Japanese encephalitis (JE), a mosquito-borne viral brain infection, afflicts an estimated 35,000 to 50,000 inhabitants of Asia and the western Pacific annually. The disease most often strikes children, who have not yet built up a natural immunity. One-third of JE infections are fatal, and another third leave survivors with severe neurological sequelae. There is no treatment for JE; vaccination is the only defense. Funded by the Bill & Melinda Gates Foundation, PATH’s JE project (2003–2009) worked with international partners and developing countries to increase the information available for understanding the extent of the disease and how best to control it.

SA 14-14-2 JE vaccine was very cost-effective. This same strategy using the inactivated, mouse brain-derived JE vaccine was considered not cost-effective. Given limited resources, immunization strategies targeting high-risk areas also were found to be more cost-effective.\(^7\) (It is important to note that this article was completed prior to the availability of SA 14-14-2 vaccine with a public-sector price. Introducing the lower public-sector price will further improve its cost-effectiveness.)

In 2007, the National Institute of Health Research and Development of the Indonesia Ministry of Health, the Directorate General of Communicable Disease Control and Environmental Health, and PATH linked an assessment of the economic burden of JE with a study on hospital-based surveillance in six Indonesian provinces, collecting data on hospital costs associated with JE infection and financial implications for families. Similarly, PATH and investigators from the China Center for Disease Control gathered information on costs associated with JE illness in Shaanxi Province in order to perform an economic evaluation of the JE vaccination program and identify strategies to improve JE immunization.

Additionally, the Communicable Disease Department of Cambodia launched a study to analyze cost-effectiveness of JE vaccine in 2007, collaborating with the National Immunization Program, National Institute of Public Health, PATH, and WHO. Five hospital sentinel sites collected data on treatment costs associated with JE cases identified through the meningo-encephalitis syndromic surveillance system. Results helped guide decision-making and inform immunization policy.\(^7\)

Future directions
Studies have demonstrated that JE imposes a significant economic burden on households and JE vaccination is considered a cost-effective intervention for endemic populations. The public-sector price set by the manufacturer of the SA 14-14-2 JE vaccine also increases affordability and access for countries that must allocate limited public health resources. As countries continue to introduce vaccine, data on immunization program impact also will be important in refining cost-effectiveness analyses and planning future immunization strategies.

### Cost-effectiveness analysis of JE vaccines
Studies on cost-effectiveness of JE vaccination were undertaken throughout the life of the JE project. In 2006, PATH and local investigators studied cost-effectiveness of JE immunization in Andhra Pradesh, India, by (1) comparing implementation of a one-time vaccination campaign with an intervention that combined campaign plus routine immunization, and (2) comparing use of either the inactivated, mouse brain-derived JE vaccine or the SA 14-14-2 JE vaccine. Results demonstrated that the World Health Organization (WHO)-recommeded combined JE vaccine introduction strategy (catch-up campaigns plus routine immunization) using the live, attenuated
Key lessons learned

- Some elements of cost-effectiveness analyses can be comparable among countries, but it is important to consider potential variations in epidemiology patterns, target populations, and characteristics of the country health system.
- Hospital-based surveillance activities offer an opportunity to simultaneously collect information on costs of clinical treatment for JE.
- Cost-effectiveness analysis is just one piece of information that helps inform decision-making. It should be considered within a broader context of disease burden, vaccine supply, and sustainable financing.
- Countries often underestimate the programmatic costs of vaccination. It is important that countries budget time and resources for these programmatic costs, which include transportation of vaccine, training and supervision, surveillance, waste management, monitoring for adverse events following immunization, and cold chain maintenance.

ENDNOTES