SOUTH CENTRE

WHO GLASS AMR Surveillance

AMR

AMU

Antimicrobial Resistance Surveillance

REPORT ON

ANTIMICROBIAL STEWARDSHIP AND AMR SURVEILLANCE:

INSIGHTS FROM THE WAAW SOUTH CENTRE WEBINAR 2024

By: Dr Rasha Abdelsalam Elshenawy

REPORT ON ANTIMICROBIAL STEWARDSHIP AND AMR SURVEILLANCE: INSIGHTS FROM THE SOUTH CENTRE WAAW 2024 WEBINAR

By: Dr Rasha Abdelsalam Elshenawy,

Consultant on AMR, South Centre

February 2025

Opening Plenary - Dr Viviana Munoz Tellez

To mark World Antimicrobial Awareness Week 2024, the South Centre organised a webinar focusing on strategies and success stories in antimicrobial resistance (AMR) surveillance and stewardship in resource-limited settings. This reflects the South Centre's dedication to tackling global public health challenges, particularly drug-resistant infections. Dr Viviana Munoz Tellez, in the opening plenary, stressed the urgent need for robust AMR surveillance and effective antimicrobial stewardship (AMS). She highlighted the disproportionate burden of drug-resistant infections in low- and middle-income countries and emphasised that reliable surveillance is vital for understanding resistance patterns, shaping interventions, and guiding policies. Persistent challenges, such as infrastructure gaps, funding shortages, and fragmented data systems, were also addressed.

Key Messages

- Multisectoral collaboration is vital for AMR efforts.
- Digital tools enhance AMR surveillance and stewardship.
- Sustainable strategies ensure long-term AMR solutions.
- Global partnerships support AMS and surveillance systems.
- Local interventions improve AMS effectiveness in diverse settings.

The webinar was structured into two key sessions:

1. **Presentation**: Challenges and strategies for AMR surveillance in resource-limited settings.
2. **Panel Discussion**: Success stories, AMS, and overcoming barriers in developing countries.

Objectives of the Webinar

The webinar aimed to provide actionable insights to address the global AMR crisis by focusing on:

- Highlighting the critical role of antimicrobial stewardship (AMS) in mitigating AMR.
- Exploring the barriers to implementing AMS and AMR surveillance in resource-constrained settings.
- Showcasing innovative digital tools and fostering multisectoral partnerships to improve AMR data collection and analysis.
- Sharing evidence-based strategies and resources to establish sustainable AMS practices, particularly in the Global South.

By leveraging expert knowledge and practical solutions, the webinar sought to enhance the integration of AMS into health systems worldwide and strengthen collaborations between local and international stakeholders.

Opening Plenary - Dr Viviana Munoz Tellez

Session 1: Enhancing Antimicrobial Resistance Surveillance in Developing Countries

Topic: Enhancing Antimicrobial Resistance Surveillance in Developing Countries: Overcoming Challenges and Bridging Data Gaps
Speaker: Dr Rasha Abdelsalam Elshenawy

Introduction

The session opened with an insightful presentation by Dr Rasha Abdelsalam Elshenawy, a distinguished clinical pharmacist with over 20 years of expertise. Dr Rasha is the Director of the Antimicrobial Stewardship School at FADIC in the UK, a consultant with the South Centre, and a senior lecturer at the University of Hertfordshire. She highlighted the critical challenges of AMR surveillance in resource-limited settings and proposed actionable strategies to address these issues.

Learning Objectives of this Session

- Identify key challenges in AMR surveillance in developing countries.
- Explore strategies to enhance data collection and reporting.
- Emphasise the importance of regional and global collaboration in combating AMR.
- Examine the role of digital tools in improving AMR surveillance.
- Provide resources to support effective antimicrobial stewardship practices.

Key Concept

A quote from Lord Kelvin, "If you cannot measure it, you cannot improve it," was used by Dr Rasha to introduce the session. It was explained that robust surveillance is foundational to understanding, discussing, and addressing AMR effectively.

1. Key Challenges in AMR Surveillance

Challenges Identified

1. **Data Gaps:** Lack of comprehensive surveillance data in many developing countries.
2. **Technical Challenges:** Insufficient infrastructure and inconsistent surveillance methodologies.
3. **Financial Constraints:** Limited funding and reliance on inconsistent international support.
4. **Infrastructure Limitations:** Poor digital systems and weak connectivity, especially in rural areas.
5. **Data Quality Issues:** Fragmented, unreliable, and non-standardised data.

Strategies Proposed

1. **Capacity Building:**
   - Train healthcare professionals in AMR surveillance and AMS practices.
   - Establish AMS teams at local, facility, and national levels.
2. **Resource Allocation:**
   - Prioritise high-burden hospitals and regions for initial AMS implementation to maximise impact.
3. **Standardised Protocols:**
   - Adopt and adapt WHO-recommended guidelines for consistent data collection.
4. **Leveraging Technology:**
   - Use mobile apps, cloud-based systems, and machine learning tools to enhance data collection, surveillance, and decision-making.
5. **Sustainability:**
   - Advocate for government investment, regional collaboration, and long-term funding mechanisms.

Role of Digital Tools

The transformative potential of digital tools in AMR surveillance was emphasised:

- **Improved Accuracy:** Tools like mobile applications streamline data collection and reduce errors.
- **Real-Time Monitoring:** Digital systems enable constant monitoring of resistance patterns and antibiotic usage.
- **Predictive Analytics:** AI and machine learning tools can predict outbreaks and optimise antibiotic prescribing.
- **Enhanced Access:** Mobile apps empower healthcare workers in remote areas to collect and share data efficiently.

2. WHO Global Antimicrobial Resistance and Use Surveillance System (GLASS)

Overview of GLASS

The WHO Global Antimicrobial Resistance and Use Surveillance System (GLASS) was established to provide a comprehensive framework for monitoring antimicrobial resistance (AMR) and antimicrobial use (AMU) globally. With 127 countries, territories, and areas participating, GLASS aims to address gaps in AMR surveillance by promoting standardised data collection and fostering collaboration among member states (Figure 1).

Figure 1. WHO Global Antimicrobial Resistance and Use Surveillance System (GLASS)

Key Features of GLASS

1. **Pathogen-Specific Data**
   - GLASS tracks resistance rates for major pathogens such as *Escherichia coli* (*E. coli*) and *Staphylococcus aureus* (*S. aureus*).
   - It provides insights into resistance patterns across various infectious syndromes, including bloodstream and urinary tract infections.
2. **Antimicrobial Consumption (AMU)**
   - Data on key antibiotics, such as ciprofloxacin, meropenem, ceftriaxone, and co-trimoxazole, are monitored.
   - The system also evaluates trends in antimicrobial usage to assess stewardship efforts globally.
3. **Global and Regional Benchmarks**
   - GLASS facilitates comparisons between countries, enabling alignment with global AMR standards and best practices.
   - It supports benchmarking efforts to highlight progress and identify areas for improvement.

4. **Surveillance Scope Expansion**
   o Initially focused on AMR in common bacteria, GLASS has expanded to include:
     ▪ Antimicrobial use (AMU) surveillance.
     ▪ One Health surveillance, encompassing human, animal, and environmental health.
     ▪ Studies on emerging AMR trends and novel pathogens.

WHO 2022 GLASS Report Highlights

- **Significance of Data Collection:**
  o Over five years, GLASS has provided actionable insights into AMR and AMU trends, informing global and national strategies.
- **Visualisation of Data:**
  o Interactive dashboards allow countries to track resistance trends, antimicrobial consumption, and geographical variations in AMR prevalence.
  o Maps from 2016–2020 illustrate resistance rates for pathogens like *Acinetobacter spp.* and *Klebsiella pneumoniae*.
- **National and Local Applications:**
  o GLASS data empowers nations to develop context-specific AMR action plans.
  o Tools like the GLASS-AMR and GLASS-AMU reports provide comprehensive datasets for decision-making.

Participation and Achievements

- **127 Countries Engaged:**
  o Countries participate in routine surveillance and event-based monitoring to strengthen AMR and AMU data collection efforts.
  o GLASS has catalysed the integration of AMR surveillance into health systems, particularly in resource-limited settings.

South Centre Countries in WHO GLASS AMR Surveillance (2016 – 2023)

For AMR surveillance, the number of South Centre countries participating in the WHO GLASS system has shown steady growth over the years (Figure 2).

- **2016–2019:** A progressive increase in enrolment was observed, rising from 7 countries in 2016 to 8 in 2017, and 7 in 2018. By 2019, 5 additional countries had joined.
- **2020–2021:** Participation slowed, with 3 countries enrolling each year.

- **Total Participation:** As of 2021, 33 South Centre countries were enrolled in AMR surveillance, with 27 of these participating before the pandemic.
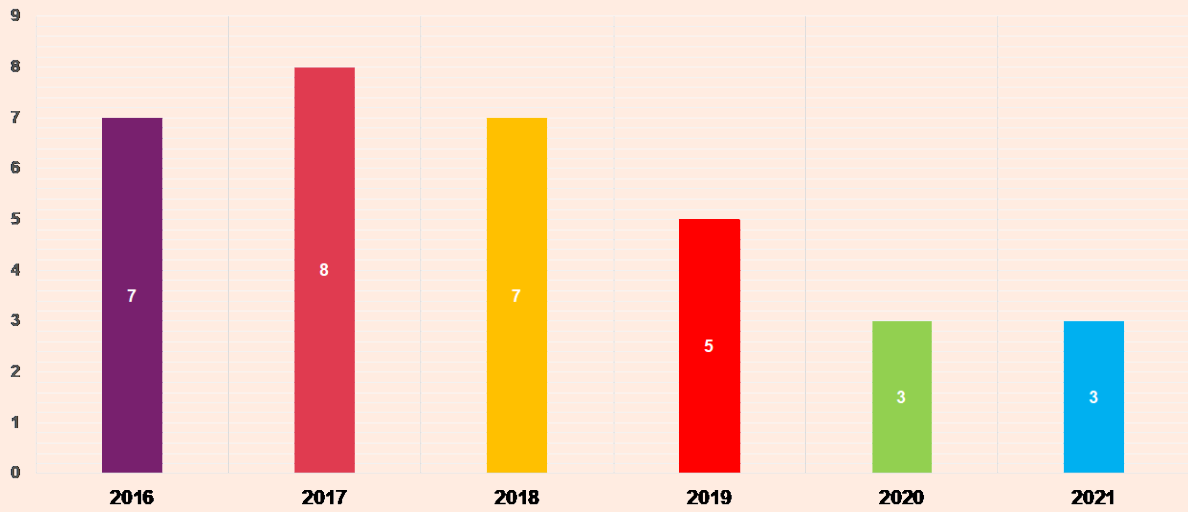
Figure 2. Number of South Centre Countries Enrolled in the WHO GLASS **AMR Surveillance**

For AMU surveillance, South Centre countries have also participated under WHO GLASS, albeit with a slower rate of growth compared to AMR surveillance (Figure 3).

- **2017–2019:** Minimal participation, with just 1 country enrolling each year.
- **2020–2022:** A significant increase was noted, with 6 countries joining in 2020, followed by 4 in 2021, and 5 in 2022.
- **2023:** A slight decline, with only 1 country enrolling.
- **Total Participation:** By 2023, 21 countries had enrolled in AMU surveillance.
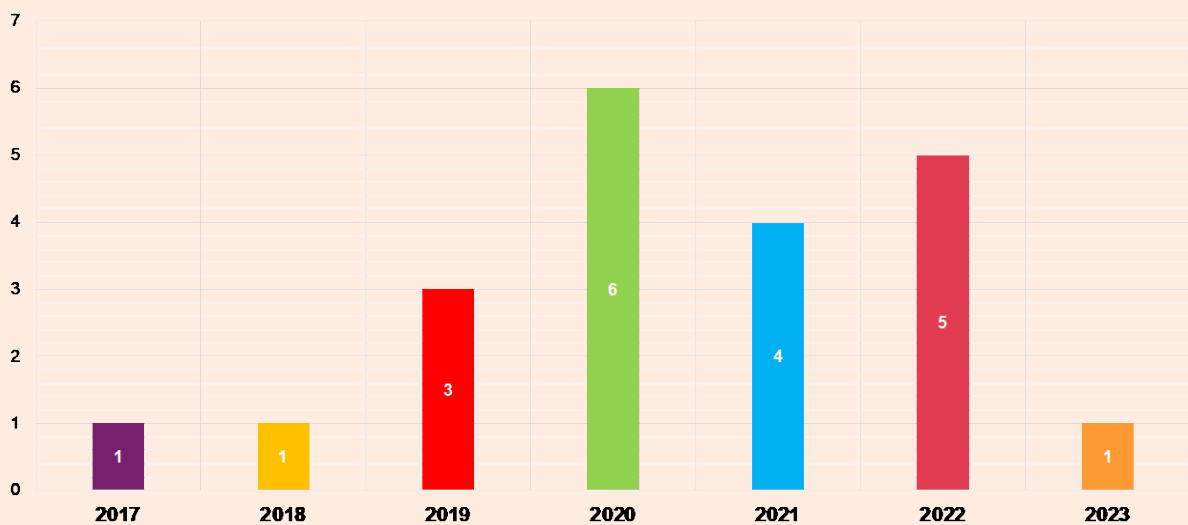
Figure 3. Number of South Centre Countries Enrolled in the WHO GLASS **AMU Surveillance**

- **Growth Trends:** While AMR surveillance has achieved broader enrolment (33 countries), AMU surveillance is still developing (21 countries).
- **Impact of the Pandemic:** Enrolment rates slowed for AMR surveillance after the pandemic began, while AMU surveillance gained traction during 2020.
- **Call to Action:** Continued efforts are needed to expand participation in both AMR and AMU surveillance, ensuring comprehensive data coverage for South Centre countries to support global AMR action plans effectively.

3. Global Resources of Antimicrobial Stewardship

Antimicrobial stewardship plays a critical role in combating antimicrobial resistance by optimising the use of antibiotics and promoting best practices across healthcare settings. The following sections outline key global resources available for AMS, including courses, toolkits, resources, and journal articles.

1- Courses	2- Toolkit
Antimicrobial Stewardship Resources	
3- Resources	4- Journal Articles

Antimicrobial Stewardship Courses

To enhance knowledge and practical skills in AMS, several global organisations offer comprehensive courses, including:

- **WHO Open Courses**: Focus on AMR and AMS awareness, providing free access to healthcare professionals.
- **BSAC Open Courses**: Interactive modules addressing AMS in clinical and hospital settings.
- **Future Learn & Coursera**: Platforms offering diverse AMS courses, such as the Stanford Antibiotic Stewardship Programme.
- **ESCMID (European Society of Clinical Microbiology and Infectious Diseases)**: Specialised AMS certification courses.

- **ECDC & CDC**: Tailored training programmes on antibiotic prescribing and resistance management.

Antimicrobial Stewardship Toolkits

AMS toolkits provide structured guidelines and best practices for implementation. Notable toolkits include:

- **WHO**: The GLASS (Global Antimicrobial Resistance Surveillance System) dashboard and data analysis tools.
- **IDSA (Infectious Diseases Society of America)**: Clinical guidelines for antibiotic stewardship in hospital and outpatient settings.
- **Public Health Ontario**: Comprehensive resources for AMS programme development and evaluation.
- **UKHSA (UK Health Security Agency)**: The "Start Smart Then Focus" clinical management algorithm for effective antibiotic use.

These toolkits are invaluable for standardising AMS approaches across diverse healthcare systems.

Antimicrobial Stewardship Resources

Various global organisations provide accessible resources to support AMS efforts, such as:

- **WHO**: Comprehensive databases and guidance documents on AMR trends and strategies.
- **African CDC**: Resources focused on AMR and AMS in the African context.
- **UKHSA**: Reports and analyses, including the English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR).
- **CDC & ECDC**: Publications and tools for implementing AMS in clinical practice.
- **United Nations**: High-level policy recommendations to address AMR globally.

These resources enable healthcare providers and policymakers to access data-driven insights and implement evidence-based AMS initiatives.

Antimicrobial Stewardship Journal Articles

Research and evidence are critical to advancing AMS practices. Prominent journals publishing AMS-related studies include:

- **Frontiers**: Articles on microbiology and infectious diseases.
- **PMC (PubMed Central)**: Open-access studies on AMS and AMR.
- **MDPI**: Research focused on microbiology and antibiotic resistance.

- **JAC-AMR (Journal of Antimicrobial Resistance)**: Dedicated to AMS research and innovations.
- **JGAR (Journal of Global Antimicrobial Resistance)**: Papers exploring AMR at a global level.

These journals provide peer-reviewed insights to inform AMS policies and practices worldwide.

4. Barriers to Effective AMR Surveillance in Developing Countries

Addressing antimicrobial resistance (AMR) in developing countries is hindered by a range of barriers that affect surveillance systems, infrastructure, and overall healthcare capacity. These challenges can be summarised as follows:

Key Barriers:

1. **Weak Laboratory Infrastructure**:
   - Many healthcare facilities in resource-limited settings lack advanced diagnostic tools and laboratory capacity, impeding the accurate identification and tracking of AMR pathogens.
2. **Insufficient Workforce**:
   - Shortages of skilled healthcare professionals, including microbiologists, infectious disease specialists, and pharmacists, hinder the implementation of effective AMR surveillance systems.
3. **Reliance on Inconsistent Funding**:
   - Financial instability and dependence on short-term international funding restrict the development and sustainability of AMR programmes.
4. **Data Gaps and Poor Standardisation**:
   - Non-standardised protocols and fragmented data collection systems limit the ability to generate reliable, comparable AMR data across different regions and facilities.
5. **Supply Chain and Quality Issues**:
   - Challenges in procuring and maintaining high-quality laboratory supplies, antibiotics, and essential medicines compromise the effectiveness of surveillance and treatment efforts.
6. **Communication and Collaboration Challenges**:
   - Limited coordination between healthcare facilities, governmental agencies, and international organisations hinders the sharing of best practices and implementation of multisectoral approaches.

5. Moving Forward: Key Recommendations to Overcome Barriers

To enhance AMR surveillance in hospitals and healthcare settings across developing countries, the following recommendations are proposed:

1. **Healthcare Accessibility**:
   o Improve access to healthcare services, particularly in rural and underserved areas, to increase population coverage and reach vulnerable groups.
2. **Strengthen Workforce Capacity**:
   o Invest in training programmes to build a skilled workforce of healthcare professionals equipped to implement and sustain AMR surveillance initiatives.
3. **Enhance Infection Prevention and Control (IPC)**:
   o Strengthen IPC measures, including sanitation and hygiene protocols, to prevent the spread of infections and reduce the burden on surveillance systems.
4. **Targeted Interventions in Urban-Local Areas**:
   o Develop specific strategies for monitoring hospital-acquired infections in intensive care units (ICUs) and community-acquired infections in local healthcare settings.
5. **Address Systemic Barriers**:
   o Implement systemic changes to address challenges such as funding inconsistencies, infrastructure gaps, and lack of standardised protocols.
6. **Leverage Multisectoral Collaboration**:
   o Foster partnerships between governments, international organisations, and community stakeholders to ensure a unified approach to AMR surveillance.

By addressing these barriers and implementing the recommended strategies, developing countries can strengthen their AMR surveillance systems and contribute to global efforts in combating antimicrobial resistance.

Call to Action

This session concluded that effective AMR surveillance is a cornerstone of combating antimicrobial resistance. Accurate data was highlighted as essential for driving precise treatment decisions, optimising antibiotic use, and enhancing public health emergency preparedness. A call was made for:

- Addressing barriers through training and capacity building.
- Integrating innovative technologies to improve data collection and analysis.
- Establishing sustainable funding mechanisms and fostering international collaborations.

This session set the stage for a comprehensive discussion on strategies to improve AMR surveillance and stewardship in resource-limited settings, aligning with the broader goals of World Antimicrobial Awareness Week 2024.

Session 2: Panel Discussion – Success Stories and AMS Practices in Implementing AMR Surveillance in Developing Countries

Topic: Success Stories and AMS Practices in Implementing AMR Surveillance in Developing Countries
Panellists:

- Dr Sasheela Sri La Sri Ponnampalavanar
- Dr Kamini Walia
- Dr Afreenish Amir

Key Discussion Points

1. AMS in Combating AMR

Speaker: Dr Sasheela

- Antimicrobial stewardship is crucial for optimising antibiotic use, reducing misuse, and slowing the progression of AMR.
- Integrating AMS with infection prevention and control (IPC) measures is essential for ensuring sustained success in combating AMR.

2. Barriers to AMS Implementation

Speaker: Dr Kamini

- **Challenges:** Workforce shortages, limited diagnostic infrastructure, and inconsistent funding hinder AMS implementation in resource-limited settings.
- **Solutions:**
    - Phased AMS implementation allows hospitals to begin small and expand over time.
    - Leveraging partnerships with both local and international organisations helps address funding and technical gaps.
    - Involving clinicians as leaders in AMS initiatives improves engagement and prioritisation of stewardship efforts.

3. Successful AMS Programmes

Speaker: Dr Kamini

- India's AMS initiatives were highlighted as examples of success, focusing on clinician-led programmes and enhanced diagnostic capabilities.
- Outcomes include sustained AMS practices during the COVID-19 pandemic, controlled antibiotic use, and improved AMR surveillance through local antibiograms and hospital-specific policies.

4. Managing Data Limitations for AMS

Speaker: Dr Afreenish

- **Challenges:**
    - Data quality issues, such as incomplete and inconsistent information.
    - Manual record-keeping in many hospitals limits access to reliable data.
    - Limited microbiology capabilities restrict advanced diagnostic outputs.
- **Solutions:**
    - Standardising data collection protocols improves reliability and scalability.

- o Leveraging health management systems (HMIS), laboratory management systems (LMIS), and mobile applications facilitates real-time data sharing.
- o Employing AI and machine learning tools enhances predictive analytics and intervention optimisation.

5. Resource-Efficient AMS Strategies

Speaker: Dr Sasheela

- AMS efforts should prioritise high-burden areas for maximum impact.
- Start small, focusing on specific interventions like surgical prophylaxis, and gradually scale up hospital-wide.
- The WHO's "Checklist of Essential AMS Core Elements" provides a practical toolkit to identify gaps and prioritise interventions.

6. Strengthening AMS through Partnerships

Speaker: Dr Afreenish

- **Local Partnerships:** Engage public health departments, academic institutions, and healthcare facilities to align AMS strategies with national action plans.
- **International Partnerships:** Collaborations with WHO, CDC, and other global organisations enhance AMS training, resource allocation, and guideline development.
- Public-private partnerships enable resource mobilisation, including funding, educational tools, and technical support.

7. Role of Digital Tools in AMS and AMR Surveillance

Speaker: Dr Afreenish

- Digital tools such as cloud-based databases, clinical decision support systems (CDSS), and interactive dashboards transform AMS outcomes by providing:
  - o Real-time surveillance data for informed decision-making.
  - o Automated antibiotic recommendations to optimise prescribing practices.
- Mobile applications enhance data collection in remote areas, while telemedicine supports remote consultations and AMS guidance.

8. Recommendations for Resource-Limited Settings

Speaker: Dr Sasheela

- Integrate AMS into national health strategies with dedicated funding to ensure sustainability.
- Establish multidisciplinary AMS teams with defined roles and responsibilities.
- Develop context-specific guidelines tailored to local healthcare needs.
- Employ multimodal strategies combining education, audits, system changes, and cultural shifts to drive AMS adoption.

9. AMS Resources and Toolkits

Speaker: Dr Kamini

- The WHO AMS guidelines, CDC toolkits, and IDSA stewardship resources were cited as critical tools.
- Customising these resources to local needs ensures their effective implementation in resource-limited settings.

Key Recommendations from the Panel

- **Build Capacity:**
  - Train healthcare professionals and establish multidisciplinary AMS teams to lead stewardship initiatives.
- **Leverage Digital Innovations:**
  - Use tools such as mobile applications, machine learning models, and cloud-based systems for real-time data monitoring and decision-making.
- **Foster Collaborations:**
  - Strengthen partnerships with global organisations and local stakeholders to share knowledge and resources.
- **Ensure Sustainability:**

        o   Advocate for long-term funding and government support to embed AMS into health systems.

Key Messages from the Panel Discussion

The panel discussion provided valuable insights into the challenges, strategies, and successes of implementing AMS and AMR surveillance in resource-limited settings. The panellists emphasised the importance of capacity-building, data quality improvement, and leveraging digital innovations to address AMR effectively.

By fostering global collaborations, integrating AMS into national health strategies, and ensuring sustainable practices, these efforts can significantly reduce the burden of AMR worldwide. The discussion underscored the need for customised, scalable, and evidence-based approaches to strengthen AMS and surveillance in developing countries.

The session closed with a call to action for all stakeholders to continue prioritising AMS efforts to combat the global AMR crisis.

Closing Plenary - Dr Viviana Munoz Tellez

The **South Centre WAAW 2024 Webinar** ended with a plenary by Dr Viviana Munoz Tellez, emphasising the urgency of tackling antimicrobial resistance globally. She reflected on the example of bacteria resistant to all antibiotics, underscoring the importance of **effective antimicrobial stewardship (AMS)**, particularly in resource-limited settings.

Key points included the need for **collaborations** among stakeholders, the adoption of **digital tools** and standardised protocols, and overcoming barriers like weak infrastructure and funding gaps. Dr Munoz urged sustained efforts to improve AMS practices and AMR surveillance.

The session concluded with a call for **global unity** and innovative strategies to address AMR challenges, expressing optimism for continued progress through collective action.

South Centre Webinar Resources
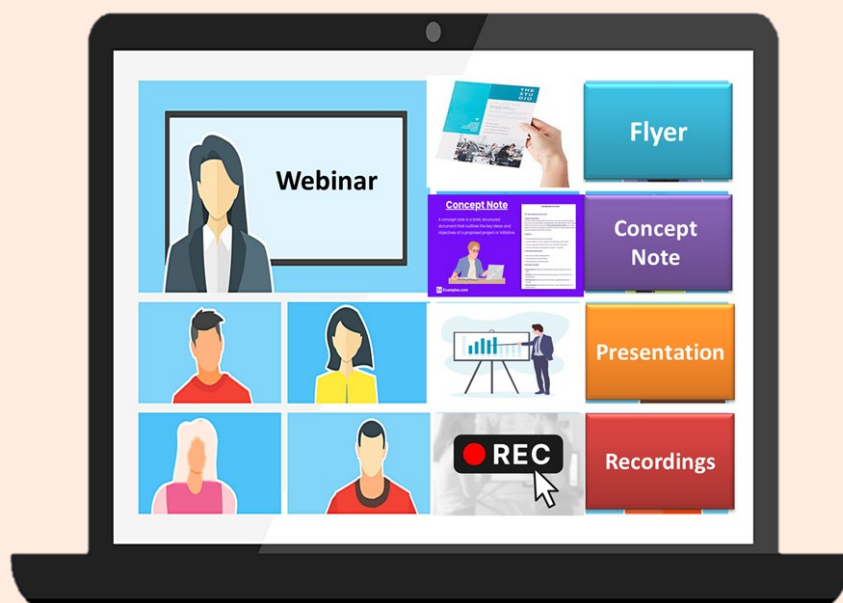
Presentations and materials from the South Centre webinar, *"Enhancing Antimicrobial Resistance Surveillance in Developing Countries"*, held on **18 November 2024**, are available for viewing. Access the resources below:

- **Webinar Link**: Click here for more information on the webinar
- **Flyer**: View the webinar flyer
- **Concept Note**: Read the concept note
- **Presentation**: Download Dr. Rasha Elshenawy's presentation
- **Recording**: Watch the webinar recording on YouTube

These resources provide valuable insights into strategies for AMR surveillance and antimicrobial stewardship in developing countries.

References:

1. Naghavi M, Vollset SE, Ikuta KS, Swetschinski LR, Gray AP, Wool EE, et al. Global burden of bacterial antimicrobial resistance 1990–2021: a systematic analysis with forecasts to 2050. The Lancet [Internet]. 2024 Sep 28;404(10459). Available from: https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(24)01867-1/fulltext

2. Department of Health and Social Care. UK 5-year action plan for antimicrobial resistance 2024 to 2029 [Internet]. GOV.UK. 2024. Available from: https://www.gov.uk/government/publications/uk-5-year-action-plan-for-antimicrobial-resistance-2024-to-2029.

3. Iskandar K, Molinier L, Hallit S, Sartelli M, Hardcastle TC, Haque M, et al. Surveillance of antimicrobial resistance in low- and middle-income countries: a scattered picture. Antimicrobial Resistance & Infection Control. 2021 Mar 31;10(1).

4. South Centre. The South Centre | Member Countries [Internet]. 2024. Available from: https://www.southcentre.int/member-countries/

- **Courses:**

5. WHO Open Courses. Antimicrobial Stewardship [Internet]. Openwho.org. 2016 [cited 2024 Nov 12]. Available from: https://openwho.org/courses?button=&category=&channel=&lang=&locale=en&q=antimicrobial+stewardship.

6. FutureLearn. Managing Antibiotic Resistance Online Course [Internet]. FutureLearn. 2020. Available from: https://www.futurelearn.com/courses/antimicrobial-stewardship

7. Coursera. Antimicrobial stewardship [Internet]. 2020. Available from: https://www.coursera.org/learn/antibiotic-stewardship?utm_medium=sem&utm_source=gg&utm_campaign=B2C_EMEA__coursera.

8. BSAC. Massive Open Online Course on Antimicrobial Stewardship - The British Society for Antimicrobial Chemotherapy [Internet]. The British Society for Antimicrobial Chemotherapy. 2019 [cited 2024 Nov 12]. Available from: https://bsac.org.uk/stewardship-surveillance/massive-course-on-antimicrobial-stewardship/.

9. European Society of Clinical Microbiology and Infectious Diseases (ESCMID). AMS Certificate Programme [Internet]. Escmid.org. 2023 [cited 2024 Nov 12]. Available from: https://www.escmid.org/education/ams-certificate/.

10. ECDC. Training courses on antimicrobial stewardship [Internet]. www.ecdc.europa.eu. 2017. Available from: https://www.ecdc.europa.eu/en/publications-data/directory-guidance-prevention-and-control/training-antimicrobial-stewardship.

11. ECDC. E-learning on Antimicrobial Stewardship [Internet]. www.ecdc.europa.eu. 2021. Available from: https://www.ecdc.europa.eu/en/news-events/e-learning-antimicrobial-stewardship.
12. CDC. Antibiotic Stewardship Trainings [Internet]. Antibiotic Prescribing and Use. 2024. Available from: https://www.cdc.gov/antibiotic-use/hcp/training/index.html.

• **Antimicrobial Stewardship Toolkit:**

13. WHO AWaRe Classification. AWaRe classification of antibiotics for evaluation and monitoring of use, 2023 [Internet]. www.who.int. 2023. Available from: https://www.who.int/publications/i/item/WHO-MHP-HPS-EML-2023.04.
14. WHO GLASS 2023. GLASS dashboard [Internet]. WHO. 2024 [cited 2024 Nov 12]. Available from: https://worldhealthorg.shinyapps.io/glass-dashboard/_w_053a572c/#!/home.
15. UK Health Security Agency (UKHSA). Start smart then focus: antimicrobial stewardship toolkit for inpatient care settings [Internet]. GOV.UK. 2023. Available from: https://www.gov.uk/government/publications/antimicrobial-stewardship-start-smart-then-focus/start-smart-then-focus-antimicrobial-stewardship-toolkit-for-inpatient-care-settings.
16. CDC. Core Elements of Antibiotic Stewardship [Internet]. Antibiotic Prescribing and Use. 2024. Available from: https://www.cdc.gov/antibiotic-use/hcp/core-elements/index.html.
17. Public Health Ontario. Antimicrobial Stewardship | Public Health Ontario [Internet]. Public Health Ontario. 2020. Available from: https://www.publichealthontario.ca/en/health-topics/antimicrobial-stewardship.
18. IDSA. Implementing an antimicrobial stewardship [Internet]. www.idsociety.org. 2019. Available from: https://www.idsociety.org/practice-guideline/implementing-an-ASP/.

• **Antimicrobial Stewardship Resources:**

19. African CDC. Resources – Africa CDC [Internet]. Africa CDC. 2024 [cited 2024 Nov 12]. Available from: https://africacdc.org/resources/
20. Antibiotic Guardian. Antibiotic Stewardship Resources [Internet]. Antibiotic Guardian. 2024. Available from: https://antibioticguardian.com/healthcare-professionals/11.
21. UK Health Security Agency (UKHSA). Start smart then focus: antimicrobial stewardship toolkit for inpatient care settings [Internet]. GOV.UK. 2023. Available from: https://www.gov.uk/government/publications/antimicrobial-stewardship-start-smart-then-focus/start-smart-then-focus-antimicrobial-stewardship-toolkit-for-inpatient-care-settings.
22. Public Health England. English surveillance programme for antimicrobial utilisation and resistance (ESPAUR) report [Internet]. GOV.UK. 2014. Available from:

https://www.gov.uk/government/publications/english-surveillance-programme-antimicrobial-utilisation-and-resistance-espaur-report.

23. .World Health Organization. Promoting antimicrobial stewardship to tackle antimicrobial resistance [Internet]. www.who.int. 2021. Available from: https://www.who.int/europe/activities/promoting-antimicrobial-stewardship-to-tackle-antimicrobial-resistance.

24. ECDC. Antimicrobial stewardship [Internet]. European Centre for Disease Prevention and Control. 2024. Available from: https://www.ecdc.europa.eu/en/publications-data/directory-guidance-prevention-and-control/prudent-use-antibiotics/antimicrobial.

25. CDC. Antibiotic Stewardship Resource Bundles [Internet]. Antibiotic Prescribing and Use. 2024. Available from: https://www.cdc.gov/antibiotic-use/hcp/educational-resources/stewardship/index.html.

• **Antimicrobial Stewardship Journal Papers:**

26. Abdelsalam Elshenawy R, Umaru N, Aslanpour Z. WHO AWaRe classification for antibiotic stewardship: tackling antimicrobial resistance - a descriptive study from an English NHS Foundation Trust prior to and during the COVID-19 pandemic. Frontiers in Microbiology [Internet]. 2023;14(12):1298858. Available from: https://pubmed.ncbi.nlm.nih.gov/38146447/

27. Rasha Abdelsalam Elshenawy, Nkiruka Umaru, Amal Bandar Alharbi, Aslanpour Z. Antimicrobial stewardship implementation before and during the COVID-19 pandemic in the acute care settings: a systematic review. BMC Public Health. 2023 Feb 10;23(1).

28. Abdelsalam Elshenawy R, Umaru N, Aslanpour Z. Impact of COVID-19 on "Start Smart, Then Focus" Antimicrobial Stewardship at One NHS Foundation Trust in England Prior to and during the Pandemic. COVID [Internet]. 2024 Jan 1;4(1):102–16. Available from: https://www.mdpi.com/2673-8112/4/1/10

29. Rasha Abdelsalam Elshenawy, Nkiruka Umaru, Aslanpour Z. Novel survey distribution methods: impact on antimicrobial resistance research outcomes. JAC-antimicrobial resistance [Internet]. 2024 Mar 5;6(2). Available from: https://academic.oup.com/jacamr/article/6/2/dlae055/7656711.

30. Elshenawy RA, Umaru N, Aslanpour Z. An Evaluation of the Five Rights Antibiotic Safety Before and During COVID-19 at an NHS Foundation Trust in the United Kingdom. Journal of Global Antimicrobial Resistance [Internet]. 2024 Jan 3; Available from: https://www.sciencedirect.com/science/article/pii/S2213716523002369?via%3Dihub.