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Commentary

From smallpox to polio and beyond: disease surveillance in India

The foundation of India's highly successful smallpox eradication programme was active disease surveillance- the search for smallpox in communities and households, at markets and at religious festivities by networks of community level health workers[1]. By identification and isolation of persons with smallpox and vaccination of their known contacts including persons living in close proximity, India interrupted endogenous transmission of smallpox in the mid-1970s. The success of smallpox eradication in India provides an example of the power of simplified infectious disease surveillance in detecting the target disease and facilitating an appropriate response.

Smallpox also provides a striking example of the complex interaction of infectious diseases, and a justification for sustainable multi-disease surveillance mechanisms. As smallpox eradication was being certified worldwide in 1980, a new and unknown infectious disease was silently spreading around the world, eluding routine disease surveillance in most countries in which it was present. In 1981 this new disease was finally identified as acquired immune deficiency syndrome (AIDS), and by 1984 AIDS and smallpox had been shown to be linked in a manner that unexpectedly impacts on smallpox vaccine safety. During that year, a human immunodeficiency virus (HIV)- infected military recruit in the United States who was vaccinated against smallpox developed generalized vaccinia and died, demonstrating the fatal potential of smallpox vaccine in HIV infected persons[2]. This silent interaction between the vaccinia virus of smallpox vaccine and HIV was detected by multi-disease surveillance for clinical disease, supported by public health laboratory capacity. The fatal interaction between vaccinia and HIV remains an obstacle to the use of smallpox vaccine, should it ever become necessary in the world.

As we enter the 21st century, the microbial world remains complex, dynamic, and constantly evolving. Microbes reproduce rapidly, mutate frequently, and adapt with relative ease to new environments and hosts. Vaccines effective one year for diseases such as meningococcal meningitis or influenza may no longer be effective the next year because of the appearance of new epidemic strains or drifts in genetic sequences[3]. Microbes are likewise quick to exploit new opportunities to spread, adapt, and resist.

Microbes that infect humans can result in infectious diseases that are endemic and kill or disfigure; or they can cause epidemics that appear suddenly and spread from human to human with ease[4]. Microbes also develop resistance to the drugs used to treat them, decreasing the effectiveness of standard treatment regimes; and they can have a negative interaction as in the case of tuberculosis and HIV where in some parts of the world, including parts of India, HIV is driving the numbers of active pulmonary tuberculosis higher than ever before[5,6].

For all of these reasons, it is important and necessary to keep the microbial world at bay through reliable multi-disease surveillance systems that detect infectious diseases, and through health systems that provide an appropriate response. Failure to identify human populations at risk for endemic diseases such as AIDS could, for example, result in AIDS prevention messages that are aimed at persons who are not at risk of HIV infection while missing those who are[7]. Failure to detect when diseases such as malaria are not cured by usual anti-malarials can result in continued use of anti-malarials to which resistance has developed, with an increase in malaria-related mortality[8]. And delayed detection of an epidemic of disease such as severe acute respiratory syndrome (SARS) can result in local or international spread with human suffering and death, and the risk of reversible but costly disruption of trade and travel[9].

Jacob John and his co-authors describe[10], a model for disease surveillance that was shown to be applicable in the Kottayam District of Kerala State, and that was then successfully applied throughout the state. The system in Kerala State is comprehensive and sustainable, encompassing both private and public sector medical

facilities. Throughout its first year of operation it has identified a newly emerging infectious disease epidemic of significant importance (leptospirosis), an unexpected risk population for a high mortality endemic infectious disease (measles) and a recurrent epidemic prone infection (cholera). Once these disease patterns were identified, clinical and public health measures were instituted permitting more effective control.

John and his co-authors emphasize two important objectives of surveillance systems: monitoring the success of ongoing interventions, and the detection and interception of outbreaks. At the same time, they underscore the importance of including both public and private health facilities in such a system, and the importance of its sustainability. By using standardized case definitions and a no cost mail-in system, the chances for standardized, uniform sustained reporting have been increased. By short-course training of medical personnel while they continued to perform their usual functions, and by not placing new contractual staff for surveillance alone, even greater chances of sustainability have been ensured.

Finally, John and his co-authors emphasize that surveillance systems depend on public health laboratories with a variety of reliable diagnostic capacities, and epidemiological services that can use the surveillance information to respond. They further point out that these are the weak links in the surveillance system in Kerala State.

Indeed, public health laboratory and epidemiological capacity are the weak links in surveillance in many other parts of the world as well. Laboratory diagnostic capacity is often not available to confirm the diagnosis of infectious diseases in clinical settings, let alone for confirmation of diagnosis in surveillance systems. Stronger and increased numbers of public health laboratories that use standard and quality controlled diagnostic procedures are required. In addition to helping better understand clinically evident infections as in the system in Kerala State, such laboratories can add a new capacity to surveillance: better understanding of the silent interplay between infectious organisms and their hosts.

Reliably conducted serological tests and isolation techniques allow the detection of persons with evidence of previous infection, persons with asymptomatic infections or persons who serve as healthy carriers of the infectious agent. Added to this, molecular biology capabilities provide a precise tool for strain characterization, and epidemiological tracking of different strains can help understand whether different endemic diseases or outbreaks are linked or independent, or if what appears to be a pandemic is in fact a juxtaposition of independent epidemics.

Nowhere is the usefulness of molecular biology more evident than in India's surveillance system for acute flaccid paralysis, a part of the national polio eradication programme. Each poliovirus isolate from children with acute flaccid paralysis undergoes meticulous molecular study at the Enterovirus Research Centre (ICMR) in Mumbai. Polioviruses studied at the Centre do not only come from children with acute flaccid paralysis however; they also come from sampling of the environment in Mumbai[11]. By genomic sequencing of each poliovirus isolated, a clear understanding of the geographical origin of that virus is obtained[12]. Such "molecular mapping" permits targeting of polio containment activities at the geographic source of wild poliovirus, speeding the way to interruption of wild poliovirus transmission. The utility and importance of such laboratory support to surveillance for acute flaccid paralysis is clearly noted this year in monitoring the impact of India's polio eradication activities: between 1 January and 13 July 2004 India has reported only 18 children with acute flaccid paralysis due to infection with the wild poliovirus compared to 87 children during the same period in 2003, and to a total of 1600 children with flaccid paralysis during the year 2002 (WHO, South East Asia Regional Office).

Surveillance systems in India have evolved greatly since the 1970s when such systems used to eradicate smallpox consisted of no more than a web of village and district level workers who actively sought out those with clinical manifestations of smallpox. Today India has developed sustainable and all-encompassing multi-disease surveillance in Kerala State, where regular information about the occurrence of infectious diseases is available for monitoring the impact of disease control and detection of epidemic diseases as they emerge or re-emerge. What is more, India has also developed high technology laboratory support for surveillance of acute flaccid paralysis at the Enterovirus Research Centre in

Mumbai.The power of India's multi-disease surveillance activities can and will be increased by the application of public health laboratory support to sustainable state level multi-disease surveillance. Further application of genetic sequencing and other high technology procedures will greatly amplify this power; while the application of the fruits of India's IT revolution will ensure timely electronic reporting, rapid communication between laboratory and epidemiology workers, and a means of geographical mapping of disease patterns to the most peripheral level of the health system. The tools for more powerful multi-disease surveillance in India are present and the surveillance system described by John and his co-authors is at its base. The future for disease surveillance in India is bright.

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