Detecting poliovirus hiding in the environment

THE NEED—DETECTING SILENT CIRCULATION

Poliovirus (PV) has been eliminated from large parts of the world, thanks in part to decades of intensive vaccination programs led by the World Health Organization (WHO), the Bill & Melinda Gates Foundation, and Rotary International. Despite these efforts, PV remains endemic in several countries including Pakistan. These countries are now the primary focus of eradication programs with two major factors posing challenges to this effort:

1. Wild-type poliovirus (WPV) can be reintroduced from the remaining endemic regions to other areas where immunization coverage has been insufficient (e.g., the Horn of Africa and Central Africa).
2. The Sabin strains of PV used in the production of oral poliovirus vaccine (OPV) are live attenuated (or weakened) viruses. These strains replicate in the vaccine recipient and can be spread to nonvaccinated individuals. This had been viewed as a benefit in that it increased overall herd immunity, but a key risk of this strategy is that the attenuated virus can revert to being virulent and cause disease in the nonvaccinated. These vaccine-derived PVs (VDPVs) are effectively as dangerous as WPV, and VDPVs are a common cause of outbreaks today.

The current environmental surveillance (ES) tool, the WHO standard two-phase method, is limited by both logistics and sensitivity. Using this method to detect polio viruses from environmental samples requires highly skilled reference laboratories. These laboratories are often far from the remote and challenging regions where PV is endemic requiring liquid samples to be shipped over long distance under cold chain to preserve the contents. These shipments limit volumes sampled to reduce costs as well as creating a potential biohazard while in transit. This method also suffers from low sensitivity due to the relatively small sample volumes that are processed and the time required for sample preparation. These factors influence the tool's detection limit and the frequency of environmental surveillance sampling.

To assist in the final push for global eradication, more effective ES tools are necessary to monitor populations for the presence of WPV and VDPV that may be silently circulating, threatening to cause outbreaks.

Poliovirus can circulate silently in a population, but it can be detected in wastewater using the bag-mediated filtration system. PATH/S. Khan.

A NEW ENVIRONMENTAL SURVEILLANCE TOOL

The goal of this project is to develop, validate, and commercialize a new ES tool to assist in the global eradication of PV. The University of Washington (UW) developed a bag-mediated filtration system (BMFS) that collects wastewater or sewage in a bag, and then passes it through a simple filter that binds PV.

The BMFS is an improvement over the current two-phase method as it is more sensitive and also more suitable for use in remote and challenging environments. The BMFS is able to sample volumes of wastewater 10 to 20 times greater

than the current method, and improves capture of PV in filter cartridges that are more easily shipped to and processed by a laboratory. Furthermore, the use of preservatives on the filter reduces the need for controlling the storage temperature when shipping the filters to a reference laboratory.

In order to confirm the eradication of PV from an area or population, it is critical to first evaluate and optimize the surveillance tools and methods utilized in this effort. PATH is collaborating with the UW to test and improve the BMFS in field settings. Preliminary validations of the BMFS prototype were conducted in Kenya and Pakistan, where the BMFS demonstrated a higher degree of sensitivity than the WHO two-phase method. Field evaluations also informed refinement of the kit design, development of protocols, and streamlining of sample collection and shipping procedures. The BMFS is currently being used in an ongoing pilot study in Pakistan.

NEXT STEPS

PATH and the UW are working to refine the BMFS to make it disposable, easier to use, and lower cost to manufacture. In 2017, the UW, the Kenya Medical Research Institute, and PATH will conduct field-based performance verification of the refined BMFS in Kenya. In addition, the current BMFS design is being used in a pilot study in Pakistan.

Ensuring commercial access is a critical step in translating the BMFS into a viable tool in the field to support PV surveillance and eradication programs. PATH is working with manufacturers and potential commercial partners to negotiate acceptable pricing and supply of all main components in the test through necessary supply chain systems to the countries where PV remains active.

PATH is grateful to the many partners supporting this work, including the US Centers for Disease Control and Prevention and the Global Polio Laboratory Network for their continued input and advice.

Once wastewater is collected, it is expelled through a filter that binds poliovirus, which can then be sent to a reference laboratory. PATH/R. Wilmouth.

FOR MORE INFORMATION

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This project is funded by the Bill & Melinda Gates Foundation.