Asian Journal of Pharmaceutical and Health Sciences
www.ajphs.com

# Global Antimicrobial Resistance; A peek in to the GLASS data

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**ARTICLE HISTORY**

Received: 07.01.2020

Accepted: 05.03.2020

Available online: 31.03.2020

**Keywords:**

GLASS, WHO, AMR, antibiotics

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**ABSTRACT**

Antibiotic resistance is present in every country. Patients with infection caused by drug-resistant bacteria are at increased risk of worse clinical outcomes and death, and it consume more health-care resources than patients infected with non-resistant bacteria. Coordinated action is required to minimize the emergence and spread of antimicrobial resistance. All countries need national action plans on AMR. Greater innovation and investment are required in research and development of new antimicrobial medicines, vaccines, and diagnostic tools. WHO is providing technical assistance to help countries develop their national action plans, and strengthen their health and surveillance systems so that they can prevent and manage antimicrobial resistance. The Global Antimicrobial Resistance Surveillance System (GLASS) is a WHO-supported system supports a standardized approach to the collection, analysis and sharing of data related to antimicrobial resistance at a global level to inform decision-making, drive local, national and regional action. Glass now in its early implementation phase which started in 2015 and ends in 2019. During this period, GLASS will provide surveillance and laboratory guidance, tools and support to countries in developing effective AMR surveillance systems. Currently as December 2018, 71 countries are enrolled in GLASS and 6 are in progress for enrollment in GLASS. These include a mix of countries in different stages of economic development from across all WHO. Key Findings of GLASS are AMR is widespread in both high and low income countries. The most com-monly reported resistant bacte-ria were *Escherichia coli (E. coli), Klebsiella pneumoniae*, Staphylococcus aureus, Streptococcus pneumonia, and Salmonella spp. There is an alarming spike in the cases resistant to penicillin and ciprofloxacin. Based on surveillance report of implementation phase a new GLASS revision will be published in 2020. World is awaiting for it.

## INTRODUCTION

Antibiotics are the substance produced by microorganism, which suppress or kill other micro organism at very low concentration-[1] Antimicrobial resistance happens when microorganisms (such as bacteria, fungi, viruses, and parasites) change when they are exposed to antimicrobial drugs (such as antibiotics, antifungals, antivirals, antimalarials, and anthelmintics). Micro organisms that develop antimicrobial resistance are sometimes referred to as "superbugs".-[2] As a result, the medicines become ineffective and infections persist in the body, increasing the risk of spread to others. Drug resistance in bacteria may be natural or acquired. Development of acquired resistance may be due to single step mutation( as seen with streptomycin and rifampicin) or multistep mutation(erythtromycin, tetracycline and chloramphenicol).-[3] Drug resistance can be transferred from one microorganism to other by gene transfer via conjugation, transduction or transformation. Mechanism of resistance include decreased affinity for the target, development of alternative metabolic pathway, elaboration of enzyme which inactivate the drug, decreased drug permeability or by development of efflux pump.-[4] New resistance mechanisms are emerging and spreading globally, threatening our ability to treat common infectious

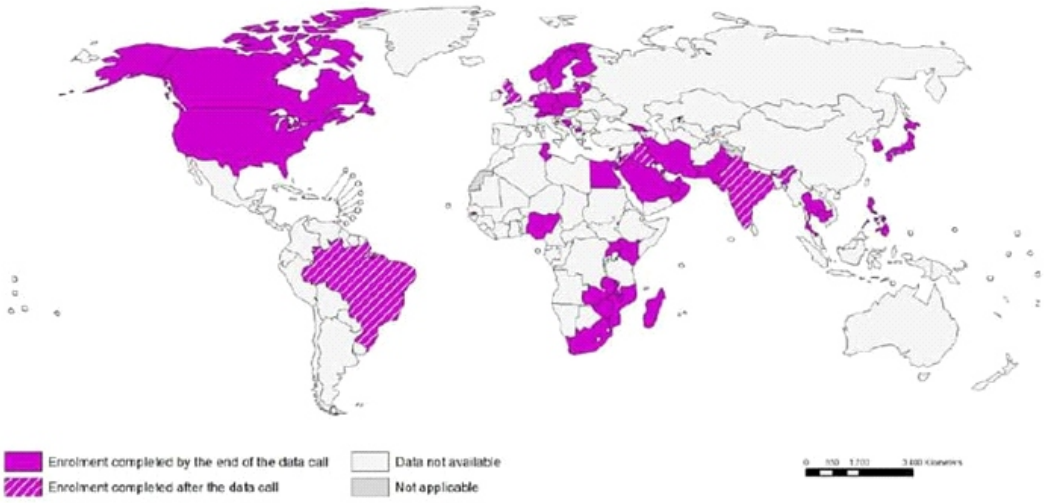


**Fig. 1 :** GLASS Enrolment map (2017)[12]

diseases, resulting in prolonged illness, disability, and death. Without effective antimicrobials for prevention and treatment of infections, medical procedures such as organ transplantation, cancer chemotherapy, diabetes management and major surgery (for example, caesarean sections or hip replacements) become very high risk.-[5] Antimicrobial resistance increases the cost of health care with lengthier stays in hospitals and more intensive care required.-[6] Antimicrobial resistance is putting the gains of the Millennium Development Goals at risk and endangers achievement of the Sustainable Development Goals.-[7] Antimicrobial resistance occurs naturally over time, usually through genetic changes. However, the misuse and overuse of antimicrobials is accelerating this process. In many places, antibiotics are overused and misused in people and animals, and often given without professional oversight. Examples of misuse include when they are taken by people with viral infections like colds and flu, and when they are given as growth promoters in animals or used to prevent diseases in healthy animals. Antimicrobial resistant-microbes are found in people, animals, food, and the environment (in water, soil and air). They can spread between people and animals, including from food of animal origin, and from person to person. Poor infection control, inadequate sanitary conditions and inappropriate food-handling encourage the spread of antimicrobial resistance.-[8] In a meeting hosted by the Swedish Ministry of Health and Social Affairs and the Public Health Agency of Sweden, 30 WHO Member States, from all WHO regions, reaffirmed the need for a global programme for surveillance of AMR relevance to human health, to form the basis for local, national and regional action and to monitor the effectiveness of intervention. -[9]

## GLASS- GLOBAL ANTIMICROBIAL RESISTANCE SURVEILLANCE SYSTEM

Global Antimicrobial Resistance Surveillance System (GLASS) is a WHO-supported system Launched in October 2015 to supports a standardized approach to the collection, analysis and sharing of data related to antimicrobial resistance at a global level to inform decision-making, drive local, national and regional action. GLASS objectives are to Foster national surveillance systems and harmonized global standards, estimate the extent and burden of AMR globally by selected indicators, analyse and report global data on AMR on a regular basis, detect emerging resistance and its international spread, inform implementation of targeted prevention and control programmes and assess the impact of interventions.-[5]

Early implementation of GLASS covers the period 2015-2019. During this period, GLASS will provide surveillance and laboratory guidance, tools and support to countries in developing effective AMR surveillance systems. GLASS aims to combine data on the status of enrolled countries AMR surveillance systems with AMR data for selected bacteria that cause infections in humans: Acinetobacter spp., Escherichia coli, Klebsiella pneumoniae, Neisseria gonorrhoeae, Salmonella spp., Shigella spp., Staphylococcus aureus, and Streptococcus pneumoniae. AMR data are collected through a case-finding surveillance system, which collects results of priority specimens from blood, urine, stool, as well as cervical and urethral specimens, that have been sent routinely to laboratories for clinical purposes. Population data are also collected, including the overall number of patients tested per specific specimen, and variables such as age, gender, and infection origin. Further development of GLASS will be based on the lessons learnt during this period. GLASS will initially focus on surveillance data on human priority bacterial pathogens considered the greatest threat globally and progressively incorporate information from other surveillance systems related to AMR in humans, such as foodborne AMR, monitoring of antimicrobial use and surveillance of infections associated with health care.-[3]

## PARTICIPATION IN GLASS

Currently as December 2018 , 71 countries are enrolled in GLASS and 6 are in progress for enrollment in GLASS. These include a mix of countries in different stages of economic development from across all WHO regions-[9]

Every country in the WHO region have to constitute a national body commitment to share data on status of national AMR surveillance and if available share atleast one surveillance site and atleast one indicator.

Key pathogens in the GLASS early implementation phase

GLASS targets 8 pathogens that causing common human infections and they are-[10]

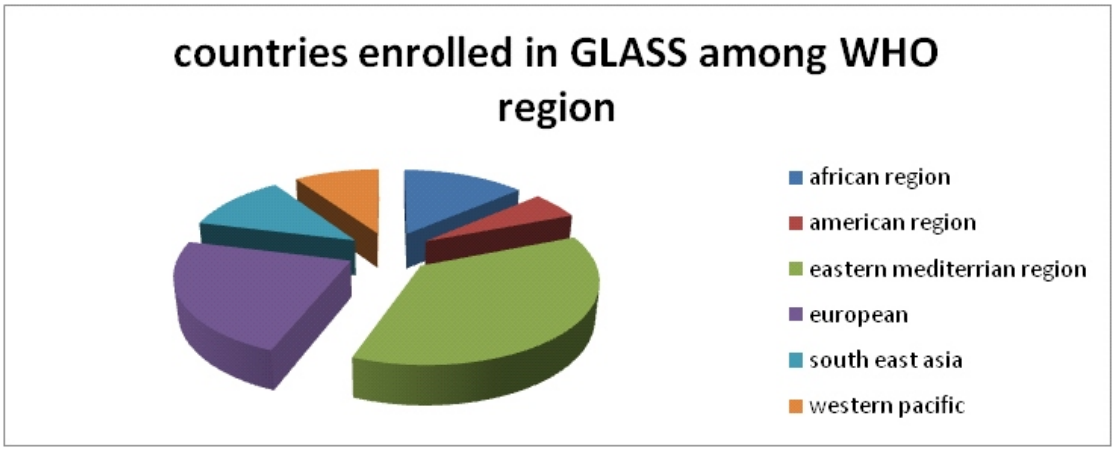


**Fig. 2**

- *Acinetobacter spp.*
- *Escherichia coli*
- *Klebsiella pneumoniae*
- *Neisseria gonorrhoeae*
- *Salmonella spp.*
- *Shigella spp.*
- *Staphylococcus aureus*
- *Streptococcus pneumonia*

These pathogens cause worldwide common hospital and community acquired infections. Rates of antibiotic resistance are reported to be increasing, to the point that infections caused by these pathogens might need to be treated with last resort drugs, which might not only be less effective and safe, but also more resource consuming and not widely available, particularly in low-resource settings. For this reason, AMR in these pathogens is now considered to rank among the most important threats to public health globally. The selected pathogens are also included in the WHO global Priority Pathogens List for research and development to address antibiotic-resistant bacteria, issued in February 2017.-[11] Each country can choose to report on the number of GLASS pathogens according to their own priorities. Data on bacterial resistance in human infections are obtained from blood, urine, stool, urethral samples, and cervical swabs-[10]

## GLASS REPORT

The first data call on glass was opened in april 2017 and closed in june 2017. The information collected during first datacall are summarized as follows-[5]

The report contains information on status of national surveillance system of 42 countries and AMR for 22 countries. In addition to that 5 countries were able to provide population data to allow the calculation of AMR frequency in the total population. So it shows the value of reporting both microbiological and core epidemiological information such as age, gender, and infection origin.

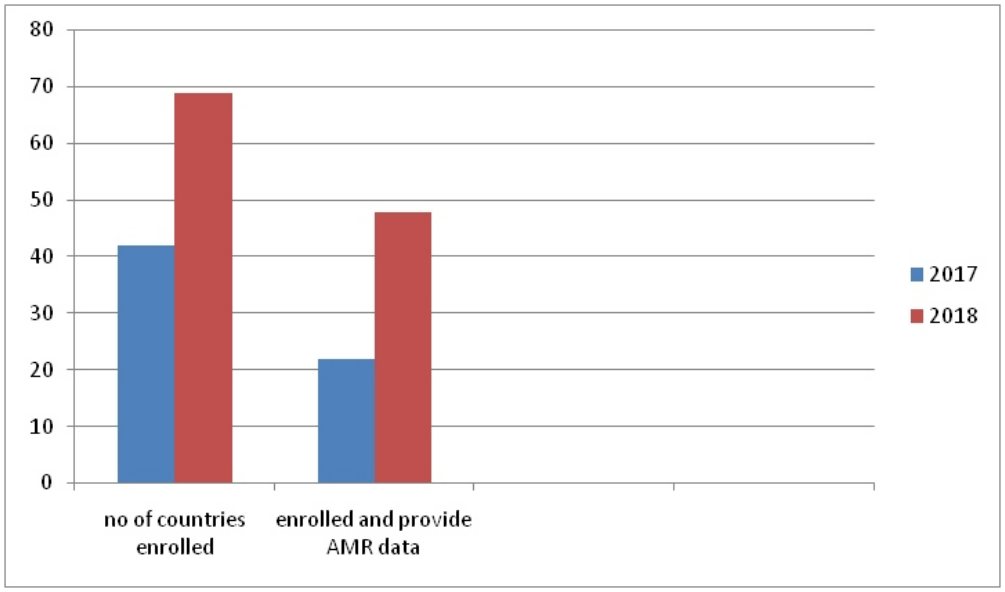


**Fig. 3 :** Enrollment status of first and second data call

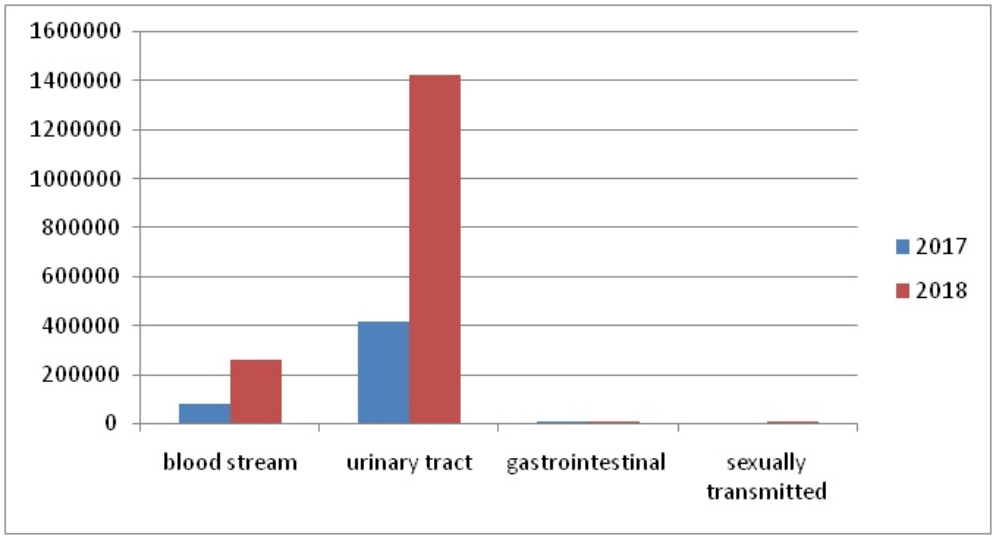


**Fig. 4 :** No of patients with suspected infections

**Table 1 :** No of sites reported to GLASS AMR-

| Sites | 2017 (22 countries) | 2018 (48 countries) |
|---|---|---|
| Hospital | 466 | 3097 |
| Outpatient clinics | 139 | 2358 |
| Other institutions | 124 | 560 |
| Total | 729 | 6015 |

**Table 2 :** No of patients with suspected

| specimen | 2017 | 2018 |
|---|---|---|
| Blood stream | 81920 | 262265 |
| Urinary tract | 415679 | 1424011 |
| Gastrointestinal | 7477 | 10735 |
| Sexually transmitted | 2847 | 9567 |
| Total | 507923 | 1706578 |

The second data call was opened in may 2018 and closed in july 2018. Report of second data call published in January 2019. It states that there are 64% increase in country enrollment and more than twice the number of countries submitting AMR data-[10]

## ENROLLMENT STATUS OF FIRST AND SECOND DATA CALL

By the end of the second data call on 31 July 2018, 69 countries were enrolled in GLASS. Sixty-eight of these countries (10 low-income countries (LICs), 16 lower middle-income countries (LMICs), 15 upper middleincome countries (UMICs), and 27 high-income countries (HICs)) provided data. Specifically, 67 countries reported information on their national AMR surveillance systems, of which 48 also provided 2017 AMR rates.-[13]

For national surveillance system three indicators were collected, they are over all coordination, surveillance system structure, and microbiology laboratory quality control. 68 countries reported status to national surveillance system. Most countries have developed and implemented an AMR national surveillance plans. More have approved a budget for it. More

**Table 3 :** Pathogens- antimicrobial combination under GLASS surveillance-[10]

| Pathogen | Antibacterial class | Antibacterial agents that may be used for AST |
|---|---|---|
| E. coli | Sulfonamides and trimethoprim | Cotrimoxazole |
| | Fluroquinolones | Ciprofloxacin or levofloxacin |
| | Third generation cephalosporins | Ceftriaxone, cefotaxime or ceftazidime |
| | Fourth generation cephlosporins | Cefepime |
| | carbapenems | Imipenem, meropenem, ertapenem, or doripenem |
| | Polymyxins | Colistin |
| | Penicillins | Ampicillin |
| Klebsiella pneumoniae | Sulfonamides and trimethoprim | Co-trimoxazole |
| | Fluroquinolones | Ciprofloxacin or levofloxacin |
| | Third generation cephalosporins | Ceftriaxone, cefotaxime or ceftazidime |
| | Fourth generation cephlosporins | Cefepime |
| | carbapenems | Imipenem, meropenem, ertapenem, or doripenem |
| | Polymyxins | Colistin |
| Acinetobacter spp | Tetracyclines | Tigecycline or minocycline |
| | Aminoglycosides | Gentamicin and amikacin |
| | carbapenems | Imipenem, meropenem, ertapenem, or doripenem |
| | Polymyxins | Colistin |
| Staphylococcus aureus | Penicillinase-stable beta-lactams | Cefoxitind |
| | Penicillins | Oxacillin |
| Streptococcus pneumoniae | Penicillins | Oxacillin |
| | Penicillins | Penicillin G |
| | Sulfonamides and trimethoprim | Co-trimoxazole |
| | Third-generation cephalosporins | Ceftriaxone or cefotaxime |
| Salmonella spp. | Fluroquinolones | Ciprofloxacin or levofloxacin |
| | Third generation cephalosporins | Ceftriaxone, cefotaxime or ceftazidime |
| | carbapenems | Imipenem, meropenem, ertapenem, or doripenem |
| Shigella spp. | Fluroquinolones | Ciprofloxacin or levofloxacin |
| | Third generation cephalosporins | Ceftriaxone, cefotaxime or ceftazidime |
| | Macrolides | Azithromycin |
| Neisseria gonorrhoeae | Third-generation cephalosporins | Cefixime |
| | Third-generation cephalosporins | Ceftriaxone |
| | Macrolides | Azithromycin |
| | Aminocyclitols | Spectinomycin |
| | Fluoroquinolones | Ciprofloxacin |
| | Aminoglycosides | Gentamicin |

countries have established or are in the process of establishing national coordination centre and have designated the national reference laboratory. All most all national reference laboratory participate in external quality assessment scheme. Antibiotic susceptibility testing (AST) was done according to internationally recognized standards. [10]

The antimicrobial drugs chosen to be monitored were selected because either they are commonly recommended first-line treatments, or resistance in the pathogenantibiotic combination is of particular clinical and public health concern. GLASS accepts both submissions of AST results for single antibiotics and antimicrobial classes.

The class susceptibility status is calculated according to the final interpretations of each antibiotic AST results. If the

pathogen AST result for at least one antibiotic is reported resistant, the pathogen is considered resistant to the whole class; if the pathogen AST result for at least one antibiotic is reported of intermediate sensitivity, and no resistant AST results are reported for any of the other antibiotics, the pathogen is considered having intermediate sensitivity to the whole class; if the pathogen AST results for all antibiotic are reported susceptible, the pathogen is considered susceptible to the whole class.-[14]

## REPORTED AMR RATES

Overall, 3097 hospitals and 2358 outpatient's clinics reported AMR data to GLASS. GLASS also received data from 560 laboratories from 26 countries that have not yet identified the surveillance sites from where the laboratory results originate. EQA provided for bacterial identification and AST to laboratories reporting to GLASS varied among regions. 45 (94%) countries submitted results from blood specimens, 24 (50%) from urine specimens, 21 (44%) from stool specimens, and 20 (42%) from cervical and urethral specimens. The most frequently reported pathogens were in order *E. coli, K. pneumoniae, Acinetobacter spp., Salmonella spp, S aureus, S pneumoniae, N gonorrhoea, and Shigella spp*

The total number of patient with suspected infection from whom a pathogen was isolated varied considerably, from a minimum of 18 patients to a maximum of 859.002 patients per country. Overall, countries reported information for a combined total of 1,706,578 patients. Antimicrobial susceptibility testing varied greatly among countries and specimen pathogen-antibiotic combination. Enterobacteriaceae (*E. coli, K. pneumoniae, Salmonella* spp., and *Shigella* spp.) were mainly tested for resistance to ciprofloxacin and imipenem, *Acinetobacter* spp. to imipenem, *S. pneumoniae* to penicillin and co-trimoxazole, and *N. gonorrhoea* to ceftriaxone. For *S. aureus,* GLASS collects only data on cefoxitin resistance, and, when not available, oxacillin resistance.

## AMR RATES IN WHO AFRICAN REGIONS

Communicable diseases remain the leading cause of death in African countries, responsible for majority of years of life lost as well as the vast majority of children under 5 years of old.-[23] The level of poverty as well as the risk factors for communicable diseases in the WHO African regions are significantly higher than in other WHO regions, correlating well with the no of reported cases of selected infectious disease[22]

In African region 15 countries have their NAP approved by national authorities, while eight are waiting for approval or heading towards finalization. In total since the official launch of GLASS in march 2016, 15 AFRO countries out of 47 completed the process. In which 14 countries provided AMR data. All the eight key pathogens in GLASS shows AMR.

## AMR RATES IN AMERICAN REGION

In American region 3 countries provided AMR data. Among WHO regions American region shows less AMR rates. AMR reported for N gonorrhea and salmonella. According to data provide by the latin American antimicrobial resistance surveillance network salmonella spp. Shows decreased susceptibility to fluoroquinolones and non susceptibility to third generation cephalosporins.-[24]

## AMR RATES IN EASTERN MEDITERRANEAN REGION

Member States of WHO's Eastern Mediterranean Region have shown firm commitment to address antimicrobial resistance by endorsing regional resolution There has been a tremendous progress in the development of national action plans for antimicrobial resistance. More than half of the countries of the Region have engaged in this process expressing their commitment to address the global issue of antimicrobial resistance. A number of countries from the Region have also enrolled in WHO's Global Antimicrobial Resistance Surveillance System (GLASS). From first data call it report resistance of enterobacteriacea to third generation cephalosporins ranged from 50-100%; while resistance to carbapenems (last resort treatment to infection caused by gram negative pathogens) was ranging from 5% to 45% in enterobacteriacea and 85% in acinetobacter spp.[25]In GLASS 2019 report it shows 14 country provided AMR data from Eastern Mediterranean region in which all the eight key pathogens shows resistant.

## AMR RATES IN EUROPEAN REGION

AMR surveillance at the European level is presently organized through EARS-net (European antimicrobial resistance surveillance network) and CAESAR (central Asian eastern

**Table 4 :** AMR rates reported on specific pathogens

| Pathogen | No of countries reported |
|---|---|
| Acinetobacter spp. | 45 |
| E. coli | 65 |
| K. pneumoniae | 65 |
| N. gonorrhea | 20 |
| Salmonella spp. | 43 |
| Shigella spp. | 14 |
| S. aureus | 41 |
| S. pneumonia | 34 |

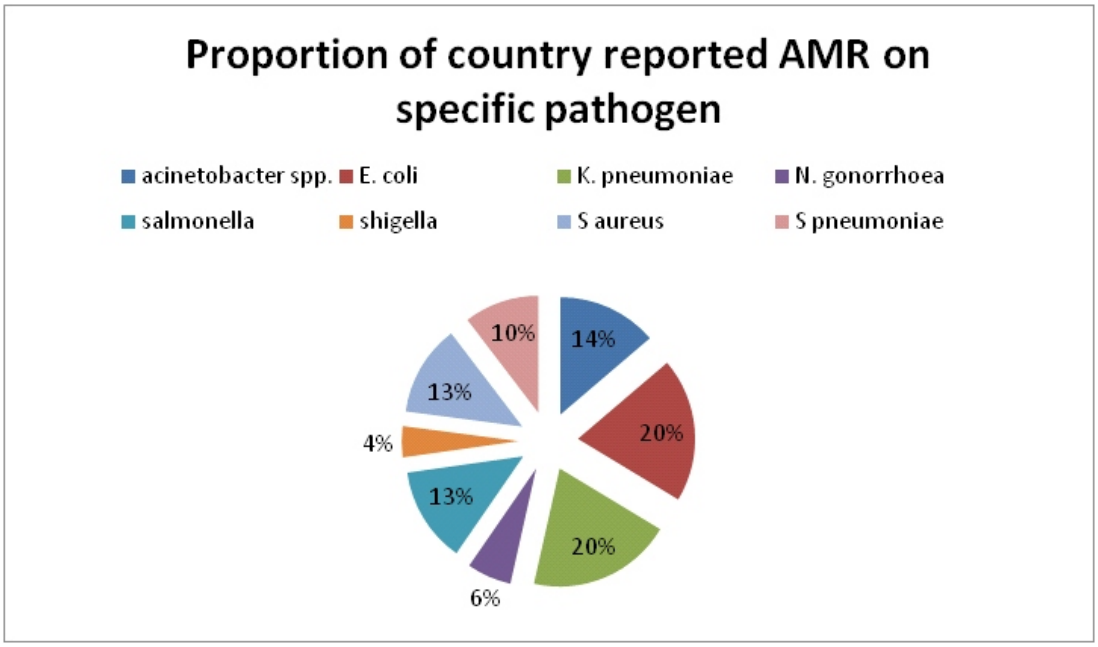


**Fig. 5 :** Proportion of country reported AMR on specific pathogen

European surveillance of antimicrobial resistance). There is close collaboration between EARS- net, CAESAR and GLASS, with European surveillance data routinely transferred to the glass database. However, there are major differences between the GLASS protocol and the methodology used in Europe. The GLASS protocol was supplemented with national priority organism and antimicrobial agents. The first year results demonstrated multi drug resistance in organism from all specimen types. Among blood culture isolates, there was 54.3% MRSA among all staphylococcus aureus, 29% vancomycin resistance in *Enterococcus faecium*, 34.7% cefotaxime resistant in E. coli and 27% cefotaxime resistance in k. pneumonia. Resistance rates were higher in infection acquired in hospitals than in the community.[26] In second data call 23 countries provided AMR data in it all the pathogens show resistant. Europe shows highest AMR rates among all the WHO region

## AMR RATES IN SOUTH EAST ASIA REGION

Data from country reports on AMR presented at who regional meeting and in published reports reflect an increasing trend of resistance among important bacterial pathogen.-[27] 8 countries provided data. E coli resistant to third generation cephalosporins and fluoroquinolones, K. pneumonia resistant to third generation cephalosporins and carbapenem, All pathogens except shigella and S pneumonia shows resistant.

## AMR RATES IN WESTERN PACIFIC

Asia and the pacific are projected to account for 4.73 million antimicrobial resistant related deaths by 2050.-[28] In the western pacific region , antibiotic resistance is being fuelled by wide spread misuse and overuse, and the increased spread of resistant bacteria as people migrate and travel more. Poor hygiene and infection control in hospitals and other healthcare settings are also key factor. Lack of control over antibiotic distribution and sale for both human and animal use is also responsible for the growth of antibiotic resistance.-[29]

In the second data call 6 countries provided data and WHO surveillance shows resistance and decreased susceptibility to a wide range of antibiotics. Resistance observed especially E. coli to third generation cephalosorins and fluoroquinolones, K. pneumonia to carbapenem and N. gonorrhea to third generation cephalosporins.

Key Findings of GLASS are AMR is widespread in both high and low income countries.-[15] The most com-monly reported resistant bacte-ria were Escherichia coli (E. coli), Klebsiella pneumoniae, Staphylococcus aureus, Streptococcus pneumonia, and Salmonella spp.-[16] The system does not include data on resistance of mycobacterium tuberculosis, as WHO has been tracking it since 1994 and providing annual updates in the Global tuberculosis report. Among patients with suspected blood stream infection, the proportion that had bacteria resistant to at least one of the most commonly used antibiotics ranged tremendously between different countries ranged from zero to 82%. There is an alarming spike in the cases resistant to penicillin and ciprofloxacin.-[17]Resistance to penicillin the medicine used for decades world wide to treat pneumonia ranged from zero to 51% among reporting countries. And between 8% to 65% of E. coli associated with urinary tract infections presented resistance to ciprofloxacin, an antibiotic commonly used to treat this condition.

## LIMITATIONS OF GLASS SYSTEM

As surveillance is a complex activity-[30] like any research or surveillance system, GLASS also possess some limitations in the interpretation of results. Which include direct consequence of constraints in the data collections such as country policies and agendas, challenging logistics, lack of resources, sampling bias, poor diagnostic capacity, measurement errors, issues with data management etc. The study by Sirajatuphat R et al mention that they find difficulty to determine if isolated bacteria was primary bacteremia, secondary bacteremia or CLASBSI unless the clinical features of patients with positive blood culture were taken in to account. So they suggest that classification of these three categories of bacteremia was necessary because the bacteria that caused by different types of bacteremia were different. In addition to that they also point out the important pieces of missing data in

culture result because patient clinical data are often not included in the information submitted to the laboratory along with the clinical sample.[31] it also shows great variability in professionals involved in data generation process and aggregation of data is also a major limitation.

## FACTORS CONTRIBUTING TO THE DEVELOPMENT OF AMR

The six main causes of antibiotic resistance have been linked to over prescription of antibiotics, patients not finishing the entire antibiotic course, over use of antibiotics in livestock and fish farming, poor infection control in health care settings and poor hygiene and sanitation.-[32] A study conducted in Europe shows corruption(quality of governance) is the main socio economic factor that explain antibiotic resistance. An improvement in one unit in the corruption indicator is associated with a reduction in antibiotic resistance by approximately 0.7 units. Private health expenditure was also an important factor. The higher the percentage of private health expenditure in a country, the larger was the degree of antibiotic resistance. Only 28% of the total variation in antibiotic resistance among countries is attributable to variation in antibiotic usage. The income level of a country appeared to have no effect on resistance rates. The findings challenge the general perception that antimicrobial resistance is predominately a reflection of just poverty and antimicrobial usage in people.-[33]

## CHALLENGES AND STEPS FORWARD

Now the glass is in its last year of early implementation phase and it initiated modules and tools which include monitoring of antimicrobial consumption and use, special project on AMR for gonorrhea, AMR surveillance in the food chain and environment 2017-2018, Glass emerging antimicrobial resistance reporting(GLASS-EAR) and GLASS web tools to improve reporting, data validation and analysis. GLASS has also started the development of frame work for AMR surveillance in invasive fungal disease.

## EMERGING AMR REPORTING (EAR)

GLASS-EAR was Launched in 2018 to support detection, early warning and risk assessment capacities of national AMR surveillance programmes. The EAR IT module is open to those in charge of national AMR surveillance system and constituencies that might discover new types of AMR in bacteria and fungi with potential relevance to public health. It is constituted by all member states regardless of their GLASS enrollment status. It facilitate early information sharing and stimulate epidemiological and microbiological discussion for coordinated actions.-[34,35]

## MONITORING OF ANTIMICROBIAL CONSUMPTION AND USE

The WHO has been working to strengthen national capacity to monitor antimicrobial consumption across 57 low and middle income countries. The source of data include production record, import record, public sector procurement(medical store), donation records, dispensing records etc. The over all consumption of antibiotics ranged from 4.4 to 64.4 defined daily doses (DDD) per 100 inhabitants per day. In which the most frequently used antibiotics were amoxicillin and amoxicillin/clavulanic acid combination.[36,37] Similar findings were observed in study conducted by Ann versporten et al. in which the combination of penicillin with a beta lactamase inhibitors was the commonly prescribed class, mainly amoxicillin with beta lactamase inhibitors.[38] The report include antibiotics categorized with in the the access, watch and reserve(AWaRe) in the essential list of medicine. Over all report shows considerable variation in antibiotic consumption in amount and types. In some areas of world use is very low while others such as Italy had high rate of use.-[37]

## ONE HEALTH AMR SURVEILLANCE

One health is the collaborative effort of multiple health science professions to attain optimal health for people, domestic animals, wildlife, plants and our environment. Most of the classes of antimicrobials used to treat human infections such as colistin, tetracycline and macrolides are also used in animals as growth promoters. Tetracyclines were more commonly used in animals and tetracycline resistance was high among animals.-[41] So it is logical to take a one health approach while addressing the problem of antimicrobial resistance. This include taking steps to preserve continued effectiveness of existing antimicrobials by elimination their inappropriate use and by limiting the spread of infection. -[39]Policy decision rely on economic and scientific evidence. So the business case for a fully integrated system have to be made. Which include cost (lost labour cost, cost of animal origin food production and international trade of such food etc) and benefits (improve synergies, accurate risk identification etc) of human health outcomes.-[40]

## SPECIAL PROJECT ON AMR FOR GONORRHEA (ENHANCED GASP OR EGASP)

The enhanced gonococcal antimicrobial surveillance program is a collaboration between the WHO and the centers for disease control and prevention. The program aims to monitor trends in antimicrobial drug susceptibilities in N. gonorrheae by using standardizd sampling and laboratory protocols. It helps to improve the quality, comparability and timeliness of gonococcal AMR data across multiples countries and thereby to assess resistance pattern in key population at highest risk for resistant gonorrhea. So country specific treatment guidelines can be formed.-[42] The first data from EGASP implemented by the Thailand Ministry of Public Health report majority of isolate (92%) were resistant to ciprofloxacin.[43] Similar findings were observed in a case- control study conducted by Nicola Low et al at Switzerland. [44]

## AMR SURVEILLANCE IN THE FOOD CHAIN AND ENVIRONMENT 2017-18

Antibiotic resistant bacteria may reach human either by indirectly through foodchain or by direct contact with infected animal or their biological substance such as blood, urine, saliva etc. Consumption of contaminated food or food derived product result in indirect zoonotic transmission of antibiotic resistant bacteria to humans.-[45] The food and agriculture organization of the united nations(FAO)[46], the world organization for animal health (OIE)-[47] , and the world health organization-[48] endorsed the one health approach, affirming that healthy animals contribute to health people and environment. AMR surveillance in the food chain and environment 2017-2018 aims to monitor antimicrobial resistance in animals and food borne pathogens. The danger of ABR in the food chain and particularly in developing countries, is a serious global public health threat. MRSA and ESBL producing enterobacteriaceae (eg- salmonella spp., E. coli, shigella spp., K. pneumonia, enterobacter spp. etc ) are the globally reported antibiotic resistant bacteria of animal origin.-[49] To reduce the burden of infectious diseases the use of

vaccines is recommended. Greater the use of vaccine, the lesser the incidence of infection.-[50] Bio security measures( good agricultural practices, good veterinary practice etc.) reduce or eliminate ARB bacteria from farm to fork.-[51,52] well controlled extensive farming practices using small chemical substances, should be promoted. Introduction of organic farm reported significant lower prevalence of ABR- E. coli (isolated from pig farm) than from conventional ones in European countries.-[53] Use of rapid diagnostic tool such as culturing, PCR, Microarray, FTIR etc. will allow agricultural practioners to identify early infection in animals, to separate infected animal from others , prevent spread of infections and thereby reduce antibiotic use.-[54]

## GLASS IT PLATFORM

The GLASS IT platform is a web based plat form for global data sharing on antimicrobial resistance. It was launched in 2016 and it is hosted on a WHO server and serves as a common environment for sharing data generated within the frame work of several WHO AMR surveillance activities. The GLASS IT platform supports the implementation of one health AMR surveillance at national level, regional and global level. Currently the platform hosts two modules/database, they are antimicrobial resistance in humans from countries participating in GLASS launched in 2016 and Emerging AMR reporting(EAR) launched in 2018.-[55]

## AMR SURVEILLANCE IN INVASIVE FUNGAL INFECTIONS

In a meeting on 24th April 2018 WHO developed a framework for global surveillance of antimicrobial resistance in invasive fungal infections for future inclusion in GLASS.[56] Precise fungal diagnosis could reduce the inappropriate prescribing of antimicrobial drugs(ie over treatment or incorrect treatment).-[57] Candida infection of respiratory tract or urinary tract, invasive fungal sinusitis, cryptococcal meningitis etc are the clinical situation in which inappropriate antibacterial or antifungal prescribing is common. C. glabrata or Rhizopus oryzae are commonly resistant to antifungal drugs.-[58]

## STRATEGIES TO COMBAT AMR

WHO global action plan antimicrobial resistance sets out five strategic objectives; to improve awareness and understanding of antimicrobial resistance, to strengthen knowledge through surveillance and research, to reduce the incidence of infection, to optimize the use of antimicrobial agents and develop the economic case for sustainable investment that takes account of the needs of all countries, and increase investment in new medicines, diagnostic tools, vaccines and other interventions.-[59] international, national and local approaches have been advised for control and prevention of AMR. Rational use of antimicrobials, regulation on over the counter availability of antibiotics, improving hand hygiene and improving infection prevention and control are the major recommended approaches.-[60] Thorough understanding of resistance mechanism and innovation of new drugs and vaccines are in need.

## CONCLUSION

Although surveillance alone cannot reduce antimicrobial resistance, it is a key to track the emergence and spread of resistant strains. It helps to create awareness among people and helps in decision making on policies to reduce antimicrobial resistance in health care facilities and in the community. GLASS is now working towards the integration of surveillance initiatives for AMR in bacterial pathogens. The report of early implementation phase highlight a series of modules now being created to facilitate this integration. These include modules on antimicrobial consumption (AMC)-[18], the enhanced Gonococcal Antimicrobial Surveillance Programme-[19], and AMR in the food chain-[20]. These surveillance modules will be added to the GLASS IT platform-[21] to allow the collection, analysis, and reporting of diverse cross-sectoral AMR data into a single repository. Despite the limitations and constraints encountered during the first GLASS data call, the information included in this report represents a first step towards improving understanding of the epidemiology and impact of AMR globally. Some countries still face huge challenges to building their national surveillance systems and improvements are still urgently needed. A global system such as GLASS can succeed only through continued data sharing as well as global collaboration, harmonisation, and coordination between all partners involved in the implementation of AMR surveillance

## REFERENCE


1. Ebimieowei Etebu, Ibemologi Arikekpar. Antibiotics: Classification and mechanisms of action with emphasis on molecular perspectives. international journal of applied microbiology and biotechnology research IJAMBR. 2016: 4 :90-101
2. Zaman et al. A Review on Antibiotic Resistance: Alarm Bells are Ringing. Cureus. 2017: 9(6): e1403. DOI 10.7759/cureus.1403
3. Suraj Narayan Mali, Tejaswini Sanjay Morbale. Mechanisms of Antibiotic and Antimicrobial Resistance: An Overview. International journal of research methodology. 2017: www.ijrm.humanjournals.com
4. Olowe O Adekunle. mechanism of antimicrobial resistance in bacteria, general approach. international journal of pharma medicine and biological sciences ; ISSN . 2012, October; Vol. 1 (2) : 2278 5221: www.ijpmbs.com
5. World health organization. WHO Global Antimicrobial Resistance Surveillance System (GLASS) Report: early implementation 2016-2017 Available from: http://www.who.int/glass/resources/publications/early-implementation-report/en/
6. Sara E. Cosgrove, Yehuda Carmeli. The impact of antimicrobial resistance on Health and Economic outcomes. Clinical Infectious Diseases. 2003; 36:14337
7. Dusan Jasovsky, Jasper Littmann, Anna Zorzet, Otto cars. Antimicrobial resistance a threat to the world's sustainable development. upsala journal of medical sciences. 2016: 121(3): 159-164,
8. Central Asian Eastern European surveillance of antimicrobial resistance annual report 2018
9. WHO MSG Antimicrobial Resistance GLASS PPT TORNIMBENEb 08JAN2019.mp4; available from youtube
10. Global Antimicrobial Resistance Surveillance System (G LASS) Report Early implementation 2017-18 available from www.who.int
11. Global priority list of antibiotics resistant bacteria to guide ,

research, discovery and development of new antibiotics, feb 2017

12. Seale AC, Gordon NC, Islam J et al. AMR Surveillance in low and middle-income settings - A roadmap for participation in the Global Antimicrobial Surveillance System (GLASS). Wellcome Open Research. 2017:2:92.(doi: 10.12688/wellcomeopenres.12527.1)
13. world health organization. monitoring global progress on addressing antimicrobial resistance, analysis report of the second round of results of AMR country self assessment survey 2018
14. world health organization surveillance standards for antimicrobial resistance available from http://www.who .int/csr/resources/publications/drugresist/whocdscsrdrs20 15.pdf?ua=1(07/10/2016)
15. Ashley EA, Recht J, Chua A et al. antimicrobial resistance in low and middle income countries, an analysis of surveillance networks 2017. Infectious disease data observatory- www.iddo.org/amr-networks
16. Chris Dall. WHO releases its first report global antibiotic resistance. CIDRAP news. 2018 jan 29 available from htto://www.cidrap.umn.edu/news-perspective/2018/ 01/who-releases-its-first-report-global-antibiotic-resistance
17. High levels of antibiotic resistance found worldwide, new data shows; 29 january 2018; https://www.who.int/ mediacentre/news/releases/2018
18. World Health Organization. WHO report on surveillance of Antibiotic consumption 2016-2018 early implementation phase; ISBN 978-92-4-151488-0 ; 2018
19. Jaray tongtoyai et al. The enhanced gonococcl antimicrobial surveillance program (EGASP) in Thailand, 2015-2016 conference paper in sexually transmitted infections; available from http://www.researchgate.net
20. Claire Veraes, S. Van Boxstael et al. Antimicrobial resistance in the food chain: A review. international journal of environmental research and public health . 2013, July: 10(7):2643-2669.
21. Derek R. MacFadden et al. A platform for monitoring regional antimicrobial resistance, using online data sources: resistance open. the journal of infectious disease. 2016, December; volume214(Issue suppl- 4.1): S393-S398; www.who.int/glass/it-platform/en/
22. World health organization. World health statistics 2014. Geneva:world health organization, 2014.
23. S Y Essack et al. Antimicrobial resistance in WHO African region: current status and road map for action. journal of public health(oxford, England). 2017 mar: 39(1):8-13
24. Pan American health organization/world health organization. Epidemiological alert: salmonella enteric serovar Typhi haplotype H58. 10 october 2018, Washington,D.C.:PAHO/WHO;2018
25. Implementation of the global action plan on antimicrobial resistance in the eastern Mediterranean region; world health organization; regional office for the eastern Mediterranean;AMR news letter; june 2018; volume 1; issue 1
26. Simonsen Gunnar Skov. Antimicrobial resistance surveillance in Europe and beyond. EuroSurveill. 2018;23(42):pii=1800560. https://doi.org/10.2807/1560-7917. ES. 2018 .23.42.1800560 .
27. Singh Shah, Aparna & Karunaratne, Kumudu & Shakya, Geeta & Barreto, Ismael & Khare, Shashi & Paveenkittiporn, Wantana & Wangchuk, Sonam & Htay Tin, Htay & Abdul Muhsin, Milza & Aung, Lin & Bhatia, Rajesh & Srivastava, Rahul & Adi Maryandi, Dwi. (2017). Strengthening laboratory surveillance of antimicrobial resistance in South East Asia. BMJ. 358. j3474. 10.1136/bmj.j3474.
28. O' Neill J. securing new drug for the future generations: the pipeline of antibiotics. Review on antimicrobial resistance; 2015 (http://amr-review.org, accessed 18 November 2015)
29. World health organization western pacific region. A primer for media antimicrobial resistance in the western pacific region; 2016
30. Public health agency of Sweden. Surveillance of antimicrobial resistance for local and global action. 2014
31. Sirijatuphat R, sripanidkulchi K, boonyasiri A et al. Implementation of global antimicrobial resistance surbeillance system(GLASS) in patients with bacteremia. PLoS ONE; 2018;13(1):e0190132; doi:10.1371/journal. pone.0190132
32. Andrew Duong. 6 factors that have caused antibiotic resistance;2015 November 18. Available from http://infectioncontrol.tips
33. Collignon P, Athukorala P-c, Senanayake S, Khan F. Antimicrobial Resistance: The Major Contribution of Poor Governance and Corruption to This Growing Problem. PLoS ONE. 2015; 10(3): e0116746.doi:10.1371/ journal.pone.0116746
34. WHO Glass team. Emerging antimicrobial resistance reporting (GLASS-EAR); 2018 october 22. Available from http://www.who.int/glass/ear/en/.
35. Carmem L pessoa- silva. Global AMR surveillance system.in; second OEI global conference on antimicrobial resistance and prudent use of antimicrobial agents in animal putting standards in to practice; 2018 october 29 to 31; marakesh, morocco; 2018
36. World health organization. WHO report on surveillance of antibiotic consumption:2016-2018 early implementation; 2018.
37. Sasika V.popescu. WHO report on antibiotic consumption. Contemporary clinic.weekly e News. 2018 NOV 19. Available from www.contangionlive.com
38. Versporten Ann, Zarb peter, Caniaux Isabella et al. antimicrobial consumption and resistance in adult hospital inpatients in 53 countries: result of an internet- based global point prevalence survey. The Lancet Global Health. 2018, April, 19; 6(6): PE619- E629.
39. McEwen SA, Collingnon PJ. Antimicrobial resistance: a one health perspective. Microbial Spectr. 2018 mar; 6(2). Doi: 10.1128/microbiolspec.ARBA-0009-2017

40. Kevin Queenan, Barbar Hasler, Jonathan Rushton. A one health approach to antimicrobial resistance surveillance: is there a business case for it?. International journal of antimicrobial agents. 2016,October; 48(4): 422-427.

41. The AMR one health surveillance committee. Nippon AMR One Health Report(NAOR) 2017. Tokyo : Tuberculosis and Infectious Disease Control Division, Health Service Bureu, Ministry of Health, Labour and welfare:2017. Available from http://www.go.jp/file/06-seisakujouhou-10900000-kenkuouk/0000204347.pdf

42. Emily J weston, Teodora Wi, John Papp. Surveillance for Antimicrobial drug- resistant Neisseria gonorrhoeae through the Enhanced Gonococcal Antimicrobial surveillance program. Emerging infectious disesa. 2017; 23(1):S47-S52.doi: https://doi.org/10.3201/id2313.170443. available from www.cdc.gov/eid

43. Sirivongrangson P, Girdthep N, Sukwicha W et al. The first year of the global enhanced gonococcal antimicrobial surveillance programme (EGASP) in Bangkok, Thailand , 2015-2016. PLoS ONE. 2013, November, 9; 13(11): e0206419. https://doi.org/10.137/journal.pone.0206419

44. Nicola Low, Bertisch B, Hauser C et al. Factors associated with antimicrobial resistant gonorrhea infections in men who have sex with men: case control study. Sex Transm Infect. 2017, July 8; 93(2): A1-A272

45. Chang Q, Wang W, Regev-Yochay G et al . Antibiotics in agriculture and the risk to human health: how worried should we be?. Evol. Appl. 2015;8:240-245. Doi: 10.1111/eva.12185

46. Food and agriculture organization of the united nations(FAO). Status report on antimicrobial resistance. Rome. Food and agriculture organization of the united nations. 2015

47. World health organization of animal health(OIE). List of antimicrobial agents of veterinary importance. Paris. World health organization for animal health. 2015

48. World health organization(WHO). Global action plan on antimicrobial resistance. Geneva. World health organization. 2015;a.

49. Founou L L, Founou R C and Essack S Y. Antibiotic resistance in the food chain: A developing country-perspective. Frontiers in microbiology. 2016, November, 23; 7(1881): 1-19. Doi: 10.3389/fmicb.2016.01881

50. Woolhouse M, ward M, Van Bunnik B and Farrar J. Antimicrobial resistance in humans, livestock and the wider environment. Philos. Trans. R. Soc. 2015; B(370); 20140083. Doi: 101098/rstb. 2014.0083

51. Nahar A, siddiquee M, Nahar S et al . multi drug resistance proteus mirabilis isolated from chicken dropping in commercial poultry farms: biosecurity concern and emerging public health threat in Bangladesh. J. Biosaf. Health Edu. 2014; 2 (120). Doi: 10.4172/23332-0893.1000120.

52. Postma M, Backhams A, Collineau L et al. Evaluation of the relationship between the biosecurity status, production parameters, herd characteristics and antimicrobial usage in farrow- to- finish pig production in four European countries. Porcine Health Manag. 2016; 2(9). Doi: 10.1186/540813-016-0028-z

53. Osterberg J, Wingstrand A, Jensen A et al. Antibiotic resistance in E. coli from pig in organic and conventional farming in four European countries. PLoS ONE. 2016; 11:e0157049. Doi: 10.1371/journal.pone.0157049.

54. O' Neill J. Tracking drug resistance globally: final report. London. welcome trust. 2016. Available online from www.amr-review.org

55. World Health Organization. Global antimicrobial resistance surveillance system(GLASS)-IT platform [Internet]. 2019. Available from www.who.int/glass/it-platform/en/

56. World health organization. Meeting on global surveillance of antimicrobial resistance in invasive candida function. WHO.Madrid. Spain 2018, April , 24: 1(7)- 7(7). Available from https://www.who.int/glass/events

57. D W Denning, D S Perlin, Eavan G et al. Delivering on antimicrobial resistance agenda not possible without improving fungal diagnostic capabilities. Emerging Infectious Disease. 2017, February; 23(2):177-183. Doi:http://dx.doi.org/10.3201/eid2302.152042. Available from www.cdc.gov/eid

58. Denning D W, Bromley M J. infectious disease. How to bolster the antifungal pipeline. Science. 2015; 347:1414-6. Doi:http:/dx.doi.org/10.1126/science.aaa6097

59. World health organization. Global action plan on antimicrobial resistance.WHO.2015. Available from https://www.who.int/antimicrobial-resistance/publications

60. Rajesh R Uchil, Gurdeep singh kohli, vijay M katekhaye et al. strategies to combat antimicrobial resistance. Journal of Clinical and Diagnostic Research. 2014, July; 8(7):ME01-ME04. Doi: 10.7860/JCDR/2014/8925.4529. Available from www.jcdr.net