

One Health in the Genomic Era: Connecting Human, Animal and Environmental Genomics

Pathogens do not read borders. They do not distinguish between a bat roost, a livestock market, an irrigation channel, and a hospital ward. For much of modern medicine, we drew those lines anyway—one set of institutions for human health, another for animal health, and a third for the environment. The COVID-19 pandemic made the cost of that fragmentation impossible to ignore, and the genomic era now offers the tools to dismantle it. In this editorial, we argue that the hospital in low- and middle-income countries (LMIC) must be recognised as the connective node of a One Health surveillance architecture and that this architecture must now extend beyond pathogens to the chemical and plastic pollutants that increasingly shape infectious disease risk.

In much of Southeast and South Asia, hospitals are the de facto frontline of One Health. The pastoralist with Q fever after lambing season, the flooded village's leptospirosis cluster, and the spray-season organophosphate poisoning are each registered first in an emergency department or microbiology laboratory, rarely in a surveillance report. Yet genomic capacity in the region remains episodic and project-dependent. The infrastructure built during COVID-19 demonstrated that the region has the capability to sequence; however, the challenge of sustaining this capacity beyond a single virus is primarily institutional rather than technical.¹ Genomic surveillance of clinical isolates, wastewater, and environmental samples now makes it technically trivial to link a human outbreak to an animal reservoir or a contaminated water source. What remains missing is the governance to act on these links.

Global forecasts suggest antimicrobial resistance (AMR) could directly cause 1.91 million deaths annually by 2050,

with South Asia bearing the heaviest burden.^{2,3} Resistance genes, however, circulate on plasmids between farms, clinics, and waterways irrespective of ministerial boundaries. In our region, antibiotics move freely across outpatient pharmacies and veterinary practices, hospital effluent enters rivers carrying resistant organisms, and no surveillance system connects an ICU isolate to a watershed sample downstream. Genomic epidemiology can establish that connection within a matter of days. Sustained, multi-sectoral platforms anchored in hospitals, serving human, veterinary, and environmental samples, with analysis retained locally, are the institutional requirements that sequencing alone cannot supply.⁴

A credible One Health framework must now look beyond pathogens. The region's horticulture economies, viz., apple, saffron, and other high-value crops, sustain hundreds of millions of livelihoods while exposing spray workers, often without protective equipment, to pesticides linked to hundreds of millions of cases of acute poisoning annually worldwide.⁵ More insidiously, pesticides and heavy metals exert selective pressure that co-selects for antimicrobial resistance, binding the agrochemical and AMR agendas into a single surveillance problem.⁶ Meanwhile, micro- and nanoplastics have been detected in human blood, placenta, and atheromatous plaque, with the first large human study linking plaque microplastics to cardiovascular events.^{7,8} In the Himalaya and across South and Southeast Asia, microplastics reach glaciers, lakes, and farmland through atmospheric deposition, plastic mulch and greenhouse films, degraded irrigation tubing, and municipal waste. Microplastics act as vectors for pathogens and resistance genes and leach endocrine-disrupting additives, making the chemical exposome a legitimate subject of genomic and

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metagenomic monitoring alongside infectious threats.⁹ A hospital that profiles clinical isolates while ignoring the chemical environment from which patients come is reading half the text.

Every ambition above founders on equity. Surveillance systems remain weakest where zoonotic and AMR risk is highest; a genomic One Health that watches only wealthy countries is a watching brief on half the world.¹⁰ Sample shipment to high-income laboratories without local analysis, authorship, or benefit is extraction, not partnership. The region's scientific community in public hospitals, agricultural universities, fisheries, and veterinary institutes has repeatedly demonstrated capacity when funded to lead rather than to assist. Data sovereignty is not rhetoric; it is the difference between building national capability and perpetuating dependency.

Conclusion.

The pastoralist's flock, the orchard's spray schedule, the lake that receives them both, and the hospital ward that receives the patient are one system. Genomics has given us the vocabulary to describe it; pesticides and microplastics are expanding its lexicon. The task of this decade is to build the institutional grammar of funding, governance, and equity that allows hospitals across South and Southeast Asia to speak this language fluently for their patients and for a world that shares their risks.

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