Antimicrobial Resistance

Drivers
Containment Policy
Implementation

April 12th 2025
Virtual session organised by
AIDCOC Training Academy

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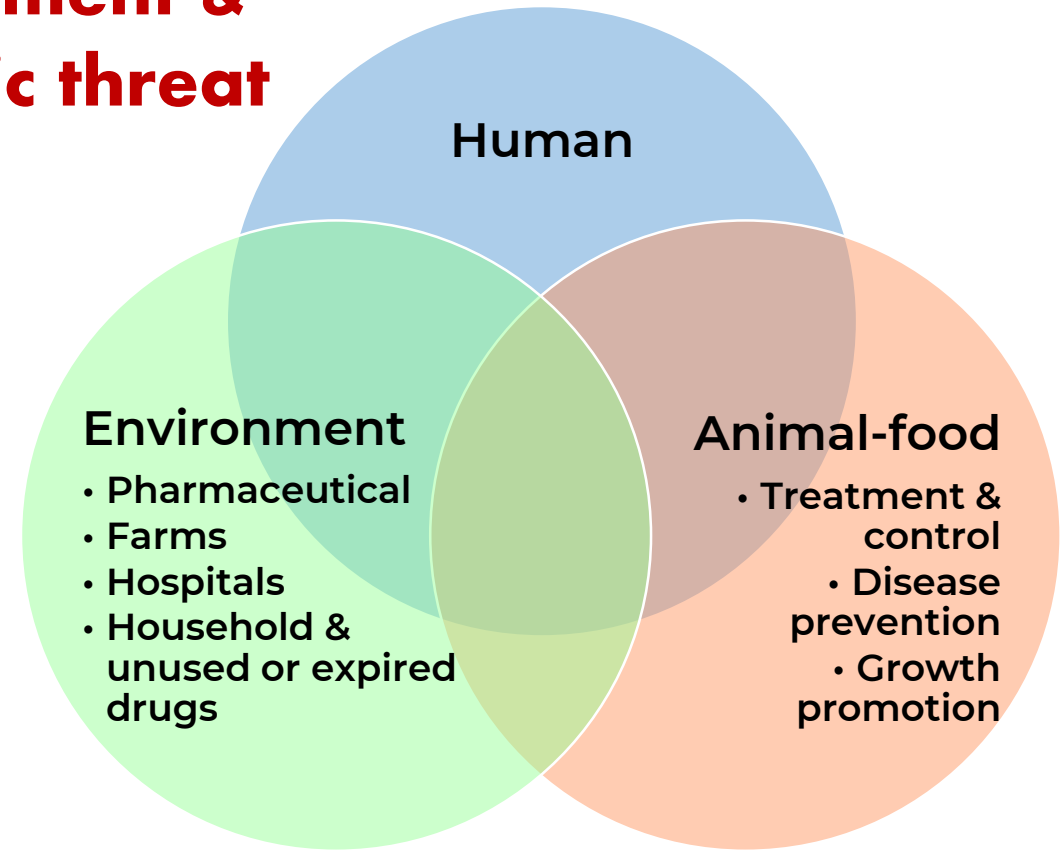
President- Infection Control Academy of India
Honorary Professor – University of Hyderabad

AMR ‘a global crisis’ and ‘the perfect example of the complex, multi-sectoral, multi-stakeholder challenges we will increasingly face in the future’.

Tedros Adhanom Ghebreyesus
DG, WHO

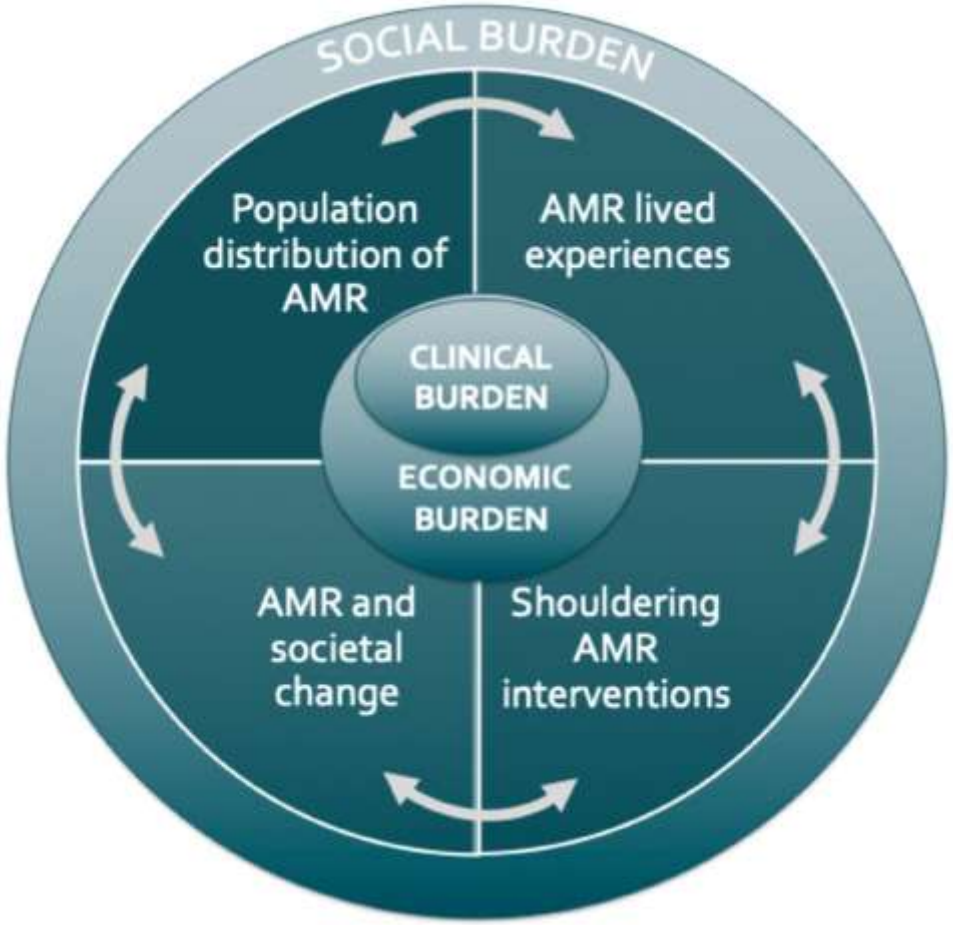
AMR is a complex issue

Major health, food security, environment & economic threat



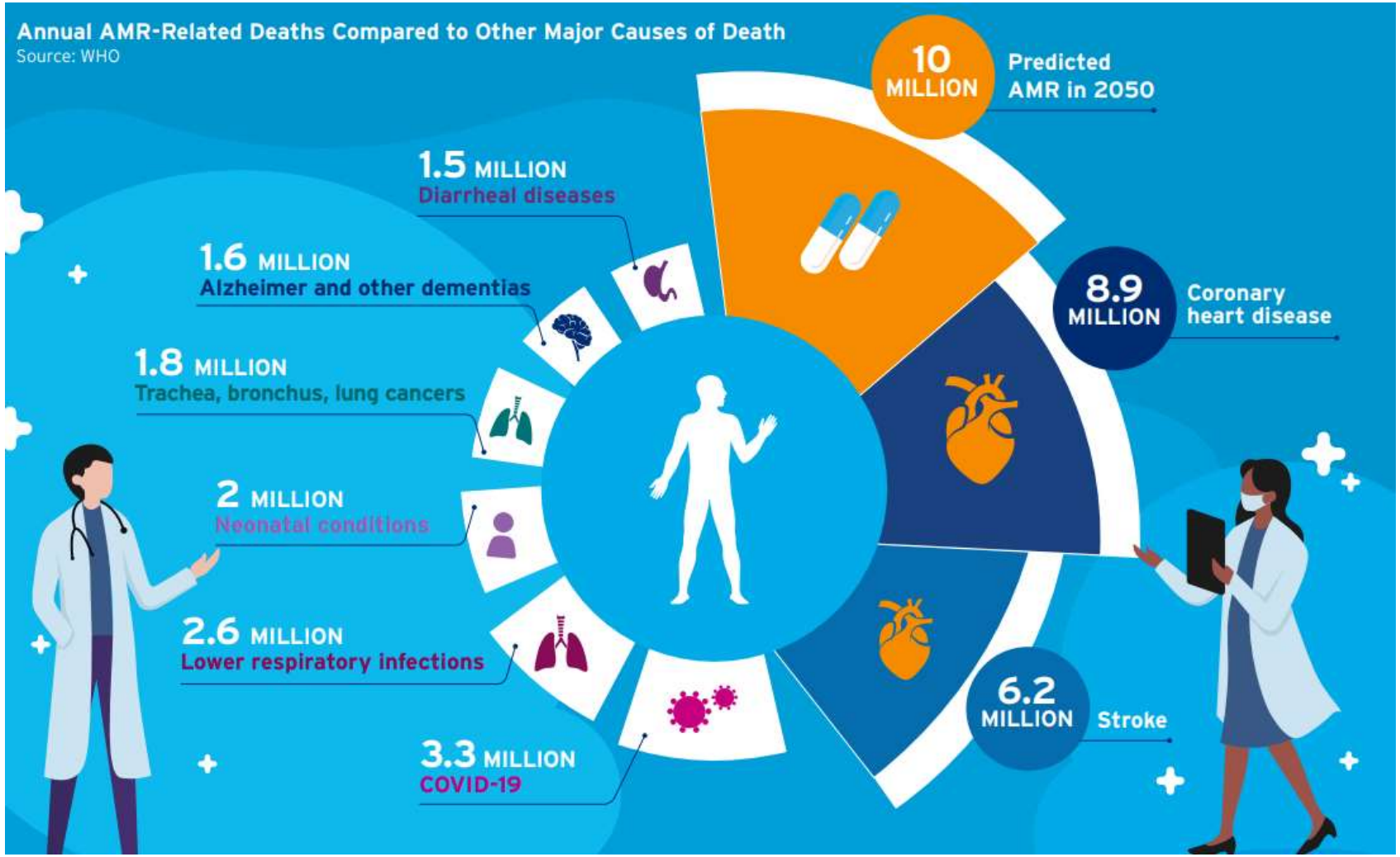
Antimicrobial Resistance is a condition in which microorganisms are able to survive at therapeutic doses of antimicrobial compound that the said microorganisms are still able to grow; reduce drug efficacy, increase risk of a disease infection, exacerbate a certain condition, and result in deaths during the treatment given to humans, animals, fish, and plants

Figure 1. Four inter-related, multi-scalar dimensions of the social burden of AMR.



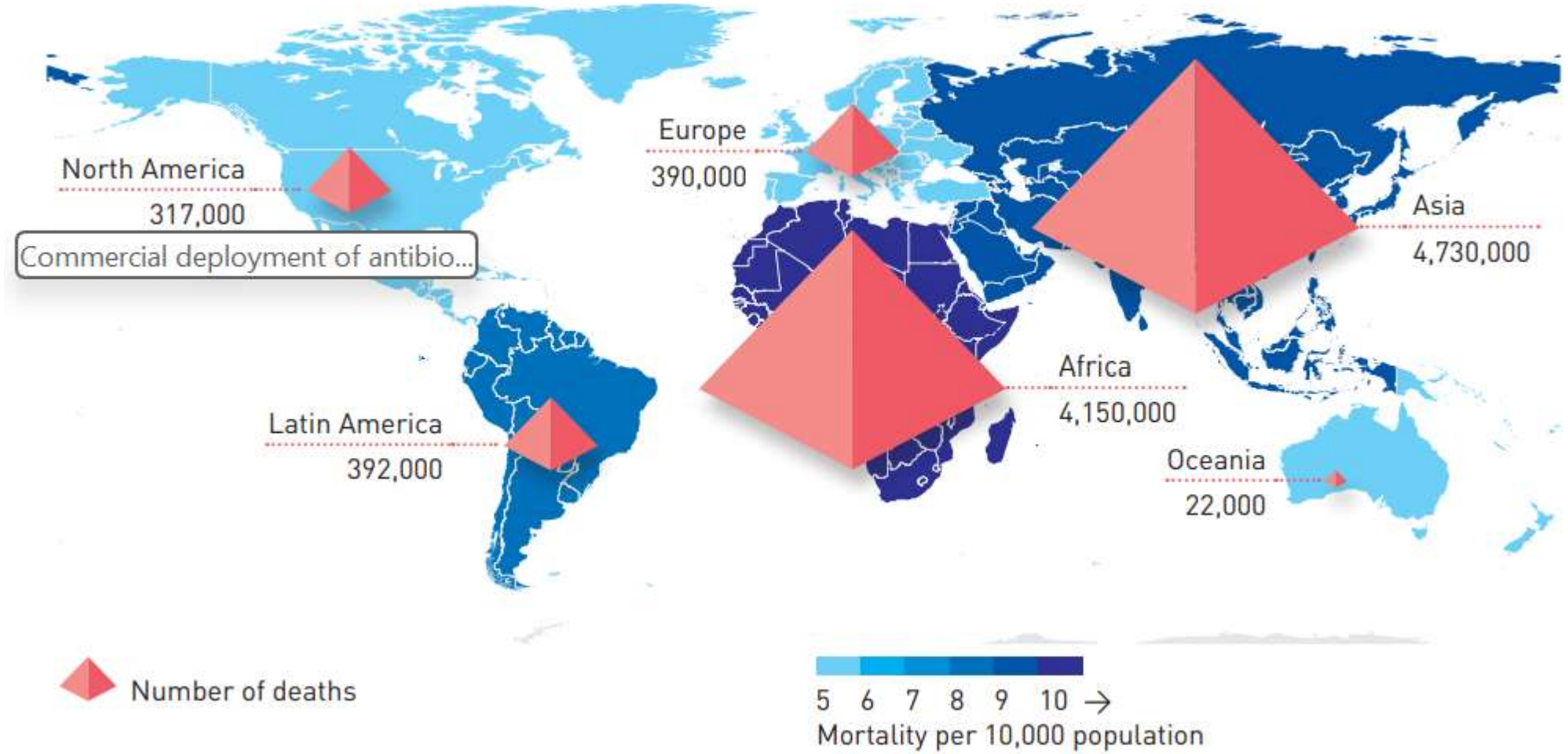
JAC Antimicrob Resist, Volume 7, Issue 2, April 2025, dlae208, https://doi.org/10.1093/jacamr/dlae208

Annual AMR-Related Deaths Compared to Other Major Causes of Death



Source: Citi GPS: Global Perspectives & Solutions

Predicted global deaths from AMR in 2050



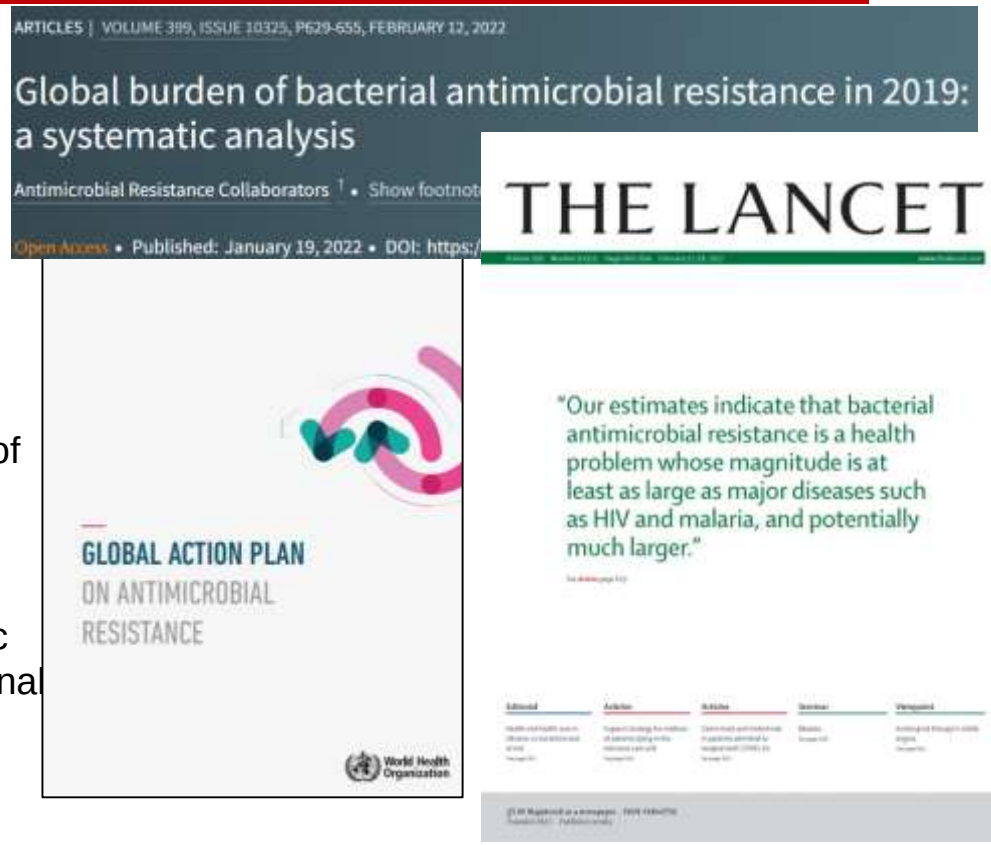
Source: O'Neil 2014/ UNEP 2023 Bracing superbugs

Antimicrobial resistance - overview

Antimicrobial resistance (AMR) is a problem that threatens the sustainability of an effective public health and medical response to infectious diseases across the globe

It is estimated that 1,27 million people die annually from drug-resistant infections[1].

Forecasts from several international bodies such as the WHO, UN and World Bank predict that this will become progressively worse unless we adapt the way we develop and use antibiotics.

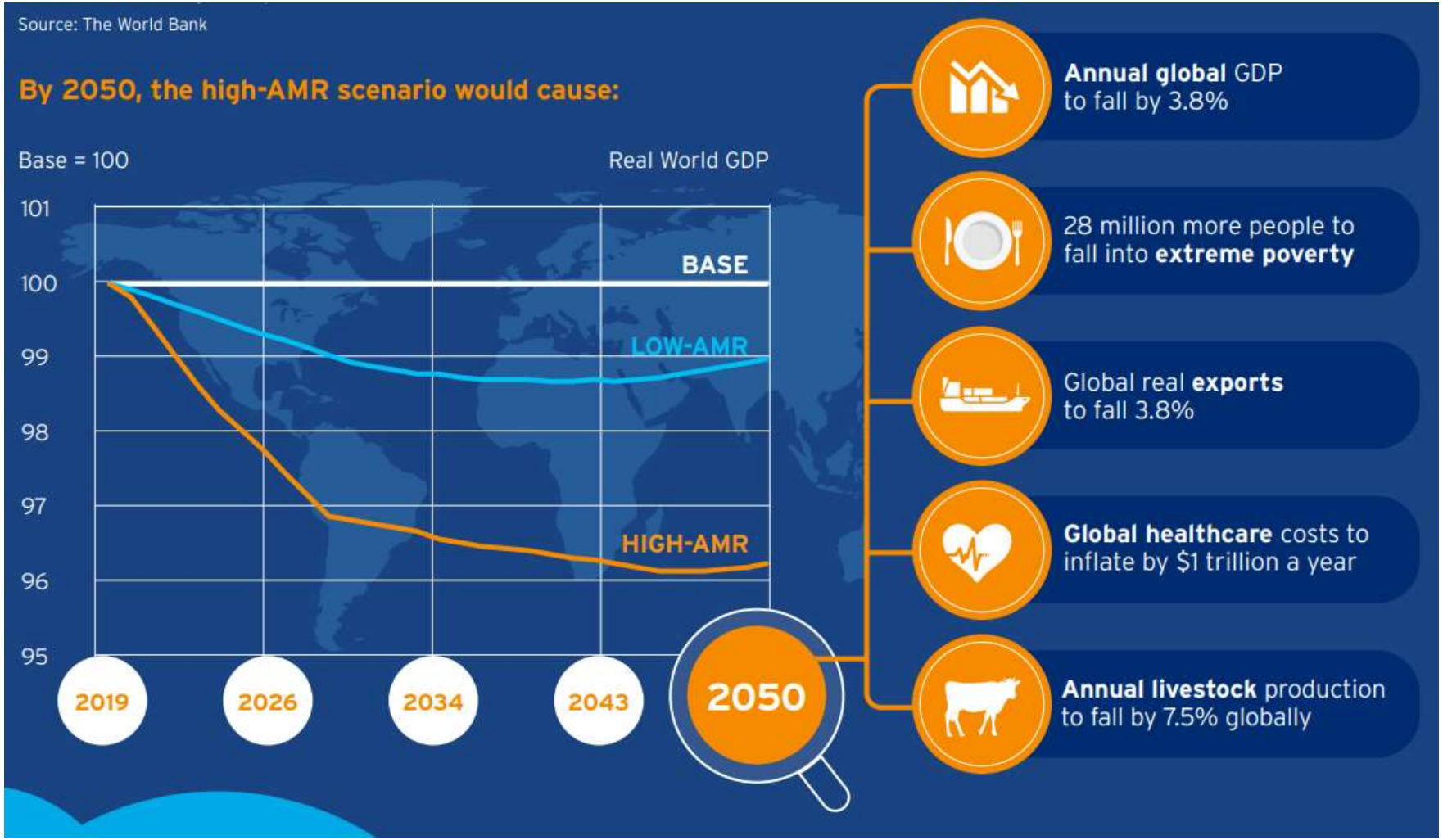


The consequences of AMR include prolonged duration of illnesses, greater risk of infection transmission, increased morbidity and mortality rates, and substantial financial and societal costs.

The WHA endorsed the Global Action Plan on AMR, which outlined five strategic objectives for combatting AMR[2]. These objectives have been adapted into National Action Plans on a country-by-country basis[3].

1. Review on Antimicrobial Resistance. Tackling Drug-Resistant Infections Globally: Final Report and Recommendations. 2016; 2. WHO Global Action Plan on Antimicrobial Resistance. 2015. Available at: https://www.who.int/antimicrobial-resistance/global-action-plan/en/ (Accessed August 2020) 3. https://www.who.int/antimicrobial-resistance/national-action-plans/en/ (Accessed August 2020)

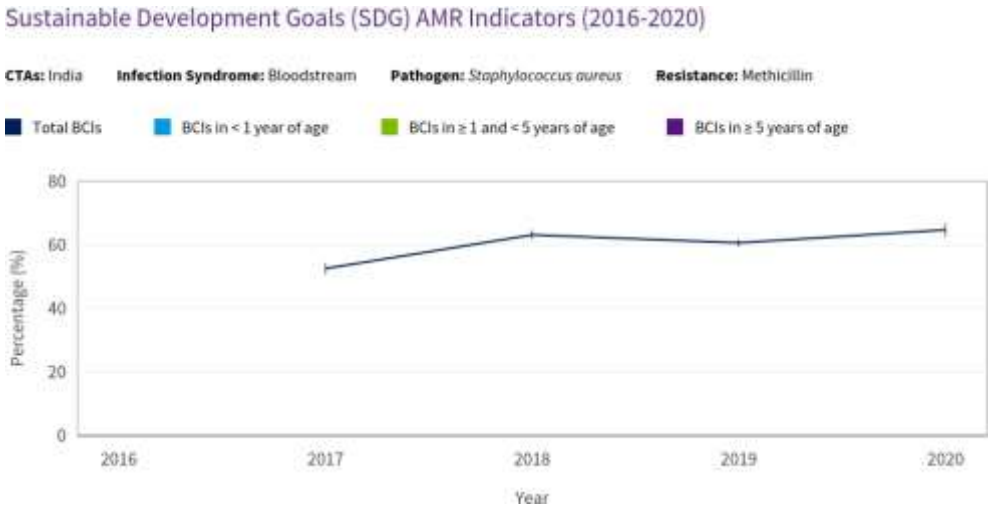
CONSEQUENCES OF ANTIMICROBIAL RESISTANCE

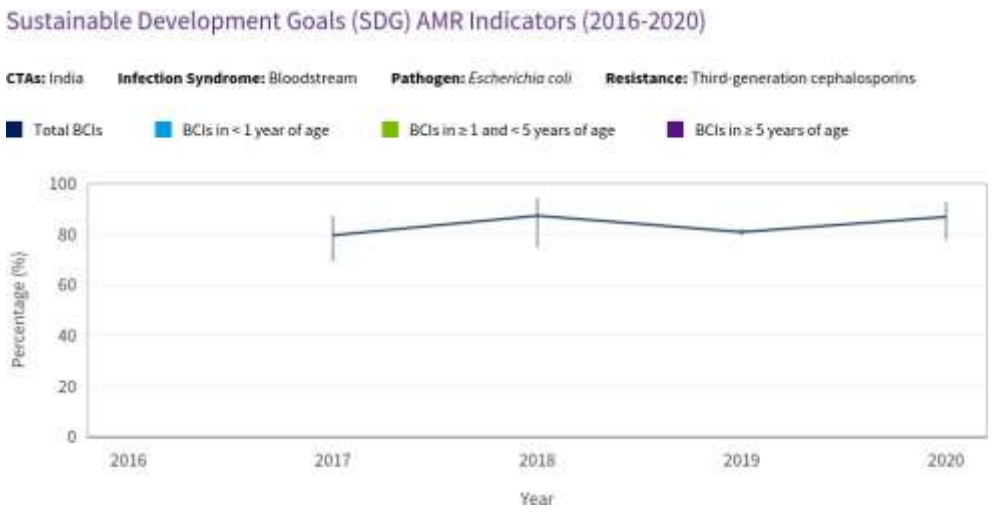


Source: Citi GPS: Global Perspectives & Solutions

AMR burden in India ?

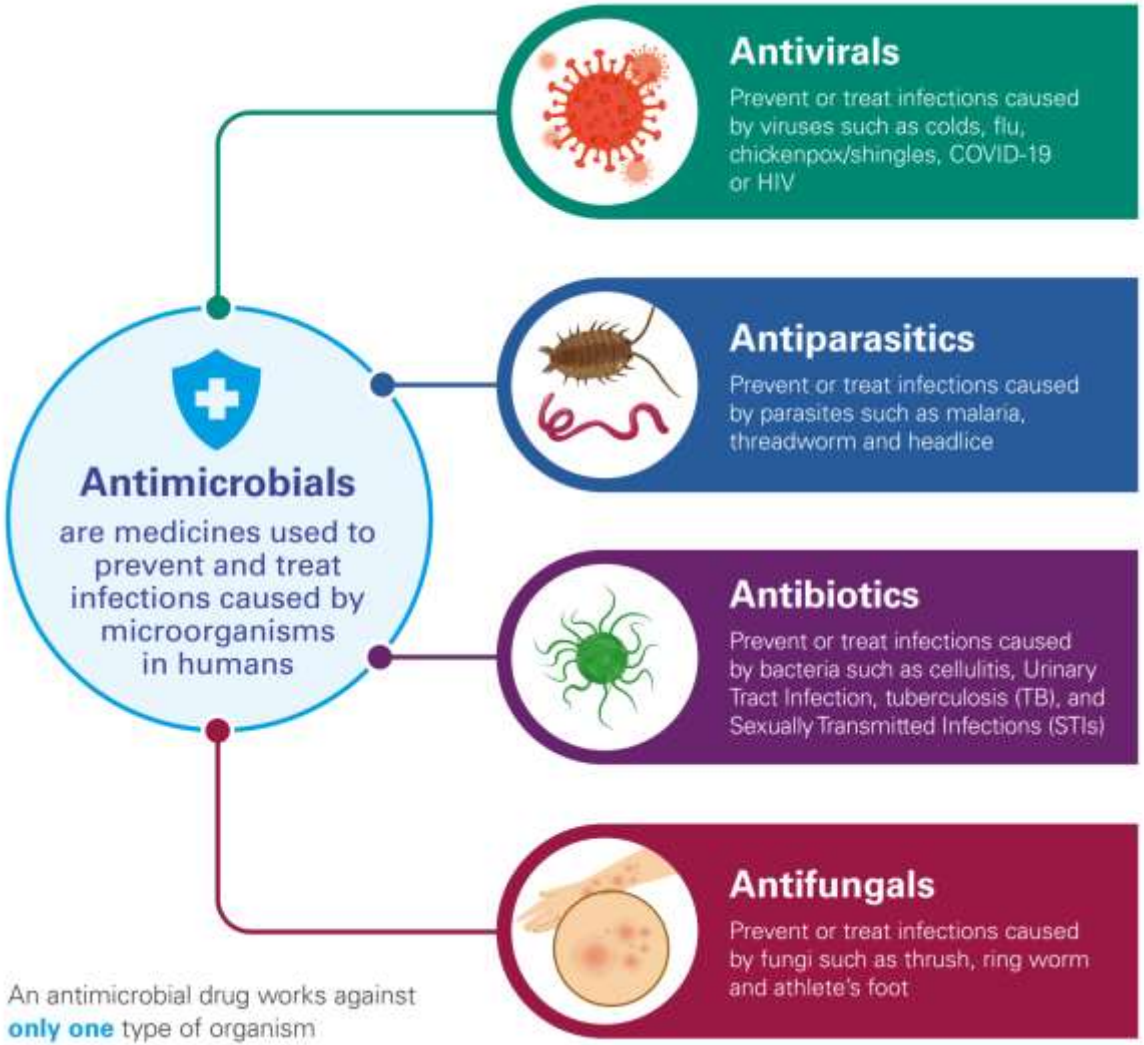
SDG 3.d.2





https://amrcountryprogress.org/download/profiles/SEARO/TrACSS-2022-India.pdf

An overview of antimicrobials

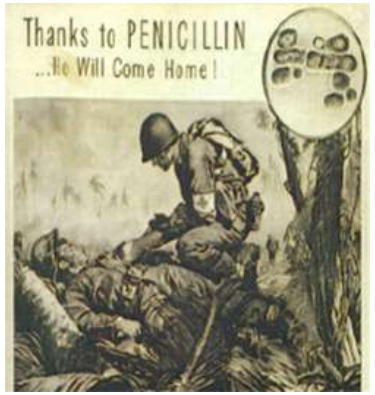


Foundation of the Antibiotic Era – Penicillin in 1940

Antibiotics are the most important weapons for the treatment of many infectious diseases caused by bacteria.

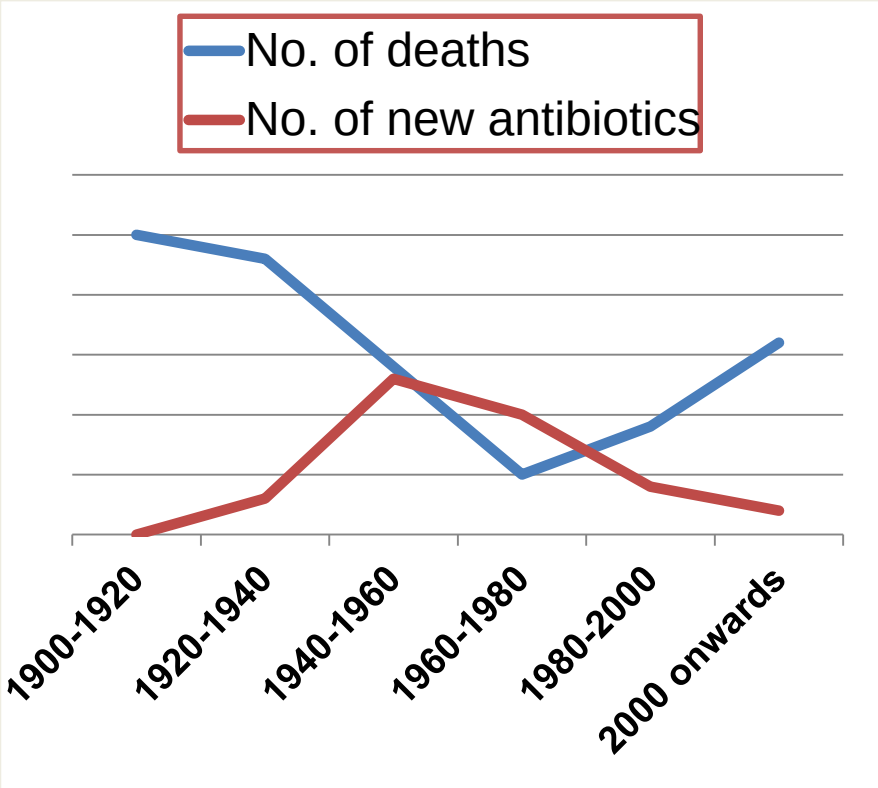
Most achievements in medicine – organ transplants, cancer treatment, major surgery – attributed to use of antibiotics

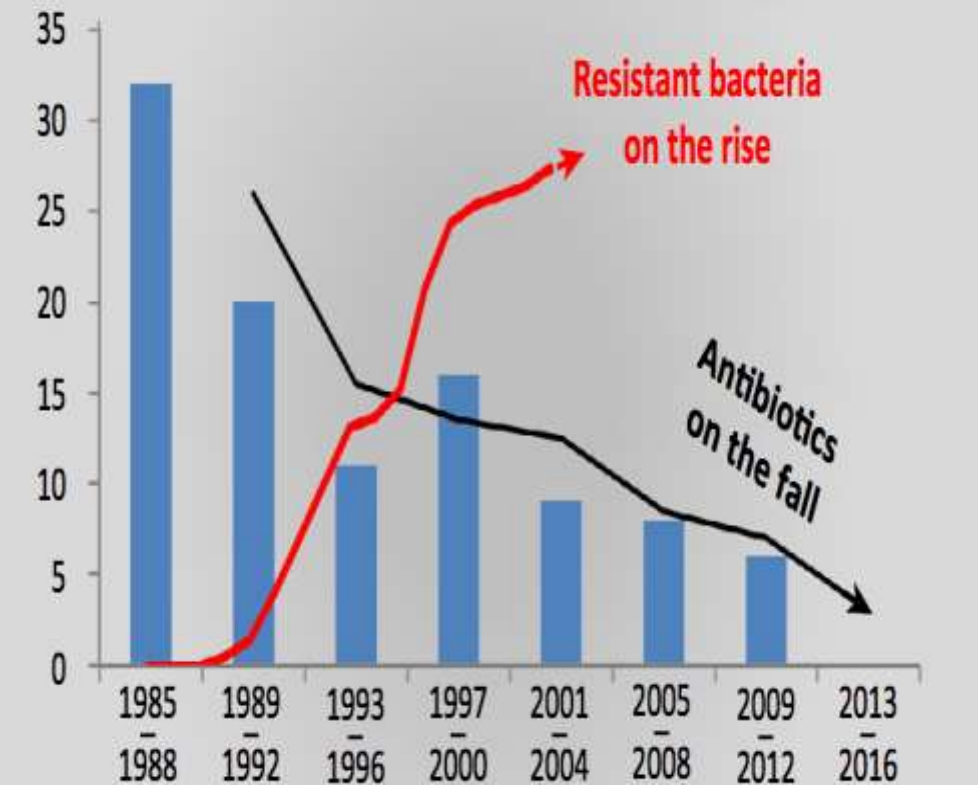
Alexander Fleming



A number of subsequent antimicrobial discoveries quickly followed changed the history of medicine

The rise & fall of antibiotics

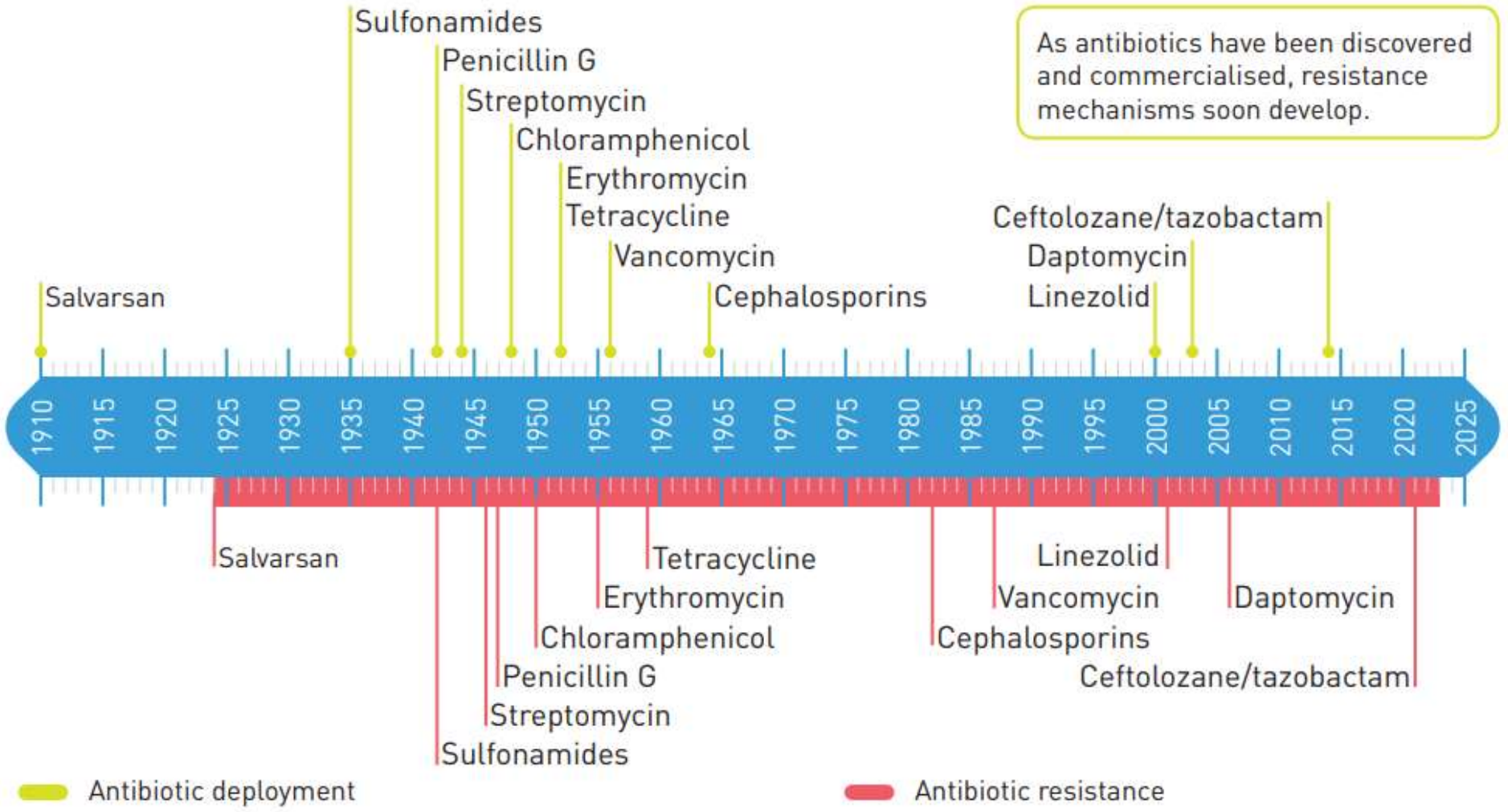




A Failing Market – Between 1960-2000, No Major Classes were introduced

Trends In Microbiology. 2014;22(4):165-167

Commercial deployment of antibiotics and emergence of resistance – a timeline

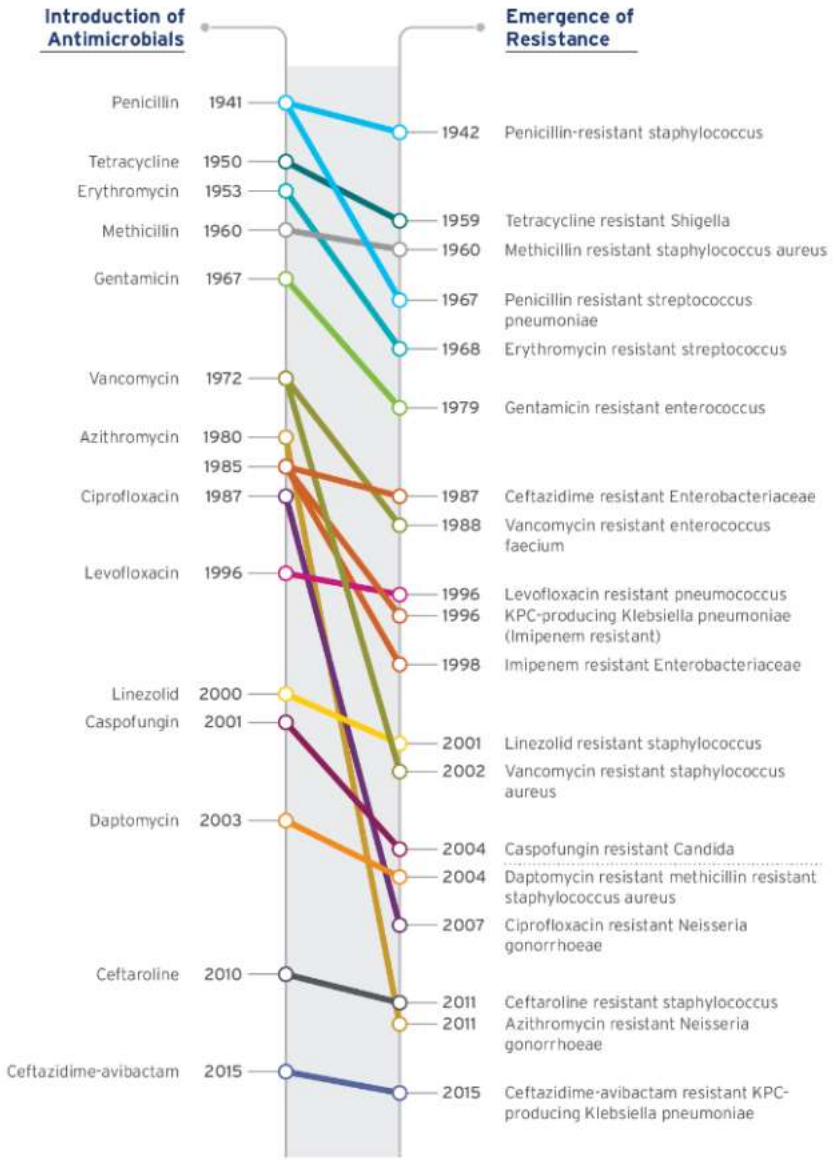


Source: UNEP 2023 Bracing superbugs

The Emergence of Antimicrobial Resistance Timeline

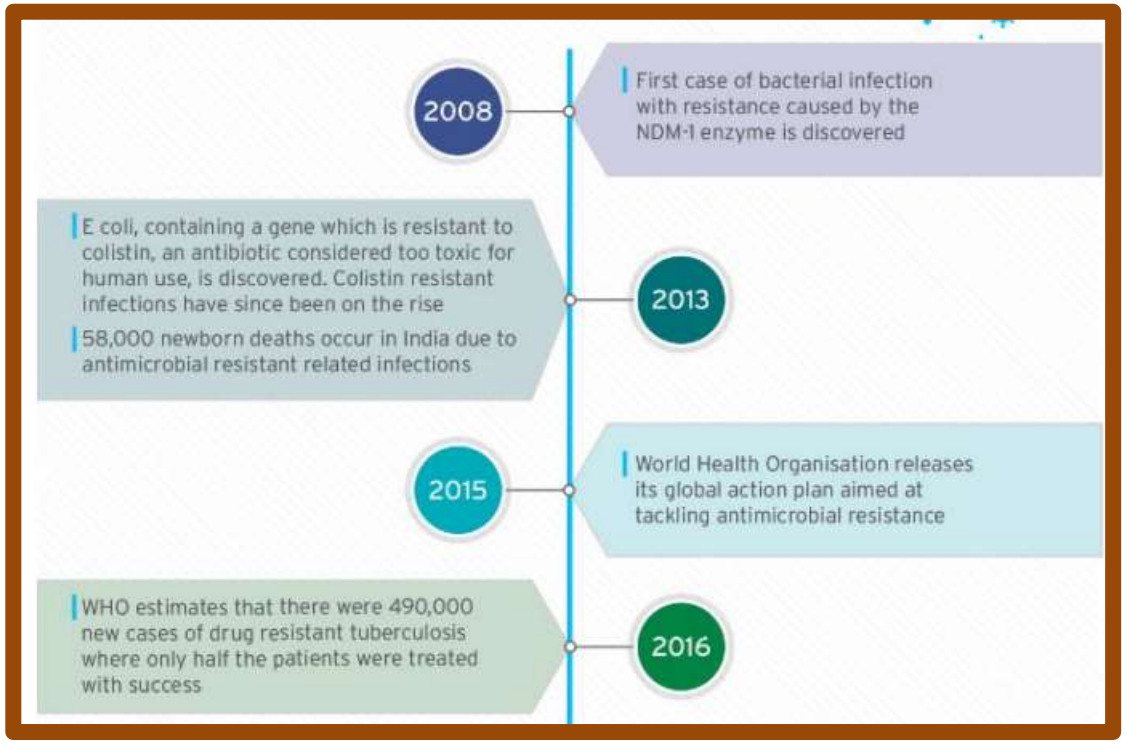
"It is not difficult to make microbes resistant to penicillin in the laboratory by exposing them to concentrations not sufficient to kill them, and the same thing has occasionally happened in the body."

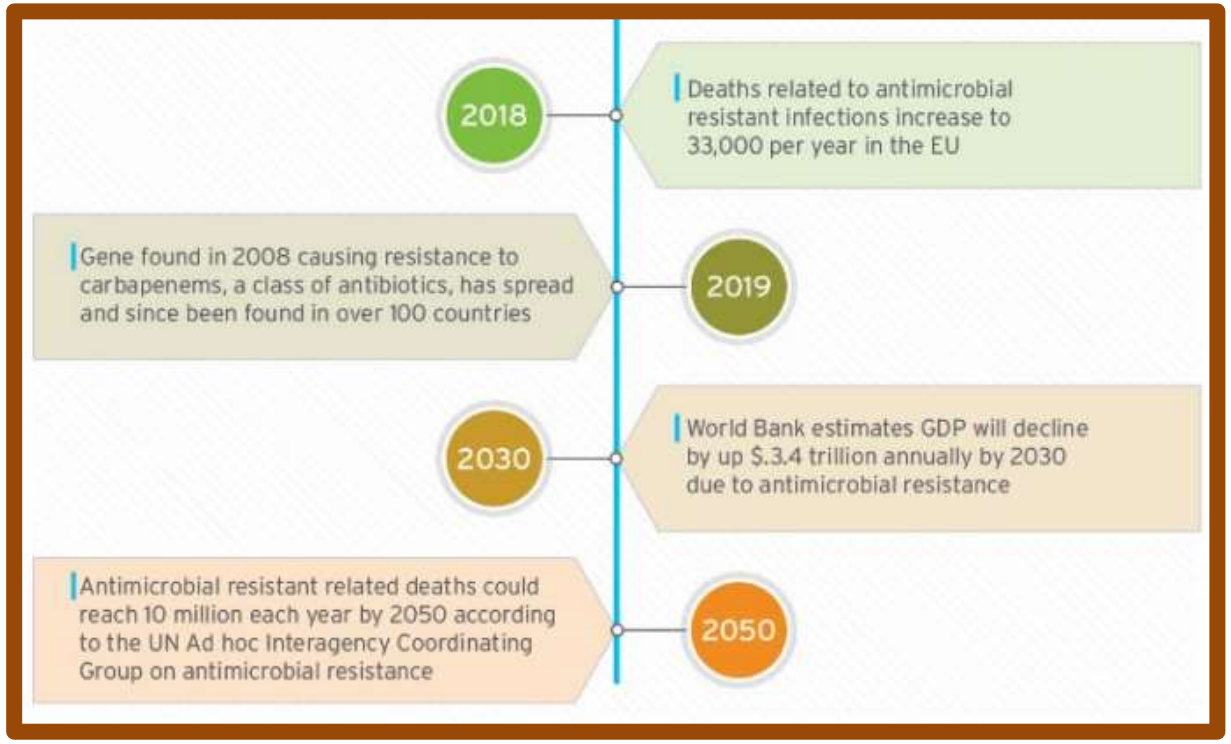
- Nobel lecture, Alexander Fleming



Source: Citi GPS: Global Perspectives & Solutions

The Emergence of Antimicrobial Resistance Timeline since turn of century





Source: Citi GPS: Global Perspectives & Solutions

Antifungal resistance

Over 1/3 of potential crop production worldwide is lost due to plant diseases including fungal infection.

Annually, invasive fungal diseases affect over **6.55 million** people and cause a death toll of **3.8 million**

Pre-20th century
Chemical fungicides used for crop disease management

1954
First **polyenes** drug nystatin introduced

1969
First **azole** drug miconazole introduced

1969
First report of benomyl resistant powdery mildew

1981
Report of azole resistant blumeria graminis

1984
Systematic fungal resistance in hospitals reported

1987
First **echinocandins** drug caspofungin introduced

21st century
AIDS & improvements in medical practices contribute to the increased in IFDs

2005
Link between clinical and environmental azole resistance in *Aspergillus fumigatus* identified

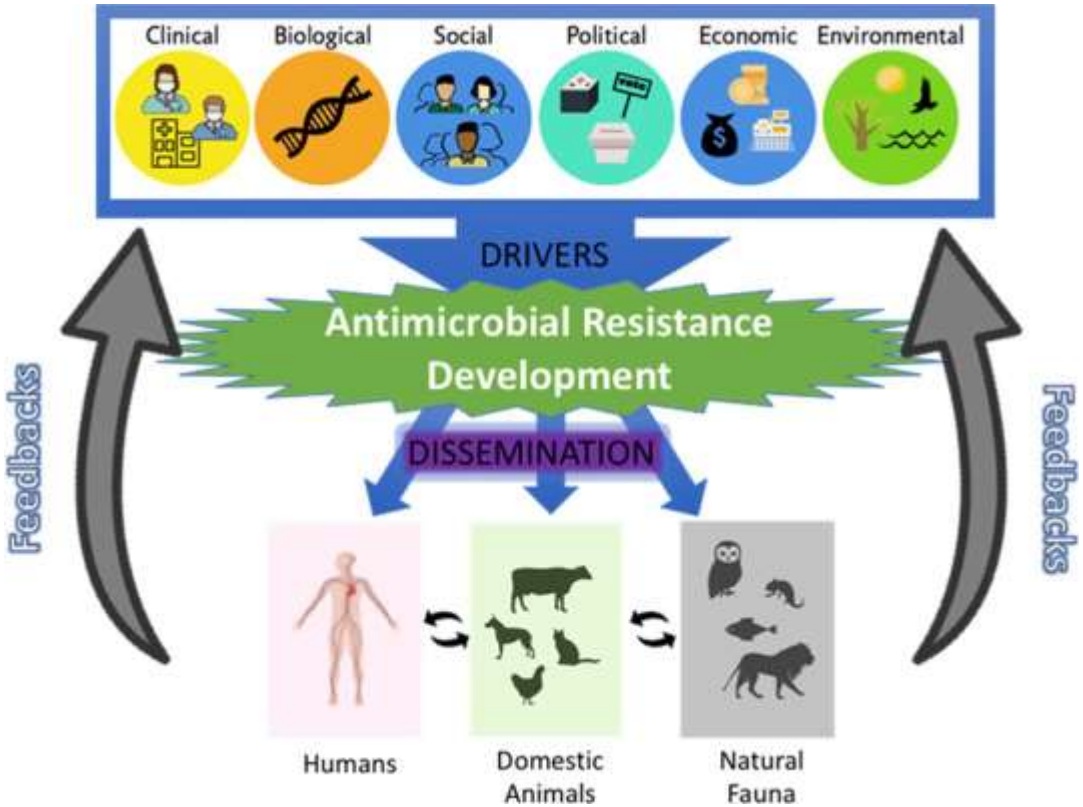
2009
First report of *Candid auris*

2010s
Increased fungicide resistance in food crops

2019
Covid-19 associated fungal infections

2022
WHO published FPPL

Trends in Microbiology
Volume 33, Issue 1, January 2025, Pages 112-129



Antimicrobial resistance is a cross-boundary challenge that is driven by clinical, biological, social, political, economic, and environmental drivers and affects not only humans but also domestic and nondomestic animals and ecosystems. Impacts of resistance dissemination exert feedbacks on the drivers that are difficult to predict.

DOI: (10.1021/acs.accounts.8b00643)

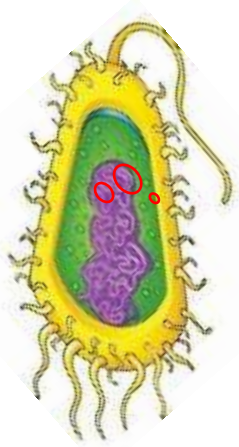
How AMR limits progress toward the SDGs

Source: The Urgent Threat of Drug-Resistant Infections 2023

Mechanism of AMR

Natural bacterial resistance

Bacterial protection against endogenous/naturally occurring antibiotics/ heavy metals/ toxins



Agricultural and environmental factors

Superfluous use of antibiotics in agriculture practices & as growth promoters in animal husbandry

Improper environmental disposal → air drift, leaching and run-off into water bodies

Medicine/ pharmaceutical factors

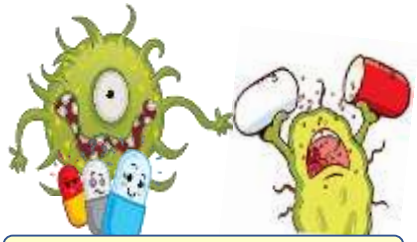
- Misuse of antibiotics in human and veterinary medicine
- Prolonged hospitalization and multiple co-morbidities
- Non-compliance with infection control practices
- Lack of stewardship
- Lack of public awareness

Selection pressure

Acquired resistance

Other anthropogenic factors

- Lack of hygiene and sanitation measures
- Use of disinfectants/pesticides at household chores
- Bioterrorism
- Travel of people and foodstuffs



Rise of "Superbugs"

- Mutations
- Horizontal gene transfer
  - Transformation
  - Transduction
  - Conjugation
- Mobile elements
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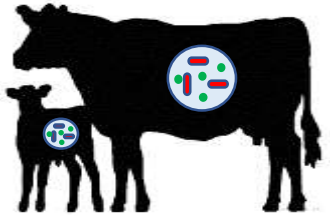
  - Insertion sequences
  - Gene cassette

What is NDM-1?

New Delhi Metallo-beta-lactimase-1 (NDM-1) can render most antibiotics ineffective, including the newest ones like carbapenems, the last line of defense against multidrug resistant bugs

Role of Human-Animal interface in spread of AMR

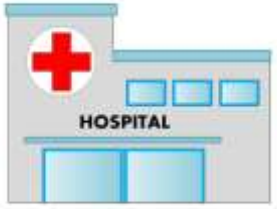
Antibiotic usage in food producing animals and spill over to crops



Animals develop drug-resistant bacteria in their gut

Antibiotic abuse: Over-prescription of antibiotics can result in development of drug-resistant bugs

Drug-resistant bacteria reaches humans through food, environment (water, soil, air)

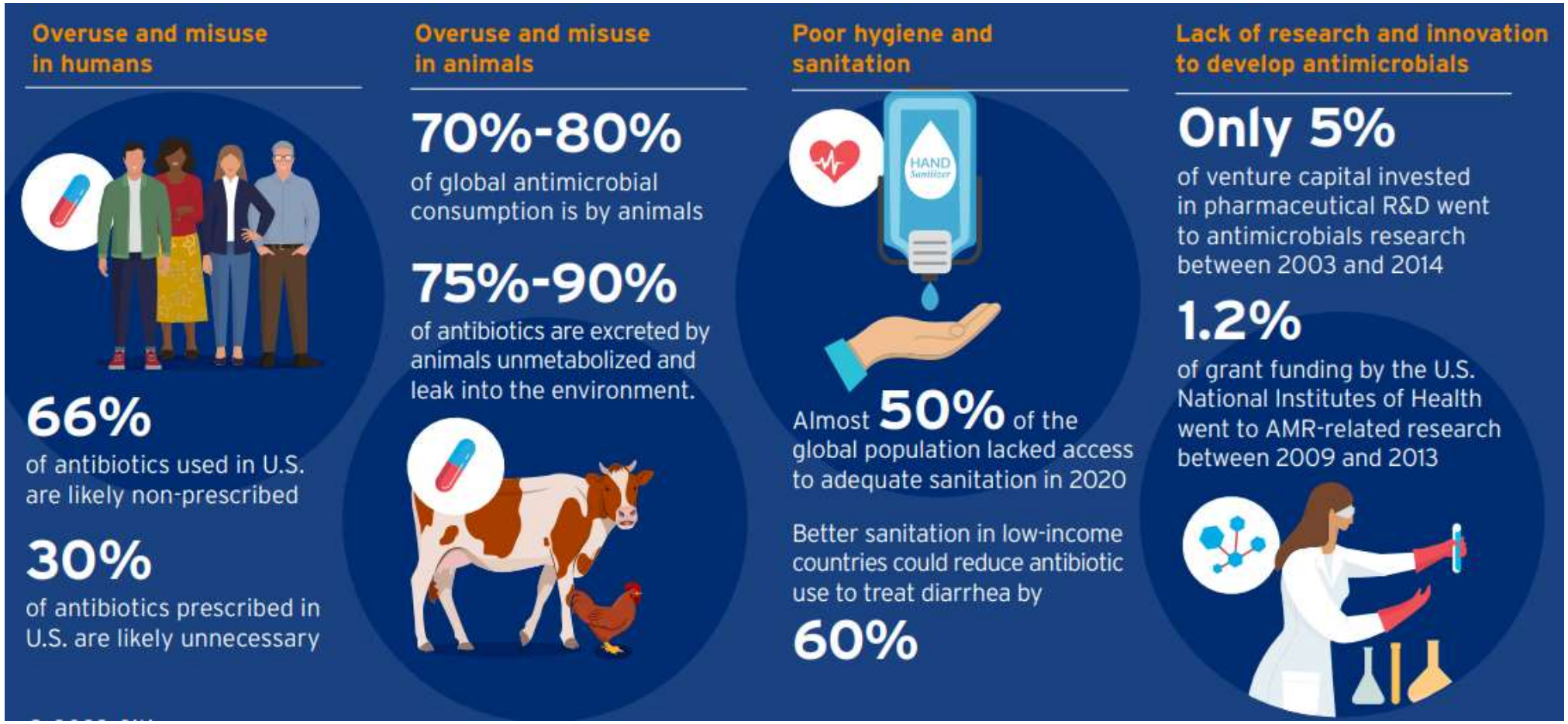


Prolonged hospitalization

Poor Hygiene Community spread

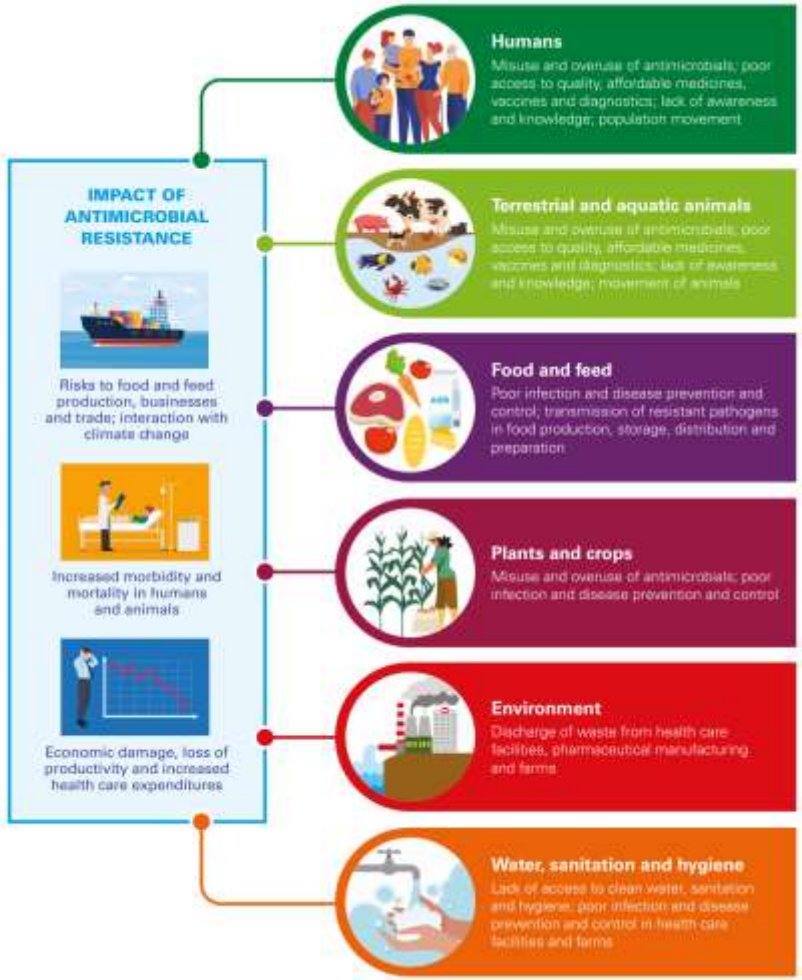
Drug-resistant bacteria spread to general public

DRIVERS OF ANTIMICROBIAL RESISTANCE



Source: Citi GPS: Global Perspectives & Solutions

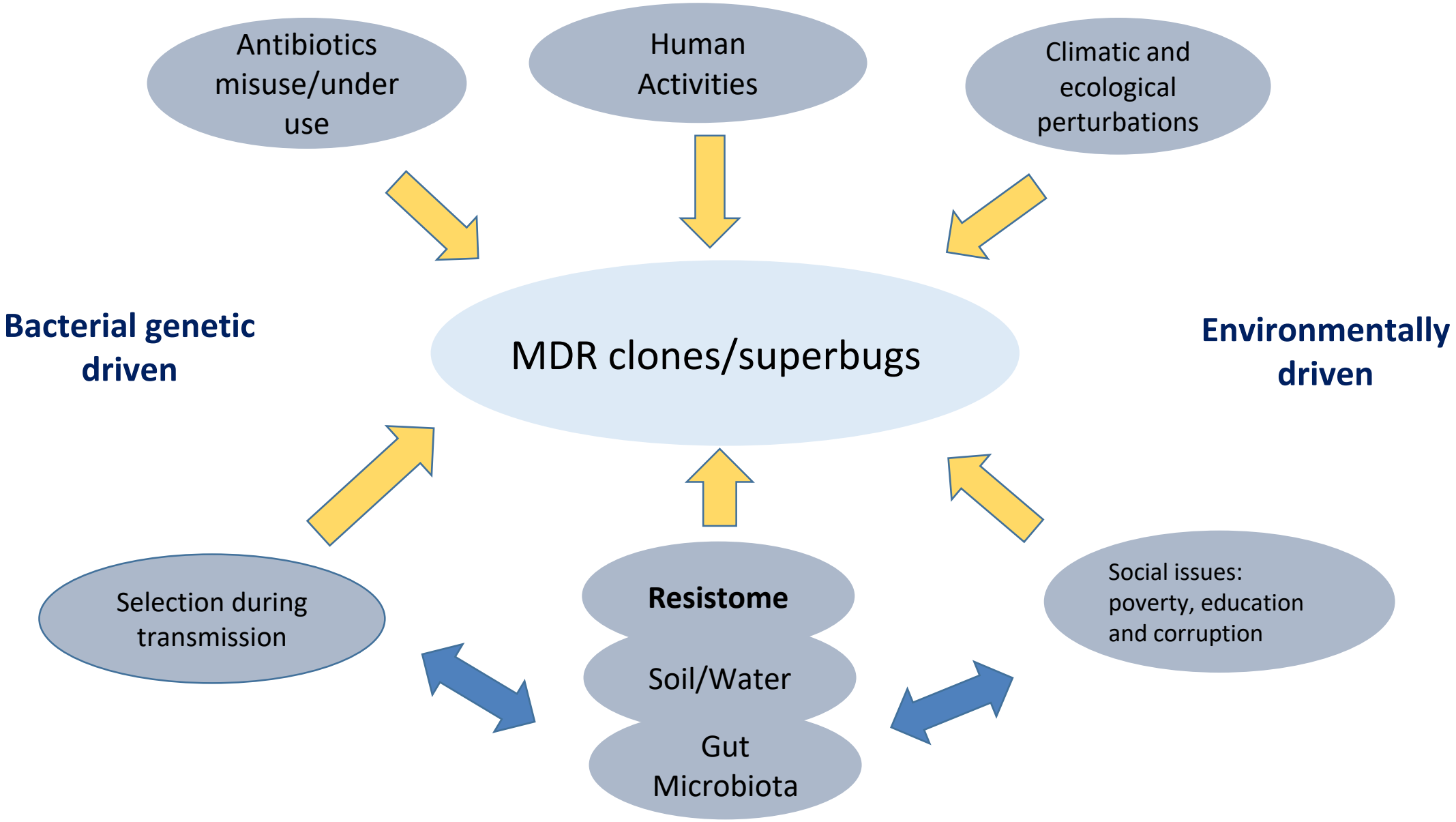
Drivers of AMR



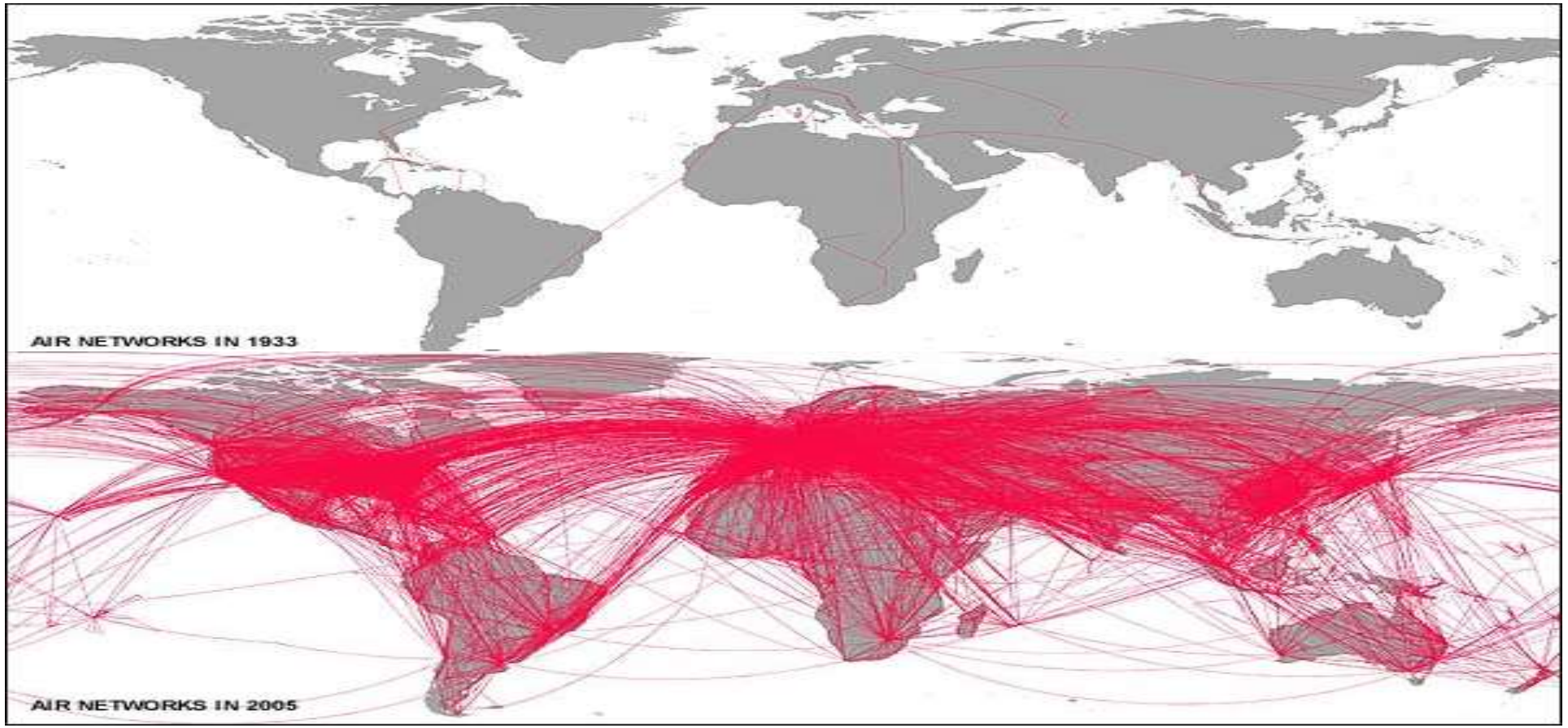
Causes of Antimicrobial Resistance

Source: Adapted from Figure 1 in World Health Organization, No Time to Wait: Securing the future from drug-resistant infections. Report to the Secretary General of the United Nations, April 2019 and Citi GPS 2022

Evolution of superbugs



Resistant organisms move across the borders through humans and food-chain



What Drives the Spread of Antimicrobial Resistance?

AMR occurs naturally over time, usually through genetic changes.

Antimicrobial resistant organisms are found in people, animals, food, plants and the environment (in water, soil and air).

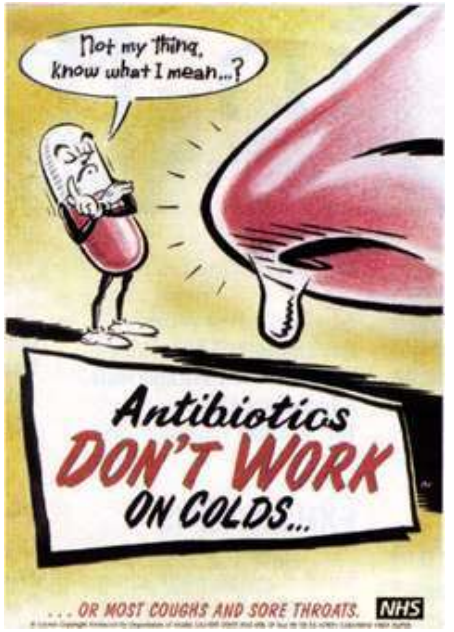
They can spread from person to person or between people and animals, including from food of animal origin.

The main drivers of antimicrobial resistance include the

- misuse and overuse of antimicrobials;
- lack of access to clean water, sanitation and hygiene (WASH) for both humans and animals;
- poor infection and disease prevention and control in health-care facilities and farms;
- poor access to quality, affordable medicines, vaccines and diagnostics;
- travel, and migration
- lack of awareness and knowledge; and lack of enforcement of legislation.

Development and Spread AMR

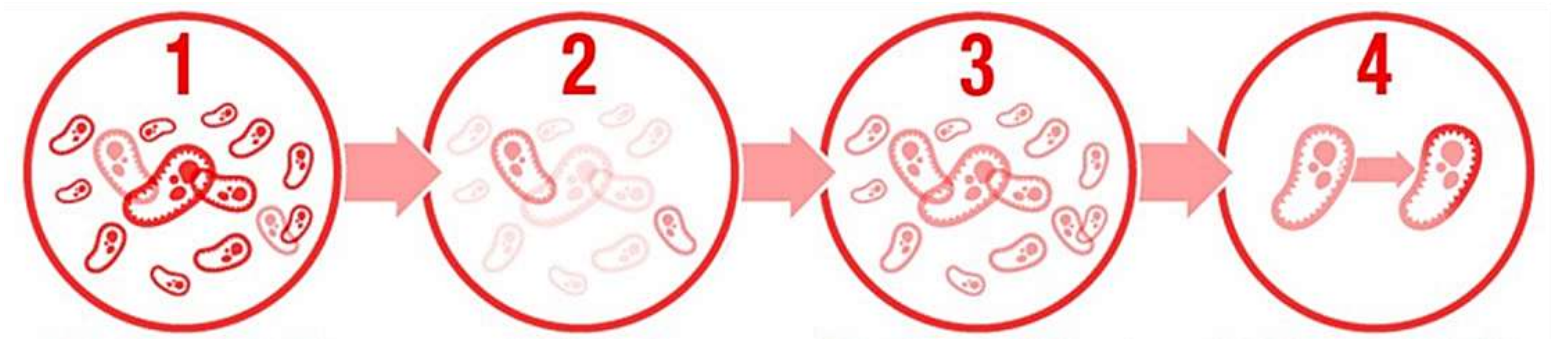
Nearly half of the in-patients receive antibiotics
Overuse of antibiotics and injections for non-bacterial/trivial infections
Use of broad-spectrum antibiotics
Failure to prescribe in accordance with clinical guidelines
Inappropriate self-medication.



Copious prescriptions worsen resistance problem

How Antibiotic Resistance Occurs

Antibiotic resistance is when a microbe evolves to become more or fully resistant to antibiotic which previously could treat it



High number of bacteria. A few of them are resistant to antibiotics

Antibiotics kill bacteria causing the illness. As well as good bacteria protecting the body from infection

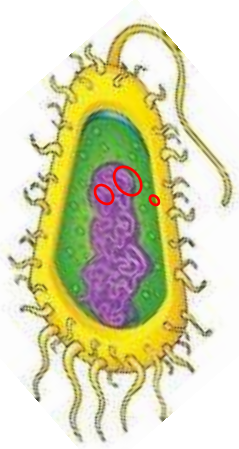
The resistant bacteria now have preferred conditions to grow and take over

Bacteria can even transfer their drug-resistance to other bacteria, causing more problems

Mechanism of AMR

Natural bacterial resistance

Bacterial protection against endogenous/naturally occurring antibiotics/ heavy metals/ toxins



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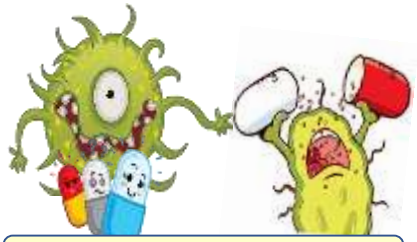

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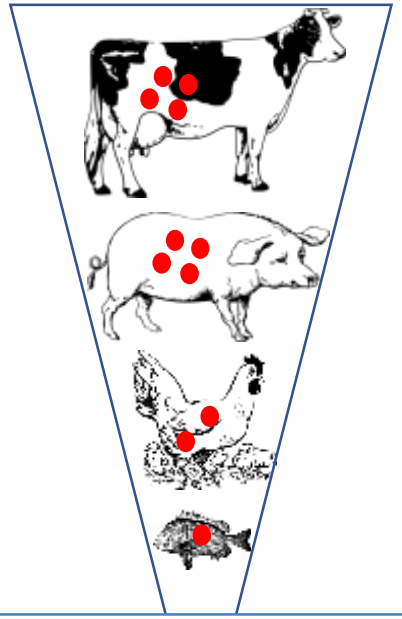
Causes of Antibiotic Resistance

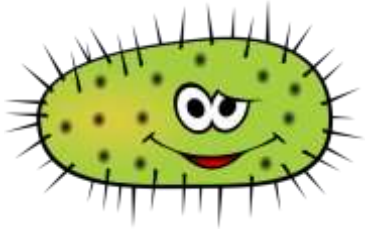
Over-prescribing of antibiotics

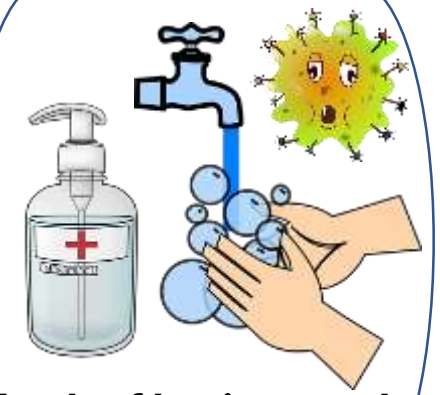
Patients not finishing their treatment

Poor infection control practices in hospitals

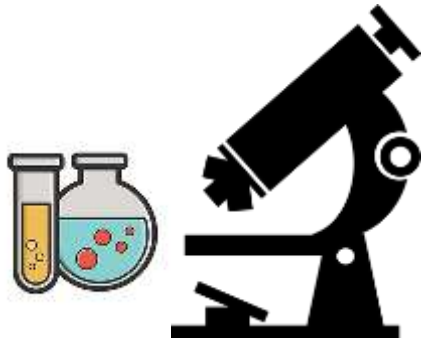


Over-use of antibiotics in livestock and fish farming



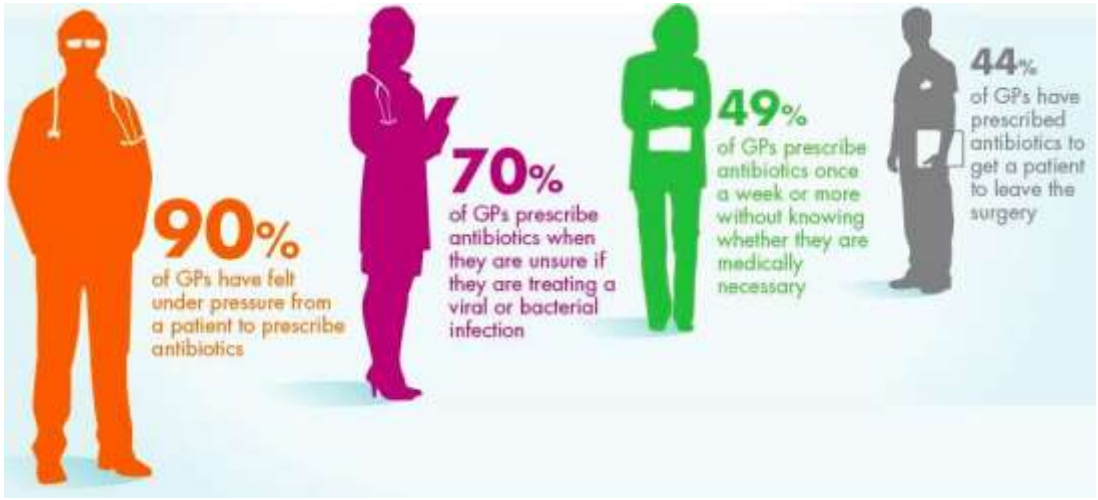


Lack of hygiene and poor sanitation



Lack of new antibiotics being developed

Human and Non-human use of antibiotics: **the key driver for AMR**

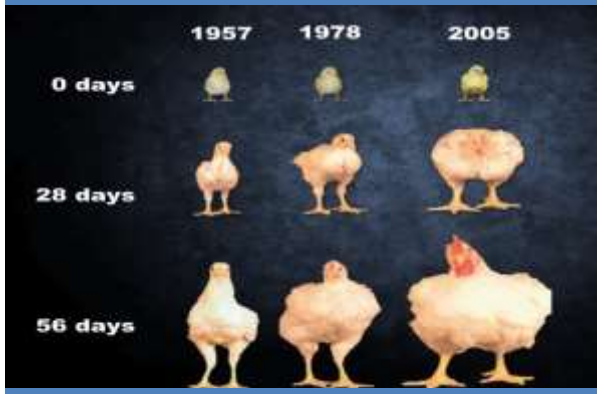


AMR pathogens and genes spread due to poor sanitation, hygiene and poor infection prevention and control

TREATMENT OF ANIMALS

CONTROL THE INFECTIONS

PREVENTION FROM DISEASES



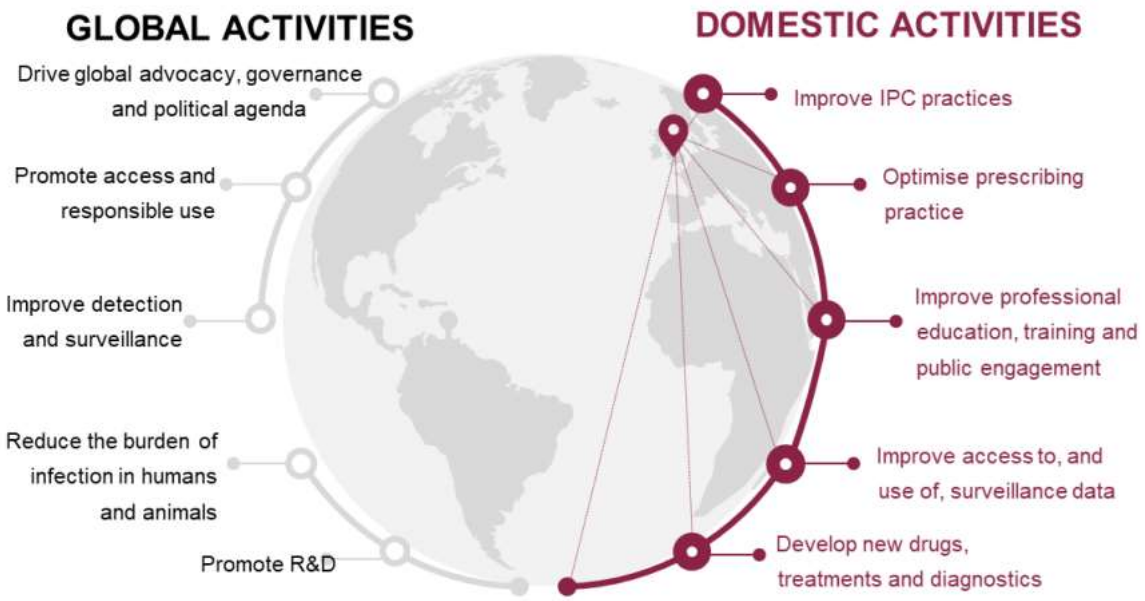
FORCED GROWTH

Key drivers for AMR: In Global South and India

Poor Health access
Lax implementation of regulations

Over the Counter Dispensing
Self prescription
Quacks

Containment actions



Source: Tackling antimicrobial resistance 2019–2024, UK

Global South vs. Global North

AMR Status in the Global North

- **Advanced healthcare systems** but still facing issues like hospital-acquired infections and resistance to first-line treatments.
- **Robust infrastructure** for research and surveillance (e.g., CDC, European Centre for Disease Prevention and Control).
- **High consumption of antimicrobials**: Particularly in human medicine and animal agriculture.
- However, rapid diagnostics, stewardship programs, and some innovative therapies are being introduced.

AMR Status in the Global South

- **Overuse and misuse of antibiotics** due to limited regulation and access to healthcare.
- **Lack of diagnostic resources** leads to overprescription and inappropriate use.
- **Limited access to newer antibiotics and diagnostics**, making it harder to treat resistant infections.
- **Inadequate infection control** in healthcare facilities, leading to the spread of resistant organisms.
- *Key statistics*: Over 70% of countries in sub-Saharan Africa report *no national AMR surveillance systems*.

Access vs Excess

The Grand Divide

Global North vs Global South

- **Technological and Resource Disparity**:
- Access to new diagnostics, vaccines, and antibiotics is far better in high-income countries, leaving low-income nations at a disadvantage.
- **Access to Treatment**:
- High rates of counterfeit or substandard antibiotics in the Global South.
- *Cost barriers* prevent low-income populations from accessing effective treatments.
- **Knowledge and Training Gaps**:
- Lack of education on AMR among healthcare workers and the public in low-resource settings.
- Insufficient implementation of antimicrobial stewardship programs in the Global South.

Antimicrobial Stewardship

- **Current Gaps**: Limited access to diagnostics and therapeutics, and a low priority on AMS by key stakeholders (researchers, pharma, policymakers).
- **Urgency**: Immediate action is needed to improve antimicrobial stewardship globally.
- **Key Challenge**: Balancing innovation with equitable access to combat AMR effectively.

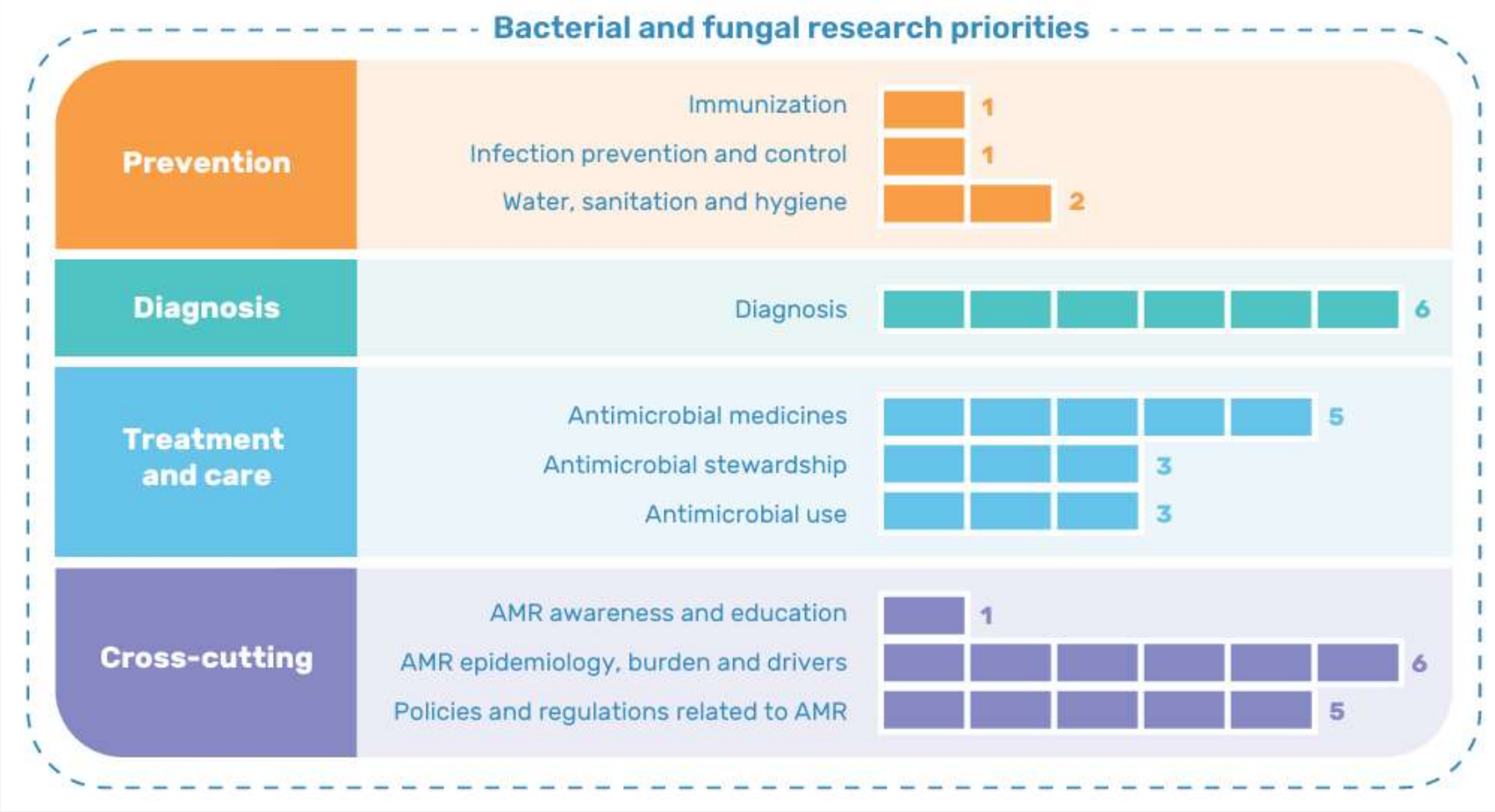
	HELPFUL	HARMFUL
INTERNAL/PRESENT FACTORS	**Strengths** *Core elements:* • AMR and AMS are a leadership priority. • IPC programme/committee is active. *Human resources:* • There is enthusiasm for AMS in the facility/wards. • There is clinical knowledge of AMS. *Antimicrobial use and resistance data:* • Prescription audit is conducted in one ward. • Facility aggregate antibiogram is available. *AMS activities:* • A pharmacist is involved in some AMS activities in one ward.	**Weaknesses** *Core elements:* • No medical record or prescription pad is available. *Human resources:* • No dedicated health-care professional is available to lead the AMS team. *Antimicrobial use and resistance data:* • The supply of microbiology reagents is poor. • The supply of antibiotics is poor. *AMS activities:* • Health-care professionals have competing priorities and little time for AMS work.
EXTERNAL/FUTURE FACTORS	**Opportunities** *Core elements:* • Active implementation of the NAP on AMR • Increasing national awareness of AMR and its consequences for health *Human resources:* • Incorporating AMS responsibility into the IPC committee *Antimicrobial use and resistance data:* • Funds for conducting a facility PPS *AMS activities:* • Presenting findings from AMS activities to other wards/ health-care professionals	**Threats** *Core elements:* • Unstable access to essential antibiotics • Increased costs for antibiotics • Prioritization of issues other than AMS in the facility • Low facility budget *Human resources:* • Too many nonfunctional committees in the health-care facility *Antimicrobial use and resistance data:* • Increasing AMR rates, including carbapenem-resistant Enterobacteriaceae (CRE) *AMS activities:* • Opposition from clinical leaders

SWOT

SWOT analysis for AMS readiness in a health-care facility

Source: WHO AMS LMIC HCFs

Research priorities by AMR area



Source: WHO Global research agenda for antimicrobial resistance in human health

10 Steps to tackle Antimicrobial Resistance

Hygiene and sanitation

Vaccine and alternate therapeutics

Always follow the advice of health professionals

Public Awareness

Antibiotic stewardship in agriculture and environment

Surveillance and data mining

Rapid diagnostic tools

Research funding for novel antibiotic discoveries

Global collaborations

One-Health approach

Preventing Antimicrobial Resistance

1. Increase availability of diagnostic testing to identify bacteria and prescribe effective antibiotics.

2. Establish systems and frameworks to work collectively and share data and knowledge across borders.

3. Address over-prescription and over-consumption of antimicrobials in humans. One estimate of the US found that 30% of all antibiotics prescribed in emergency departments were unnecessary.

4. Improve hygiene measures and access to sanitation in order to stop the spread of germs. According to a UN progress report, almost half the global population lacked access to safe sanitation services in 2020.

The Global Political Commitment to AMR

UNGA High-Level Meeting on AMR (Sept 2024)

- **Recognition of AMR as an urgent global threat** affecting human, animal, and plant health with colossal **Economic and healthcare impact**:
  - Projected $1 trillion in additional healthcare costs per year by 2050.
  - Estimated loss of 1.8 years of global life expectancy by 2035 due to AMR.
- **One Health Approach** reaffirmed as essential for addressing AMR comprehensively.
- **Commitments to reducing AMR-associated deaths by 10% by 2030** (baseline: 4.95 million deaths in 2019).
- **<u>Urgent need for equitable access</u>** <u>to antimicrobials, diagnostics, and vaccines</u>

WHO’s Global Action Plan

1. To improve awareness and understanding of antimicrobial resistance
2. To strengthen knowledge through surveillance and research
3. To reduce the incidence of infections
4. To optimize the use of antimicrobial agents
5. 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

Key Challenges in AMR Response

Global Inequities in AMR Burden & Response

•Developing countries bear a disproportionate burden of AMR.

•Lack of access to effective antibiotics and diagnostics causes more deaths than resistance itself.

•AMR threatens economic stability, food security, and sustainable development.

Gaps in Surveillance and Stewardship

•Only 52% of countries have a functioning multisectoral coordinating mechanism.

•Many low- and middle-income countries (LMICs) lack strong antimicrobial stewardship programs.

Underfunding of R&D for New Therapies and Diagnostics

•The antibiotic pipeline remains weak, with fewer than 10 truly novel antibiotics in development.

•Diagnostics remain inaccessible in many parts of the Global South, leading to empirical antibiotic use.

Environmental and Industrial Contributions to AMR

•Pollution from pharmaceutical manufacturing, agriculture, and wastewater is fueling AMR.

•Need for stronger regulations on antibiotic manufacturing and disposal.

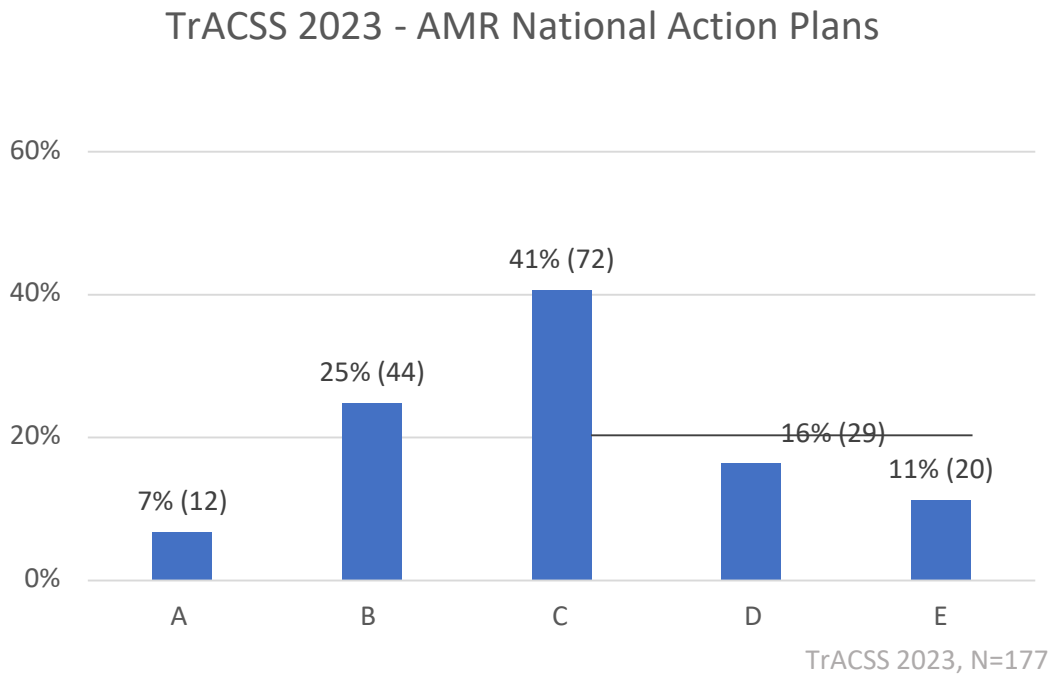
The Jeddah Commitments (Nov 2024) – Moving from Policy to Action

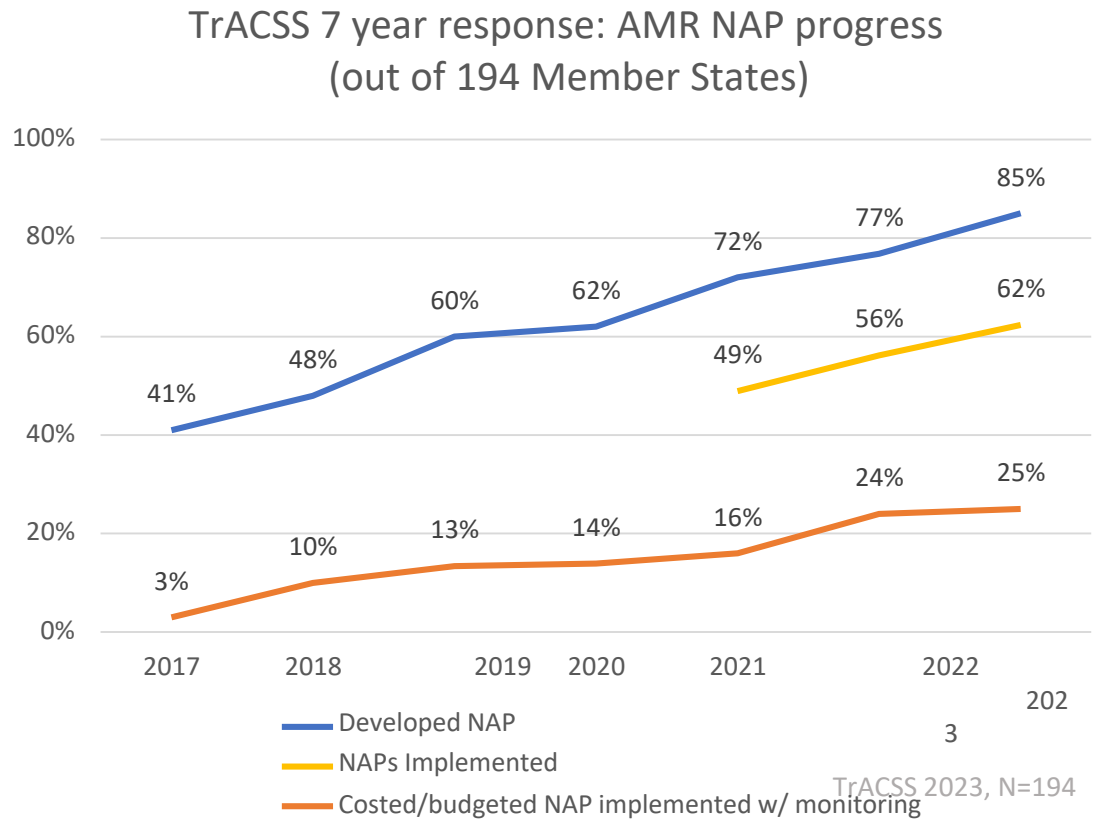
Translating the UNGA Political Declaration into practical commitments.

2030 Goals:

- Reduce global AMR-related deaths by **10%**.
- **Strengthen national AMR coordination mechanisms** in all countries.
- **Expand global access to diagnostics, vaccines, and antibiotics** in underserved regions.
- **Enhance surveillance systems**, integrating genomic data sharing.
- **Launch of AMR One Health Learning Hub in Saudi Arabia** to build capacity in LMICs.
- **Creation of a Regional Antimicrobial Access & Logistics Hub** to improve procurement and distribution of antimicrobials in low-resource settings.
- **Commitment to sustainable financing for AMR action**, including mobilizing private and philanthropic funding.

Global status of AMR National Action Plans (AMR NAPs)





Of 177 countries in TrACSS 2023,

165 (93%) reported having a developed NAP (level B-E)

121 (68%) are implementing their AMR NAPs (level C-E)

49 (27%) have a costed and budgeted NAP that is being implemented and monitored (levels D-E)

20 (11%) have made financial provision for AMR in national budget (E)

AMR NAP Implementation gap: majority of countries have NAPs developed, many have started implementing plans, but only ~25% have costed and budgeted NAP with monitoring in place

The Battle Against Antimicrobial Resistance

Accelerating Efforts to Combat AMR

Combating AMR requires a multipronged approach the comprises all critical components—from policy to implementation.

- Development of new antibiotics and alternative treatments in the era of Antimicrobial Resistance
- Overcoming difficulties in finding new drugs
- Antibiotic repurposing
- Development of alternate therapies like Bacteriophages
- Improving infection prevention and control practices
- Optimising antimicrobial use
- Strengthening surveillance and data collection
- Integrated One Health approach to unify and integrate multiple sectors
- Incorporating AMR into national and global health plans
- Engaging stakeholders and raising awareness about AMR
- Mobilising political will and fostering multi-sectoral collaboration

Source: Ranga Reddy Burri et al.

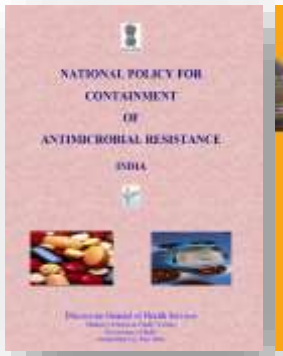
Containment of AMR- National response

2010

- National **AMR Task Force** set up

2011

- **National Policy** for AMR containment adopted
- **Jaipur Declaration** on AMR signed by SEAR ministers



2013

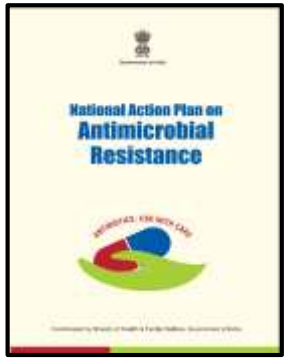
- **National Programme** on AMR Containment (NCDC)
- AMR Research and Surveillance Network (ICMR)

2016

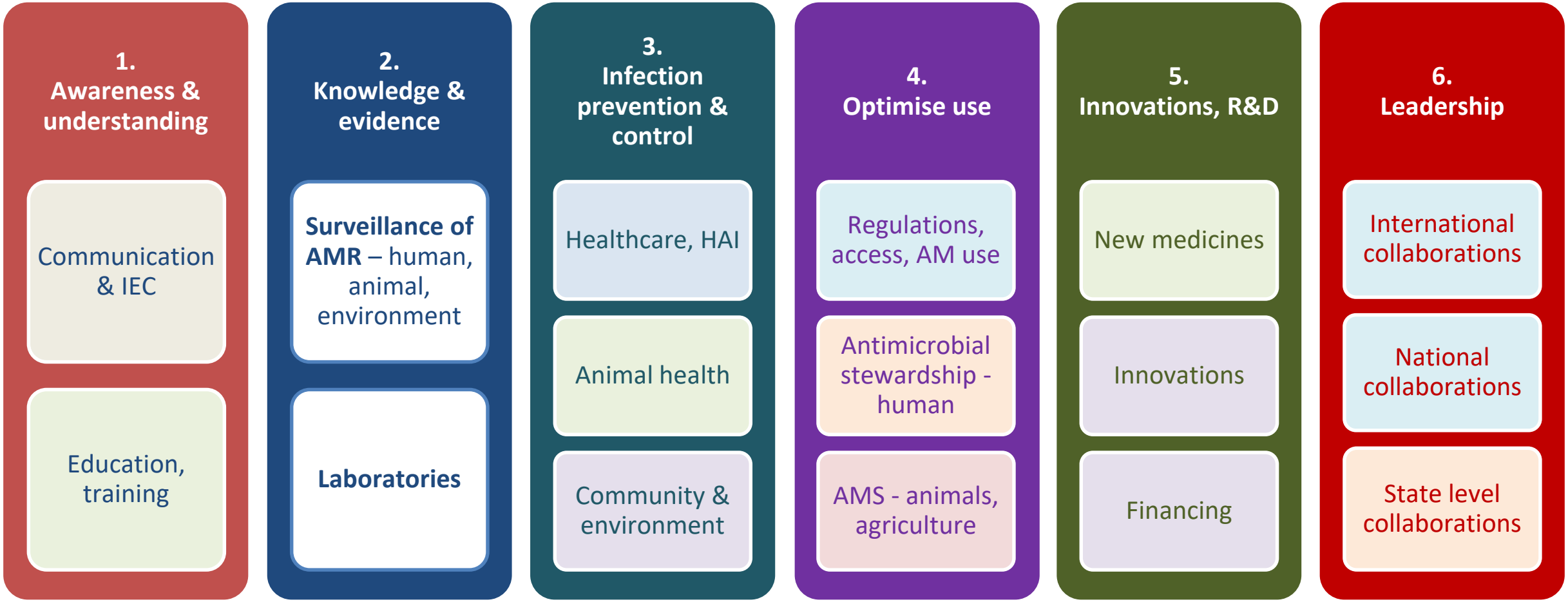
- **Treatment guidelines** for infectious diseases
- **Red Line** campaign
- Governance mechanisms notified for NAP-AMR

2017

- **Inter-Ministerial Consultation on AMR**, April 2017
- NAP-AMR launched
- Delhi Declaration signed by 4 Union ministers



National action plan on AMR



- In alignment with Global action plan
- Involves Integrated “One Health approach”
- Includes six strategic priorities:

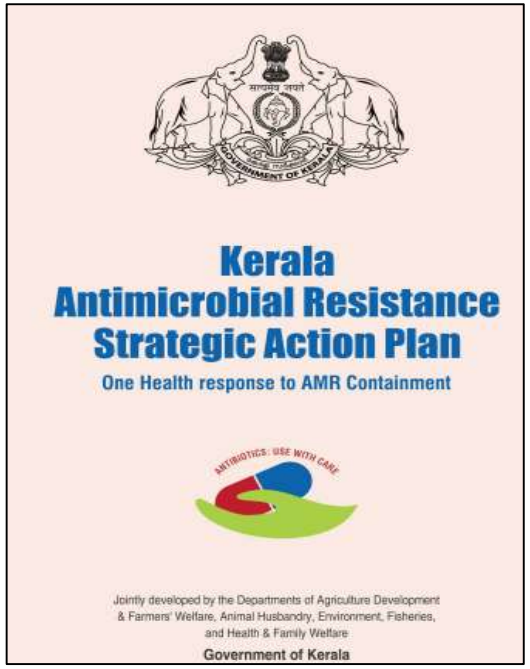
SP 4 : Optimize the use of antimicrobial agents in health, animals and food

Institution level Antimicrobial consumption studies

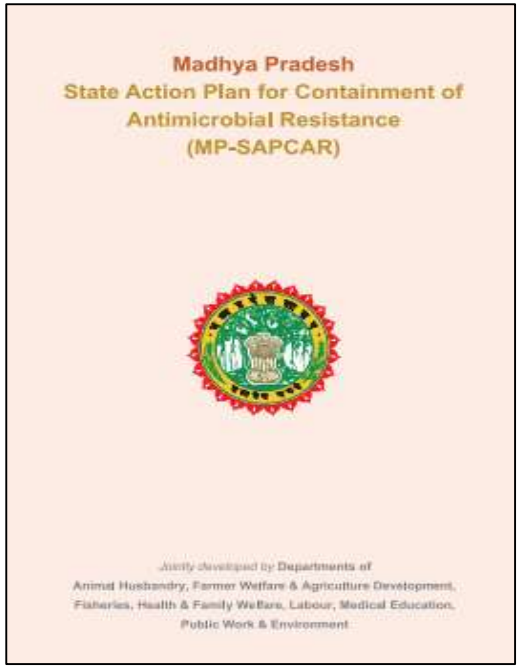
Regulatory mechanisms in place **(CDSCO,FSSAI)**

- **Schedule H** – sale of drugs (including antimicrobials) only on prescription
- **Schedule H-1** introduced in 2013 for high-end antimicrobials with stringent record keeping
- Use of 19 antimicrobials (and veterinary drugs) prohibited in terrestrial and aquatic animals for food production (2018)
- **Tolerance limits** specified for 43 antimicrobials (and veterinary drugs) in animal tissues and milk
- **Sale and distribution of Colistin prohibited** for food-producing animals and animal feed supplements (2019)

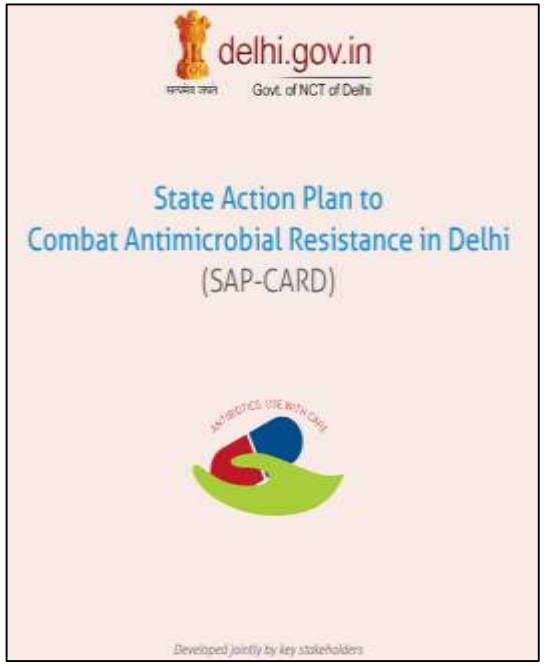
State action plans for Containment of AMR



Kerala
KARSAP, Oct 2018



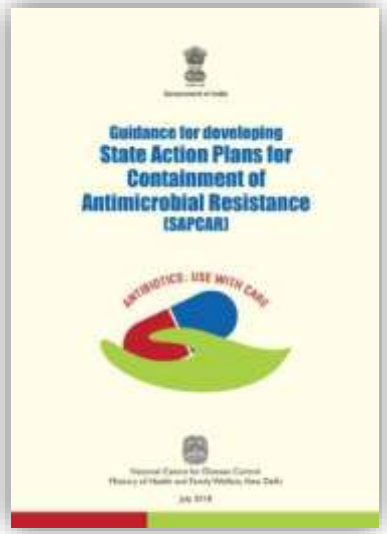
Madhya Pradesh
MP-SAPCAR, Jul 2019



Delhi
SAPCARD, Jan 2020

Andhra Pradesh Action Plan for Containment of AMR
(APAPCAR)

Andhra Pradesh
SAPCARD, June 2022



Ministry of Health & Family Welfare
Government of India

Regional AMR Workshop
Kochi | 31 Jan - 1 Feb 2020

Kerala Antimicrobial Resistance Strategic Action Plan (KARSAP) 25 October 2018

Madhya Pradesh State Action Plan for Containment of Antimicrobial Resistance (MP-SAPCAR) 26 July 2019

Directorate of Health Services,
Dept. of Health & Family Welfare, Govt of NCT of Delhi

Andhra Pradesh State Action Plan to Combat Antimicrobial Resistance (AP-APCAR) 25-26 November 2022

State Action Plan to Combat Antimicrobial Resistance in **Delhi** (SAP-CARD) 3 January 2020

BEST PRACTICES
AIDCOC CONSUMER EDUCATION THROUGH DIRECT ACTION

a) Awareness on spurious drugs

b) Providing support to other organizations

c) National project on consumer awareness

Source: https://aidcoc.in/activites.html

Conclusion:
Our actions to cover Blind Spots in Tackling AMR

Weak Global Surveillance – Fragmented and inconsistent monitoring of AMR trends.

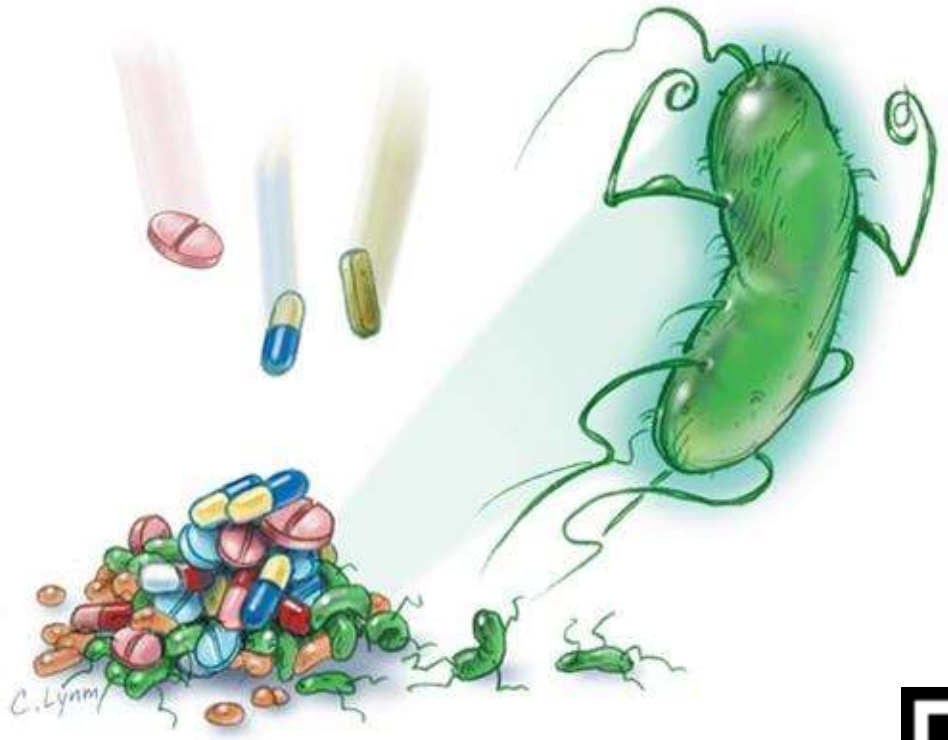
R&D Investment Gap – Declining antibiotic development due to economic and scientific challenges.

Agricultural Overuse – Excessive antibiotic use in livestock and aquaculture driving resistance.

Low Public Awareness – Limited understanding of AMR risks and responsible antibiotic use.

Weak Health Systems – Inadequate infection prevention and control, especially in LMICs.

Source: Prof Madhukar Pai, MD, PhD, FRSC comments in Lancet



GLOBAL SOUTH CONFERENCE ON

Infection Prevention and Control Antimicrobial Stewardship (G-SPARC)

We welcome you to join us at

G-SPARC-2026

Dates to be announced soon

Please visit

www.ifcai.in

www.g-sparc.com

Together, we can combat Antimicrobial Resistance (AMR) more effectively!

president@ifcai.in