Quick Response Code:

Indian J Med Res 149, February 2019, pp 299-302
DOI: 10.4103/ijmr.IJMR_2074_17

Developing a hybrid antimicrobial resistance surveillance system in India: Needs & challenges

Jasmine Kaur[1], Arun Sharma[1], Ajay Singh Dhama[1], Harish Buttolia[1], V.C. Ohri[2], Kamini Walia[2], Amitesh Kumar Sharma[1], Koji Yahara[3], Rafi Ahmad[4] & Harpreet Singh[1]

Divisions of [1]Informatics, Systems & Research Management & [2]Epidemiology & Communicable Diseases, Indian Council of Medical Research, New Delhi, India, [3]Antimicrobial Resistance Research Center, National Institute of Infectious Diseases, Tokyo, Japan & [4]Institute of Biotechnology, Inland Norway University of Applied Sciences, Hamar, Norway

Received December 28, 2017

Growing resistance to antimicrobials has become one of the most important problems of the 21st century. The development of new antibiotics is a time-consuming process involving huge financial resources. An alternate approach is proper utilization of the existing antibiotics through the surveillance of resistance. An important component of surveillance is the informatics tool for collection, management and analysis of antimicrobial resistance susceptibility testing data. Based on the scope, antimicrobial resistance surveillance resistance tools can be broadly classified as collectors and integrators. Individually, both the integrators and collectors have limitations which restrict their use in India. There is a strong requirement to develop a hybrid AMR surveillance tool that captures standardized data from small laboratories and integrates data from multiple sources to present a complete picture of the country. Here we describe a tool *i*-AMRSS developed by the Indian Council of Medical Research for collection, storage and management of AMR data from collaborating institutes/laboratories and to generate real-time analytics and reports.

Key words Analysis suite - antimicrobial resistance - antimicrobial resistance surveillance system - *i*-AMRSS

Antimicrobial resistance (AMR) is a global crisis, and it is estimated that approximately 0.7 million people die every year from drug-resistant strains of microbes. The number will increase to 10 million by 2050, surpassing cancer (8.2 million deaths per year)[1]. Largest contributors of resistance are developing countries where the burden of infectious diseases is high[2]. Increased resistance has jeopardized our ability to treat simple infections leading to prolonged hospital stays, higher mortality and increased treatment costs[3]. With the emergence of superbugs, resistance to the last resort antibiotics has been observed[4]. Discovery of new antibiotics is a time-consuming process involving the requirement of huge financial resources[5]. An alternate solution to the problem is optimum utilization of existing antibiotics through the surveillance of antimicrobial resistance data. An important component of surveillance is the

informatics tool for capturing, storage and analysis of antimicrobial resistance susceptibility testing (AMST) data. The article discusses development of *i*-AMRSS by the Indian Council of Medical Research (ICMR) for management and analysis of AMR data from different laboratories.

Existing surveillance system

Based on the scope, informatics solutions for AMR can be classified into two groups - the collectors and Integrators. Collectors are laboratory-based tools used by individual laboratories for capturing and monitoring AMST data. These are easily installable, platform dependent, customizable and are designed with a view to collect extensive data. For example, WHONET[6], a Windows-based software tool developed by the WHO collaborating centre and endorsed by the WHO. It is being used worldwide by many laboratories for management and analysis of AMST. Other examples of collectors include AMWeb[7], a web-based tool launched by Public Health England and British Society for Antimicrobial Chemotherapy.

Integrators are employed to compile data from collectors at various laboratories. These have limited customization and are designed to collect limited set of variables common/shared across different data sources. Examples include Japan Nosocomial Infections Surveillance (JANIS)[8], the European Antimicrobial Resistance Surveillance Network[9] and the National Antimicrobial Resistance Monitoring System[10] from Japan, Europe and the USA, respectively.

Although used worldwide, some of the limitations of collectors include issues with data security, integrity, confidentiality and corruption in shared computational resource settings, limited client-server architecture, platform dependence such as limitation in installation and data entry from other platforms, and lack of data validation. Some limitations of integrators include closed source with constrained capability for adding new modules, lack of data validation, limited client-server architecture along with restricted ability to enforce uniform standards for data collection, and analysis across the network. To overcome the limitations, a hybrid solution (Figure) that can bridge individual laboratories and hospitals to complete picture of AMR in the country would be required. Some of the desirable qualities of the hybrid AMR surveillance tool are use of latest technologies, freely available in the public domain, standardization in data collection and analysis, customization, scalability and extensibility, built-in tools for real-time data analysis, and import and export AMST data in standardized data exchange format.

Hybrid surveillance tool in India

As per the National Action Plan on antimicrobial resistance, India is among the nations with the highest burden of bacterial infections[11]. The crude

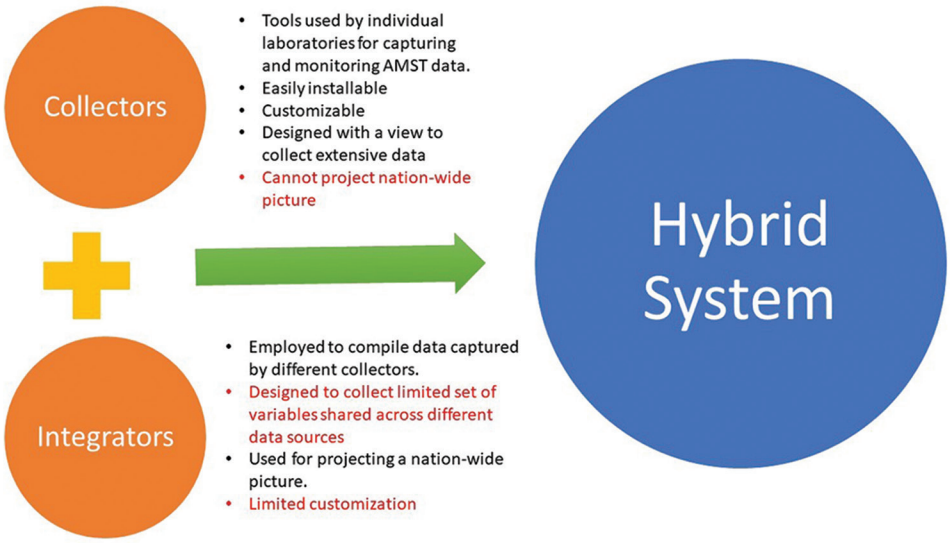

Figure. Designing of an ideal hybrid surveillance system to overcome the limitations associated with existing collectors and integrators. AMST, antimicrobial resistance susceptibility testing.

mortality from infectious diseases in India is 417 per 100,000 persons. Consequently, the impact of AMR is likely to be higher in the Indian setting[11]. To facilitate research and surveillance of AMR in India, the National Programme on the Containment of Antimicrobial Resistance was launched by National Centre for Disease Control (NCDC) along with the Antimicrobial Resistance Surveillance Research Network by the Indian Council of Medical Research (ICMR), New Delhi in 2013[11]. One of the mandates of both the programmes included developing an informatics solution which could enforce both quality antimicrobial susceptibility testing in laboratories and provide analytics to support the development of national policies on antimicrobial usage. Considering the features of an ideal AMR surveillance tool and the limitations of the existing tools, the development of *i*-AMRSS was initiated. This tool is being used by more than 20 tertiary care hospitals across India.

Modules available on i-AMRSS for AMST data collection, storage and analysis

i-AMRSS is a user-friendly web interface to collect AMST data from various laboratories in the network. Registered users can upload AMST data which are validated by expert microbiologists. After successful validation, tables and graphs depicting isolation rates and resistance patterns are generated. A brief description of available modules is given in the Table. The tool has built-in reporting modules for different stakeholders. It enforces standardization of data collection through antibiotic panels implemented across the network. It is a web-based tool and an open source standalone version is under development. Data can be exchanged through a standardized XML format.

Table. A brief description of major modules and their functions available on *i*-AMRSS

Module	Description
Super administrator module	Configure the system
	Generate nation-wide reports
	Import/export data in XML format
Regional centre module	Perform laboratory-specific analysis
	Export data into excel
Nodal centre module	Validate the records
	Perform organism-specific analysis
	Upload molecular data
Data entry module	Upload AMST data
	Edit records
	Upload denominator data

XML- extensible markup language; AMST- antimicrobial resistance susceptibility testing

Applications of i-AMRSS in AMR research

i-AMRSS is suitable for capturing the AMST data in developing countries to project a fair picture of nation-wide resistance pattern. It will facilitate genomic studies by identifying priority pathogens showing exceptionally high resistance. *i*-AMRSS is a web-based tool and can be accessed free. A demo version of the tool is available at *http://bic.icmr.org.in/amr/.*

***Financial support & sponsorship*:** The authors acknowledge the Indian Council of Medical Research, New Delhi, for financial assistance.

***Conflicts of Interest*:** None.

References

1. O'Neill J. Tackling Drug-Resistant Infections Globally: Final Report and Recommendations; The Review on Antimicrobial Resistance. May, 2016. Available from: *https://amr-review.org/sites/default/files/160518_Final%20paper_with%20cover.pdf,* accessed on November 20, 2018.
2. Laxminarayan R, Duse A, Wattal C, Zaidi AK, Wertheim HF, Sumpradit N, *et al.* Antibiotic resistance-the need for global solutions. *Lancet Infect Dis* 2013; *13* : 1057-98.
3. Palanisami A, Khan S, Erdem SS, Hasan T. Guiding empiric treatment for serious bacterial infections via point of care [Formula: See text]-lactamase characterization. *IEEE J Transl Eng Health Med* 2016; *4* : 2800410.
4. Ah YM, Kim AJ, Lee JY. Colistin resistance in *Klebsiella pneumoniae*. *Int J Antimicrob Agents* 2014; *44* : 8-15.
5. Welte T. New antibiotic development: The need versus the costs. *Lancet Infect Dis* 2016; *16* : 386-7.
6. Stelling JM, O'Brien TF. Surveillance of antimicrobial resistance: The WHONET program. *Clin Infect Dis* 1997; *24* (Suppl 1) : S157-68.
7. Ironmonger D, Edeghere O, Gossain S, Bains A, Hawkey PM. AmWeb: A novel interactive web tool for antimicrobial resistance surveillance, applicable to both community and hospital patients. *J Antimicrob Chemother* 2013; *68* : 2406-13.
8. Japan Nosocomial Infections Surveillance. About JANIS; 2018. Available from: *https://janis.mhlw.go.jp/english/about/index.html*, accessed on November 20, 2018.
9. European Centre for Disease Prevention and Control; 2018. Data from the ECDC surveillance atlas - Antimicrobial resistance. Available from: *https://www.ecdc.europa.eu/en/about-us/networks/disease-networks-and-laboratory-networks/ears-net-about,* accessed on November 20, 2018.

10. Karp BE, Tate H, Plumblee JR, Dessai U, Whichard JM, Thacker EL, *et al*. National antimicrobial resistance monitoring system: Two decades of advancing public health through integrated surveillance of antimicrobial resistance. *Foodborne Pathog Dis* 2017; *14* : 545-57.

11. World Health Organization. National Action Plan on Antimicrobial Resistance; 2017. Coordinated by Ministry of Health & Family Welfare, Government of India. New Delhi. Available from: *http://www.searo.who.int/india/topics/antimicrobial_resistance/nap_amr.pdf,* accessed on November 20, 2018.

For correspondence: Dr Harpreet Singh, Division of Informatics, Systems & Research Management, Indian Council of Medical Research, V. Ramalingaswami Bhawan, Ansari Nagar, New Delhi 110 029, India
e-mail: hsingh@bmi.icmr.org.in