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# Convergence of surveillance blind spots with antimicrobial resistance hotspots

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Antimicrobial resistant pathogens that are detected and reported cause an estimated 700,000 deaths per year.[1] The global distribution of antimicrobial resistance (AMR) means that future generations can expect to stay in hospital longer, have increased treatment complications and be at greater risk of dying following surgical procedure.[2,3] The economy will also suffer from escalating healthcare costs and loss of productivity due to excess morbidity and premature mortality.[1,4] An appropriate response relies on accurate data; however, it is becoming increasingly clear that the true burden of infection is significantly greater than what is reported through clinical surveillance data. Indeed, resource-constrained and geographically isolated regions have limited infrastructure, resources and are often outside of surveillance reach. This surveillance blind spot limits health services' ability to provide early warning signs and response at regional, national and international level. The consequences of delayed disease response are now, more than ever, recognised in the context of the current pandemic.

Globally, Australia is considered a low-AMR region with a reported national average of 10% resistance for eight priority bacteria.[1] However, this omits the striking geographical variation of AMR across the country, with as much as 56% of *Staphylococcus aureus* clinical isolates resistant to methicillin and an emergence of inducible-clindamycin co-resistance in northern Australia.[5] Accurate geographical and temporal changes of AMR are invaluable for guiding empiric treatment, particularly in light of high community MRSA in regional Australia.[5,6] Persistent clusters of AMR hotspots are converging with surveillance blind spots in regional Australia and to effectively contain this threat, we need innovative, region-specific solutions.

To address this surveillance blind spot, a geospatial surveillance tool called *HOTspots* was developed specifically targeting northern Australia.[5] HOTspots is an analytical platform that uses spatial epidemiology to deliver synthesised data to clinicians on evolving antimicrobial susceptibility by region. Health providers with access to rapid molecular tests that identify the infecting organism and resistance determinants within hours of patient presentation can make an informed decision about antibiotic selection. However, in the absence of such tools, the health provider must rely on population-level susceptibility data, their expertise and available treatment guidelines. The HOTspots tool provides at point of care, AMR data by region that are accurate for local needs and up-to-date. Health providers can choose the region of interest (i.e. where patient may be residing), and visualise maps and graphs of the combinations of pathogens with AMR important for empiric treatment. HOTspots is currently being deployed in clinical settings as an interactive and secure surveillance system that provides ongoing automated synthesis of AMR across community clinics and hospitals in northern Australia.

HOTspots is a longitudinal surveillance platform that has the capacity to perform a vital role in public health, informing the allocation of resources and facilitating the evaluation of region-specific and population-level infection prevention strategies. In additional to detection of AMR hotspots, the platform permits an epidemiological surveillance function by capturing vital statistics (age, sex) and measures of economic impact, which are currently being developed.

A current limitation of HOTspots is that it is a passive system reporting data on phenotypic AMR isolated from clinical infections. It does not capture patients who do not seek healthcare or are not diagnosed, which is important in regional and rural settings. It is currently only available for northern Australia and plans for expanding beyond this region are being developed.

The strength of HOTspots is the large geographical coverage of previously unsurveyed regions. It directly assesses the population-at-risk and empowers decision makers to lead and manage AMR more effectively by providing timely and region-specific evidence. Additionally, the geospatial visualisation of AMR data from both primary and tertiary healthcare sectors, and from various sites of infection (i.e. blood, urine, skin) held in an easily accessible tool will innovate communication and information for action.

Future growth of HOTspots and other AMR surveillance platforms should focus not only on individual user needs and representations of graphs, but on the context of available data. Centralised access to reliable and timely antibiotic utilisation data,[7] disease-specific estimates of morbidity and mortality[3,4] are the minimum information needs required to take strategic action on AMR. While culture-based systems examine the ability of bacteria to grow in the presence of each antibiotic at varying concentrations, microbiology labs are increasingly able to generate molecular data that identify genetic mutations that bacteria have developed or acquired to counteract the effects of the particular antibiotic. Complementing culture-based surveillance with molecular data can overcome some of the challenges faced in remote parts of Australia where transport distances and climate pose limits on the viability of samples for culture. Genetic variation by geography and cluster detection, as it relates to *Neisseria gonorrhoeae*[8] or others and monitoring commensal bacterial flora of healthy populations[9] should continue to be developed. Finally, valuation of the economic cost of AMR is important for decision making and should be estimated accurately.[10] If AMR action is to be sustained it needs to be properly resourced, it has to be part of the national agenda. That means AMR surveillance and activities must be embedded in government planning and budget at all levels.

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