical Education is responsible for monitoring the implementation of ratified regulations and procedures.

Antimicrobial Resistance Surveillance System

Given the continuous and increasing incidence of microbial resistance in a broad range of microorganisms and the need for taking measures for controlling it, in the sixty-eighth World Health Assembly held in 2015, this issue was discussed and a global action plan was ratified. The plan outlines five main objectives including the followings: improve public awareness and understanding, strengthen the knowledge through surveillance and research, reduce the incidence of infections, optimize the use of antimicrobials, and ensure sustainable investment to inhibit microbial resistance.

One of the important objectives of this action plan for combating antimicrobial resistance is to strengthen the knowledge and increase evidences through surveillance and research; thus, the presence of an antimicrobial surveillance system is necessary to estimate the burden of this problem at national and international levels. To support the launch of a standardized surveillance system at the global level, the WHO in 2015 designed a general guideline for the surveillance of microbial resistance called GLASS (Global Antimicrobial Resistance Surveillance System). In fact, GLASS is a global system which is based on national care information. The objectives of this program include the followings:

- strengthen antimicrobial surveillance systems using international standards
- assess and report on the basis of selected criteria for antimicrobial resistance
- identify emerging antimicrobial resistance
- inform and evaluate interventions

Overall the program, integrates the data obtained from patients and laboratories and provides useful information to evaluate the burden of the problem. The implementation of this guideline, helps to compare valid and reliable information collected at national and international levels and provides relevant information necessary for decision-making in the field of health at national and regional levels and evidence necessary for interventions and support.

The program is expected to be implemented from 2015 to 2019 and the WHO has recommended all countries to gradually implement this program and integrate it in their own health care system.

National program for antimicrobial resistance surveillance system and rational use of antibiotics, proposed by center for communicable disease control

In Iran, in line with the global efforts made to combat antimicrobial resistance, the national program for antimicrobial resistance surveillance system and rational use of antibiotics was proposed by communicable disease control center in 2016. This program which is currently under preparation and

initial implementation, is consistent with the antimicrobial surveillance program prepared by the WHO. Iran will be the first country in the Eastern Mediterranean region which implements antimicrobial surveillance system.

According to this system, antibiotics will be prescribed and used on the basis of need and based on the status of antibiotic resistance in every part of the country. Moreover, based on existing guidelines in the program, the use of antibiotics in the food industry will be gradually limited and inhibited over time. The program will be run in ground paved by the health sector evolution plan, because its implementation is dependent on the implementation of family physician program and requires much coordination with insurance organizations.

Antimicrobial surveillance system will be run in 23 university (teaching and non-teaching) and private hospitals in the country. Different bodies are involved in its implementation including Health Deputy, Treatment Deputy, Education Deputy, Food and Drug Administration, the reference health laboratory, and scientific associations of infectious diseases including specialists in infectious and tropical diseases, and the association of subspecialists in pediatric infectious. Hospital enrolled into the antimicrobial resistance surveillance program are selected from among major teaching hospitals which have various wards, particularly infectious diseases ward. In view of that, in 2015 a total of 6 hospitals that were more prepared for the implementation of the program started collecting data for the antibiotic surveillance system.

Developing strategic plan for combating antimicrobial resistance in the Islamic Republic of Iran (IRIAMR)

Developing a national strategic plan for combating antimicrobial resistance is one of the main pillars for the implementation of antimicrobial surveillance system. To develop a plan for combating antimicrobial resistance, as one of the important aspects of national health programs, it is necessary to pay attention to the highest levels of government and community. This plan can be implemented via the participation of various organizations in the country. The proper mobilization of all stakeholders will help to implement antimicrobial resistance action plan in line with other national health programs. It can be effectively linked with different sectors, other than health sectors which are directly involved in the control of antimicrobial resistance.

Steps of developing strategic plan for combating antimicrobial resistance in the Islamic Republic of Iran

- Holding regular meetings with the team members participating in the development of the plan for combating antimicrobial resistance in the center for communicable disease control
- Identifying potential stakeholders

- Holding brainstorming sessions and interviews with key people and stakeholders
- Strategic planning based on the SWOT matrix
 - Determining the strengths, weaknesses, opportunities, and threats facing each of the stakeholder organizations based on the SWOT matrix
 - Analyzing SWOT matrix and determining the strategic zones of the plan for combating antimicrobial resistance based on the SWOT matrix
 - Determining the approaches to be taken based on the analysis of SWOT matrix
- Develop a national action plan for combating antimicrobial resistance 2008-2023

Health Deputy of the Ministry of Health and Medical Education is in charge of implementing national antimicrobial surveillance system and developing the national action plan. Thus, Health Deputy plays the major role at all stages of the development of this plan. In order to develop this plan, the first coordination meeting of the team members participating in the development of the national action plan for combating antimicrobial resistance was held in March 2015 and the members made decisions about the schedule of meetings, the stakeholders who should be invited for interviews, and the structure of invitations. It was decided to regularly held meetings in the center for disease control. During the meetings with experts, potential stakeholders who might help in the formulation and implementation of the program were identified. Different departments of the Ministry of Health and Medical Education including Treatment Deputy, Food and Drug Administration, the reference health laboratory, the reference food and drug reference laboratory, Deputy of Legal and Parliamentary Affairs, the veterinary organization, and the health insurance organization were identified as key organizations to be involved in the implementation the program. During the several sessions of brainstorming and interviews with representatives from each of the abovementioned organizations, which were held in the second quarter of 2016, the feasibility and different aspects of the program were evaluated. In addition, using the SWOT matrix, each of the organizations presented its own strengths, weakness, opportunities, and threats facing the implementation of the program. In the following section, a summary of the process of data collection and SWOT matrix analysis is presented.

Process of data collection in the SWOT matrix

The SWOT matrix is recognized as an efficient tool to detect environmental conditions and internal capabilities of organizations. Understanding the environment surrounding an organization is the basis element of this efficient tool which is used in strategic management. SWOT is an acronym which stands for the words strengths, weaknesses, opportunities, and threats. The strengths and weaknesses are internal organizational factors while the opportunities and threats usually are external factors.

During the meetings it was decided to ask the representatives from each of the organizations to detect all their strengths, weaknesses, opportunities, and threats facing the action plan for combating antimicrobial resistance and classify them into two evaluation matrixes, including internal factors evaluation matrix (strengths and weaknesses) and external factors evaluation matrix (opportunities and threats). Then, they were asked to assign a weight to each factor, from zero (unimportant) to one (very important). The sum of weights must be equal to one. The weight represents the relative importance of each factor. Then, using the following scoring table, each factor was rated from 1 to 4. These rates indicate the effectiveness of current strategies to give an appropriate response to the relevant factors. By multiplying the factor weights by factor rates, the weighted score of each factor is calculated and the sum of the weighted scores presents the final weighted score of each group of internal and external factors in the matrix.

Table 1. Scoring the internal and external factors

Strategic factors / weights	1	2	3	4
Internal factors	Major weakness	Weakness	Strength	Major strengths
External factors	Too bad response	Bad response	Good response	Excellent response

Pattern of strategy evaluation and selection in the SWOT matrix

In order to simultaneously analyze both internal and external factors to determine the status of any organization, it is necessary to put the scores obtained from the internal factors evaluation matrix and external factors evaluation matrix in the vertical and horizontal columns and rows of the matrix. After the insertion of weighted score of each of the internal and external factors in the vertical and horizontal axes and identifying their intersection, the SWOT matrix can systematically specify the appropriate strategies for each organization. This matrix always provides four types of strategies. The strategies include the followings.

SO strategies: Strategies that **use strengths** to **maximize opportunities**. Every organization is interested to be always in this position to take advantage of the internal strengths and derive maximum benefit from external events and opportunities.

WO Strategies: Strategies that **minimize weaknesses** by **taking advantage of opportunities**.

WT Strategies: Strategies that **minimize weaknesses** and **avoid threats**.

ST Strategies: Strategies that **use strengths** to **minimize threats**.

Table 2. Determining strategy in the SWOT matrix

Final score of external factors matrix	Final score of internal factors matrix				
	4	3	2.50	2	1
	Development strategies (SO)		4 3	Competitive strategies (WO)	
	Conservative strategies (WO)		2 1	Defensive strategies (WT)	

Strategic planning based on the SWOT matrix

As described earlier, each of the stakeholder organizations identified the strengths, weaknesses, opportunities, and threats of their own organization based on the above-mentioned method. This section presents the specific and common factors, in any organization and in the Ministry of Health and Medical Education in general, which affect Action plan on AMR.

- Specific factors affecting Action plan on AMR in Health Deputy
- Specific factors affecting Action plan on AMR in Treatment Deputy
- Specific factors affecting Action plan on AMR in Food and Drug Administration
- Specific factors affecting Action plan on AMR in reference health laboratory
- Specific factors affecting Action plan on AMR in reference food and drug laboratory
- Common factors affecting Action plan on AMR in different sectors of the Ministry of Health and Medical Education
- Specific factors affecting Action plan on AMR in Veterinary Organization
- Specific factors affecting Action plan on AMR in Iran Health Insurance Organization

Table 3. Specific factors affecting Action plan on AMR in Health Deputy

Strengths

- Resolution of different parts of the Ministry of Health and Medical Education to perform antimicrobial resistance surveillance system
- Implementation of the Health Sector Evolution Plan
- Availability of laboratories equipped with the necessary equipment to run the plan in the country
- Proposing the inclusion of mandatory implementation of antibiotic resistance surveillance programs in the Sixth National Development Plan
- Measurement of antibiotic residues in food by food laboratory
- Previous experience of launching various surveillance systems in the Center for Communicable Diseases Control and health reference laboratory

Weaknesses

- Poor coordination between different parts of the Ministry of Health and Medical Education
- Use of various software in different hospitals in the country
- Using various methods for antibiotic sensitivity testing
- Serious weaknesses in the control of hospital laboratories to perform tests in a standard manner
- Difficult access to the latest CLSI guidelines
- Not operationalizing guidelines designed for the classification of antibiotic use in health care centers and hospitals in the country
- Inappropriate tariff system for antimicrobial sensitivity testing
- Inconsistency between medical trainings and administrative guidelines (in some cases)

Opportunities

- Implementing the plan for measuring the residues of antibiotics in food products of animal origin by veterinary laboratory
- Relative coordination between the Veterinary Organization and the Ministry of Health and Medical Education to carry out antimicrobial resistance surveillance

- Preparedness of Veterinary Organization for implementing antimicrobial resistance surveillance plan in the field of livestock production and poultry farming
- Parliament and government support to continue Health Sector Evolution Plan in the country by the Ministry of Health and Medical Education
- International organizations emphasis on the implementation of the plan and their follow-up activities in the country
- Availability of international consultants to implement the plan

Threats

- Incomplete regulations (and sometimes lack of regulations) and inadequate enforcement for proper prescription of antibiotics
- Low public awareness of the antibiotic resistance which consequently results in irrational use of antibiotics
- Not involving insurance organization in the detection of inappropriate prescribing of antibiotics
- Extreme prescribing of antibiotics for outpatients by doctors in the private sector
- Selling antibiotics without a prescription by some pharmacies

Table 4. Specific factors affecting Action plan on AMR in Treatment Deputy

Strengths

- Resolution and commitment of senior management in Treatment Deputy for the implementation of Action plan on AMR
- Proper coordination between the WHO Country Office and Treatment Deputy in the Ministry of Health and Medical Education
- Availability of accreditation system in hospital inpatient wards
- Paying attention to health care-associated infections in the country as an indicator of patient safety

Weaknesses

- Lack of a proper organizational structure (qualitative and quantitative) with specific job descriptions for following up the plan
- Not including Action plan on AMR in the mission, vision, major goals, and specific objectives of organizations and in national social and economic development plans
- Lack of a national guideline for AMR
- Lack of a national guideline for rational use of antibiotics
- Unfeasibility of monitoring and supervision over the prescribing and distribution of drugs because of the wide range of drugs
- Patients free access to drugs for self-medication
- Poor trainings and poor corporate culture for proper and accurate registration of health care-associated infections in the country
- Lack of awareness and inadequate participation of patients and other people in reporting the accessibility of medicines in the community
- Lack of qualified oversight groups to monitor institutions and offices which perform limited surgeries
- Lack of self-care programs and not promoting the community awareness of the rational use of antibiotics
- Overlooking laws and regulations and not separating and disposing wastes produced in pharmaceutical processes, chemical imaging centers, clinics, institutions, limited surgery centers, injections centers, and finally the chemical pharmaceutical waste generated by patients in their homes

Opportunities

- International organizations' support, especially the WHO's support, for successful implementation of Action plan on AMR
- Insurance organizations' interest in Action plan on AMR because of cost-effectiveness of the plan and reduction of health care costs as a result of the rational use of antibiotics
- Mass media's interests in promoting public awareness about self-medication and drug therapy
- Education Deputy's interest in including Action plan on AMR and rational use of antibiotics in the curriculum of medical students and other related fields of the study
- Overlap between the objectives of Action plan on AMR and rational use of antibiotics with the objectives of some other national programs including: patient safety and infection prevention and control
- Including the programs for safe disposal of chemical and pharmaceutical hospital wastes into the agenda of the Parliament and the Department of Environment

Threats

- Free access to drugs without a prescription by physicians
- Low level of public awareness and information about the risks of antimicrobial resistance and self-medication
- Indiscriminate use of hospital services and inadequate supervision of hospital health officials over the use of antiseptics and disinfectant solutions in hospitals
- Medical community's disinterest in the use of guidelines for rational prescribing of antibiotics

Table 5. Specific factors affecting Action plan on AMR in Food and Drug Administration, National Committee on Rational Use of Drugs

Strengths

- Chance to receive comments and advices from experts and faculty members in related areas of expertise
- Availability of insurance databases containing data on prescribed medicines in the country
- Development and implementation of effective interventions for reforming the culture of using antimicrobials and good relationships with the Ministry of Education for promoting rational use of drugs
- Development and implementation of effective interventions for reforming the culture of using antimicrobials and good relationships with other organizations such as National Iranian Gas Company, Media, Social Welfare Organization, municipalities, etc.
- Capability of National Committee on Rational Use of Drugs to prepare and publish scientific and educational contents for different age groups

Weaknesses

- Limited human resources
- Lack of access to advanced software and hardware
- Lack of access to non-insurance prescription databases in the country
- Instability of the management system and frequent and short-term changes of the authorities

Opportunities

- Preparedness of international organizations for the implementation and follow-up of programs in the country because of its significance at the global level
- Availability of a suitable platform for cooperation with mass media to inform the public
- Membership in international organizations such as INRUD (International Network for Rational Use of Drugs) and utilization of the programs and experiences of these organizations

Threats

- Low public awareness and false beliefs about the antibiotics and its direct impact on irrational use of drugs
- Poor coordination between different departments of Ministry of Health and Medical Education
- Extreme use of antibiotics for livestock production and poultry farming
- Ineffective participation of insurance organizations
- Unprincipled advertising of pharmaceutical companies with the aim of increasing the sale of antibiotics
- Lack of proper plans for adequate production of antibiotics in the country
- Lack of funding and limitations in financial resources for developing and implementing effective interventions
- Defects in medical education system
- Lack of regulations and efficient enforcement for rational use of antibiotics, and selling antibiotics without prescription by some pharmacies
- Extreme prescribing of antibiotics by doctors in private sector for outpatients and lack of efficient regulations and enforcement
- Inappropriate elimination of antibiotics and their inappropriate return to the cycles of the nature
- Not implementing electronic prescription program

Table 6. Specific factors affecting Action plan on AMR in reference food and drug laboratory

Strengths

- Availability of reference food and drug control laboratory to take part in antimicrobial resistance surveillance system
- Availability of more than 50 food and drug control laboratory in food and drug deputies of Universities of Medical Sciences which are under the supervision of reference food and drug control laboratory
- Availability of more than 200 partner and accredited food and drug control laboratories in the country which are under the supervision of reference food and drug control laboratory
- Implementation of annual PMS program nationwide by food and drug control laboratory in food and drug deputies of Universities of Medical Sciences which are under the supervision of reference food and drug control laboratory
- Holding annual training workshops for food and drug control laboratories in food and drug deputies of Universities of Medical Sciences
- Holding annual training workshops for partner and accredited food and drug control laboratories in food and drug deputies of Universities of Medical Sciences
- Annual visits to food and drug control laboratories in food and drug deputies of Universities of Medical Sciences and ranking them
- Annual visits to partner and accredited food and drug control laboratories in food and drug deputies of Universities of Medical Sciences and ranking them
- Use of quality control system in all food and drug control laboratories
- Implementation of the program for controlling food and drug control laboratories through sending anonymous samples to reference food and drug control laboratory

Weaknesses

- Limited human resources
- Limited financial resources
- Not routinely perform antibiotic sensitivity test in food and drug control laboratories
- Lack of previous history of antibiotic sensitivity test in food and drug control laboratories

Opportunities

- Developing strategies and the WHO's support for controlling antimicrobial resistance in various fields
- Explaining the significance of antimicrobial resistance control to the authorities in Food and Drug Administration and food and drug control laboratories

Threats

- Administrative constraints due to lack of sufficient personnel and lack of adequate laboratory equipment

Table 7. Specific factors affecting Action plan on AMR in reference health laboratory

Strengths

- Resolution of beneficiaries and authorities for implementing antimicrobial resistance surveillance system
- Preparedness of the National Reference Laboratory for implementing antimicrobial resistance surveillance system (a partner of the WHO in the field of quality control)
- Availability of well-equipped and accredited laboratories to implement the program in the country in the early stages
- Presence of a national program for registration of laboratory tools and a surveillance system for the consumable products
- Previous history of launching various surveillance systems in the center for communicable disease control and reference health laboratory
- Presence of a scientific committee composed of professors who are expert in relevant fields
- Presence of a laboratory accreditation system

Weaknesses

- Poor coordination between different departments of the Ministry of Health and Medical Education
- Use of different Health Information System (HIS) software in hospitals in the country
- Unfeasibility of transferring the data from HIS software to WHONET software
- Regulatory problems prevent microbial testing in laboratories to be in line with the standards
- Lack of comprehensive supervision over laboratory diagnostic tools available in the market
- Limited access to the latest reference guidelines (CLSI)
- Limited financial resources

Opportunities

- The WHO's support for the allocation of facilities
- Insurance coverage for a large number of diagnostic tests such as antimicrobial sensitivity test

Threats

- Trafficking and illegal import of laboratory diagnostic tools
- Long delay in the delivery of kits and reagents requested and purchased from foreign manufacturers
- Restrictions intended by laws and regulations on import and related import licenses
- Lack of appropriate tariffs for specialized microbiological tests
- Companies non-compliance with the rules and standards of production and delivery of laboratory diagnostic tools
- Lack of access to good-quality materials due to sanctions
- Staff's disinterest in the program as it might increase the workload in microbiology sector

Table 8-1. Common factors affecting Action plan on AMR in various sectors of Ministry of Health and Medical Education

Internal Factors Evaluation Matrix

Strengths

- Resolution and commitment of senior management in different sectors of Ministry of Health and Medical Education to implement antimicrobial resistance surveillance system
- Proposing the inclusion of mandatory implementation of antibiotic resistance surveillance programs in the Sixth National Development Plan
- Previous experience of launching various surveillance systems in the Center for Communicable Diseases Control and health reference laboratory
- Proper coordination between the WHO Country Office and Treatment Deputy in the Ministry of Health and Medical Education
- Presence of a scientific committee composed of professors who are expert in the field of antimicrobial resistance control
- Availability of laboratories equipped with the necessary equipment required for the implementation of Action plan on AMR in the country

Weaknesses

- Poor coordination between different sectors of the Ministry of Health and Medical Education
- Limited financial resources
- Limited human resource
- Lack of a proper organizational structure (qualitative and quantitative) with specific job descriptions for following up the plan
- Instability of the management system and frequent and short-term changes of the authorities
- Use of different HIS software in hospitals in the country
- Limited access to the latest reference guidelines (CLSI)
- Not operationalizing guidelines designed for the classification of antibiotic use in health care centers and hospitals in the country
- Inconsistency between medical trainings and administrative guidelines (in some cases)

Table 8-1. Common factors affecting Action plan on AMR in various sectors of Ministry of Health and Medical Education

External Factors Evaluation Matrix

Opportunities

- International organizations' support, especially the WHO's support, for successful implementation and follow-up of Action plan on AMR in the country
- Availability of international consultants to implement the plan
- Parliament and government support to continue Health Sector Evolution Plan in the country by the Ministry of Health and Medical Education
- Relative coordination between the Veterinary Organization and the Ministry of Health and Medical Education to carry out antimicrobial resistance surveillance
- Preparedness of Veterinary Organization for implementing antimicrobial resistance surveillance plan in the field of livestock production and poultry farming
- Education Deputy's interest in including Action plan on AMR and rational use of antibiotics in the curriculum of medical students and other related fields of the study
- Opportunity to receive comments and advices from experts and faculty members in related areas of expertise

Threats

- Lack of standards for appropriate prescribing of antibiotics and lack of effective enforcement for rational use of antibiotics
- Lack of proper plans for adequate production of antibiotics in the country
- Extreme prescribing of antibiotics by doctors in private sector for outpatients
- Selling antibiotics without prescription by some pharmacies
- Unprincipled advertising of pharmaceutical companies with the aim of increasing the sale of antibiotics
- Inappropriate elimination of antibiotics and their inappropriate return to the cycles of the nature
- flaws and lack of laws and regulations, including pharmaceutical waste separation and disposal of chemical imaging centers, clinics, institutions, limited surgery, injections and finally the chemical pharmaceutical waste generated by patients' homes

- Ineffective participation of insurance organizations and not involving insurance organizations in the detection of inappropriate prescribing of antibiotics
- Defects in medical education system
- Low public awareness of the antibiotic resistance which consequently results in irrational use of antibiotics
- Extreme use of antibiotics for livestock production and poultry farming

Table 9.1. Factors affecting Action plan on AMR in Veterinary Organization

Internal Factors Evaluation Matrix

Strengths

- Presence of HACCP and GMP systems in protein product packaging centers
- Microbial control:
 1. Imported and domestic frozen protein products
 2. Imported cattle products
 3. Raw milk
 4. Centers such as livestock and poultry processing plants
- monitoring the residues of drugs, organochlorine and organophosphorus pesticides, hormones, and pollutants
- Availability of statistical data on the use of antibiotics in veterinary medicine
- Implementation of the program to produce poultry without antibiotics (FREE OF ANTIBIOTICS)
- Continuous improvement and development of standards and laboratory ISOs for public and private laboratories and GLP in veterinary laboratories
- Study and evaluation of drugs and the use of a system for registration of antibiotics used in veterinary medicine
- Development of qualitative and semi-quantitative methods such as ELISA and rapid diagnostic tests to detect antibiotics in solid and liquid protein products
- Use of LIMS software in the laboratory
- Proper management of pharmaceutical wastes, including antibiotics

Weaknesses

- Not performing antibiotic sensitivity test for treating microbial infections in livestock, poultry, and fish
- Lack of prior and current records for microbial resistance program
- Performing parallel tasks by Veterinary Organization and Standards Institute
- Lack of knowledge about the activities performed by the Ministry of Health and Medical Education, Standards Institute, and Food and Drug Administration

- Lack of laws, regulations, and directives on food products to be observed by all stakeholders
- Lack of companies which produce antibiogram discs for veterinary medicine purposes
- Lack of legal support for elimination of protein products which are contaminated with resistant microbes
- Antibiotic resistance in veterinary medicine
- Differences between the allowable limits (maximum tolerances) set by Standard Institute and Veterinary Organization
- Not implementing surveillance program for identifying the source of risk

Table 9-2. Factors affecting Action plan on AMR in Veterinary Organization

External Factors Evaluation Matrix

Opportunities

- Establishing a food safety structure and setting AMR as one of its branches
- Advertising the importance of working on AMR in television and other mass media.
- Holding Continuing Medical Education (CME) classes and courses for veterinarians and training them about limiting the use of antibiotics
- Integrating information and establishing databases
- Developing a unique software such as LIMS
- Emphasizing the need to have a plan and formulating it
- Reforming the farm management methods to reduce the use of antibiotics
- Promoting the level of food safety and developing the export of protein products to neighboring countries
- Assigning biological and chemical tests to the private sector and increasing monitoring activities
- Integrating standard testing procedures for public and private sector

Threats

- Possibility of the transmission of antimicrobial resistance from animals to humans
- Using antibiotics as a growth promoter to produce balanced animal feed for livestock, poultry, and fish
- Incidence of new and emerging diseases and drug resistant epidemics
- Not controlling antibiotic resistance in imported fresh or frozen protein products
- Irrational use of antibiotics for the treatment and prevention of diseases, and the use of antibiotics which are not recommended for the target host (the manufacturer does not provide any instruction to avoid taking the medication)
- Livestock trafficking without quarantine control
- Legal and illegal antibiotics trafficking
- Fraud in protein food products and lack of proper control over it

- Not informing the public about the dangers that threaten them
- Not eliminating unusable products

Table 10.1. Factors affecting Action plan on AMR in the Health Insurance Organization

Internal Factors Evaluation Matrix

Strengths

- Availability of expert human resources in headquarters and provincial offices of the Health Insurance Organization
- Presence of a hospital supervisor in all hospitals under contract with the Health Insurance Organization
- Designing a strategic drug purchase model by the Health Insurance Organization and presenting it to the secretariat of the National Council of Health Services Insurance
- The Health Insurance Organization's interest in Action plan on AMR because of cost-effectiveness of the plan and reduction of health care costs as a result of the rational use of antibiotics
- Predicting and including the drug list covered by the Health Insurance Organization in strategic and operational plans
- Legal capacity of Iran Health Insurance Organization to determine a variable franchise in line with general policies of antimicrobial resistance control

Weaknesses

- Limited role of the Health Insurance Organization in managing drug costs in the country
- Delays in payments to pharmacies and centers under the contract with the Health Insurance Organization
- Lack of enough data on the amount of antibiotics used in the country
- Not replacing existing insurance notebooks with electronic ones (such as smart cards) so that to prescribe antibiotics using electronic tools
- Lack of indicators and criteria for including and excluding antibiotics in basic health insurance package
- Lack of IT-based health insurance systems which would interact with Electronic Health Record System (SEPAS) to produce electronic health records for all insured people
- Not forecasting and including a variable franchise and deductible in the design of the model for financial contribution of insured people in costs of pharmaceuticals, particularly antibiotics, at the site of service delivery

- Not promoting the knowledge of insured people about the use of antibiotics

Table 10.2. Factors affecting Action plan on AMR in the Health Insurance Organization

External Factors Evaluation Matrix

Opportunities

- Considering the Health Insurance Organization as one of the executive agencies involved in the development and implementation on Action Plan on AMR
- Appropriate legal foundations envisioned by high level documents to implement the plans proposed by the organization in line with the this national document
- Possibility of establishing insurance coverage for home care services provided based on clinical guidelines

Threats

- Not intending an effective role for hospital supervisors (assigned by the Health Insurance Organization) to monitor treatment and diagnostic procedures performed for the insured people
- Not including Action plan on AMR in the mission, vision, major goals, and specific objectives of organizations and in national social and economic development plans
- Lack of a national guideline for AMR
- Unfeasibility of monitoring and supervision over the prescribing and distribution of drugs because of the wide range of drugs
- Poor trainings and poor corporate culture for proper and accurate registration of health care-associated infections in the country
- Lack of awareness and inadequate participation of patients and other people in reporting the accessibility of medicines in the community
- Lack of proper supervisory mechanisms for monitoring limited surgery institutions and offices
- Lack of plans for supporting self-care programs and promoting community awareness of the rational use of antibiotics
- Lack of referral system and family physician
- Lack of a national guideline for rational use of antibiotics
- Lack of adequate intersectoral cooperation between executive agencies and national stakeholders to implement a joint national program

- Lack of clear rules for the inclusion of certain antimicrobial drugs in the national pharmacopoeia and insurance services packages
- High frequency of unnecessary hospitalizations and prolonged hospital stay
- Selling antibiotics without prescription by pharmacies
- Inappropriate use of antibiotics for the treatment of upper respiratory tract infections (mostly with a viral origin)

Analysis of the SWOT matrix and determining the strategic zone for Action plan on AMR in each organization

Based on the results of SWOT matrix analysis, the following tables are presented for each of the organizations.

Table 11: Ranking internal and external factors affecting Action Plan on AMR in the Health Deputy, Ministry of Health and Medical Education

Internal Factors Evaluation Matrix					
			Weight	Score current situation	Score weighted
Strengths	1	Resolution of different parts of the Ministry of Health to perform antimicrobial resistance surveillance system	0.1	4	0.4
	2	Implementation of the Health Sector Evolution Plan	0.1	4	0.4
	3	Availability of laboratories equipped with the necessary equipment to run the plan in the country	0.05	3	0.15
	4	Proposing the inclusion of mandatory implementation of antibiotic resistance surveillance programs in the Sixth National Development Plan	0.05	4	0.20
	5	Measurement of antibiotic residues in food by food laboratory	0.05	4	0.20
	6	Previous experience of launching various surveillance systems in the Center for Communicable Diseases Control and health reference laboratory	0.03	3	0.09
Weaknesses	1	Poor coordination between different parts of the Ministry of Health	0.02	2	0.04
	2	Use of various software in different hospitals in the country	0.34	2	0.68
	3	Using various methods for antibiotic sensitivity testing	0.05	2	0.10
	4	Serious weaknesses in the control of hospital laboratories to perform tests in a standard manner	0.0.1	1	0.1
	5	Difficult access to the latest CLSI guidelines	0.01	1	0.01
	6	Not operationalizing guidelines designed for the classification of antibiotic use in health care centers and hospitals in the country	0.04	2	0.08
	7	Inappropriate tariff system for antimicrobial sensitivity testing	0.05	2	0.10
	8	Inconsistency between medical trainings and administrative guidelines (in some	0.01	2	0.02

		cases)			
Total score			1.00		2.57
External Factors Evaluation Matrix					
Opportunities	1	Implementing the plan for measuring the residues of antibiotics in food products of animal origin by veterinary laboratory	0.05	3	0.15
	2	Relative coordination between the Veterinary Organization and the Ministry of Health and Medical Education to carry out antimicrobial resistance surveillance	0.05	3	0.15
	3	Preparedness of Veterinary Organization for implementing antimicrobial resistance surveillance plan in the field of livestock production and poultry farming	0.05	4	0.20
	4	Parliament and government support to continue Health Sector Evolution Plan in the country by the Ministry of Health and Medical Education	0.05	3	0.15
	5	International organizations emphasis on the implementation of the plan and their follow-up activities in the country	0.10	3	0.30
	6	Availability of international consultants to implement the plan	0.05	4	0.20
threats	1	Incomplete regulations (and sometimes lack of regulations) and inadequate enforcement for proper prescription of antibiotics	0.10	2	0.20
	2	Low public awareness of the antibiotic resistance which consequently results in irrational use of antibiotics	0.25	2	0.50
	3	Not involving insurance agencies in the detection of inappropriate prescribing of antibiotics	0.15	2	0.30
	4	Extreme prescribing of antibiotics for outpatients by doctors in the private sector	0.10	2	0.20
	5	Selling antibiotics without a prescription by some pharmacies	0.05	2	0.10
Total score			1.00		2.45

Figure 1 shows the strategic zone for Action plan on AMR in the Health Deputy which was determined through summing up the scores of strengths, weaknesses, opportunities, and threats

Figure 1. Strategic zone for Action plan on AMR in the Health Deputy, Ministry of Health and Medical Education

Final score of external factors matrix	Final score of internal factors matrix				
	4	3	2.50	2	1
	Development strategies (SO)		4 3	Competitive strategies (WO)	
	Conservative strategies (WO)			2 1	Defensive strategies (WT)

Approach to be taken by the Health Deputy based on the results of SWOT matrix analysis:

As the strategy type is located in the Conservative zone, the Health Deputy should utilize strengths to reduce threats

Table 12: Ranking internal and external factors affecting Action Plan on AMR in the Treatment Deputy, Ministry of Health and Medical Education

Internal Factors Evaluation Matrix					
	No.	Task descriptions	Weight	Rate of current state	Weighted score
Strengths	1	Resolution and commitment of senior management in Treatment Deputy for the implementation of Action plan on AMR	0.1	4	0.4
	2	Proper coordination between the WHO Country Office and Treatment Deputy in the Ministry of Health	0.05	3	0.15
	3	Availability of accreditation system in hospital inpatient wards	0.0.1	4	0.4
	4	Paying attention to health care-associated infections in the country as an indicator of patient safety	0.05	3	0.15
Weaknesses	1	Lack of a proper organizational structure (qualitative and quantitative) with specific job descriptions for following up the plan	0.1	2	0.2
	2	Not including Action plan on AMR in the mission, vision, major goals, and specific objectives of organizations and in national social and economic development plans	0.1	2	0.2
	3	Lack of a national guideline for AMR	0.02	2	0.04
	4	Lack of a national guideline for rational use of antibiotics	0.02	2	0.04
	5	Unfeasibility of monitoring and supervision over the prescribing and distribution of drugs because of the wide range of drugs	0.02	2	0.04
	6	Patients free access to drugs for self-medication	0.02	2	0.04
	7	Poor trainings and poor corporate culture for proper and accurate registration of health care-associated infections in the country	0.02	2	0.04
	8	Lack of awareness and inadequate participation of patients and other people in reporting the accessibility of medicines in the community	0.1	2	0.2
	9	Lack of qualified oversight groups to monitor institutions and offices which perform limited surgeries	0.2	2	0.4
	10	Lack of self-care programs and not promoting the community awareness of the rational use of antibiotics	0.04	2	0.08
	11	Overlooking laws and regulations and not separating and disposing wastes produced in pharmaceutical processes, chemical imaging centers, clinics, institutions, limited surgery centers, injections centers, and finally the chemical pharmaceutical waste generated by patients in their homes	0.05	2	0.1

Total score			1.00		2.48
External Factors Evaluation Matrix					
Opportunities	1	International organizations' support, especially the WHO's support, for successful implementation of Action plan on AMR	0.15	4	0.6
	2	Insurance organizations' interest in Action plan on AMR because of cost-effectiveness of the plan and reduction of health care costs as a result of the rational use of antibiotics	0.15	4	0.6
	3	Mass media's interests in promoting public awareness about self-medication and drug therapy	0.1	4	0.4
	4	Education Deputy's interest in including Action plan on AMR and rational use of antibiotics in the curriculum of medical students and other related fields of the study	0.1	4	0.4
	5	Overlap between the objectives of Action plan on AMR and rational use of antibiotics with the objectives of some other national programs including: patient safety and infection prevention and control	0.1	4	0.4
	6	Including the programs for safe disposal of chemical and pharmaceutical hospital wastes into the agenda of the Parliament and the Department of Environment	0.1	4	0.4
Threats	1	Free access to drugs without a prescription by physicians	0.05	2	0.1
	2	Low level of public awareness and information about the risks of antimicrobial resistance and self-medication	0.05	2	0.1
	3	Indiscriminate use of hospital services and inadequate supervision of hospital health officials over the use of antiseptics and disinfectant solutions in hospitals	0.1	2	0.2
	4	Medical community's disinterest in the use of guidelines for rational prescribing of antibiotics	0.1	2	0.2
Total score			1.00		3.4

Figure 2 shows the strategic zone for Action plan on AMR in the Treatment Deputy which was determined through summing up the scores of strengths, weaknesses, opportunities, and threats.

Figure 2. Strategic zone for Action plan on AMR in the Treatment Deputy, Ministry of Health and Medical Education

Final score of external factors matrix	Final score of internal factors matrix				
	4	3	2.50	2	1
	Development strategies (SO)		4	Competitive strategies (WO)	
	Conservative strategies (WO)		3		
			2	Defensive strategies (WT)	
			1		

Approach to be taken by the Treatment Deputy based on the results of SWOT matrix analysis:

As the strategy type is located in the Competitive zone, the Treatment Deputy should try using the opportunities to reduce weaknesses.

Table 13: Ranking internal and external factors affecting Action Plan on AMR in the Food and Drug Administration, Ministry of Health and Medical Education

Internal Factors Evaluation Matrix					
	No.	Task descriptions	Weight	Rate of current state	Weighted score
Strengths	1	Preparedness of international organizations for the implementation and follow-up of programs in the country because of its significance at the global level	0.025	4	0.1
	2	Availability of a suitable platform for cooperation with mass media to inform the public	0.25	2	0.5
	3	Membership in international organizations such as INRUD (International Network for Rational Use of Drugs) and utilization of the programs and experiences of these organizations	0.05	4	0.2

Weaknesses	1	Low public awareness and false beliefs about the antibiotics and its direct impact on irrational use of drugs	0.1	4	0.4
	2	Poor coordination between different departments of Ministry of Health	0.025	2	0.05
	3	Extreme use of antibiotics for livestock production and poultry farming	0.025	2	0.05
	4	Ineffective participation of insurance organizations	0.05	4	0.2
	5	Unprincipled advertising of pharmaceutical companies with the aim of increasing the sale of antibiotics	0.05	4	0.2
	6	Lack of proper plans for adequate production of antibiotics in the country	0.05	4	0.2
	7	Lack of funding and limitations in financial resources for developing and implementing effective interventions	0.025	2	0.05
	8	Defects in medical education	0.025	2	0.05
	9	Lack of regulations and efficient enforcement for rational use of antibiotics, and selling antibiotics without prescription by some pharmacies	0.05	2	0.1
	10	Extreme prescribing of antibiotics by doctors in private sector for outpatients and lack of efficient regulations and enforcement	0.05	4	0.2
	11	Inappropriate elimination of antibiotics and their inappropriate return to the cycles of the nature	0.05	4	0.2
	12	Not implementing electronic prescription program	0.75	1	0.175
Total score			1.00		2.675
External Factors Evaluation Matrix					
Opportunities	1	Chance to receive comments and advices from experts and faculty members in related areas of expertise	0.025	4	0.10
	2	Availability of insurance databases containing data on prescribed medicines in the country	0.25	4	1.00
	3	Development and implementation of effective interventions for reforming the culture and good relationships with the Ministry of Education for promoting rational use of drugs	0.05	3	0.15
	4	Development and implementation of effective interventions for reforming the culture and good relationships with other organizations such as National Iranian Gas Company, Media, Social Welfare Organization, municipalities, etc.	0.05	3	0.15
	5	Committee's capability to prepare and publish scientific and educational contents for different age groups	0.125	4	0.5
Threats	1	Limited human resources	0.15	1	0.15
	2	Lack of access to advanced software and hardware	0.15	1	0.15
	3	Lack of access to non-insurance prescription databases in the country	0.15	1	0.15

	4	Instability of the management system and frequent and short-term changes of the authorities	0.15	1	0.15
Total score			1.00		5/2

Figure 3 shows the strategic zone for Action plan on AMR in the Food and Drug Administration which was determined through summing up the scores of strengths, weaknesses, opportunities, and threats.

Figure 3. Strategic zone for Action plan on AMR in the Food and Drug Administration, Ministry of

Final score of external factors matrix	Final score of internal factors matrix				
	4	3	2.50	2	1
	Development strategies (SO)		4	Competitive strategies (WO)	
			3		
	Conservative strategies (WO)		2	Defensive strategies (WT)	
			1		

Approach to be taken by the Food and Drug Administration based on the results of SWOT matrix analysis:

As the strategy type is located in the Development zone, the Food and Drug Administration should try using the strengths to take advantage of opportunities.

Table 14: Ranking internal and external factors affecting Action Plan on AMR in the Reference food and drug laboratory, Ministry of Health and Medical Education

Internal Factors Evaluation Matrix					
	No.	Task descriptions	Weight	Rate of current state	Weighted score
Strengths	1	Preparedness of reference food and drug control laboratory to take part in antimicrobial resistance surveillance system	0.025	4	0.1
	2	Availability of more than 50 food and drug control laboratory in food and drug deputies of Universities of Medical Sciences which are under the supervision of reference food and drug control laboratory	0.10	4	0.4
	3	Availability of more than 200 partner and accredited food and drug control laboratories in the country which are under the supervision of reference food and drug control laboratory	0.10	3	3
	4	Implementation of annual PMS program nationwide by food and drug control laboratory in food and drug deputies of Universities of Medical Sciences which are under the supervision of reference food and drug control laboratory	0.10	2	0.2
	5	Holding annual training workshops for food and drug control laboratories in food and drug deputies of Universities of Medical Sciences	0.05	4	0.2
	6	Holding annual training workshops for partner and accredited food and drug control laboratories in food and drug deputies of Universities of Medical Sciences	0.05	4	0.2
	7	Annual visits to food and drug control laboratories in food and drug deputies of Universities of Medical Sciences and ranking them	0.05	4	0.2
	8	Annual visits to partner and accredited food and drug control laboratories in food and drug deputies of Universities of Medical Sciences and ranking them	0.05	4	0.2
	9	Use of quality control system in all food and drug control laboratories	0.05	4	0.2
	10	Implementation of the program for controlling food and drug control laboratories through sending anonymous samples to reference food and drug control laboratory	0.05	4	v2
Weaknesses	1	Limited human resources	0.10	4	0.4
	2	Limited financial resources	0.10	4	0.4
	3	Not routinely perform antibiotic sensitivity test in food and drug control laboratories	0.05	4	0.2
	4	Lack of previous history of antibiotic sensitivity test in food and drug control laboratories	0.05	4	0.2
Total score			1.00		3.6
External Factors Evaluation Matrix					

Opportunities	1	Developing strategies and the WHO's support for controlling antimicrobial resistance in various fields	0.5	4	2.0
	2	Explaining the significance of antimicrobial resistance control to the authorities in Food and Drug Administration and food and drug control laboratories	0.4	3	1.2
Threats	1	Administrative constraints due to lack of sufficient personnel and lack of adequate laboratory equipment	0.1	4	0.4
Total score			1.00		3.4

Figure 4 shows the strategic zone for Action plan on AMR in the Reference food and drug laboratory which was determined through summing up the scores of strengths, weaknesses, opportunities, and threats.

Figure 4. Strategic zone for Action plan on AMR in the Reference food and drug laboratory, Ministry of Health and Medical Education

Final score of external factors matrix	Final score of internal factors matrix				
	4	3	2.50	2	1
	Development strategies (SO)		4	Competitive strategies (WO)	
			3		
	Conservative strategies (WO)		2	Defensive strategies (WT)	
			1		

Approach to be taken by the Reference food and drug laboratory based on the results of SWOT matrix analysis:

As the strategy type is located in the Development zone, the Reference food and drug laboratory should try using the strengths to take advantage of opportunities.

Table 15: Ranking internal and external factors affecting Action Plan on AMR in the reference health laboratory, Ministry of Health and Medical Education

Internal Factors Evaluation Matrix					
	No.	Task descriptions	Weight	Rate of current state	Weighted score
Strengths	1	Resolution of beneficiaries and authorities for implementing antimicrobial resistance surveillance system	0.1	4	0.4
	2	Preparedness of the National Reference Laboratory for implementing antimicrobial resistance surveillance system (a partner of the WHO in the field of quality control)	0.1	4	0.4
	3	Availability of well-equipped and accredited laboratories to implement the program in the country in the early stages	0.03	2	0.06
	4	Presence of a national program for registration of laboratory tools and a surveillance system for the consumable products	0.1	4	0.4
	5	Previous history of launching various surveillance systems in the center for communicable disease control and reference health laboratory	0.05	2	0.1
	6	Presence of a scientific committee composed of professors who are expert in relevant fields	0.05	2	0.1
	7	Presence of a laboratory accreditation system	0.1	4	0.4
Weaknesses	1	Poor coordination between different departments of the Ministry of Health	0.08	2	0.16
	2	Use of different HIS software in hospitals in the country	0.05	1	0.05
	3	Unfeasibility of transferring the data from HIS software to WHONET software	0.02	1	0.02
	4	Regulatory problems prevent microbial testing in laboratories to be in line with the standards	0.1	2	0.2
	5	Lack of comprehensive supervision over laboratory diagnostic tools available in the market	0.1	2	0.2
	6	Limited access to the latest reference guidelines (CLSI)	0.02	1	0.02
	7	Limited financial resources	0.1	2	0.2
Total score			1.00		71/2
External Factors Evaluation Matrix					
Opportunities	1	The WHO's support for the allocation of facilities	0.1	2	0.2
	2	Insurance coverage for a large number of diagnostic tests such as antimicrobial sensitivity test	0.1	3	0.3
Threats	1	Trafficking and illegal import of laboratory	0.05	4	0.2

		diagnostic tools			
	2	Long delay in the delivery of kits and reagents requested and purchased from foreign manufacturers	0.1	3	0.3
	3	Restrictions intended by laws and regulations on import and related import licenses	0.1	3	0.3
	4	Lack of appropriate tariffs for specialized microbiological tests	0.15	2	0.3
	5	Companies non-compliance with the rules and standards of production and delivery of laboratory diagnostic tools	0.1	2	0.2
	6	Lack of access to good-quality materials due to sanctions	0.2	2	0.4
	7	Staff's disinterest in the program as it might increase the workload in microbiology sector	0.1	2	0.2
Total score			1.00		2.2

Figure 5 shows the strategic zone for Action plan on AMR in the reference health laboratory which was determined through summing up the scores of strengths, weaknesses, opportunities, and threats.

Figure 5. Strategic zone for Action plan on AMR in the Reference health laboratory, Ministry of Health and Medical Education

Final score of external factors matrix	Final score of internal factors matrix				
	4	3	2.50	2	1
	Development strategies (SO)		4 3	Competitive strategies (WO)	
	Conservative strategies (WO)			Defensive strategies (WT)	
			2		
		1			

Approach to be taken by the Reference health laboratory based on the results of SWOT matrix analysis:

As the strategy type is located in the Development zone, the Reference health laboratory should try try using the strengths to take advantage of opportunities.

Table 16: Ranking internal and external factors affecting Action Plan on AMR in Iran Veterinary Organization

Internal Factors Evaluation Matrix					
	No.	Task descriptions	Weight	Rate of current state	Weighted score
Strengths	1	Presence of HACCP and GMP systems in protein product packaging centers	0.025	4	0.1
	2	Microbial control: 1) Imported and domestic frozen protein products 2) Imported cattle products 3) Raw milk 4) Centers such as livestock and poultry processing plants	0.03	4	0.12
	3	monitoring the residues of drugs, organochlorine and organophosphorus pesticides, hormones, and pollutants	0.1	4	0.4
	4	Availability of statistical data on the use of antibiotics in veterinary medicine	0.025	3	0.075
	5	Implementation of the program to produce poultry without antibiotics (FREE OF ANTIBIOTICS)	0.05	3	0.15
	6	Continuous improvement and development of standards and laboratory ISOs for public and private laboratories and GLP in veterinary laboratories	0.03	3	0.09
	7	Study and evaluation of drugs and the use of a system for registration of antibiotics used in veterinary medicine	0.025	3	0.075
	8	Development of qualitative and semi-quantitative methods such as ELISA and rapid diagnostic tests to detect antibiotics in solid and liquid protein products	0.025	3	0.075
	9	Use of LIMS software in the laboratory	0.025	3	0.075
	10	Proper management of pharmaceutical wastes, including antibiotics	0.01	3	0.03
Weaknesses	1	Not performing antibiotic sensitivity test for treating microbial infections in livestock, poultry, and fish	0.03	1	0.03
	2	Lack of prior and current records for microbial resistance program	0.01	1	0.01
	3	Performing parallel tasks by Veterinary Organization and Standards Institute	0.01	2	0.02
	4	Lack of knowledge about the activities performed by the Ministry of Health, Standards Institute, and Food and Drug Administration	0.01	2	0.02
	5	Lack of laws, regulations, and directives on food products to be observed by all stakeholders	0.025	1	0.025
	6	Lack of companies which produce antibiogram discs for veterinary medicine purposes	0.125	1	0.125
	7	Lack of legal support for elimination of	0.025	1	0.025

		protein products which are contaminated with resistant microbes			
	8	Antibiotic resistance in veterinary medicine	0.1	1	0.1
	9	Differences between the allowable limits (maximum tolerances) set by Standard Institute and Veterinary Organization	0.025	2	0.05
	10	Not implementing surveillance program for identifying the source of risk	0.025	2	0.05
Total score			1.00		1.645
External Factors Evaluation Matrix					
Opportunities	1	Establishing a food safety structure and setting AMR as one of its branches	0.025	4	0.10
	2	Advertising the importance of working on AMR in television and other mass media.	0.01	3	0.03
	3	Holding CME classes and courses for veterinarians and training them about limiting the use of antibiotics	0.01	3	0.03
	4	Integrating information and establishing databases	0.2	2	0.4
	5	Developing a unique software such as LIMS	0.01	2	0.02
	6	Emphasizing the need to have a plan and formulating it	0.225	4	0.9
	7	Reforming the farm management methods to reduce the use of antibiotics	0.02	3	0.06
	8	Promoting the level of food safety and developing the export of protein products to neighboring countries	0.02	2	0.04
	9	Assigning biological and chemical tests to the private sector and increasing monitoring activities	0.02	3	0.06
	10	Integrating standard testing procedures for public and private sector	0.01	2	0.02
Threats	1	Possibility of the transmission of microbial resistance from animals to humans	0.2	1	0.2
	2	Using antibiotics as a growth promoter to produce balanced animal feed for livestock, poultry, and fish	0.15	2	0.3
	3	Incidence of new and emerging diseases and drug resistant epidemics	0.018	1	0.018
	4	Not controlling antibiotic resistance in imported fresh or frozen protein products	0.01	2	0.02
	5	Irrational use of antibiotics for the treatment and prevention of diseases, and the use of antibiotics which are not recommended for the target host (the manufacturer does not provide any instruction to avoid taking the medication)	0.01	2	0.02
	6	Livestock trafficking without quarantine control	0.001	2	0.002
	7	Legal and illegal antibiotics trafficking	0.001	2	0.002
	8	Fraud in protein food products and lack of proper control over it	0.02	1	0.02
	9	Not informing the public about the dangers	0.03	1	0.03

		that threaten them			
	10	Not eliminating unusable products	0.01	1	0.01
Total score			1.00		2.282

Figure 6 shows the strategic zone for Action plan on AMR in the Veterinary Organization which was determined through summing up the scores of strengths, weaknesses, opportunities, and threats.

Figure 6. Strategic zone for Action plan on AMR in the Veterinary Organization, Ministry of Health and Medical Education

Final score of external factors matrix	Final score of internal factors matrix				
	4	3	2.50	2	1
	Development strategies (SO)	4	Competitive strategies (WO)		
		3			
	Conservative strategies (WO)	2	Defensive strategies (WT)		
1					

Approach to be taken by the Veterinary Organization based on the results of SWOT matrix analysis:

As the Veterinary Organization is located in the defensive zone, it should try to reduce weaknesses and threats.

Table 17: Ranking internal and external factors affecting Action Plan on AMR in the Health Insurance Organization

Internal Factors Evaluation Matrix					
	No.	Task descriptions	Weight	Rate of current state	Weighted score
Strengths	1	Availability of expert human resources in headquarters and provincial offices of the Health Insurance Organization	0.05	4	20
	2	Presence of a hospital supervisors in all hospitals under contract with the Health Insurance Organization	0.04	3	12
	3	Designing a strategic drug purchase model by the Health Insurance Organization and presenting it to the secretariat of the National Council of Health Services Insurance	0.08	4	32
	4	The Health Insurance Organization's interest in Action plan on AMR because of cost-effectiveness of the plan and reduction of health care costs as a result of the rational use of antibiotics	0.03	3	09
	5	Predicting and including the drug list covered by the Health Insurance Organization in strategic and operational plans	0.05	4	20
	6	Legal capacity of Iran Health Insurance Organization to determine a variable deductible in line with general policies of antimicrobial resistance control			
Weaknesses	1	Limited role of the Health Insurance Organization in managing drug costs in the country	0.10	2	20
	2	Delays in payments to pharmacies and centers under the contract with the Health Insurance Organization	0.15	2	30
	3	Lack of enough data on the amount of antibiotics used in the country	0.10	2	20
	4	Not replacing existing insurance notebooks with electronic ones (such as smart cards) so that to prescribe antibiotics using electronic tools	0.12	2	24
	5	Lack of indicators and criteria for including and excluding antibiotics in basic health insurance package	0.11	2	22
	6	Lack of IT-based health insurance systems which would interact with SEPAS to produce electronic health records for all insured people	0.06	1	06
	7	Not forecasting and including a variable deductible in the design of the model for financial contribution of insured people in costs of pharmaceuticals, particularly antibiotics, at the site of service delivery	0.07	2	14

	8	Not promoting the knowledge of insured people about the use of antibiotics	0.04	1	04
Total score			1.00	-	2.33
External Factors Evaluation Matrix					
Opportunities	1	Considering the Health Insurance Organization as one of the executive agencies involved in the development and implementation on Action Plan on AMR	0.06	2	0.12
	2	Appropriate legal foundations envisioned by high level documents to implement the plans proposed by the organization in line with the this national document	0.10	3	0.30
	3	Possibility of establishing insurance coverage for home care services provided based on clinical guidelines	0.05	3	0.15
Threats	1	Not intending an effective role for hospital supervisors (assigned by the Health Insurance Organization) to monitor treatment and diagnostic procedures performed for the insured people	0.04	2	0.08
	2	Not including Action plan on AMR in the mission, vision, major goals, and specific objectives of organizations and in national social and economic development plans	0.05	3	0.15
	3	Lack of a national guideline for AMR	0.10	4	0.40
	4	Unfeasibility of monitoring and supervision over the prescribing and distribution of drugs because of the wide range of drugs	0.09	3	0.27
	5	Poor trainings and poor corporate culture for proper and accurate registration of health care-associated infections in the country	0.06	2	0.12
	6	Lack of awareness and inadequate participation of patients and other people in reporting the accessibility of medicines in the community	0.03	1	0.03
	7	Lack of proper supervisory mechanisms for monitoring limited surgery institutions and offices	0.02	2	0.04
	8	Lack of plans for supporting self-care programs and promoting community awareness of the rational use of antibiotics	0.04	2	0.08
	9	Lack of referral system and family physician	0.05	3	0.15
	10	Lack of a national guideline for rational use of antibiotics	0.06	4	0.24
	11	Lack of adequate intersectoral cooperation between executive agencies and national stakeholders to implement a joint national program	0.06	3	0.18
	12	Lack of clear rules for the inclusion of certain antimicrobial drugs in the national pharmacopoeia and insurance services packages	0.05	4	0.20
	13	High frequency of unnecessary hospitalizations and prolonged hospital stay	0.05	3	0.15

	14	Selling antibiotics without prescription by pharmacies	0.04	4	0.16
	15	Inappropriate use of antibiotics for the treatment of upper respiratory tract infections (mostly with a viral origin)	0.02	4	0.08
	16	Prescribing antibiotics without medical indications	0.03	3	0.09
Total score			1.00	-	2.99

Figure 7 shows the strategic zone for Action plan on AMR in the Health Insurance Organization which was determined through summing up the scores of strengths, weaknesses, opportunities, and threats.

Figure 7. Strategic zone for Action plan on AMR in the Health Insurance Organization

Final score of external factors matrix	Final score of internal factors matrix				
	4	3	2.50	2	1
	Development strategies (SO)	4	Competitive strategies (WO)		
	Conservative strategies (WO)	2	Defensive strategies (WT)		
	1				

Approach to be taken by the Health Insurance Organization based on the results of SWOT matrix analysis:

As the strategy type is located in the Competitive zone, the Health Insurance Organization should try to use opportunities to reduce weaknesses.

Part Two

National Action Plan of the Islamic Republic of Iran for combating antimicrobial resistance

(IRIAMR) 2016 – 2021

Objectives

A review of documents and reports published by the WHO and strategic plans for combating antimicrobial resistance published by some countries and the results of focus group discussions with experts in related fields showed that to slow down the emergence of antimicrobial resistance and prevent its spread it is of great importance to consider the following items:

1. Improve public awareness and knowledge of microbial resistance and the use of antimicrobial drugs, especially those involved in health care, nursing care, livestock production and aquaculture, and food production
2. Monitor and evaluate antimicrobial resistance to detect the emergence and spread of antimicrobial resistance
3. Promote appropriate methods for infection prevention and control
4. Promote antimicrobial stewardship
5. Promote and accelerate research and development in the field of antimicrobial resistance and develop new methods for prevention, diagnosis, and treatment of drug-resistant infections

In view of that, the National Action Plan of the Islamic Republic of Iran for combating antimicrobial resistance (IRIAMR) 2016 – 2021 will be designed based on the aforementioned objectives.

Framework

Based on the aforementioned objectives, to promote the combat against antimicrobial resistance, the overall structure of the National Action Plan of the Islamic Republic of Iran for combating antimicrobial resistance (2016 – 2021) will cover the five following fields (Table 18).

Table 18: General structure of the national action plan for combating antimicrobial resistance (2016 – 2021)

Goals	Field
Raise public awareness and promote the trainings and educations for professional groups	Raising public awareness and training professional groups
Monitor microbial resistance continuously, monitor the use of medications and antimicrobial drugs, and identify the signs of change and the expansion of microbial resistance	Monitoring and Surveillance
Prevent the spread of microorganisms resistant to antimicrobial agents and drugs via implementing appropriate control and prevention programs	Infection Prevention and Control
Promote the appropriate use of antimicrobial agents and drugs in the fields of health care, livestock production and poultry farming and aquaculture	Appropriate Use of Antimicrobial drugs
Promote research and development activities in the field of microbial resistance	Research and Development

Strategies necessary to achieve the abovementioned objectives are explained within the framework shown below (Figure 4).

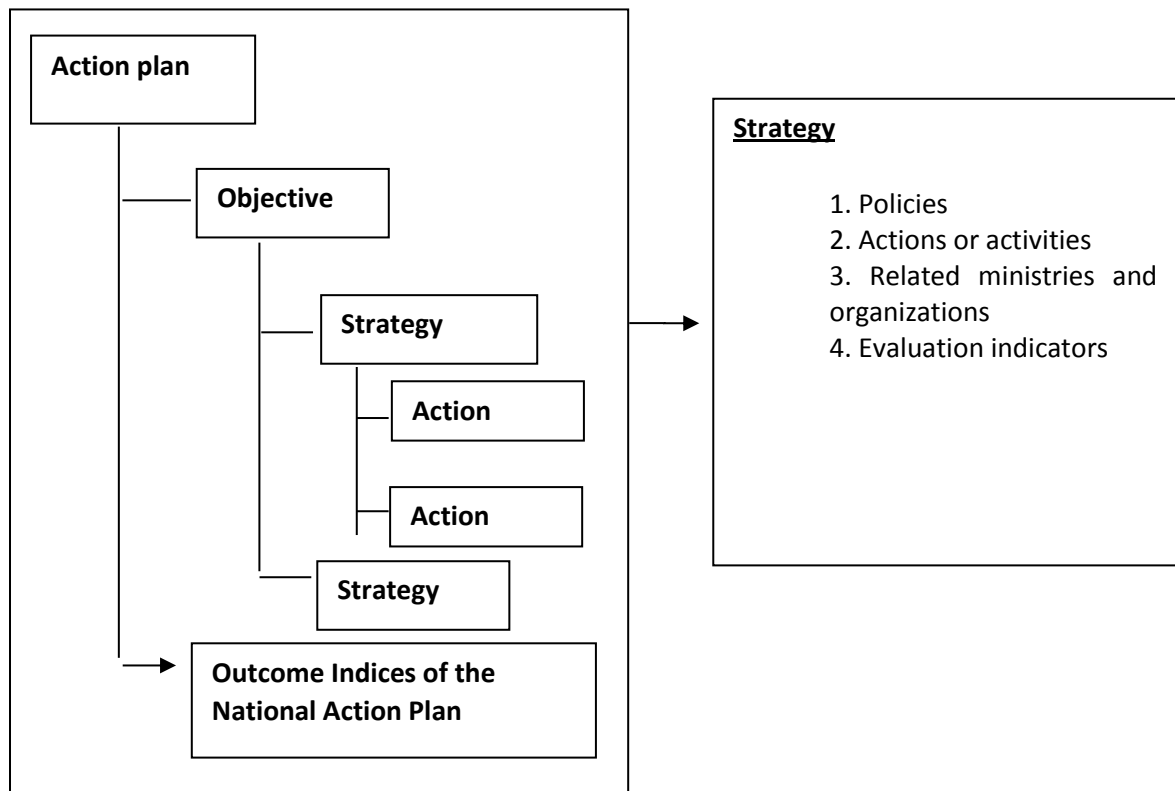


Figure 4: Framework of the National Action Plan on AMR

Objective 1:

Raise public awareness and promote education and trainings for related professional groups

Strategies

- 1.1. Promote activities to raise public awareness and knowledge of antimicrobial resistance
- 1.2. Promote education and training for professionals in the fields related to antimicrobial resistance

Strategy 1.1. Promote activities to raise public awareness and knowledge of antimicrobial resistance

Policies

- Implement targeted activities to raise awareness on the prevention and control of infections and antimicrobial resistance; the activities must be performed for specific audiences such as children and their parents, the elderly, specific population groups that often have a high consumption of antimicrobial drugs, companies with business activities related to microbial resistance, and academic organizations active in the field of health care, animal health, and food safety.
- Use of the potentials of non-governmental organizations to promote public awareness and transfer the experiences of vulnerable groups to other groups at risk (Patient for Patient education) or peer education
- Form working groups at the national level to develop campaigns to raise public awareness of the threats of antimicrobial resistance through cooperation with the media and related organizations and groups
- Integrate educational activities in the field of antimicrobial resistance for specific groups, such as children, their parents, and the elderly to inform them about taking antibiotics only based on a standard prescription
- Start campaigns to raise the awareness of people who are working in the fields related to antimicrobial resistance such as staffs working in health care, animal health, and food safety facilities and centers
- Improve awareness and understanding of insured people and health care institutions (that have a contract with insurance agencies) about antimicrobial resistance, prevention of infection, and rational prescribing and use of antibiotics

Actions

1. Establish Microbial Resistance National Committee to adopt policies and monitor and evaluate activities and the status of infection prevention and control, antimicrobial resistance, and public awareness
2. Establish strategic committees at the national, provincial, and district level for the prevention and control of infections and antimicrobial resistance
3. Formulate new practical laws and regulations for the prevention and control of infections and antimicrobial resistance

4. Set up and run up-to-date structures for informing people about antimicrobial resistance (such as websites)
5. Develop tools for increasing public awareness of antimicrobial resistance, for instance raising children awareness of antimicrobial resistance through providing educational materials and including them in school's curriculum
6. Conduct periodic and regular studies on knowledge, attitudes, and actions in the field of antimicrobial resistance in different groups
7. Administer awareness-raising programs in line with the World Antibiotic Awareness Week
8. Provide the access to up-to-date and useful information for public and patients about the national policies, knowledge and essential information on the use of antimicrobial drugs, and public actions to address this challenge as a citizen
9. Prepare and promote awareness-raising tools in the field of antimicrobial resistance in accordance with the needs of the audience (children and parents, the elderly, outpatients and inpatients)
10. Promote trainings about the prevention and control of infectious diseases and the importance of using medicines appropriately and prevent irrational use
11. Provide information on antimicrobial resistance through a site or brochure for passengers who want to go abroad (tailored for different destinations)
12. Develop guidelines for non-governmental sectors (such as companies with business activities related to antimicrobial resistance) to carry out their responsibilities in the field of antimicrobial resistance and include a statement or an article in their statutes confirming that they avoid activities that lead to increased antimicrobial resistance
13. Use social media to attract public participation in rational use of drugs
14. Broadcast training programs about microbial resistance through using local, provincial, and national media to raise public awareness
15. Provide informational tags or labels to inform the consumers about the antibiotics used in food products
16. Train insured people about microbial resistance, infection prevention, and appropriate use of antibiotics

Related ministries and organizations

- Ministry of Health and Medical Education
- Ministry of Science, Research and Technology

- Ministry of Interior
- Ministry of Education
- Ministry of Agriculture
- Ministry of Cooperatives, Labor, and Social Welfare
- Islamic Republic of Iran Broadcasting (IRIB)
- Ministry of Culture and Islamic Guidance
- Parliament's Health Commission
- Medical Council of Iran
- Ministry of Industry, Mine and Trade
- Institute of Standards and Industrial Research of Iran
- Municipal Cooperation Organization
- Iran Health Insurance Organization

Evaluation Indicators

- Raised awareness of community and patients about antimicrobial resistance
- Increase in the number of websites designed for informing people about the consequences of the spread of antimicrobial resistance and the participation of community members in the related activities
- Number of training materials distributed among people and number of training sessions held to increase awareness of antimicrobial resistance
- Increase in the number of training programs implemented in the public media to raise public awareness of antimicrobial resistance
- Number of training programs and materials used to promote knowledge and awareness of insured people

Strategy 2.1: Promote education for individuals and professional groups in the disciplines and fields related to antimicrobial resistance

Policies

- Prepare clinical guidelines to provide solutions to reduce antimicrobial resistance and present them to health care workers
- Train people using available clinical guidelines designed for the prevention and control of infections
- Monitor and evaluate health care staff's commitment to antibiotic stewardship guideline
- Provide protocols for the promotion of required knowledge and skills, develop scientific training programs, and promote their use in related organizations to improve knowledge in the field of antimicrobial resistance
- Promote the trainings on the prevention and control of infections and antimicrobial stewardship among employees and professionals in various sectors such as health care workers and practitioners working in the fields of veterinary, agriculture, livestock production, and aquaculture
- Create and promote a system of continuing education on antimicrobial resistance for undergraduate, graduate, doctoral, and post-graduate students
- Create a system to facilitate the access to specialists and informants and experts in the field of infectious diseases in the city and province and create a structure for easy access to the information needed for professionals
- Improve awareness and understanding of health care organizations with a contract with insurance organizations about antimicrobial resistance, prevention of infection, and rational prescribing and use of antibiotics

Actions

1. Prepare training packages in the field of antimicrobial resistance, prevention and control of infectious diseases, and antimicrobial stewardship and include them in the curriculum of universities and use them especially for healthcare practitioners, and people working in the fields of veterinary, agriculture, and food production, and promote educational activities in related organizations
2. Hold an increased number of sessions and increase the content of trainings on antimicrobial resistance, prevention and control of infectious diseases, and antimicrobial stewardship and include them in training courses for professionals such as doctors, pharmacists, nurses, and veterinarians
3. Increase the number of questions about antimicrobial resistance, prevention and control of infectious diseases, and antimicrobial stewardship and include them in qualification examinations for professionals such as doctors, pharmacists, nurses, and veterinarians

4. Encourage related groups and authorities to develop training courses on antimicrobial resistance and make it mandatory for health care staffs especially doctors, dentists, and pharmacists to pass the courses as a prerequisite for issuing and renewal of their work certificates
5. Integrate training courses on antimicrobial resistance which are presented in the educational system within the curriculum of physicians, specialists, and dentists
6. Hold regular conferences and seminars to train veterinarians and animal health inspectors
7. Develop and promote training programs on antimicrobial resistance, prevention and control of infectious diseases, and antimicrobial stewardship and include them in the curriculum of postgraduate students in related fields
8. Train the involved people about the methods of improving the performance of antimicrobial resistance laboratories in the fields of agriculture, veterinary, livestock production, and aquaculture and create a structure to provide information on antimicrobial resistance
9. Provide training programs on infectious disease outbreaks caused by antimicrobial resistance and include them in professional trainings
10. Hold continuing education events such as seminars, congresses, and conferences on antimicrobial resistance for all categories of health workers, veterinary staff, and people working in jobs related to aquaculture, livestock production, and food industry, and support the actions by the related organizations
11. Create a structure to select some people as the focal points in different organizations and training them, giving them a certificate to provide professional trainings, and re-training them
12. Create a training structure to provide trainings on the epidemiology of antimicrobial resistance in hospitals using existing structures such as infection control committee
13. Create a training or fellowship course on antimicrobial resistance in animals for related professionals such as veterinarians
14. Formulate appropriate and up-to-date training programs and packages for infectious diseases specialists and including them the curriculum of postgraduate courses
15. Prepare necessary guidelines and rules with practical enforcement
16. Prepare training pamphlets and providing information for health care centers under the contract with the Health Insurance Organization about the rational prescribing and appropriate use of antibiotics based on scientific guidelines and lists of antibiotics within the basic health insurance package

Related ministries and organizations

- Ministry of Health and Medical Education
- Ministry of Science, Research and Technology
- Ministry of Agriculture
- Ministry of Cooperatives, Labor, and Social Welfare
- Parliament's Health Commission
- Medical Council of Iran
- Ministry of Industry, Mine and Trade
- Municipal Cooperation Organization
- Scientific communities
- Iran Health Insurance Organization

Evaluation Indicators

- Number of training courses on antimicrobial resistance
- Percentage of satisfaction with training courses
- Percentage of knowledge gained from training courses which must be measured through conducting related studies
- Percentage of coverage of eligible individuals who have completed training programs
- Percentage of coverage of groups that received training packages and integrated education
- Number of people who receive certificates of attending training courses on antimicrobial resistance
- Trend of increase in the preparation of educational packages on antimicrobial resistance designed for health care workers
- Trend of the staff's compliance with the guidelines for the prevention and control of infections, microbial resistance, hand hygiene, use of personal protective equipment, etc. during a 5-year period, as compared with the baseline
- Number of training and informing tools prepared and distributed in centers and institutions under the contract

Objective 2:

Continuously monitor resistance and the use of antimicrobial drugs and on-time diagnosis of the signs of change and spread of antimicrobial resistance

Strategies

- 2.1. Strengthen antimicrobial resistance surveillance system in health care centers and medical institutions (limited surgery centers, day care, medical offices and clinics)
- 2.2. Monitor the trend of prescribing and use of antimicrobial drugs in inpatient and outpatient service centers
- 2.3. Strengthen the surveillance and monitoring of microbial resistance in the fields of veterinary medicine, livestock production and poultry farming, and aquaculture
- 2.4. Standardize laboratory tests and strengthen the performance of antimicrobial tests for diagnosis in laboratories
- 2.5. Implement integrated health care system for three sectors including human, animals, environment and food

Strategy 2.1. Strengthen antimicrobial resistance surveillance system in health care centers and medical institutions (limited surgery centers, day care, medical offices and clinics)

Policies

- Strengthen the surveillance system in the health care sector and create a strong surveillance system, particularly for infections caused by resistant bacteria which are spreading in the world
- Monitor the trend of antimicrobial resistance in people through nursing care services in health care centers and evaluate the target organizations in terms of infections resulting from health care
- Strengthen antimicrobial resistance surveillance system in hospitals
- Formulate enforcement mechanism by the national committee on antimicrobial resistance to collect information in Iran and other countries about antimicrobial resistance, and providing information for researchers and clinicians
- Prepare policy recommendations for governments and international organizations such as the WHO
- Rational prescribing of antibiotics

Actions

1. Strengthen human resources working in inpatient and outpatient service centers to observe the measures designed for the prevention and control of infection
2. Strengthen the surveillance system in inpatient service centers to give on-time response to community-borne epidemics
3. Strengthen the surveillance system in inpatient service centers to give on-time response to infections transmitted through tools and procedures
4. Strengthen national epidemiological surveillance systems for infectious diseases and training personnel working in this system
 - Strengthen the monitoring of resistant infections caused by bacteria which are listed as a priority in the program
 - Standardize antimicrobial sensitivity testing methods in the country
 - Conduct molecular research on high priority drug-resistant bacteria

5. Design laws and enforcement procedures to facilitate mandatory reporting of infectious diseases, for instance strengthen the electronic reporting system for all public and private medical centers and integrate data collected from different centers for the diagnosis and analysis

6. Strengthening surveillance system for health care-associated infections in the country

- Conduct research on health care-associated infections in the country
- Support the appropriate implementation of antimicrobial resistance surveillance system in medical institutions that do not have access to laboratory tests, so that they refer the samples
- Integrate the surveillance system for bacteria¹¹ covered by the WHO Global Antimicrobial Resistance Surveillance System (GLASS) with the infectious disease surveillance system
- Facilitate data collection for molecular analysis of microbial resistant genes
- Set up a system for the analysis of data on infections caused by microorganisms resistant to antimicrobial drugs at the local, regional, and national level
- Set obligations to include the results of antibiotic sensitivity tests as a prerequisite for paying the costs of antibiotics

7. Support and strengthen research on the surveillance system for health care associated infections

- Conduct research for the evaluation of the ability of the surveillance system for health care associated infections
- Collect data on health care associated infections¹² as part of the responsibilities of antimicrobial stewardship teams in medical institutions
- Provide training on the implementation of the surveillance system for health care associated infections

8. Create a working group and a think tank on Antimicrobial Resistance by the national Committee on antimicrobial resistance

9. Prepare and formulate guidelines and regulations for the rational use of antimicrobial drugs by insurance organizations and supervise its implementation and setting the observation of the standards as a prerequisite for paying the salary to the physicians

10. Check the physicians' prescriptions by insurance organizations to monitor and prevent irrational prescribing of antimicrobial drugs and set preventive measures for physicians who practice substandard prescribing of antibiotics

¹¹ *Escherichia coli*, *Klebsiella pneumoniae*, *Staphylococcus aureus*, *Streptococcus pneumoniae*, Non-Typhoidal *Salmonella*, *Shigella* species, *Neisseria gonorrhoeae*

¹² The United States of America's Surveillance System for the prevention and control of the diseases set the followings as the target infections: infections resulting from surgery, respiratory infections caused by ventilator, urinary tract infections in patients with urine catheter, and internal infections caused by *Clostridium difficile*, and bloodstream infections

- Supervise the proper implementation of the protocols by all medical personnel
- Cooperate with scientific communities
- Design preventive measures for physicians who practice substandard prescribing of antibiotics and do not observe the scientific rules on the use of antibiotics for upper respiratory tract infections
- Formulate Appropriateness Evaluation Protocol (AEP) for admission and hospitalization in the country and monitor its proper implementation

11. Pay the hospitalization fees by the insurance organizations only in case of observing the AEP

Related ministries and organizations

- Ministry of Health and Medical Education
- Ministry of Science, Research and Technology
- Ministry of Agriculture
- Ministry of Cooperatives, Labor, and Social Welfare
- Medical Council of Iran
- Parliament's Health Commission
- Iran Health Insurance Organization

Evaluation Indicators

- Amount of hand hygiene solutions consumed in inpatient wards of hospitals
- Adherence to guidelines for the prevention and control of infections in inpatient wards of hospitals
- Number of clinical guidelines designed for disease management of diseases in inpatient wards of hospitals
- Adherence to clinical guidelines designed for the management of diseases in inpatient wards of hospitals
- Amount of antimicrobial drugs consumed based on the OTC of urban pharmacies
- Number of cases reported with drug-resistant tuberculosis and *Neisseria gonorrhoeae*
- Number of medical institutions participating in the antimicrobial resistance surveillance system to collect data
- Number of related research conducted each year
- Percentage of the cost of antibiotics which were paid only after reporting the results of antibiotic sensitivity test in patients' hospital profiles
- Trend of changes in prescribing antibiotics

- Proportion of hospital admissions which comply with AEP in the country to the total hospital admissions
- Proportion of hospital cases complying with AEP paid by insurance organizations to the total number of hospitals

Strategy 2.2. Monitor the trend of prescribing and use of antimicrobial drugs

Policies

- Develop a surveillance system to monitor prescribing and use of antimicrobial drugs in inpatient and outpatient sectors
- Formulate, update, and monitor some criteria for prescribing and use of antimicrobial drugs by medical institutions
- Monitor the prescriptions containing antimicrobial drugs in medical institutions

Actions

1. The development and updating care and medications prescribed drugs in medical institutions

- Use information technology platform to monitor the patterns of prescribing and use of antimicrobial drugs in outpatient and inpatient service centers (including all schemes such as rural insurance, family physician, etc.)
- Encourage medical institutions to participate in the antimicrobial drugs surveillance system
- Conduct research on integrating surveillance system for prescribing and use of antimicrobial drugs in outpatient and inpatient service centers
- Study the feasibility of integrating surveillance system for prescribing and use of antimicrobial drugs with the surveillance system for health care associated infection in outpatient and inpatient service centers

2. Use the antimicrobial resistance surveillance system for managing the related risks

- Conduct qualitative and quantitative evaluation of antimicrobial stewardship in medical institutions
- Formulate guidelines for evaluating the quality of antimicrobial stewardship by using antimicrobial drugs consumption index
- Create a system of quantitative and qualitative evaluation using antimicrobial drugs consumption index at the local, regional, and national level
- Continuously monitor the amounts and methods of prescribing and using antimicrobial drugs in institutes and centers under the contract

Related ministries and organizations

- Ministry of Health and Medical Education
- Ministry of Science, Research and Technology

- Ministry of Agriculture
- Ministry of Cooperatives, Labor, and Social Welfare
- Medical Council of Iran
- Parliament's Health Commission
- Iran Health Insurance Organization

Evaluation Indicators

- Amount of antimicrobial drugs prescribed in outpatient and inpatient service center
- Percentage of prescriptions containing antimicrobial drugs classified by outpatient service, inpatient service, physician specialty, etc.
- Amount of antimicrobial drug consumption based on the drugs sale statistics
- Number of institutions participating in the surveillance system for prescribing and use of antimicrobial drugs in inpatient and outpatient service centers

Strategy 2.3. Strengthen the surveillance and monitoring of antimicrobial resistance in the fields of veterinary medicine, livestock production and poultry farming, and aquaculture

Policies

- Strengthen the capacity and structure of antimicrobial resistance laboratories in the fields of livestock production, aquaculture, and veterinary
- Strengthen monitoring and evaluation systems through the establishment of a research system for the study of antimicrobial resistance genes in livestock production and aquaculture

Actions

1. Creating and strengthening the monitoring and evaluation system in the fields of livestock production, aquaculture, and veterinary
 - Strengthen the monitoring and evaluation system in the fields of livestock production and aquaculture
 - Develop antimicrobial resistance monitoring and evaluation system in animal husbandry and aquaculture centers through strengthening the veterinary antimicrobial resistance surveillance system
 - Formulate and develop guidelines for antimicrobial sensitivity testing for uniform comparison and evaluation of livestock production and aquaculture
 - Collecting data via using similar quality control procedures and ensure the coordination with the organizations that use the laboratory tests
 - Establish a monitoring system for the targeted antimicrobial resistance genes
 - Establish a monitoring and evaluation system to control adding antibiotics to foods for any type of animal
2. Establish a monitoring and evaluation system of pets
3. Utilize monitoring and evaluation system for controlling the use of antimicrobial drugs in agriculture

Related ministries and organizations

- Ministry of Health and Medical Education
- Ministry of Science, Research and Technology
- Ministry of Agriculture
- Ministry of Cooperatives, Labor, and Social Welfare

Evaluation Indicators

- Trend of changes in resistance of index strains
- Trend of changes in resistant genes of index strains

Strategy 2.4. Standardize laboratory tests and strengthen the performance of antimicrobial tests for diagnosis in laboratories

Policies

- Try to improve the level of testing technology and the availability of an evaluation system to conduct standard comparisons and evaluations through advocacy for establishing a quality control system at the national level for antimicrobial resistance testing
- Conduct research on microbial surveillance systems, with the aim of strengthening the antimicrobial stewardship in medical institutions
- Study the feasibility of introducing and utilizing new technologies and equipment in animal and health laboratories to improve their capacity in the field of antimicrobial resistance

Actions

1. Standardization of laboratory methods and strengthen quality control

- Develop a guideline for antimicrobial sensitivity testing guidelines, in line with international standards, which allows uniform comparison and evaluation of all service providers
- Support the establishment of a quality control system and extend it to medical institutions
- Create and develop manuals and guidelines for antimicrobial resistant gene testing and conduct comparative analyses of organisms resistant to antimicrobials
- Develop manuals and guidelines for each medical institution to create a table of antimicrobial sensitivity (such as antibiogram) for main pathogenic microorganisms
- standardize methods used in livestock, aquaculture, and pets laboratory centers

2. Determine legal and real tariffs for sensitivity tests

3. Strengthen and develop the capacity of animal and human health reference laboratories

- Strengthen clinical research on the use of basic tests in clinical laboratories for diagnosis of antimicrobial resistance which may help to strengthen the antimicrobial stewardship.

4. Introduce new technologies for monitoring and evaluation and using them to control defined Indicators

- Develop new technologies based on molecular epidemiology for monitoring and evaluation and promote their use in human and animal health laboratories
- Strengthen monitoring and evaluation based on molecular epidemiology through developing a database of antimicrobial resistance genomes and using the results for risk assessment and management

Related ministries and organizations

- Ministry of Health and Medical Education
- Ministry of Science, Research and Technology
- Ministry of Agriculture
- Ministry of Cooperatives, Labor, and Social Welfare
- Medical Council of Iran
- Parliament's Health Commission
- Institute of Standards and Industrial Research of Iran

Evaluation Indicators

- Percentage of national standards which comply with international standards
- Percentage of organizations that use the standards
- Number of training seminars on standardization
- Number of samples obtained through monitoring and evaluation based on molecular epidemiology

Strategy 2.5. Implement integrated health care system for three sectors including human, animals, environment and food

Policies

- Create a network to collect and share data; the network will connect and integrate the data collected by several monitoring and evaluation systems
- Create a national working group to integrate data obtained from various monitoring and evaluation system and compares them with international measures of antimicrobial resistance and control Indicators
- Create and strengthen a monitoring and evaluation system for prescribing and use of antimicrobial drugs for livestock, fish, pets, and agricultural products
- Conduct research to set up a monitoring and evaluation system for resistant microorganisms in food industry
- Conduct research on monitoring and evaluation of resistant microorganisms and antimicrobial residues in aquatic, domestic, and wild animals

Actions

1. Create a comprehensive and unique health care system
 - Adopt an integrated approach to health care concerning antimicrobial resistance in order to collect and share data
 - Analyze and evaluate antimicrobial resistance and use antimicrobial drugs based on an the data obtained from an integrated data monitoring and evaluation system and other scientific studies
 - Establish national and provincial scientific committees to use the generated data
 - Prepare and publish an annual report on comprehensive monitoring and evaluation
 - Develop the existing monitoring and evaluation guidelines
2. Conduct research to set up a monitoring and evaluation system for antimicrobial resistance in foods
3. Analyze factors involved in the transmission of bacterial resistance in humans, animals, and food; conduct research to clarify the process of transmission
4. Conduct research on monitoring antimicrobial resistance and antimicrobial residues in aquatic and terrestrial environments

5. Promote monitoring and evaluation of antimicrobial resistance in livestock, aquatic animals, and pets through setting up a monitoring and evaluation system
6. Make a link between the data obtained through monitoring and evaluation of microbial resistance in human, animals, and foods
7. Implement the monitoring and evaluation program for assessing the use of antimicrobial drugs in agriculture industry
8. Reform the monitoring and evaluation system in line with the global antimicrobial resistance surveillance system

Related ministries and organizations

- Ministry of Health and Medical Education
- Ministry of Science, Research and Technology
- Ministry of Agriculture
- Ministry of Cooperatives, Labor, and Social Welfare

Evaluation Indicators

- Report the surveillance reports under an integrated health approach

Objective 3:

Prevent the spread of microorganisms resistant to antimicrobial drugs via implementing appropriate control and prevention programs

Strategies

- 3.1. Prevent and control infections in healthcare services and promote intersectoral cooperation
- 3.2. Promote the prevention and control of the use of antibiotics in livestock production, aquaculture, agricultural products in the and food supply chain
- 3.3. Strengthen the capacity to response to antimicrobial resistance outbreaks

Strategy 3.1. Prevent and control infections in healthcare services and promote intersectoral cooperation

Policies

- Prevent and control infections via promoting the system of integrated collaboration between different sectors such as the outpatient and inpatient service providers in medical institutions, the elderly nursing homes, home care, improving the control of microbial resistance, make a line between infection control teams and the antimicrobial stewardship team
- Promote activities for prevention and control of infection in coordination with regional hospitals and related organizations (clinics, pharmacies, nursing and public health service providers, etc.) and develop a model of interconnected activities for the prevention and control of infections, use control network and support its launch all across the country
- Promote research to provide technical support for strengthening the efforts aimed at the prevention and control of infection (such as the systems designed for automatic analysis of clinical data)
- Promote the use of vaccination and use the frameworks for assessing the quality of medical care

Actions

1. Promote new findings in the field of prevention and control of infections and strengthen cooperation at regional and national level
 - Promote measures by antimicrobial resistance technical council to strengthen the prevention and control of infections in the fields of outpatient services and home care (Cf. Strategy 4.1.)
 - Conduct research to review centers and issues targeted by health care-associated infection surveillance system in Iran (Cf. Strategy 2.1)
 - Conduct studies to develop a model of interrelated activities on measures designed for the regional infection control, and the regional network for prevention and control of infectious diseases
 - Develop practical tangible models for the promotion of regional cooperation to prevent and control infections and achieve an effective performance
 - Introduce and include the components of antimicrobial resistance screening and antimicrobial stewardship in manuals and guidelines designed for prevention and control of infections, based on a review of the current statue of antimicrobial resistance in the elderly nursing care facilities (Cf. Strategy 5.2)

- Develop clinical guidelines for home care services by the Ministry of Health and Medical Education
- Cover the home care services by insurance schemes in order to prevent and reduce infections in line with the approved clinical guidelines

2. Strengthen cooperation between laboratories, medical institutions, and local governments

- Establish consultation and reporting system for the identification of clinically important microorganisms in the laboratory
- Conduct studies in collaboration with local stakeholders to formulate and develop guidelines for the assessment and management of antimicrobial resistance
- Implement benchmarking plans or use basic standards for the prevention and control of infections in medical institutions and at regional and national levels, and conduct research to promote the measures of prevention and control of infection based on the results

3. Strengthen activities aimed at the prevention of infection

- promote vaccination (pneumococcal vaccine, Haemophilus influenzae type b vaccine, and influenza vaccine) to prevent infections caused due to antimicrobial resistance
- Promote the measures for the evaluation of infection prevention and control, antimicrobial stewardship, etc. and include them in the programs on accreditation and evaluation of health care institutions

Related ministries and organizations

- Ministry of Health and Medical Education
- Ministry of Science, Research and Technology
- Ministry of Agriculture
- Ministry of Cooperatives, Labor, and Social Welfare
- Ministry of Foreign Affairs
- Tehran office of the WHO
- Iran Health Insurance Organization

Evaluation Indicators

- Number of health care-associated infections
- Number of universities of medical sciences which have a regional network for prevention and control of infection that meet the requirements
- Rate of immunity achieved by pneumococcal vaccine, Haemophilus influenzae type b vaccine, and influenza vaccine

- Number of clinical guidelines formulated for homecare services
- Number of homecare services under the coverage of insurance schemes (based on approved clinical guidelines)

Strategy 3.2. Promote the prevention and control of the use of antibiotics in livestock production, aquaculture, agricultural products in the and food supply chain

Policies

- Make efforts to raise awareness about the prevention and control of infections in livestock production, aquaculture, and veterinary centers through the preparation and distribution of the manual on health management during production
- Raise awareness about the fact that the prevention of infectious diseases is likely to control antimicrobial resistance and reduce the use of veterinary antibiotics
- Promote hazard analysis and critical control point in the process of food production and distribution

Actions

1. Promote the prevention and control of infection in livestock, aquatic animals, and pets
 - Promote the development and use of vaccines for livestock, aquatic animals, and pets
 - Ensure full compliance with the standards of production and process management and wider use of guidelines on health management during production
2. Promote the prevention and control of infection in the process of food production and distribution
 - Promote hazard analysis and critical control point
 - Minimize antibiotics residual in livestock, poultry, and agricultural products,

Related ministries and organizations

- Ministry of Health and Medical Education
- Ministry of Science, Research and Technology
- Ministry of Agriculture
- Ministry of Cooperatives, Labor, and Social Welfare

Evaluation Indicators

- Dosage of vaccines used in veterinary medicine
- Level of compliance of production and process management with approved standards

- Amount of antibiotics prescribed or used in livestock production, poultry farming, aquaculture, and agricultural products

Strategy 3.3. Strengthen the capacity to response to antimicrobial resistance outbreaks

Policies

- Develop instructions and guidelines for responding to health care-associated infections in the country and the outbreak of infections caused by antimicrobial resistance at the local level and establish a system whereby professionals respond to outbreaks
- Strengthen the response capacity and build networks through increasing training Opportunities for those who are involved in the rise of antimicrobial resistance
- Create a rapid response system through sending experts to all parts of the country to evaluate the epidemiological status, clinical management, and public health responses to large outbreaks that result in a serious shortage of manpower.

Actions

1. Support local-level response to outbreaks of infections caused by antimicrobial resistance
 - Support the local response to outbreaks of infections caused by microbial resistance via utilizing the regional network for the prevention and control of infectious diseases
 - Prepare guidelines and instructions for responding to outbreaks of nosocomial infections at the local level
 - Develop some Indicators for early reporting of outbreaks to prevent the local spread of the infection
2. Hold training seminars for members of the regional network for the prevention and control of infectious diseases (Cf. Strategy 2.1)
3. Hold training seminars for authorities at the local level (city or province) (Cf. Strategy 2.1)
4. Strengthen the capacity to respond to large outbreaks
 - Utilize a system to create a team of experts in the field of antimicrobial resistance to deal with the shortage of manpower during severe outbreaks

Related ministries and organizations

- Ministry of Health and Medical Education
- Ministry of Science, Research and Technology
- Ministry of Agriculture
- Ministry of Cooperatives, Labor, and Social Welfare

- Ministry of Interior
- Passive Defense Organization

Evaluation Indicators

- Number of patients with antimicrobial resistant infections
- Number of training programs on related diseases
- Number of proper responses to outbreaks

Objective 4:

Promote the appropriate use of antimicrobial drugs in the fields of healthcare, livestock production, and poultry farming, aquaculture

Strategies

4.1. Promote antimicrobial drugs and materials stewardship in medical institutions

4.2. Ensure prudent use of antibiotics and antimicrobials in the fields of veterinary medicine, livestock production, poultry farming, and aquaculture

Strategy 4.1. Promote antimicrobial drugs and materials stewardship in medical institutions

Policies

- Create a working group at the national level to promote antimicrobial resistance stewardship and formulate guidelines for antimicrobial stewardship, and manuals for the clinical management of infectious diseases
- Develop guidelines to empower every medical institution to develop manuals and guidelines for their antimicrobial stewardship and for the management of infectious diseases based on the microbial sensitivity in the institute
- Promote antimicrobial stewardship and proper management of infectious diseases through the activities of antimicrobial stewardship team and evaluate the quality of antimicrobial stewardship
- Promote measures to strengthen antimicrobial stewardship in the fields of prevention, diagnosis, and treatment of infectious diseases
- Perform strategic purchases based on the quality of antibiotics in the national health care system

Actions

1. Publish guidelines / instructions for antimicrobial stewardship

- Form a technical stewardship team in the field of antimicrobial resistance in the Ministry of Health and Ministry of Agriculture to strengthen the prevention and control of infectious diseases and to support antimicrobial stewardship (Cf. Strategy 3.1)
- Formulate antimicrobial stewardship guidelines and national clinical management guidelines for infectious diseases
- Formulate strategic antibiotics purchase policies for outpatient and inpatient service centers in accordance with approved guidelines

2. Review existing regulations in the field of diagnosis and treatment to strengthen antimicrobial stewardship

- Review information printed on food packages about the ingredients and antimicrobial drugs based on scientific evidences
- Find the latest evidences on the pharmacokinetics and pharmacodynamics and include them in clinical management guidelines and other documents for the management of infectious diseases

3. Review rules and regulations on rational prescribing and use of antimicrobial drugs for outpatients

4. Support the establishment of systems to promote antimicrobial stewardship in medical institutions

- Use electronic systems and toll to prescribe and deliver all medications, especially antibiotics, as part of the Electronic Health Record
- Prevent pharmacies from selling antibiotics without a prescription through the provision of an IT Platform
- Add the contents on antimicrobial stewardship into the curriculums for training professionals including doctors, pharmacists, nurses, and clinical technicians (Cf. Strategy 2.1.)
- Formulate antimicrobial stewardship guidelines, including the guidelines on proper management of conflicts of interest, and guidelines on clinical management of infectious diseases based on antimicrobial sensitivity by the Ministry of Health and Medical Education
- Form antimicrobial stewardship teams by all stakeholder in medical institutions
- Determine the role of the antimicrobial stewardship governance in hospital infection control committee
- Establish referral system and family physician to control the prescribing of antibiotics, especially in outpatient service centers
- Develop a local mechanism to send the experts to provide in-demand training and advisory services (Cf. Strategy 2.1) through a regional network for the prevention and control of infectious diseases (Cf. Strategy 3.1)
- Conduct research on the development and use of antimicrobial chemotherapy registration system and mobilize pharmacists (Cf. strategy 3.5)

5. Control and supervise the production of antibiotics in pharmaceutical companies in order to control the actual effectiveness of drugs

6. Buy antibiotics based on their quality recommended in health insurance package

- Revise the list of antibiotics included in the basic national health insurance package
- Qualitative assessment of antibiotics available in the health market.
- Apply variable (stepped) deductible for a number of antibiotics with a low Cost and a high frequency of consumption.

Related ministries and organizations

- Ministry of Health and Medical Education
- Ministry of Science, Research and Technology
- Ministry of Agriculture
- Ministry of Cooperatives, Labor, and Social Welfare
- Medical Council of Iran

- Iran Health Insurance Organization
- Ministry of Communications and Information Technology

Evaluation Indicators

- Number of medical institutions that implement antimicrobial stewardship program
- Number of systems supporting antimicrobial stewardship in each region
- Number of electronic prescriptions
- Proportion of health care services presented within the framework of health care referral system to all health services provided in the country
- Proportion of antibiotics available in the list revised based on the inclusion and exclusion criteria to all antibiotics available in drug list and in the market (regulations governing the review of list of antibiotics in the basic health insurance package)
- Proportion of revised rules and regulations on rational prescribing and use of antibiotics to all the existing rules and regulations
- Proportion of antibiotics with a variable deductible to all antimicrobials with a low cost and a high frequency of consumption.

Strategies 4.2. Ensure prudent use of antibiotics and antimicrobials in the fields of veterinary medicine, livestock production, poultry farming, and aquaculture

Policies

- Develop risk management measures
- Develop and strengthen the procedures required to ensure safe and appropriate use of veterinary antimicrobials and antibiotics by veterinarians
- Evaluate and promote the participation of experts in the use of veterinary antimicrobials and antibiotics for aquatic animals

Actions

1. Promote risk management and assess the effects of using antibiotics on animals on human health
 - Develop and implement appropriate risk management plan based on the results of risk assessments carried out by the Food Security Committee
 - Promote risk assessment and food security plans for antimicrobial-resistant bacteria and formulate guidelines to determine the effects of using antimicrobial drugs and materials in animal food products on human health
 - Revise risk management measures used in the field of veterinary antibiotics and antibiotic food additives
2. Strengthen the systems which are used to ensures proper use of veterinary antibiotics
 - Ensure the appropriate use of antibiotics in livestock production and aquaculture and its compliance with guidelines
 - Prepare brochures on the proper use of antibiotic feed additives by food producers
 - Utilize antimicrobial sensitivity testing methods as a foundation for appropriate use of veterinary antibiotics and develop Indicators for effective treatment
 - Check the status of using veterinary antibiotics in industrial sites
 - Strengthen the responsibility of professionals (veterinarians, pharmacists, aquaculture experts) in the use of antibiotics
3. Determine the appropriate dosage of antibiotics to be used for animals
 - Assess and monitor the total amount of antibiotics used in humans and animals in Iran through cooperation between different monitoring and evaluation systems in different related sectors

- Calculate the amount of antibiotics used for every type of animals and crops, based on the appropriate dosage of antibiotics to be used in veterinary and agricultural activities, and compare them with similar trends in other countries
- Utilize the findings of the latest evidence on the pharmacokinetics and pharmacodynamics etc. and include them in clinical management guidelines and other documents for the management of infectious diseases
- Review the rules on prescribing antimicrobial drugs for outpatients with acute upper respiratory tract infections based on the results of studies conducted in this field

4. Support the establishment of a system to promote antimicrobial stewardship in medical institutions

- Add the contents on antimicrobial stewardship into the curriculums designed for training professionals including doctors, pharmacists, nurses, and clinical technicians (Cf. Strategy 2.1.)
- Support clinical institutions to develop antimicrobial stewardship guidelines, including proper management of conflicts of interest and design clinical management guidelines for infectious disease based on the results of antimicrobial sensitivity tests in each medical institution
- Form antimicrobial stewardship teams in medical institutions, livestock production and food production centers
- Determine the role of the antimicrobial stewardship governance in hospital infection control committee
- Develop a local mechanism to send the experts to provide in-demand training and advisory services (Cf. Strategy 2.1) through a regional network for the prevention and control of infectious diseases (Cf. Strategy 3.1)
- Conduct research on the development and use of antimicrobial chemotherapy registration system and mobilize pharmacists (Cf. strategy 3.5)

Related ministries and organizations

- Ministry of Health and Medical Education
- Ministry of Science, Research and Technology
- Ministry of Agriculture

Evaluation Indicators

- Number of risk management measures which are developed / implemented
- Number of medical institutions, livestock production and food production centers which have an antimicrobial stewardship team

- Number of training programs and brochures on the proper use of antibiotic food additives designed for food producers
- Number of electronic prescriptions

Objective 5:

Promote research and development in the field of antimicrobial resistance

Strategies

5.1. Promote research to reveal the mechanisms of emergence and transmission of antimicrobial resistance and its socioeconomic effects

5.2. Promote research on public awareness / training in the field of antimicrobial resistance, prevention and control of infections, and antimicrobial drugs stewardship

5.3. Promote clinical research on the optimization of existing methods of prevention, diagnosis, and treatment of infectious diseases

5.4. Promote research and development activities in the fields of new methods of prevention, diagnosis, and treatment and promote cooperation between universities, industry, and related sectors

5.5. Promote international collaboration for conducting research on antimicrobial resistance and promote research and development for introducing new methods of prevention, diagnosis, and treatment of antimicrobial resistant infections

Strategy 5.1. Promote research to reveal the mechanisms of emergence and transmission of antimicrobial resistance and its socioeconomic effects

Policies

- Promote research to clarify and explain the emergence and transmission of antimicrobial resistance based on genome analysis
- Promote a surveillance system for antimicrobial resistance genomes to detect antimicrobial resistance mechanisms and discover drugs through promoting the preservation of antimicrobial resistant strains
- Create a database of genome-resistant bacteria in the fields of agriculture and aquaculture
- Conduct studies to estimate the impact of infections caused by antimicrobial resistance on health, community, and the economy and publish the results in an easily comprehensible manner to promote public awareness

Actions

1. Promote research on the incidence and transmission of antimicrobial resistance and provide financial support for related research

- Promote research and financial support for studies on the mechanisms of antimicrobial resistance, transmission of resistance microorganisms and microbial genomes (Cf. Strategy 2.1)
- Establish an isolation bank available for industry, university, and other sectors (Cf. Strategies 2.4 and 5.4)
- Promote surveillance system for antimicrobial resistance genomes, conduct research on the mechanisms of emergence and transmission of antimicrobial resistance, research and development for drug discovery through the use of isolation bank and antimicrobial resistance genome database
- Develop antimicrobial resistance genome database through collecting data from Iran and other countries
- Create a genome databases in the field of agriculture and aquaculture as part of antimicrobial resistance surveillance system
- Conduct research to clarify the mechanism of antimicrobial resistance and its transmission process and critical control points in the production of livestock, aquaculture, and veterinary medicines

2. Promote research on socioeconomic and health burden of antimicrobial resistance

- Promote research on economic burden and disease burden caused by resistant microorganisms in health care institutions (Cf. Strategy 2.1)
- Promote research on the effects of antimicrobial resistance measures on the reduction of medical costs
- Promote research on risk assessment based on the results of the surveillance system
- Utilize the data collected by the committee on rational prescribing and use of drugs for measuring the consumption of antimicrobial drugs

Related ministries and organizations

- Ministry of Health and Medical Education
- Ministry of Science, Research and Technology
- Ministry of Agriculture
- Vice-Presidency for Research
- Management and Planning Organization

Evaluation Indicators

- Number of research financially supported by the National grants in related fields
- Number of genomes collected in the genome database

Strategy 5.2. Promote research on public awareness / training in the field of antimicrobial resistance, prevention and control of infections, and antimicrobial agents and drugs stewardship

Policies

- Change the pattern of community behaviors toward infection prevention and control
- Create a positive attitude toward decreasing antimicrobial resistance
- Conduct research on intervention methods and benchmarking methods which are effective in measuring the effectiveness of activities performed to raise public awareness of and knowledge on antimicrobial stewardship and infection prevention and control

Actions

- Conduct studies on the cost-effective methods for changing behavior
- Conduct studies on the cost-effectiveness of interventions designed and implemented to raise public awareness
- Conduct study to measure changes in knowledge, attitude, and behavior of people toward antimicrobial resistance
- Promote clinical and epidemiological research on antimicrobial stewardship and infection prevention and control
- Conduct research on rational prescribing and use of drugs (determine DDD of frequently used antibiotics, determine DUE of broad-spectrum antibiotics in hospitals, determine the amount of expired antibiotics, and determine antimicrobial wastes in pharmacies in urban areas)
- Conduct research to evaluate the antimicrobial stewardship and its effectiveness and cost-effectiveness in medical institutions (Cf. Strategy 4.1)
- Conduct clinical research on the use of antimicrobial sensitivity tests which support the implementation of antimicrobial stewardship (Cf. Strategy 2.4)
- Conduct research on formulation of regulations for effective prescribing of drugs for outpatients with acute upper respiratory tract infection (Cf. Strategy 4.1)
- Conduct research on the risk of transmission by resistant microorganisms and evaluate screening methods used by relevant medical institutions
- Conduct research on the use of antimicrobial drugs in the elderly nursing and care facilities (Cf. Strategy 3.1)

- Conduct research on the development of regional cooperation systems for benchmarking data related to the prevention and control of infections and antimicrobial stewardship (Cf. Strategy 3.1)
- Conduct research and development to support the diagnosis and treatment of infectious diseases in line with the policies of antimicrobial stewardship
- Conduct research on isolation trends and molecular epidemiology of antimicrobial resistance
- Conduct research on microbiological wastes and their disposal
- Conduct research on livestock production, aquaculture, and veterinary medicine
- Promote research to prepare guidelines for the use of veterinary antibiotics in livestock production, poultry farming, and aquaculture; conduct research about the changes in resistance after stopping the use of antibiotics in animals and assess the secondary risk

Related ministries and organizations

- Ministry of Health and Medical Education
- Ministry of Science, Research and Technology
- Ministry of Agriculture
- Municipal Cooperation Organization
- Ministry of Energy
- Management and Planning Organization

Evaluation Indicators

- Changes in the attitudes of community toward antimicrobial resistance over a period of five years
- Changes in the patterns of antimicrobial drugs consumption in the community over a period of five years
- Number of studies on the abovementioned actions

Strategy 5.3. Promote clinical research on the optimization of existing methods of prevention, diagnosis, and treatment of infectious diseases

Policies

- Revise methods of prevention, diagnosis and treatment of infectious diseases that helps to control antimicrobial resistance in Iran and promote research on the optimal use of drugs based on the available new scientific evidence
- Promote research to collect scientific evidences and utilize them to develop antimicrobial resistance measures

Actions

1. Conduct studies on the optimization of existing methods of prevention, diagnosis and treatment
 - Conduct research to discover and introduce useful methods for the prevention, diagnosis, and treatment of infectious diseases to tackle antimicrobial resistance in Iran (the methods may not be available in other countries)
 - Conduct research on regulations designed for maintaining the effectiveness of antimicrobial drugs
 - Conduct research on the treatment of infections caused by resistant microorganisms using high dose combination therapy
 - Conduct research on the development of antimicrobial chemotherapy registration systems

Related ministries and organizations

- Ministry of Health and Medical Education
- Ministry of Science, Research and Technology
- Ministry of Agriculture
- Management and Planning Organization

Evaluation Indicators

- Advances in research on the abovementioned actions

Strategy 5.4. Promote research and development activities in the fields of new methods of prevention, diagnosis, and treatment and promote cooperation between universities, industry, and related sectors

Policies

- Promote research to help develop new methods of prevention, diagnosis, and treatment of infectious diseases in human and veterinary medicine, including the development of new vaccines and other methods for the prevention of infectious diseases, and rapid diagnosis to support antibacterial stewardship, and discover new antimicrobial drugs with new mechanisms
- Form a working group to promote intersectoral cooperation between the public and private sectors in the field of antimicrobial resistance to set priorities for research and development and create incentives for research and development

Actions

1. Promote research and development on new methods of prevention

- Promote research and development on new vaccines to reduce the incidence of infectious diseases in humans and animals

2. Promote research and development on new diagnostic procedures

- Promote research and development on equipment and facilities for rapid diagnosis to support antimicrobial stewardship and develop methods for combating antimicrobial resistance organisms such as rapid sensitivity test and reinforced Multiplex Nucleic test for antimicrobial resistance genes
- Develop simplified test methods that help to promote the proper use of antibiotics in the production centers

3. Promote research and development on novel treatment methods

- Promote research and development on antimicrobial materials and drugs with new mechanisms to treat infections caused by resistant microorganisms in humans
- Promote research and development on new antibiotics for treatment of infectious diseases that are different from traditional antibiotics

4. Promote collaboration between industry, university, and other sectors

- Form a working group for coordination between industry, university, and other sectors, including representatives of medical institutions, research institutions, universities, and industry

5. Develop incentives for research and development

- Develop guidelines for international evaluation of clinical practices and for the development of antimicrobial drugs for humans (Cf. Strategy 5.5)
- Promote research and development on new methods of prevention, diagnosis, and treatment of drug resistant TB and Malaria
- Develop a mechanism to review and prioritize new antimicrobial drugs for infections caused by resistant microorganisms
- Develop new incentives to promote the development of new drugs (with low market value and profit) to fight infectious diseases caused by resistant microorganisms
- Hold complementary training courses on antimicrobial resistance

Related ministries and organizations

- Ministry of Health and Medical Education
- Ministry of Science, Research and Technology
- Ministry of Agriculture
- Ministry of Industry, Mine and Trade
- Management and Planning Organization

Evaluation Indicators

- Number of complementary training courses on antimicrobial resistance
- Number of new vaccines produced to reduce the incidence of infectious diseases in humans and animals
- Number of national grants allocated to research and development on antimicrobial resistance

Strategy 5.5. Promote international collaboration for conducting research on antimicrobial resistance and promote research and development for introducing new methods of prevention, diagnosis, and treatment of antimicrobial resistant infections

Policies

- Promote research and development on a global level through supporting international research and participation in international research projects in the field of antimicrobial resistance
- Promote research and development on new drugs through international cooperation, for instance developing common clinical assessment guidelines for antimicrobial drugs in coordination with other countries

Actions

1. Formulate / revise clinical trial evaluation guidelines

- Develop common guidelines for the development of new antimicrobial drugs (Cf. Strategy 5.4)
- Develop and revise common international guidelines for the tests required for licensing veterinary antibiotics

2. Promote cooperation for conducting international research

- Help to promote research and development on antimicrobial resistance through continuous participation in international research projects, for instance through international exchanges between researchers
- Promote the link between research and policies through international dialogue, for instance through cooperation with international financial organizations

Related ministries and organizations

- Ministry of Health and Medical Education
- Ministry of Science, Research and Technology
- Ministry of Agriculture
- Ministry of Industry, Mine and Trade
- Management and Planning Organization

Evaluation Indicators

- Proportion of common international clinical assessment manuals for the development of antimicrobial drugs for use in humans to the total number of baseline manuals and periodic assessments and evaluations
- Proportion of common international manuals for studies needed to confirm the veterinary antibiotics to the total number of baseline manuals and periodic assessments and evaluations

Outcome Indicators for national action plan of the Islamic Republic of Iran for combating antimicrobial resistance

Human-related Indicators:

- Reduce the resistance of *S. pneumoniae* to penicillin to the level set by the National Committee by 2021
- Reduce the resistance of *S. aureus* to the level set by the National Committee by 2021
- Reduce the resistance of *E. coli* to fluoroquinolones to the level set by the National Committee by 2021
- Reduce the resistance of *Pseudomonas aeruginosa* to carbapenems (imipenem) to the level set by the National Committee by 2021
- Maintain the resistance of *Escherichia coli* and *Klebsiella pneumoniae* to carbapenems in the level set by the National Committee by 2021
- Reduce the daily prescribing and use of antimicrobial drugs per 1,000 people by 10% by 2021
- Reduce the daily use of oral cephalosporins, fluoroquinolones, macrolides per 1,000 people by 25% by 2021
- Reduce the use of intravenous antimicrobial drugs per 1,000 people by 20% by 2021

Animal-related Indicators:

- Reduce resistance of *E. coli* to tetracycline to the level set by the National Committee or lower
- Reduce the resistance of *E. coli* to third-generation cephalosporin to the level set by the National Committee
- Reduce the resistance of *E. coli* resistant to fluoroquinolones to the level set by the National Committee

Monitoring and evaluation

The progresses in each strategy and action must be evaluated annually. The outcome indicators must be evaluated based on published annual reports of health care surveillance system under the integrated health approach on antimicrobial resistance.

References:

1. WHO. Antibiotic resistance: WHO; 2015 [updated 2016; cited 2015]. Available from: <http://www.who.int/mediacentre/factsheets/antibiotic-resistance/en/>.
2. Yavari P. Antimicrobial resistances. In: SHarifi H, Akbarian H, Bloki Z, editors. Epidemiology Textbook of Prevention diseases in Iran. 1. Rasht: GAPNashr; 2014. p. 373- 93.
3. World health organization. Global action plan on antimicrobial resistance: WHO; 2015 [updated 2016; cited 2016].
4. The European Centre for Disease Prevention and Control. Antimicrobial resistance surveillance in Europe(Annual report of the European Antimicrobial Resistance Surveillance Network (EARS-Net)): (ECDC) 2014 [updated 2016; cited 2014]. Available from: <http://ecdc.europa.eu/en/publications/Publications/antimicrobial-resistance-europe-2014.pdf>.
5. World health organization. ANTIMICROBIAL RESISTANCE Global Report on Surveillance WHO; 2014 [updated 2016; cited 2016]. Available from: http://apps.who.int/iris/bitstream/10665/112642/1/9789241564748_eng.pdf.
6. Soleymani F, Mohammadhosseini N, Agha Mohammad Zadeh S, Keshavarz Maleki R. statistics of drug administration [Persian]. Qom: Andisheh mandegar; 2016.
7. Hadifar S, Moghoofei M, Nematollahi S, Ramazanzadeh R, Sedighi M, Salehi-Abargouei A, et al. Epidemiology of Multi Drug Resistant Uropathogenic Escherichia coli in Iran: a Systematic Review and Meta-analysis. Japanese journal of infectious diseases. 2016 (0).
8. Moini AS, Soltani B, Ardakani AT, Moravveji A, Erami M, Rezaei MH, et al. Multidrug-Resistant Escherichia coli and Klebsiella pneumoniae Isolated From Patients in Kashan, Iran. Jundishapur journal of microbiology. 2015;8(10).
9. Sadeghabadi AF, Ajami A, Fadaei R, Zandieh M, Heidari E, Sadeghi M, et al. Widespread antibiotic resistance of diarrheagenic Escherichia coli and Shigella species. Journal of Research in Medical Sciences : The Official Journal of Isfahan University of Medical Sciences. 2014 01/16/received01/20/revised03/02/accepted;19(Suppl 1):S51-S5. PubMed PMID: PMC4078378.
10. Askari E, Soleymani F, Arianpoor A, Tabatabai SM, Amini A, Naderi Nasab M. Epidemiology of mecA-methicillin resistant Staphylococcus aureus in Iran: A systematic review and meta-analysis. Iranian journal of basic medical sciences. 2012;15(5):1010-9.
11. Poorabbas B, Mardaneh J, Rezaei Z, Kalani M, Pouladfar G, Alami MH, et al. Nosocomial Infections: Multicenter surveillance of antimicrobial resistance profile of Staphylococcus aureus and Gram negative rods isolated from blood and other sterile body fluids in Iran. Iranian journal of microbiology. 2015;7(3):127.
12. Koupahi H, Jahromy SH, Rahbar M, Eslami P, Khodadadi E. A study on prevalence of Methicillin and Vancomycin resistance among Staphylococcus aureaus isolates in an Iranian 1000-bed tertiary Care Hospital. Health Sciences. 2016;5(3):105-9.

13. Pourhajibagher M, Hashemi FB, Pourakbari B, Aziemzadeh M, Bahador A. Antimicrobial Resistance of *Acinetobacter baumannii* to Imipenem in Iran: A Systematic Review and Meta-Analysis. *The open microbiology journal*. 2016;10:32.
14. Rahmani M, Peighambari SM, Svendsen CA, Cavaco LM, Agersø Y, Hendriksen RS. Molecular clonality and antimicrobial resistance in *Salmonella enterica* serovars Enteritidis and Infantis from broilers in three Northern regions of Iran. *BMC veterinary research*. 2013;9(1):1.
15. Hosseini SM, Poorolajal J, Karami M, Ameri P. Prevalence of Nasopharyngeal Carriage of *Streptococcus pneumonia* in Iran: A Meta-Analysis. *Journal of research in health sciences*. 2015;15(3):141-6.
16. Alian F, Rahimi E, Shakerian A, Momtaz H, Riahi M, Momeni M. Antimicrobial resistance of *Staphylococcus aureus* isolated from bovine, sheep and goat raw milk. *Global Veterinaria*. 2012;8(2):111-4.
17. Rahimi E, Chaleshtori SS, Parsaei P. Prevalence and antimicrobial resistance of *Escherichia coli* O157 isolated from traditional cheese, ice cream and yoghurt in Iran. *African Journal of Microbiology Research*. 2011;5(22):3706-10.
18. Safaeian S, Moghadam Z, Hosseini H, Esmaeili A. Antibiotic resistance in Gram-negative bacteria isolated from the intestines of wild carp in Anzali wetland [persian]. *Environmental Science & Technology*. 2103;15(4):65-74.
19. World health organization. Patient safety assessment manual. 2nd ed. Regional Office for the Eastern Mediterranean: WHO.