DISSERTATION PRESENTATION 2021-23

Antimicrobial Resistance

JYOTI YADAV (Health Information Technology)

Organization- PricewaterhouseCooper (PwC)

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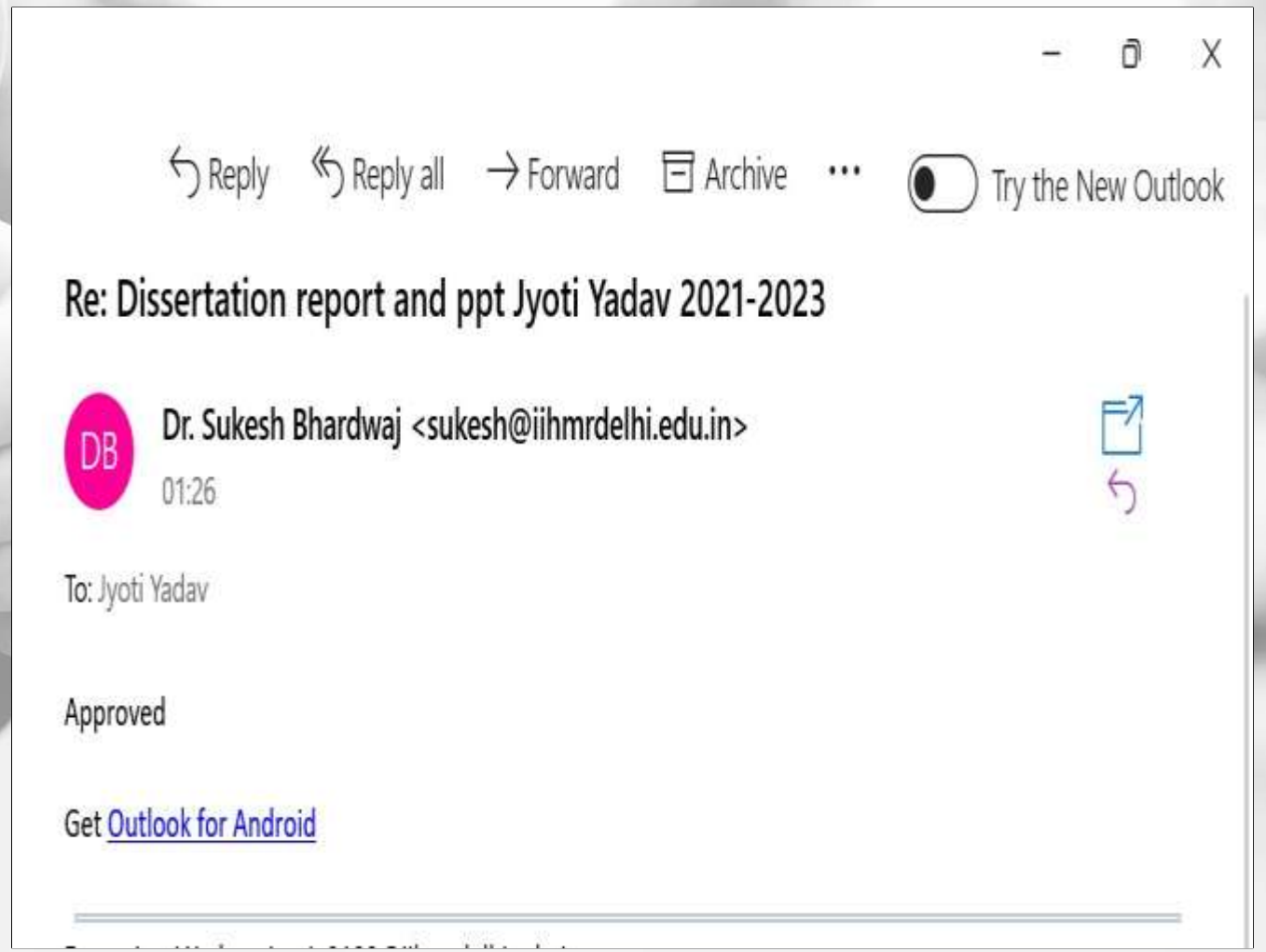
CERTIFICATE OF APPROVAL



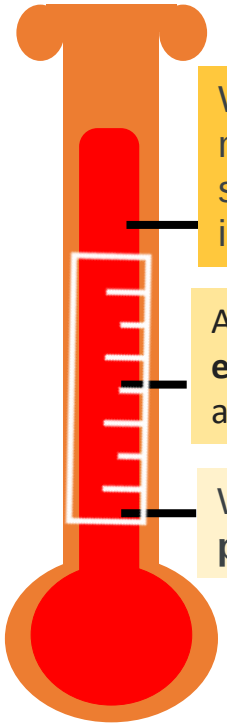
'The Superbug is under surveillance' : AMR surveillance tool and proposed solution to fill the gaps in India

Antimicrobial Resistance

Antimicrobial Resistance (AMR) occurs when bacteria, viruses, fungi and parasites change over time and no longer respond to medicines making infections harder to treat and increasing the risk of disease spread, severe illness and death.
Antimicrobials – including antibiotics, antivirals, antifungals and antiparasitic – are medicines used to prevent and treat infections in humans, animals and plants.

The important antimicrobial bacteria ***ESKAPE,*** *encompassing Enterococcus faecium, Staphylococcus aureus, Klebsiella pneumoniae, Acinetobacter baumannii, Pseudomonas aeruginosa, and other Enterobacter species.*

Why the topic is under the sun?

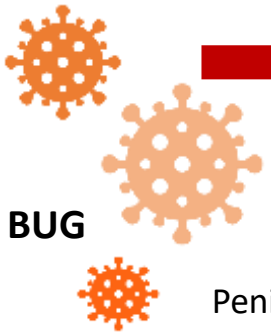


Without effective antimicrobials, the success of modern medicine **in treating infections**, including during major surgery and cancer chemotherapy, would be at increased risk.

AMR could push 28.3 million people could be pushed into **extreme poverty by 2050** due to high costs of treatment and chronic infections & will loss 4% of GDP.

WHO has declared that AMR is one of the top 10 global **public health threats** facing humanity.

'Evidences of mutation to superbug'



BUG

Penicillin — 1943

Streptomycin — 1946

'Golden age of antibiotics' — 1950-70

Strains of Shigella bacteria show resistance to tetracycline — 1959

Methicillin — 1960

Penicillin resistance bacteria started to spread — 1965

MRSA first case — 1968

In 2000, case of MDR-TB was found. — 1990 ---------- 2010

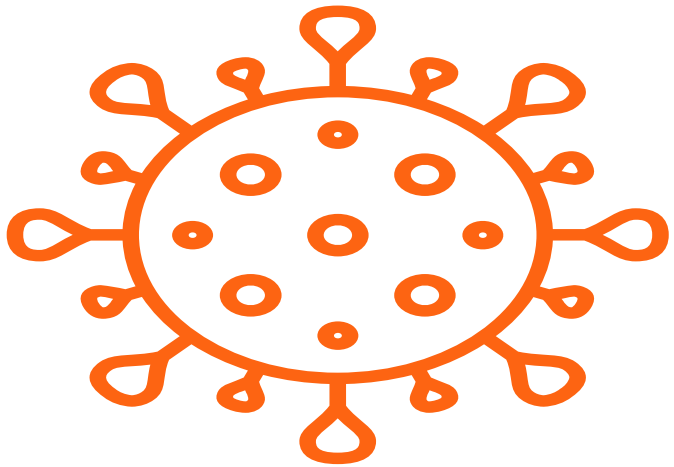
Discovery void — 1990 ---------- 2010

2008 — A new gene New Delhi Methallo-beta-lactamase that give bacteria resistance to two of the largest class of antibiotics.

2009 — Strains of Neisseria gonorrhea resistant to treatment discovered

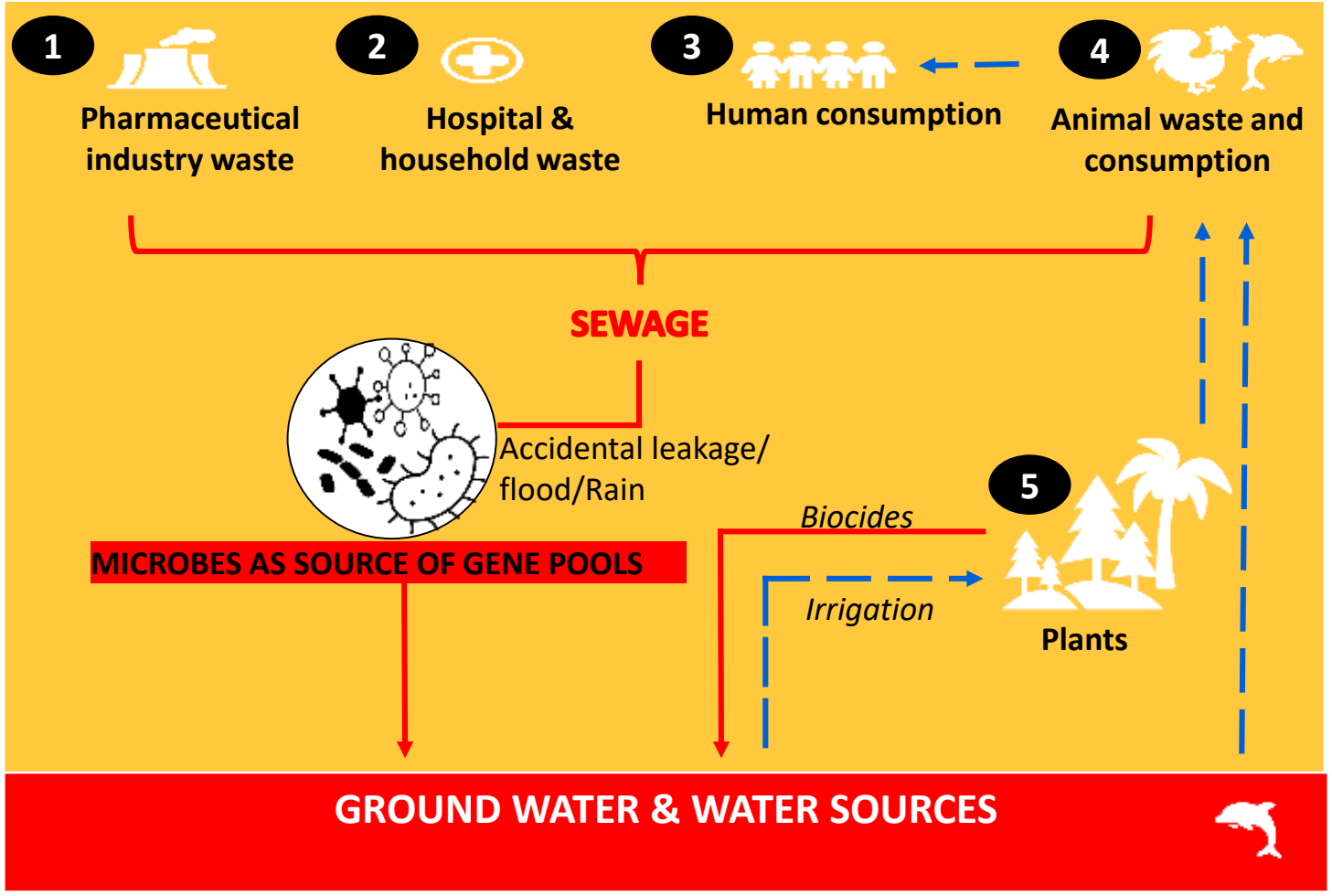
2012 — Several hospital reported outbreak of carbapenem resistance Enterobacter due to inappropriate cleaning of duodenoscope

2017 — A women died from a bacterial infection resistance to 26 antibiotics available in US

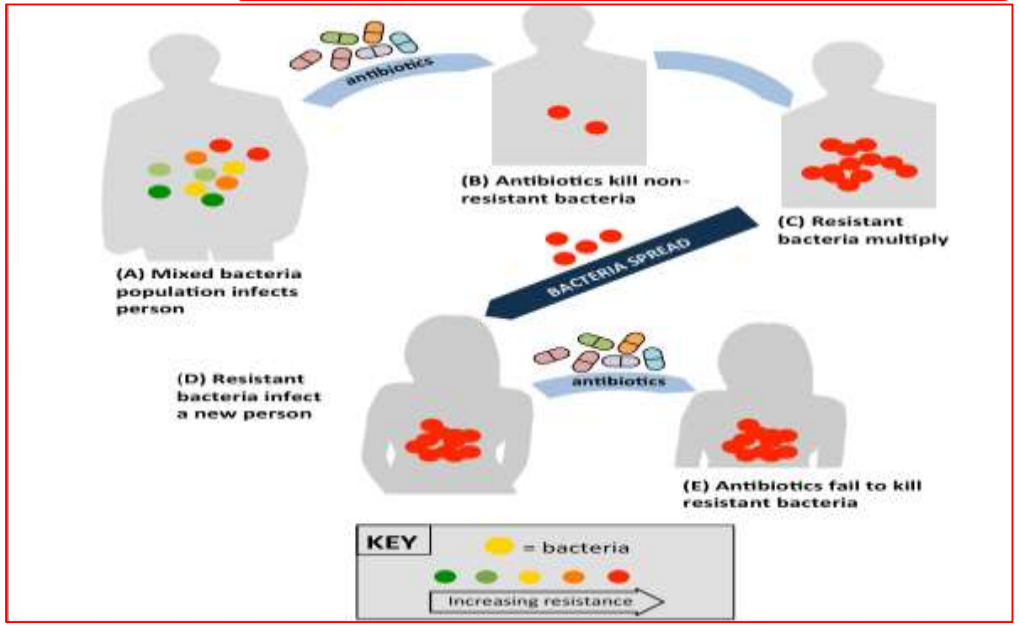


SUPERBUG

Connection from consumption of antibiotics to creation of superbug



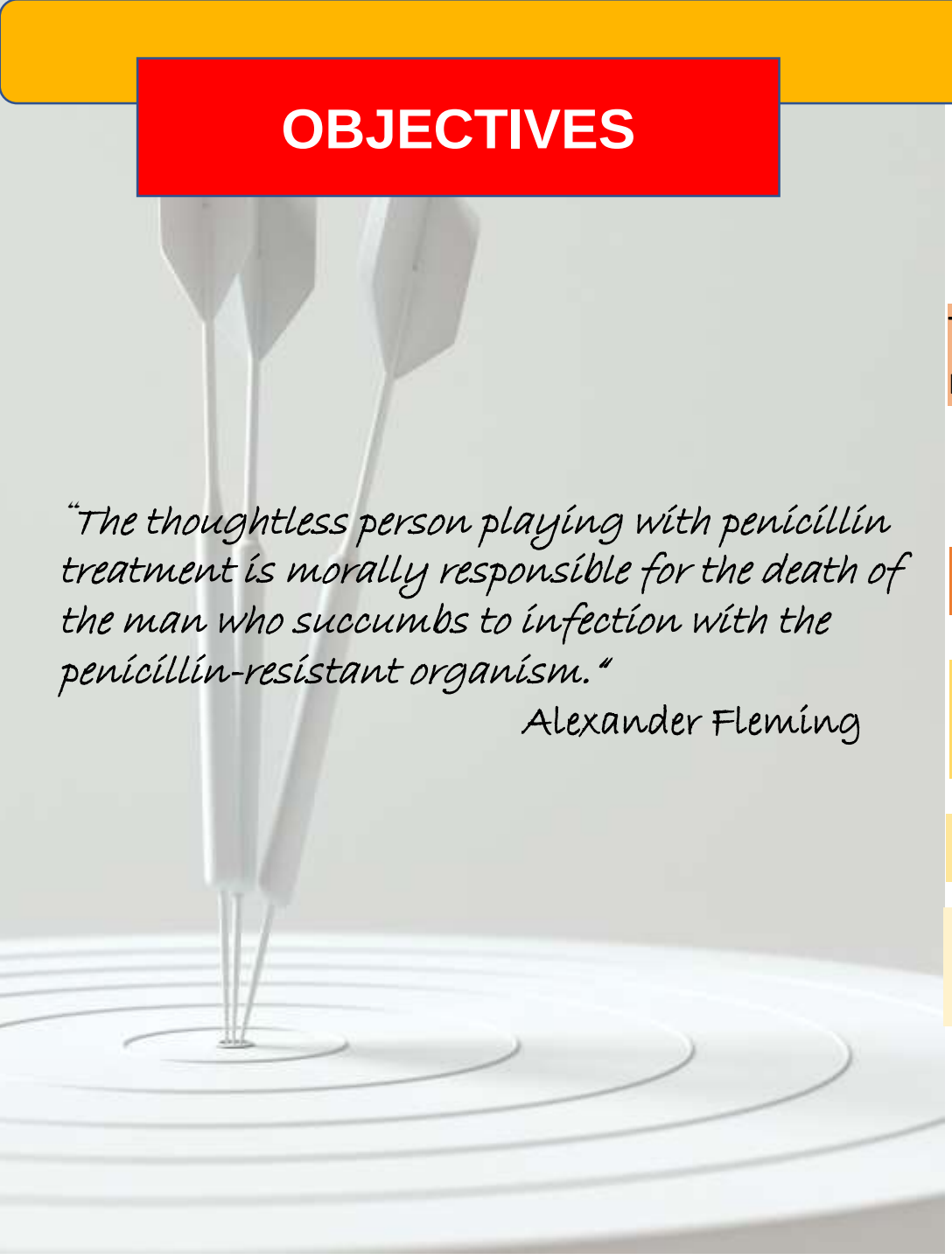
CREATION OF SUERBUG



PRODUCTION OF ANTIBIOTICS

- In the fiscal year of 2018–2019 India exported antibiotic ingredients and medicines for a value of **2.4 billion USD**, compared to 268 million USD in 1996–1997.
- In 2015, study found **the polluted lakes harbored** considerably high proportion of ciprofloxacin resistant and sulfamethoxazole- resistant bacteria. About **80-90% of the world's antibiotics** are made in factories in India and China.

OBJECTIVES



"The thoughtless person playing with penicillin treatment is morally responsible for the death of the man who succumbs to infection with the penicillin-resistant organism."

Alexander Fleming

PRIMARY OBJECTIVE

To study the surveillance system in India for Antimicrobial resistance and fill the gaps with proposed solution.

SECONDARY OBJECTIVES

To estimate the burden of antimicrobial resistance across globe.

To define & describe the NARS-Net and ICMR surveillance network and the necessary finding on AMR in India.

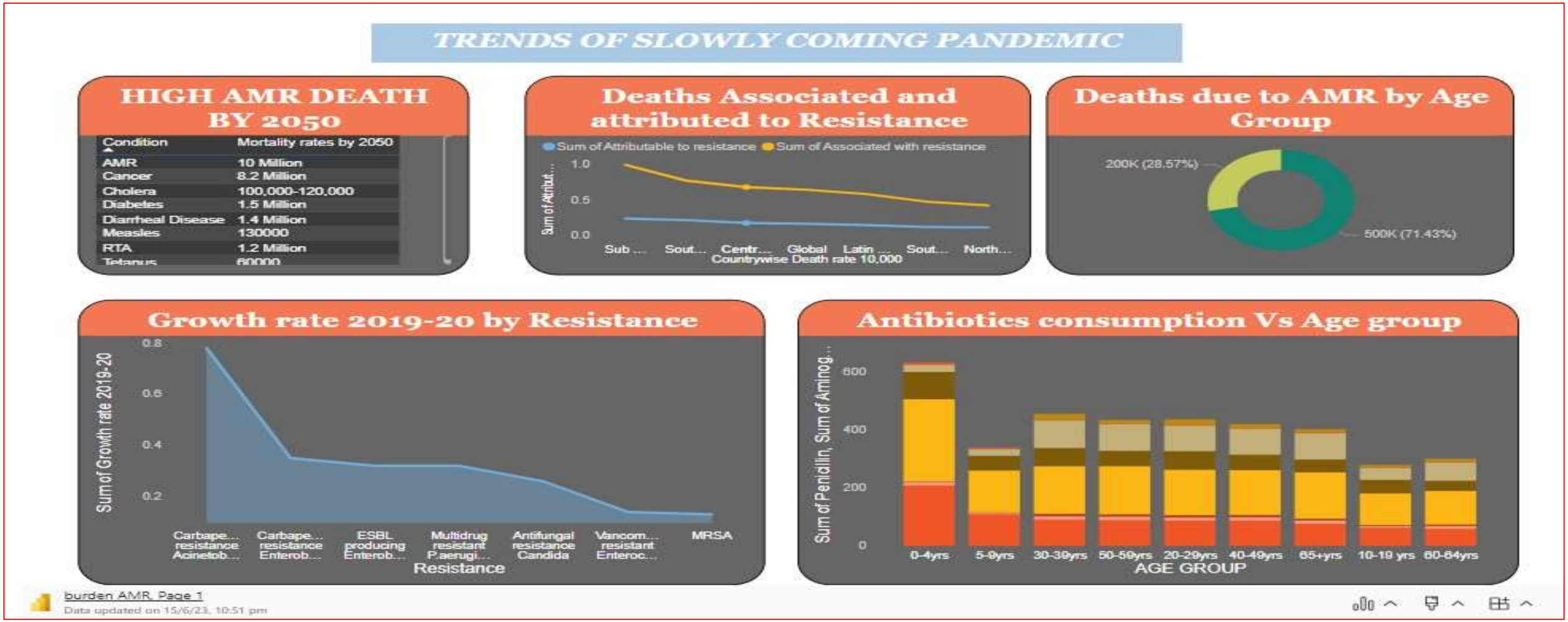
To conduct SWOT analysis for gaps in the surveillance system.

To propose solution to strengthen the surveillance of AMR using current network in India.

METHODOLOGY

This is a secondary research paper that rely on the analysis of data collected from the web sources(PubMed, Google scholar, WHO and ICMR & NCDC reports)
The data for the study is collected from web based and WHO website and ICMR reports. Also, to drive to an integrated solution after analysis.
Tools used are Draw io, MS-Excel, Power BI.
Antimicrobial resistance, surveillance, AMR detection & Antibiotic susceptibility testing, AMRSS and India

To estimate the burden of antimicrobial resistance across globe.	01



The dashboard depicts:

1. By 2050 AMR will surpass all other disease condition and will cause 10million death across the globe.
2. Sub-Saharan region have presently the highest deaths associated with resistance followed by South Asian countries.
3. Presently, 700000 deaths are caused BY AMR. Among them 200000 are among under 5yrs which even have highest consumption of antimicrobials. Acinetobacter baumanii have highest resistance rate.

1


Drug Resistance Index

2


Carbapenem resistant klebsiella pneumoniae

3


3rd generation Cephalosporin resistant to Klebsiella pneumoniae

4


3rd generation Cephalosporin resistant E.coli

5


3rd generation Cephalosporin resistant E.coli

6


MRSA

7


Carbapenem resistant Acinetobacter Baumannii

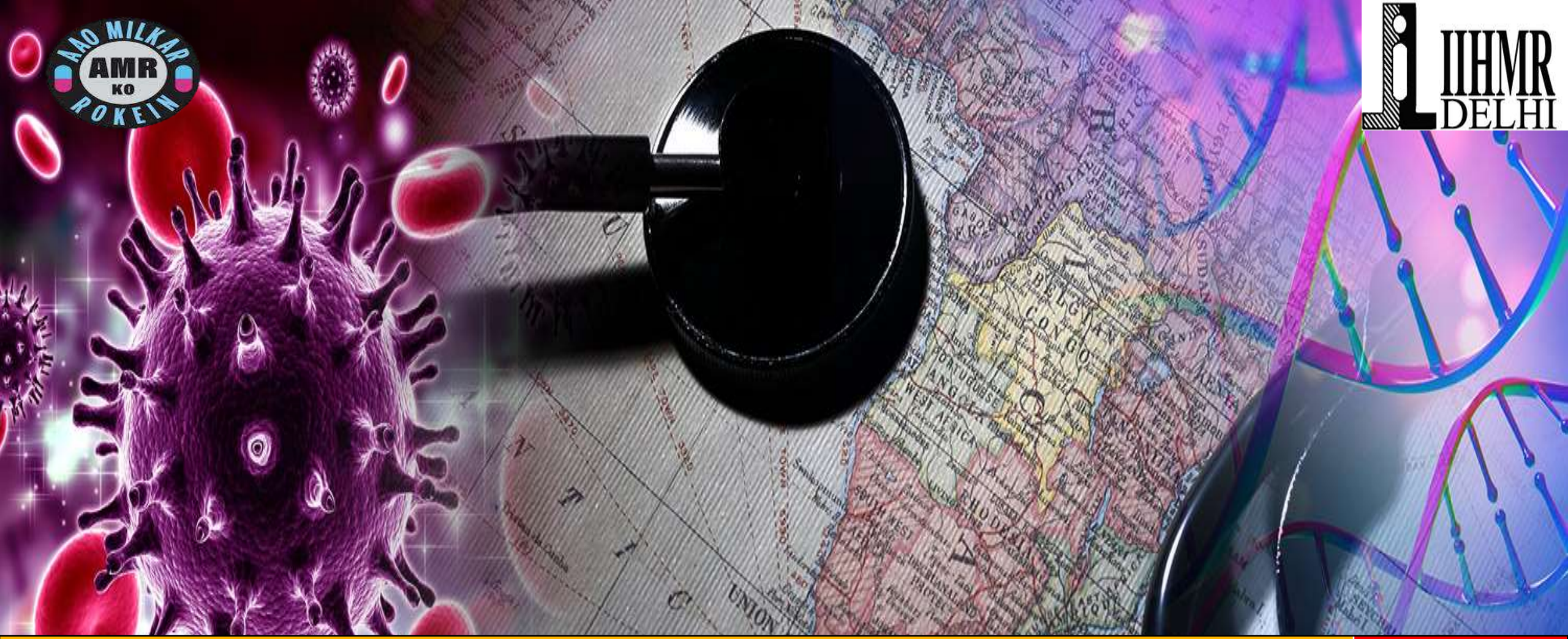
Key findings on Burden of Antimicrobial resistance globally

There were an **estimated 4·95 million (3·62-6·57) deaths associated** with bacterial AMR in 2019, including 1·27 million (95% UI 0·911-1·71) deaths attributable to bacterial AMR. Death rate attributable to resistance to be **highest in western sub-Saharan Africa.**

The **six leading pathogens for deaths associated** with resistance (Escherichia coli, followed by Staphylococcus aureus, Klebsiella pneumoniae, Streptococcus pneumoniae, Acinetobacter baumannii, and Pseudomonas aeruginosa) were responsible for **929000 deaths attributable to AMR and 3·57 million associated with AMR in 2019**.

Carbapenem-resistant ***A baumannii*, we estimated that it was the fourth leading pathogen–drug combination** globally for 2019, responsible for slightly fewer deaths than third-generation cephalosporin-resistant *E coli*.

India has >50% for all 7 AMR categories/ findings along with >80% resistance for A baumannii. The reasons could be self-medication and not following proper regime along with parenteral route of medication.



IIHMR DELHI

To define & describe the NARS-Net and ICMR surveillance network and the necessary finding on AMR in India.

02

GLASS – Global Antimicrobial Resistance Surveillance System

111 countries are enrolled in GLASS-AMR

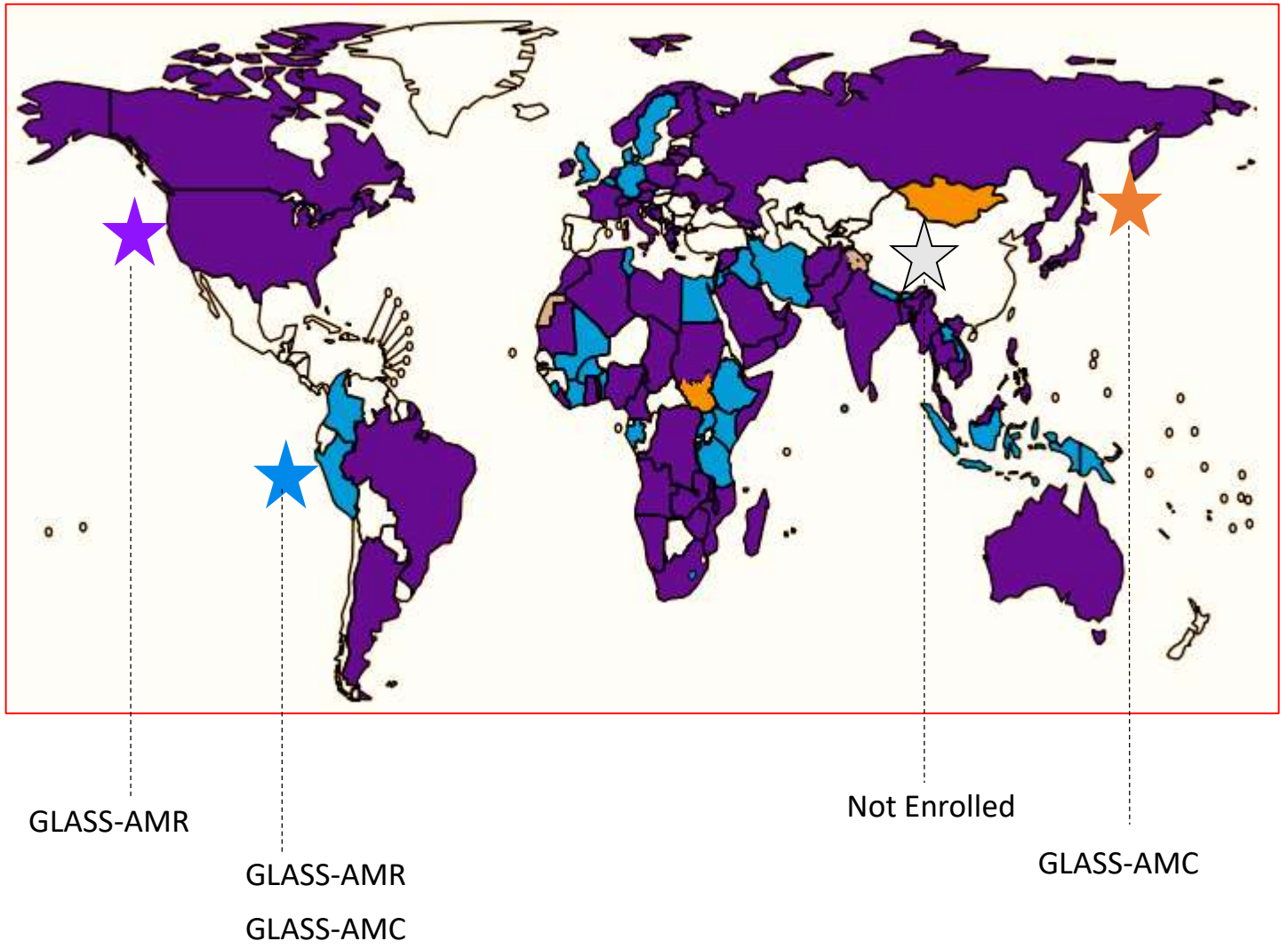
33 are enrolled in AMR &AMC whereas, Montanergo, Mongolia & Sudan only for AMC

Annual reports are released by WHO based on data on priority pathogen

WHONET is the free software used contain 36 languages (Data entry, capture and analysis)

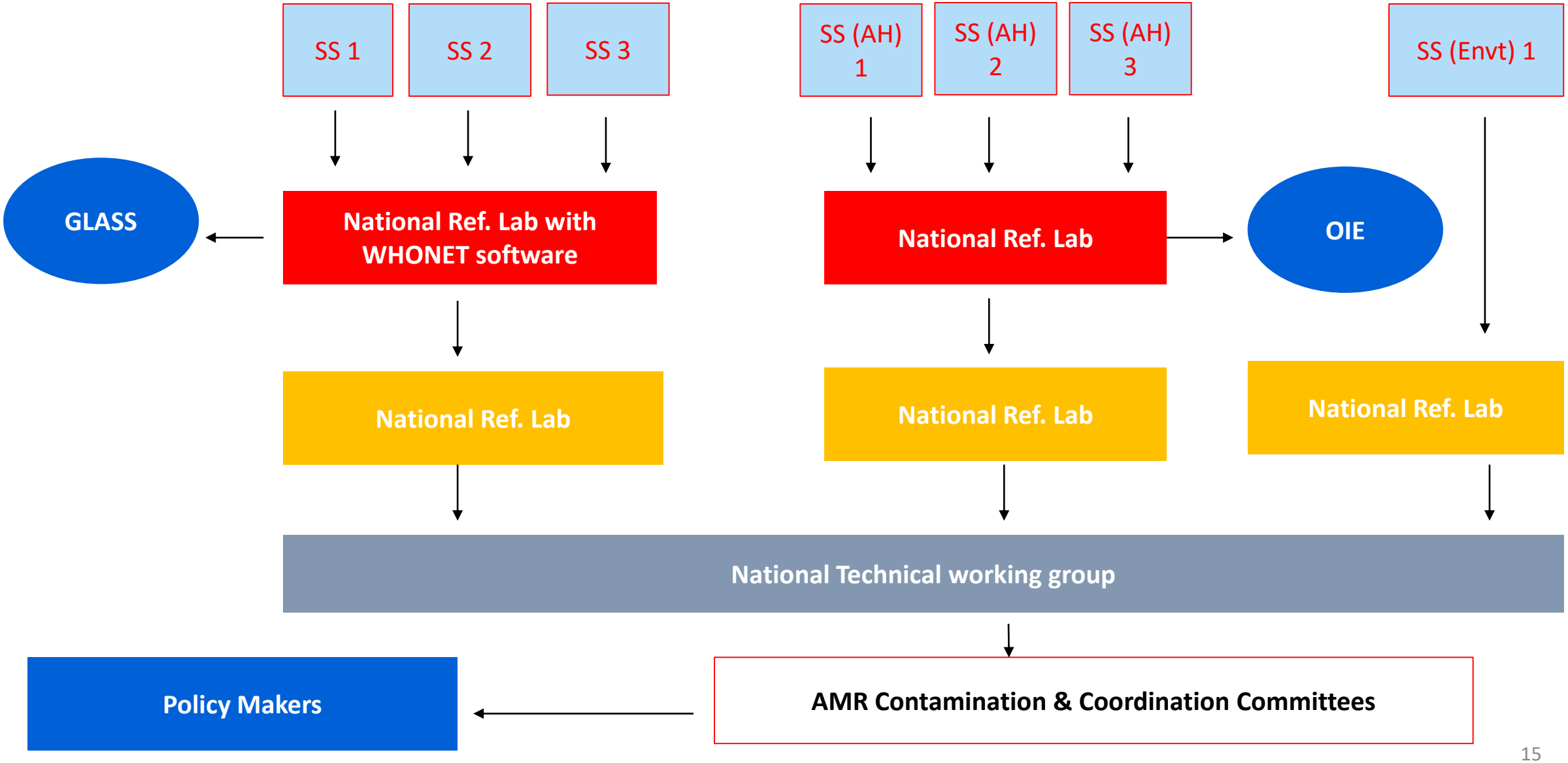
It was started in 2017 and till date it is in continuation

COUNTRIES ENROLLED IN GLASS 2021



AMR = Antimicrobial resistance
AMC= Antimicrobial consumption

'Entire surveillance breakup' for human and animals



Journey from regional centers to International level reports

Patient → Infection → Laboratory test to identify cause etc. → Antibiotic susceptibility test → Disk test takes 48 hrs → Result derived according to CLSI scale in WHONET

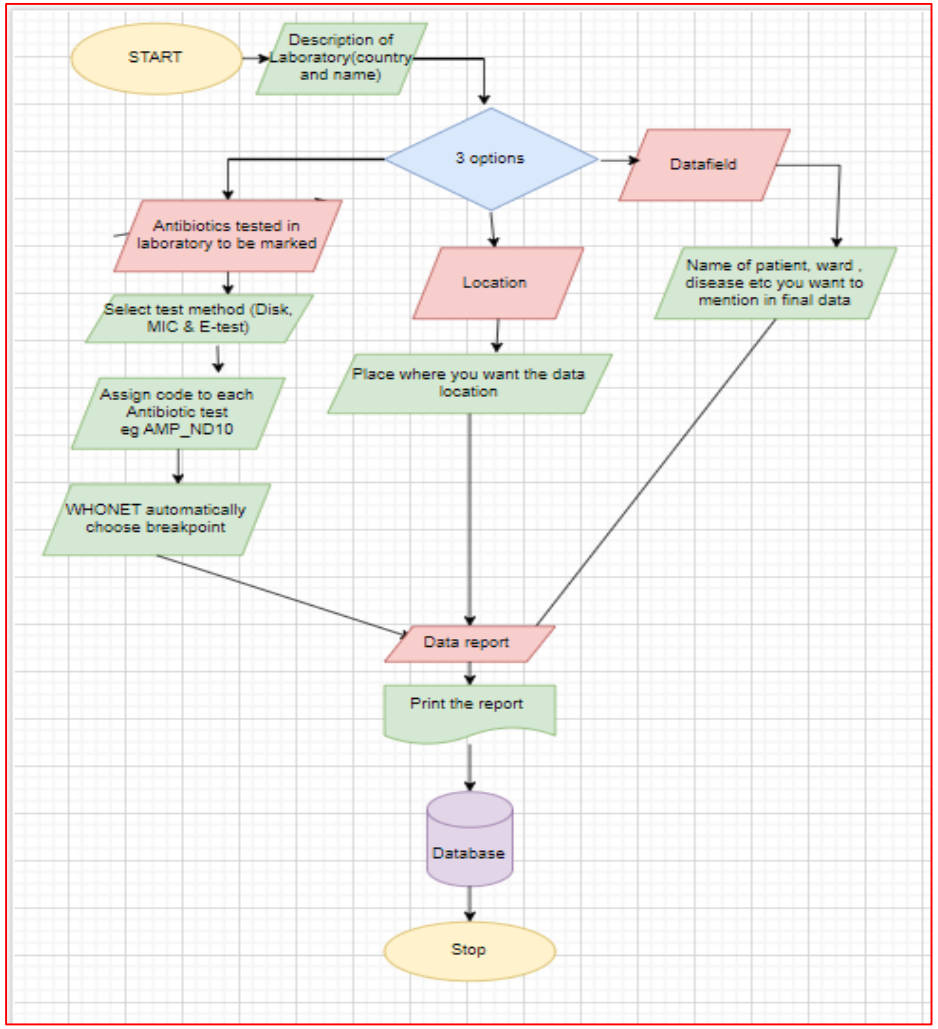
Antimicrobial agent * (n° of strains)	CLSI susceptibility breakpoint (mg/L)
Ampicillin-sulbactam (223)	≤2
Amoxicillin-clavulanate (47.030)	≤4
Cefaclor (28.338)	≤8
Cefixime (7.403)	≤1
Cefpodoxime (20.842)	≤2
Cefuroxime axetil (94.671)	≤4
Cefuroxime parenteral (94.671)	≤4
Cefotaxime (13.655)	≤2
Ceftriaxone (170)	≤2
Cefepime (396)	≤2
Ceftibuten (444)	≤2
Meropenem non meningitis (6.511)	≤0.5
Imipenem (3.828)	≤4
Ciprofloxacin (12.794)	≤1
Levofloxacin (22.880)	≤2
Moxifloxacin (14.177)	≤1

Data is stored with center → Quarterly the data is stored → Nodal officer sign and send to central body before 15th of next month → Database → Data Analysis on country data

Report → Send to GLASS & for research studies → Action could be taken based on findings

WHONET- core of the surveillance

Software process flow

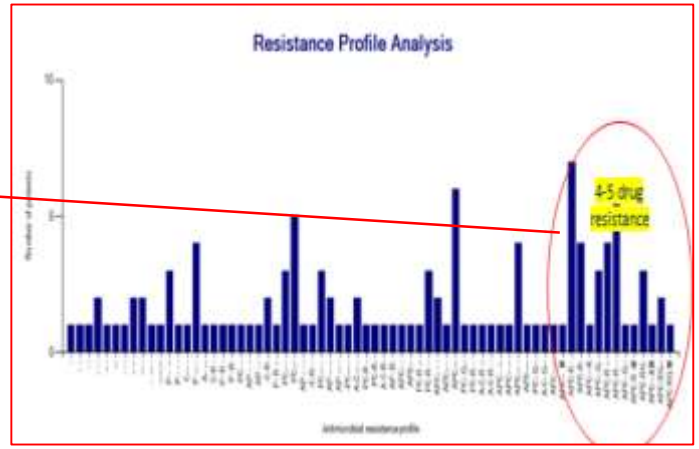


Send alerts via mail for missing data, duplicated data and for key findings

Versatile software with ability to configure many laboratories with different function. Embeded scale to measure radius in disc test.

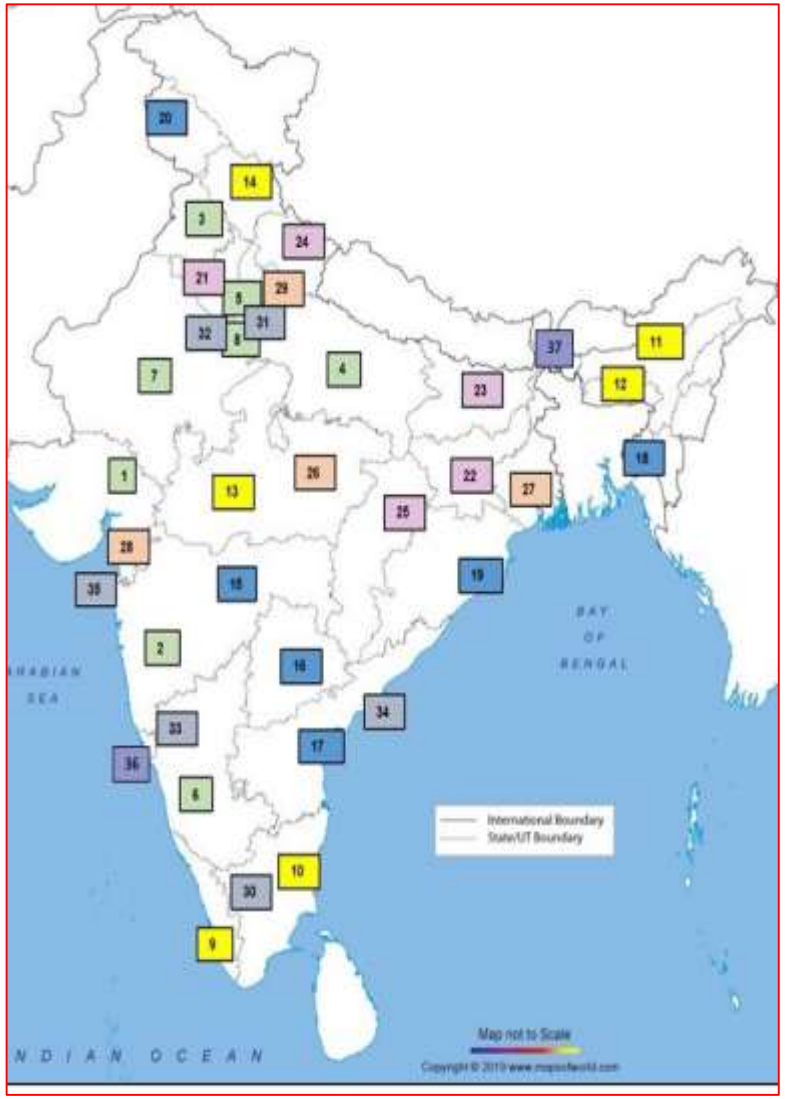
The software is able to integrate microscopy with cultural enabling accurate interpretation

Antibiogram(percentage susceptibility) can be easily obtained .It has no additional cost.



NCDC is the coordinating center for AMR in India (NARS-Net)

NCDC AMR surveillance network (NARS-Net)



1. Lady Hardinge Medical College and Associated hospitals, Delhi
2. Vardhman Mahavir Medical college and S.J Hospital, Delhi
3. SMS medical College, Jaipur, Rajasthan
4. B.J Medical College, Ahmedabad, Gujarat
5. B.J Medical college, Pune, Maharashtra
6. Government Medical college, Chandigarh
7. Mysore Medical college, Mysuru, Karnataka
8. GSVM Medical College, Kanpur, Uttar Pradesh
9. Gauhati Medical College and Hospital, Guwahati, Assam
10. K.A.P V. Government Medical College, Tiruchirappalli, Tamil Nadu
11. NEIGRIHMS, Shillong, Meghalaya
12. Govt. Medical College, Thiruvananthapuram, Kerala
13. M.G.M College and Hospital, Indore, Madhya Pradesh
14. IGMC, Shimla, Himachal Pradesh
15. Govt. Medical College and Hospital, Aurangabad, Maharashtra
16. Osmania Medical College, Hyderabad, Telangana
17. Govt. Medical College & Hospital, Jammu, Jammu and Kashmir
18. Agartala Govt. Medical College, Agartala, Tripura
19. Guntur Medical College, Guntur, Andhra Pradesh
20. SCB Medical College & Hospital, Cuttack, Odisha
21. Pt. Jawaharlal Nehru Memorial Medical College, Raipur, Chattisgarh
22. Rajendra Institute of Medical Sciences, Ranchi, Jharkhand
23. Pandit Bhagwat Dayal Sharma, Post Graduate Institute of Medical Sciences (PGIMS) Rohtak, Haryana
24. Indira Gandhi Institute of Medical Sciences, Sheikhpura, Patna, Bihar
25. Govt. Medical College, Haldwani, Uttarakhand
26. Gandhi Medical College, Bhopal, Madhya Pradesh
27. Calcutta School of Tropical Medicine, Kolkata, West Bengal
28. Lala Lajpat Rai Memorial (LLRM) Medical College, Meerut, Uttar Pradesh
29. GMERS Medical College and Civil Hospital, Valsad, Gujarat
30. Coimbatore Medical College & Hospital, Coimbatore, Tamil Nadu
31. Karnataka Institute of Medical Sciences (KIMS), Hubli, Karnataka
32. Indira Gandhi Medical College & Research Institute (IGMC & RI) Puducherry
33. NAMO Medical Education and Research Institute (MERI), Silvassa, Dadra & Nagar Haveli
34. Maulana Azad Medical College (MAMC) and Associated Hospitals, Delhi
35. Sardar Patel Medical College (SPMC) and Hospital, Bikaner, Rajasthan
36. Goa Medical College & Hospital, Bambolim

Seven pathogen under nodal centers

1. Staphylococcus aureus
2. Enterococcus species
3. Escherichia coli
4. Klebsiella species
5. Pseudomonas species
6. Acinetobacter species
7. Salmonella enterica serotype Typhi and Paratyphi

2021 REPORTS WITH N ~ 87,996

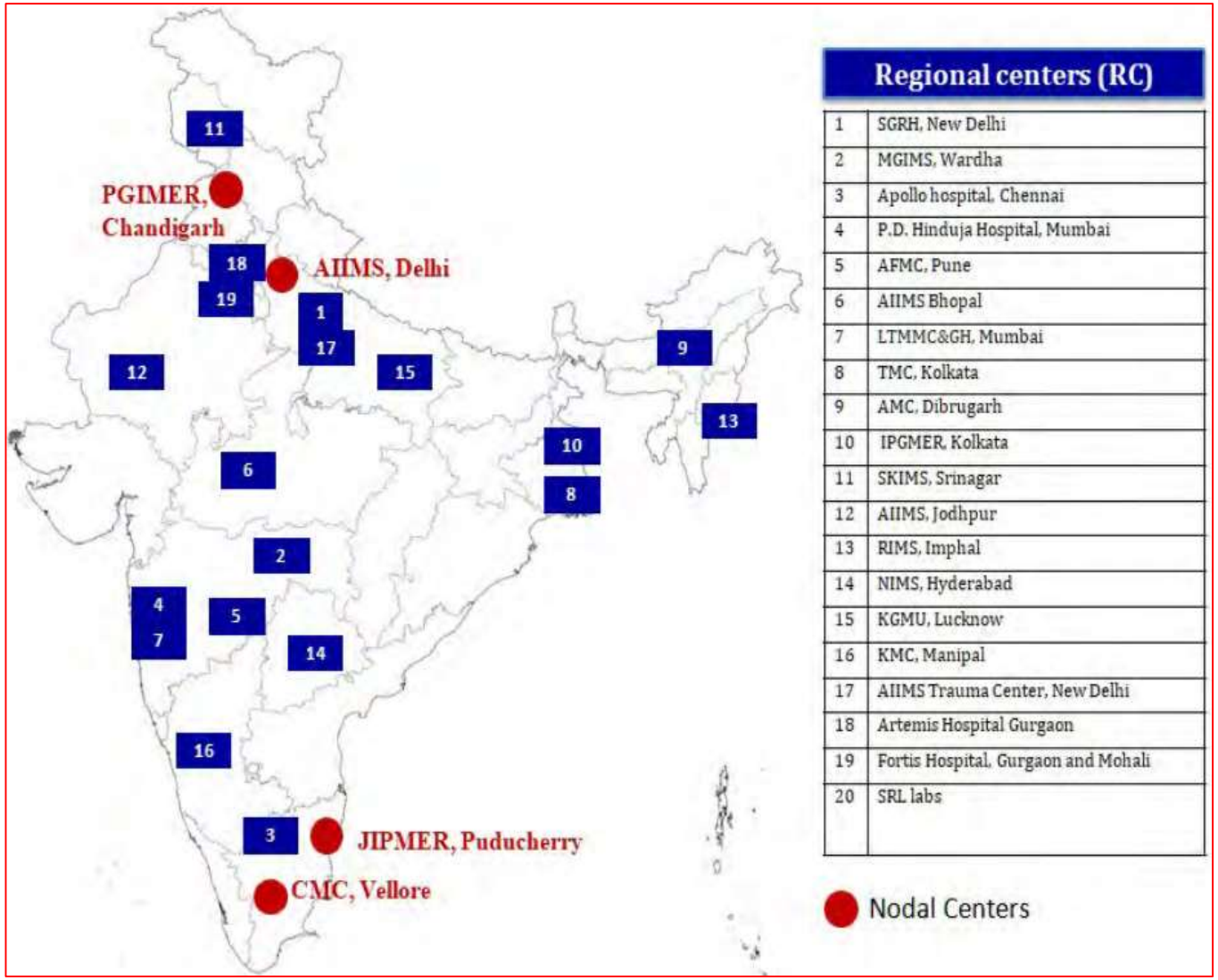
NAP on AMR

- Awareness by IEC
- Strengthening knowledge, evidence by AMR surveillance
- IPC guidelines AIIMS-ICMR-NCDC-CDC
- Optimization of antibiotics by CDSCO regulation
- Research & Innovation
- Strengthening collaboration at all levels

* National action plan - NAP

India's AMR Surveillance Infrastructure- ICMR

ICMR labs and Surveillance network

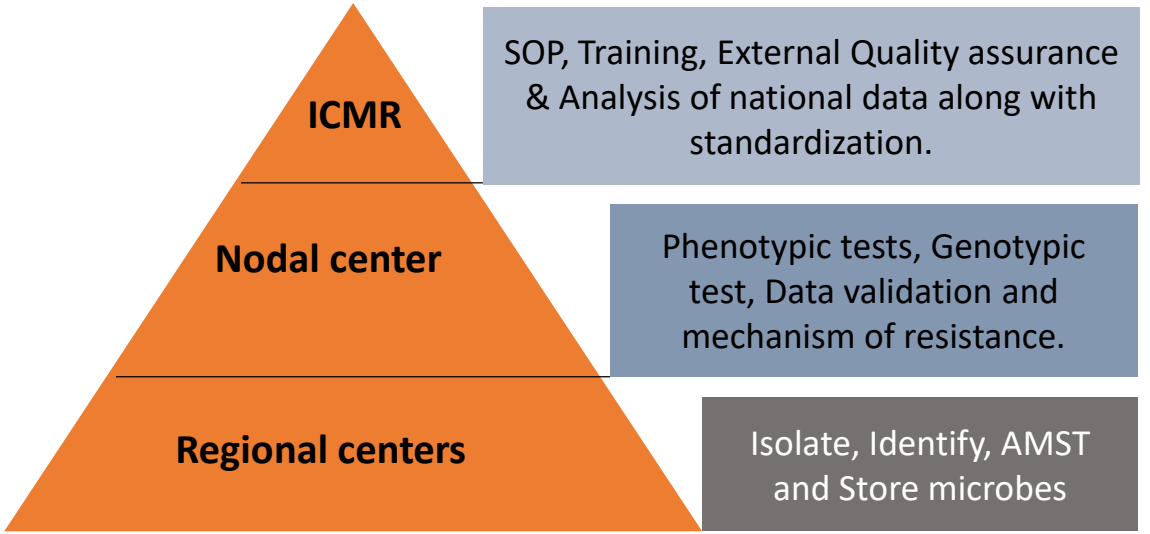


Regional centers (RC)	
1	SGRH, New Delhi
2	MGIMS, Wardha
3	Apollo hospital, Chennai
4	P.D. Hinduja Hospital, Mumbai
5	AFMC, Pune
6	AIIMS Bhopal
7	LTMMC&GH, Mumbai
8	TMC, Kolkata
9	AMC, Dibrugarh
10	IPGMER, Kolkata
11	SKIMS, Srinagar
12	AIIMS, Jodhpur
13	RIMS, Imphal
14	NIMS, Hyderabad
15	KGMU, Lucknow
16	KMC, Manipal
17	AIIMS Trauma Center, New Delhi
18	Artemis Hospital Gurgaon
19	Fortis Hospital, Gurgaon and Mohali
20	SRL labs

Seven pathogen under nodal centers

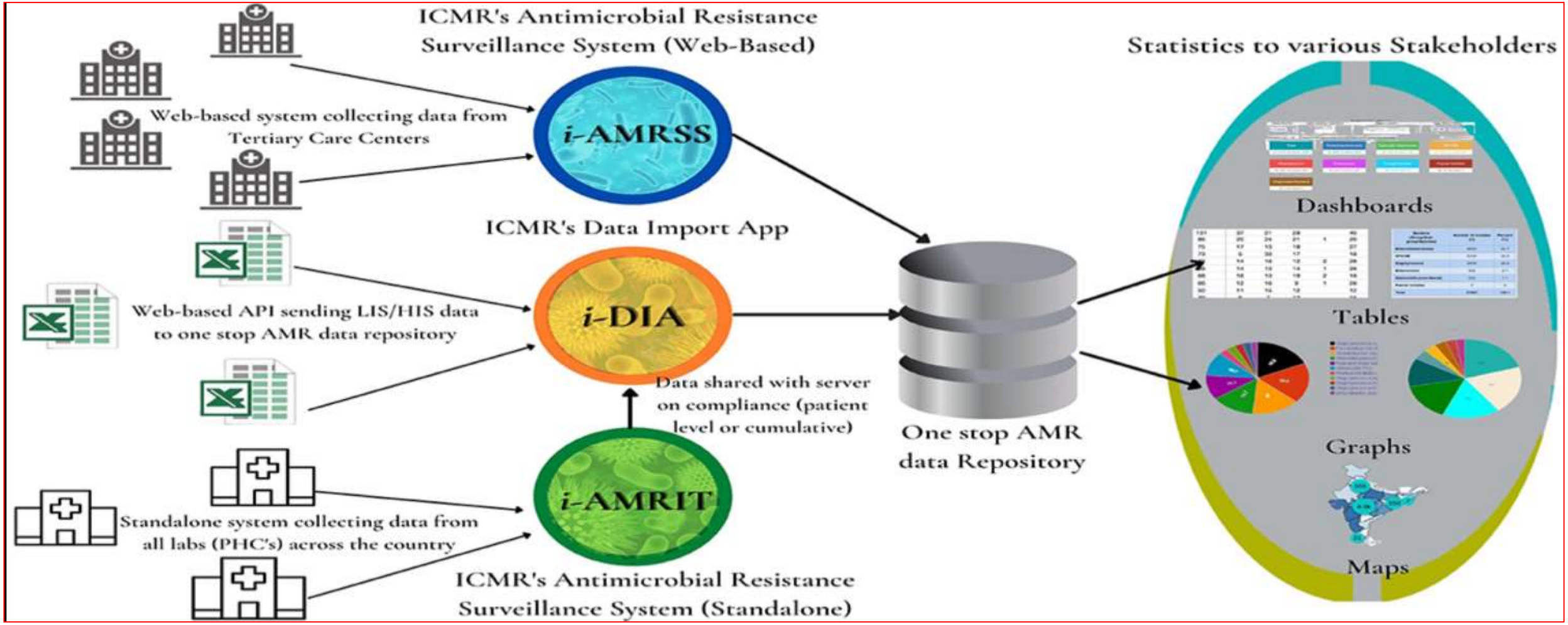
- Enterobacterales causing sepsis (PGIMER, Chandigarh)
- Gram-negative non-fermenters (CMC Vellore)
- Gram-positives: staphylococci and enterococci, (JIPMER, Puducherry)
- Typhoidal Salmonella (AIIMS New Delhi)
- Diarrhoeagenic bacterial organisms (CMC Vellore)
- Fungal pathogens (PGIMER, Chandigarh)
- Streptococcus pneumoniae (CMC Vellore)

2021 REPORTS WITH N ~1LAKHS

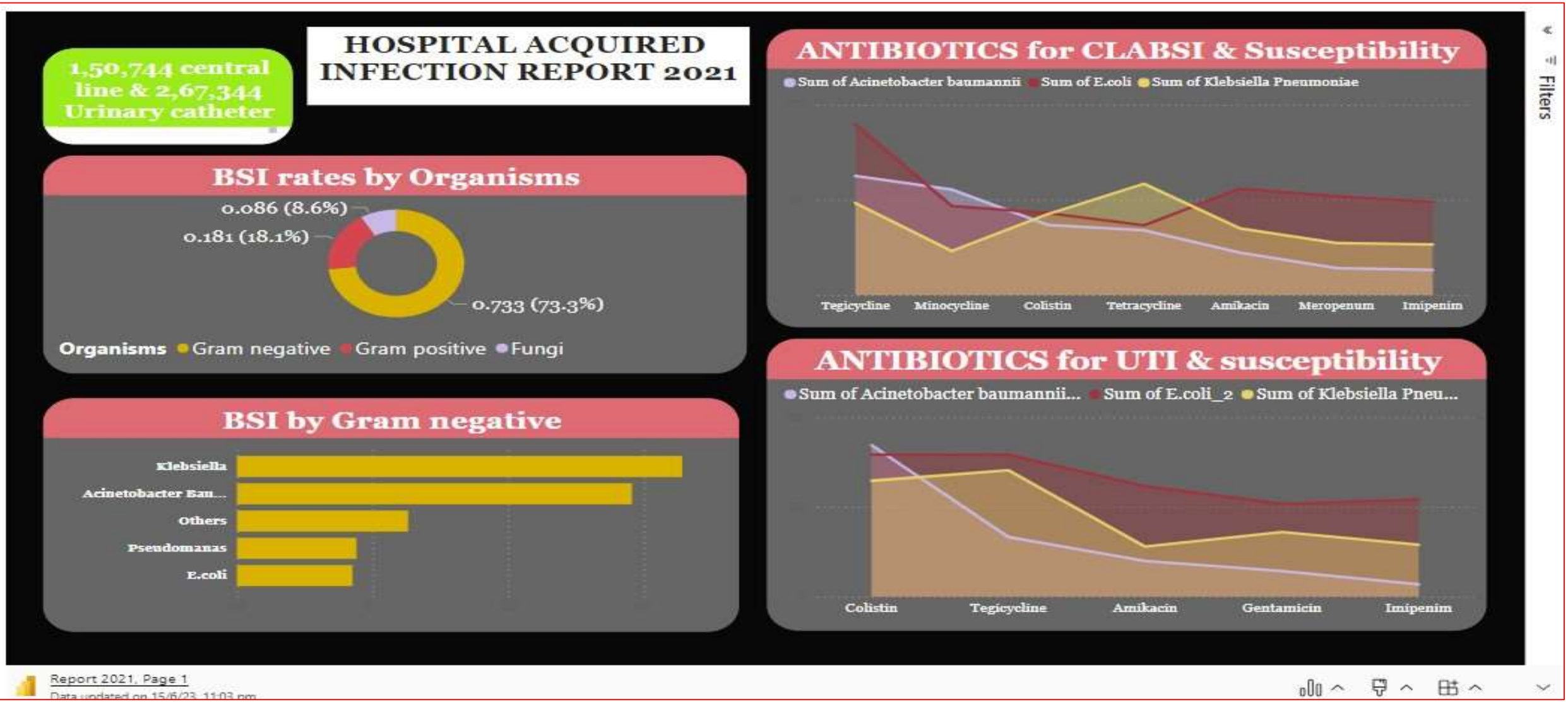


Role and responsibilities

ICMR surveillance network



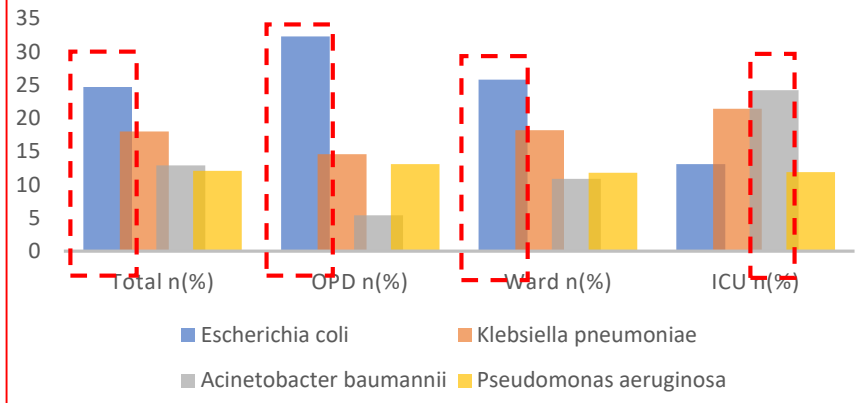
ICMR network has i-AMRSS which collects data from tertiary center. Currently the LIS/HIS and PHC are not functional due to lack of infrastructure and lack of manpower at location.



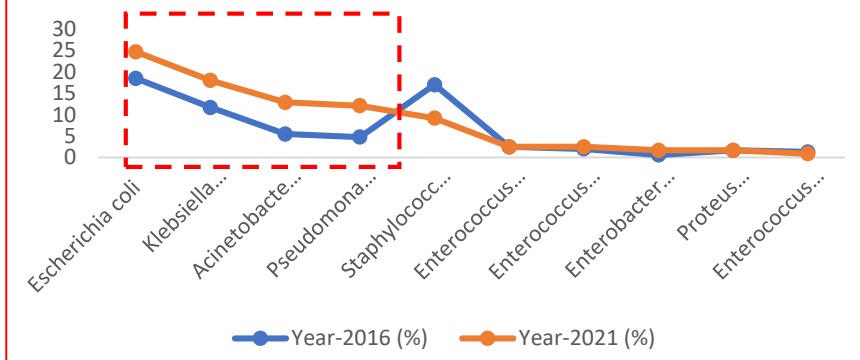
Report 2021 of ICMR captured BSI and genomic data. Gram negative bacteria are highly prominent among which Klebsiella are the major. Colistin is toxic but its susceptibility is great among other medicine for UTI whereas Meropenem and Imipenem is less for CLABSI.

Pathogen and their resistance %

Organisms found Wardwise

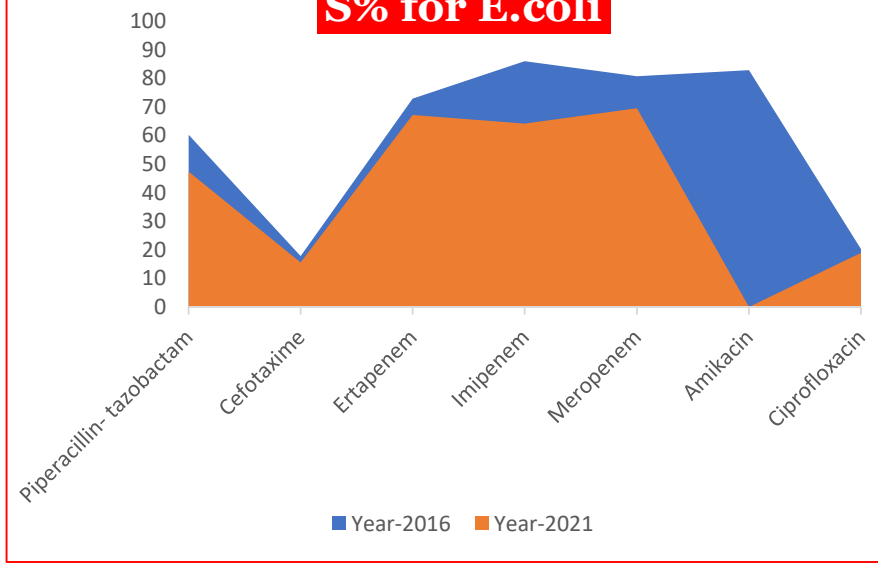


Bacteria trends since 2016 to 2021

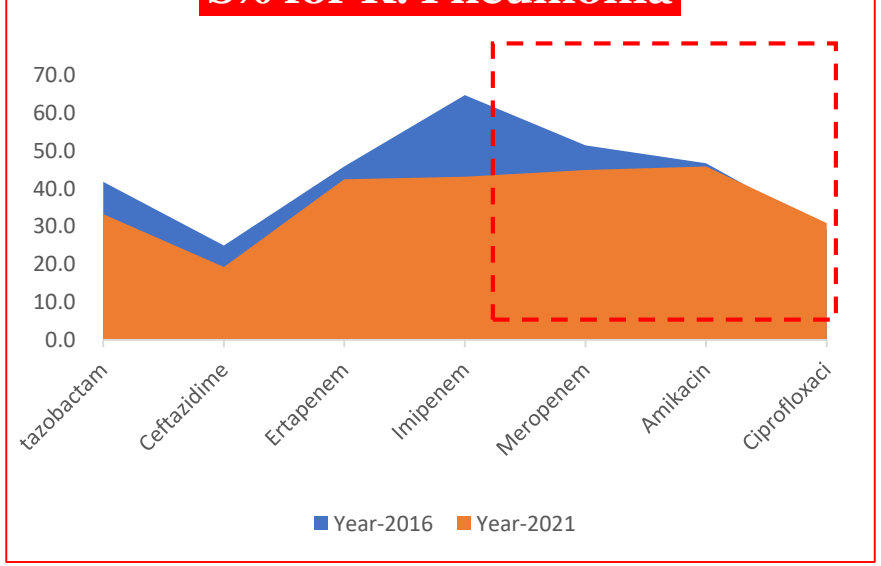


1. E.coli is most found among all the samples.
2. Imipenem susceptibility of E. coli has dropped steadily from 86% in 2016 to 64% in 2021
3. Resistance to carbapenems in Acinetobacter baumannii was recorded as 87.5% in the year 2021

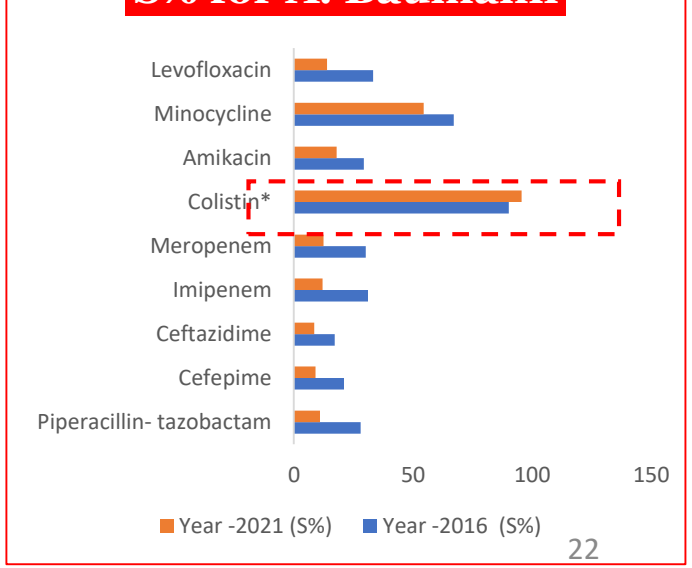
S% for E.coli



S% for K. Pneumonia



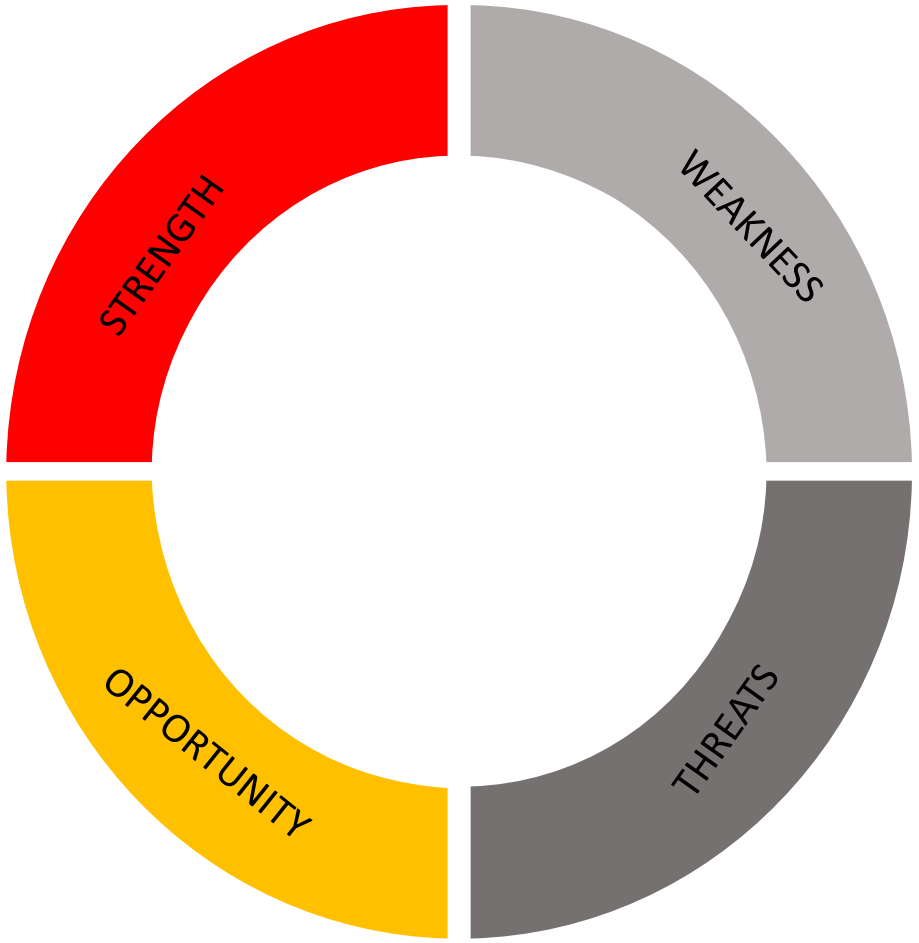
S% for A. Baumanii



To conduct SWOT analysis for gaps in the surveillance system.	O3

*SWOT Analysis for Indian AMRSS**

- Priority pathogen data recorded.
- Ward wise data collection
- Genotypic study done and HAI also included since 2021
- Free software WHONET used to maintain standardization
- Specific nodal centers for specific organism



- Population covered is very less.
- Sampling bias (tertiary population)
- **Patchy infrastructure(NARS-Net & ICMR)**
- Non availability of antibiotic consumption data
- Do not have enough data on Animal surveillance (one health approach)
- Silo data
- Lack of central repository on data

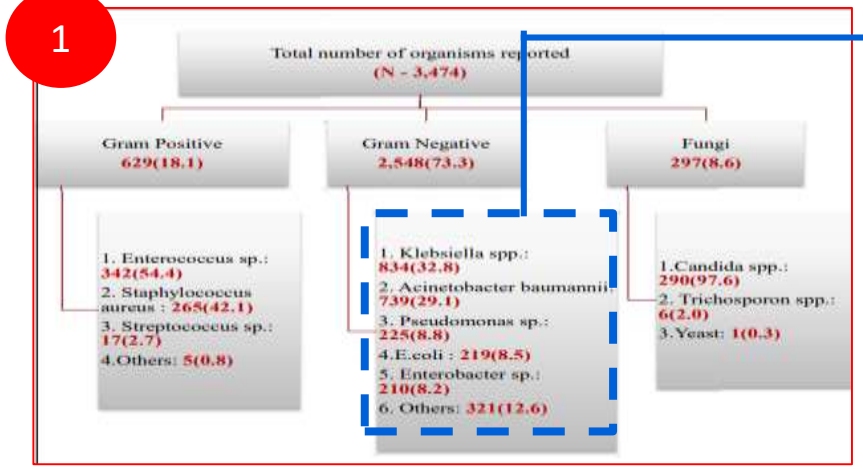
- Strengthen molecular studies.
- Usage of analysis in generating treatment guidelines specifically for the country.

- Over the counter tracking of antibiotics have no record.
- Data privacy and security issues.
- Treatment guidelines are based on foreign research instead of focusing on our inheritance.

*Antimicrobial resistance surveillance system

Cases presented during 'ICMR webinar on innovations'

1



This was a case of patient suffering septic shock, was already a cancer patient. He was given Vancomycin and Meropenum as per international guidelines on susceptible organisms. But rather in Indian context HAI(BSI) 3/4TH causative agents being *gram negative bacteria*.

MUST HAVE KNOWLEDGE OF LOCAL ENVIRONMENT

The case where LRTI is mostly caused by *Acinetobacter baumanni* accordingly treatment to be planned.

TREATMENT GUIDLINES

2

1.2: Isolation distribution of top 10 isolates from different specimens

Organism	Total	Blood	LRT	Superficial Infection	Deep Infection	SS	Faeces	Urine
Escherichia coli	23629/95728 (24.7)	3096/18988 (16.3)	1338/16746 (8)	3980/19587 (20.3)	1911/8125 (23.5)	874/2787 (31.4)	0/651 (0)	10096/19319 (52.3)
Klebsiella pneumoniae	17216/95728 (18)	3270/18988 (17.2)	4238/16746 (25.3)	2952/19587 (15.1)	1158/8125 (14.3)	520/2787 (18.7)	0/651 (0)	3583/19319 (18.5)
Acinetobacter baumannii	12393/95728 (12.9)	2508/18988 (13.2)	5088/16746 (30.4)	1845/19587 (9.4)	752/8125 (9.3)	312/2787 (11.2)	0/651 (0)	415/19319 (2.1)
Pseudomonas aeruginosa	11622/95728 (12.1)	1336/18988 (7)	3291/16746 (19.7)	3066/19587 (15.6)	1085/8125 (13.4)	244/2787 (8.8)	0/651 (0)	1398/19319 (7.2)
Staphylococcus aureus	8827/95728 (9.2)	1663/18988 (8.8)	701/16746 (4.2)	3719/19587 (19)	1563/8125 (19.2)	109/2787 (3.9)	0/651 (0)	230/19319 (1.2)
Enterococcus faecium	2422/95728 (2.5)	700/18988 (3.7)	20/16746 (0.1)	402/19587 (2.1)	109/8125 (1.3)	124/2787 (4.4)	0/651 (0)	810/19319 (4.2)
Enterococcus faecalis	2373/95728 (2.5)	472/18988 (2.5)	14/16746 (0.1)	546/19587 (2.8)	129/8125 (1.6)	66/2787 (2.4)	0/651 (0)	871/19319 (4.5)
Enterobacter cloacae	1644/95728 (1.7)	356/18988 (1.9)	182/16746 (1.1)	462/19587 (2.4)	217/8125 (2.7)	40/2787 (1.4)	0/651 (0)	206/19319 (1.1)
Proteus mirabilis	1611/95728 (1.7)	71/18988 (0.4)	91/16746 (0.5)	607/19587 (3.1)	350/8125 (4.3)	35/2787 (1.3)	0/651 (0)	286/19319 (1.5)
Enterococcus spp.	852/95728 (0.9)	160/18988 (0.8)	31/16746 (0.2)	124/19587 (0.6)	71/8125 (0.9)	67/2787 (2.4)	0/651 (0)	257/19319 (1.3)

3

Look at the site of culture.

If the organism is relevant than scrutinize the susceptibility report and MIC

CHOOSE ANTIBIOTICS based on efficacy against pathogen

Example:

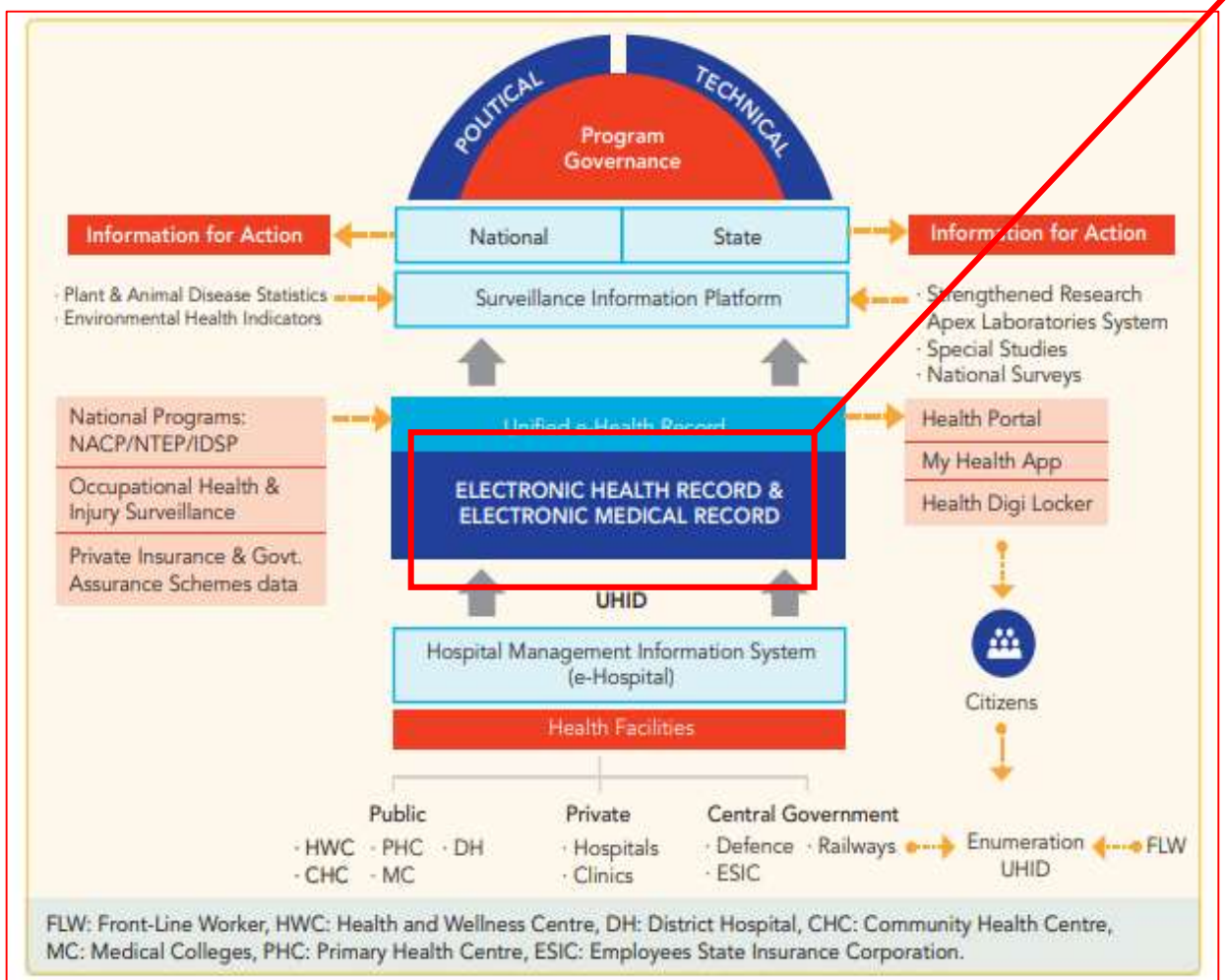
- Oxacillin if found resistant i.e the organism is *MRSA*
- *Staphylococcus Aureus* will not be tackled by Ciprofloxacin even if found susceptible.

https://amrtg.icmr.org.in/ Site for ICMR data findings-based guidelines

To propose solution to strengthen the surveillance of AMR using current surveillance platforms in India.	O4

Public health surveillance system 2035 - VISION

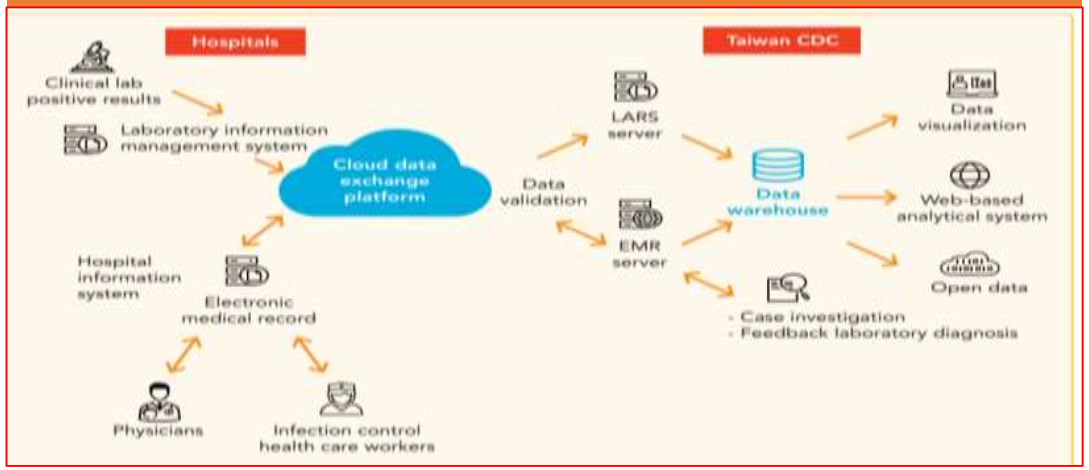
Architecture of Public health surveillance 2035



Electronic health record with UHID will create a single platform for all kind of surveillance.

- Predictive system
- Performance management
- Analysis by researcher
- Automated system that send alerts

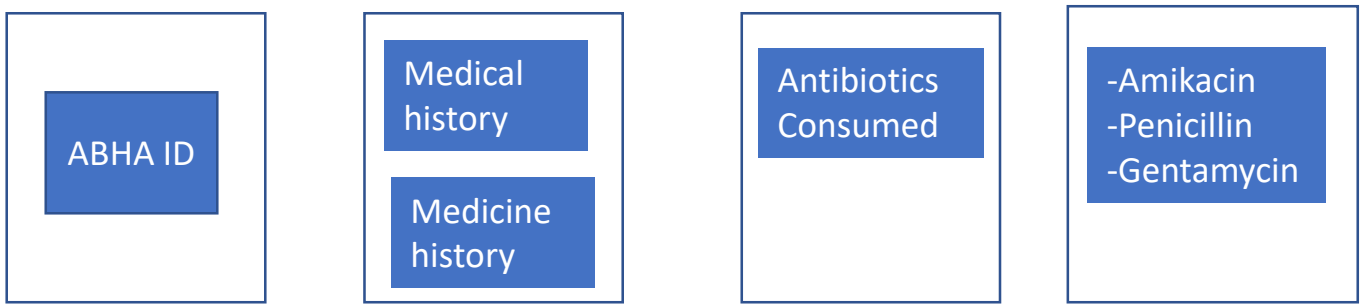
Centralized repository on Surveillance Information



'Taiwan' depicts the best example for centralized repository by maintaining data confidentiality with use of masking of data. The information tracked is used to carry out analysis.

How can technology help...depiction through wireframe

PROBLEMS: 1. Antibiotic consumption data not available
2. Geographical data not available
3. Lack of drug repository



Integrated disease surveillance programme/ ABHA
- Geographical data
- Real time data disease based can provide data on Antibiotic consumption

Technology for guidance:
- CDSS
- Antibiogram at hospital level

Pharmacovigilance Program network
- Track resistance
- Track treatment based on resistance

'Track and tracing' quality of drugs based on barcode.

Diagnostic innovation

1.We can have an app to track the antibiotics consumption history.
2.The application is linked with ABHA and hence can provide geographical data and other demographic details.
3.Doctors can take decision too or CDSS can be integrated to send alerts.

DISCUSSION & CONCLUSION

Discussion & Conclusion

DISCUSSION

1. AMR burden is heavy in India. We need to work to tackle the situation.
2. Among all the countries the South Asian countries are carry load of AMR, India is at >50% burden for many microbes.
3. NARS-NET and ICMR surveillance network capturing the data on resistance for India.
4. The SWOT analysis shows how silo the structure is and need the PHC and LIS &HIS covered.
5. Antibiogram and CDSS are some of the technological aspects. The centralised repository is the need of the hour.

CONCLUSION

1. The study highlights that AMR is at rise and hence need better digital application at hospital level and national level to track before it is over the head.

2. LIS and HIS can integrate the data for national benefit.

3. Along with this we need tools to diagnose the resistance without consuming time.

DISSERTATION EXPERIENCE

- Learning atmosphere
- Variety of Projects
- Experienced simulation
- Motivating interactive session
- Very well mentored by the team members
- Great learning from everyone I worked with.
- Technical skills developed

"Superbug was beating the door" while I was working to look for solution.

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THANK YOU