Dynamic Modeling Helps Raise $4 Billion Toward Global Polio Eradication

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The Bill and Melinda Gates Foundation and other partners of global poliovirus eradication efforts recently raised $4 billion supported by the use of models that include System Dynamics tools Systems Dynamics tools.

Dr. Kimberly Thompson and her team at the non-profit organization KidRisk, Inc. (www.kidrisk.org) make a powerful case for integrating systems modeling with economic, risk, and decision analysis tools in the context of of modeling polio. They used interdisciplinary dynamic modeling to estimate the projected net savings from pursuing global polio eradication and provided motivation to fund the project with sufficient resources. Their work has been leveraged by partners around the world to put money and energy towards eradicating polio.

Systems Thinking Approach Clarifies Need for Continued Poliovirus Eradication Efforts

In 1988, when the World Health Assembly (WHA) committed to global polio eradication by the year 2000, little tangible evidence existed about the resource requirements and the scope of involvement necessary to complete eradication.

The partner organizations that launched the Global Polio Eradication Initiative (GPEI) to achieve the goal (Rotary International, the World Health Organization [WHO], UNICEF, and the Centers for Disease Control and Prevention [CDC]), worked with individual countries to successfully eradicate one of the three strains of polioviruses by the year 2000.[1]

However, missing the year 2000 deadline for all polio eradication, repeated delays, and mounting costs led some people to question the need for poliovirus eradication in the mid-2000s. Thompson and Dr. Radboud Duintjer Tebbens used an integrated dynamic model to characterize the economic costs of an effective control solution compared to eradication and showed that eradication represented the better option in terms of both costs and cases.

Dynamic Factors used in Systemic Modeling Add Insights

The team began to build a dynamic poliovirus transmission model in 2001 that aimed to correctly incorporate the complexity of poliovirus immunity and its spread in populations. While other models took a static approach and overlooked complexity associated with uncertainty and variability, Thompson and her team “strongly believed that time cannot be ignored, and the use of Systems Dynamics with other analytical tools is a necessity,” said Thompson.

Combining dynamic modeling with risk analysis and other economic tools enabled the team to perceive these elements in a way that led to their understanding of the savings possible from continued poliovirus eradication efforts. As seen in the resulting causal loop in Figure 1, a wavering commitment to poliovirus eradication is influenced by the perceived costs per case—as the number of cases (or incidences) decreases, the perception is that the high costs of treating fewer cases is no longer worthwhile.[1]

This perception manifests in a wavering commitment that leads to a high number of cases of poliovirus and low cost for treating each case, and then a low number of cases of poliovirus and high cost for treating each case.[1] Thompson and Duintjier Tebbens compared this scenario to an intensive immunization for eradication scenario. The ability to incorporate these dynamic factors through the use of Systems Thinking tools and to compare the cost and implications of the two options made this insight highly effective.

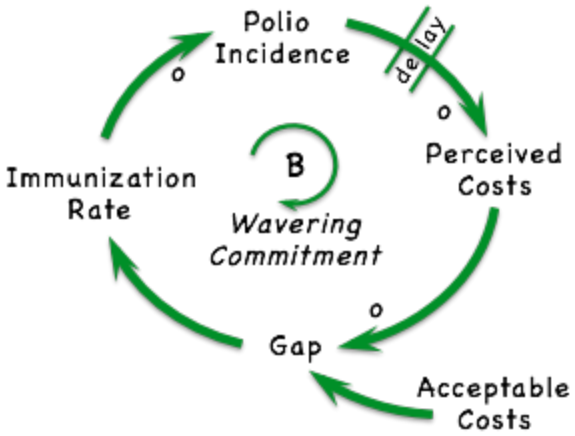

Figure 1: This feedback loop illustrates the "wavering" commitment to global poliovirus eradication, which leads to oscillation in the occurrences of polio cases. Source: Thompson and Duintjer in Wiley InterScience[1]

Collaborative Modeling Across Disciplines Fosters Learning

Thompson notes that the use of a systems thinking approach provided significant value in their ability to facilitate collaboration across disciplines. "Modelers must work with subject level experts if they're going to understand the complexity of challenging problems to get the model right," said Thompson.

Early in its efforts, the Kid Risk, Inc. team reached out to the CDC for this subject-level expertise, which led to a 12-year collaboration between the two organizations. "The learning curve on both sides was a significant part of the collaboration all along," noted Dr. Mark Pallansch, Director of Viral Diseases at the CDC. "This led to a more complete picture of the

questions, the limitations of available data, and the uncertainties of inference. The most important addition was the need to consider all of this in a dynamic framework."

Dynamic Simulation Illustrates $40-50 Billion Saved from Continued Eradication Efforts

Dynamically modeling global polio eradication allowed collaborators to make the case for sustained eradication efforts. Although completing eradication requires a high initial investment, the team estimated that overall the GPEI will save an expected $40 billion dollars worldwide once complete.[2] Figure 2 illustrates these relative costs and expected cases of polio for both scenarios.

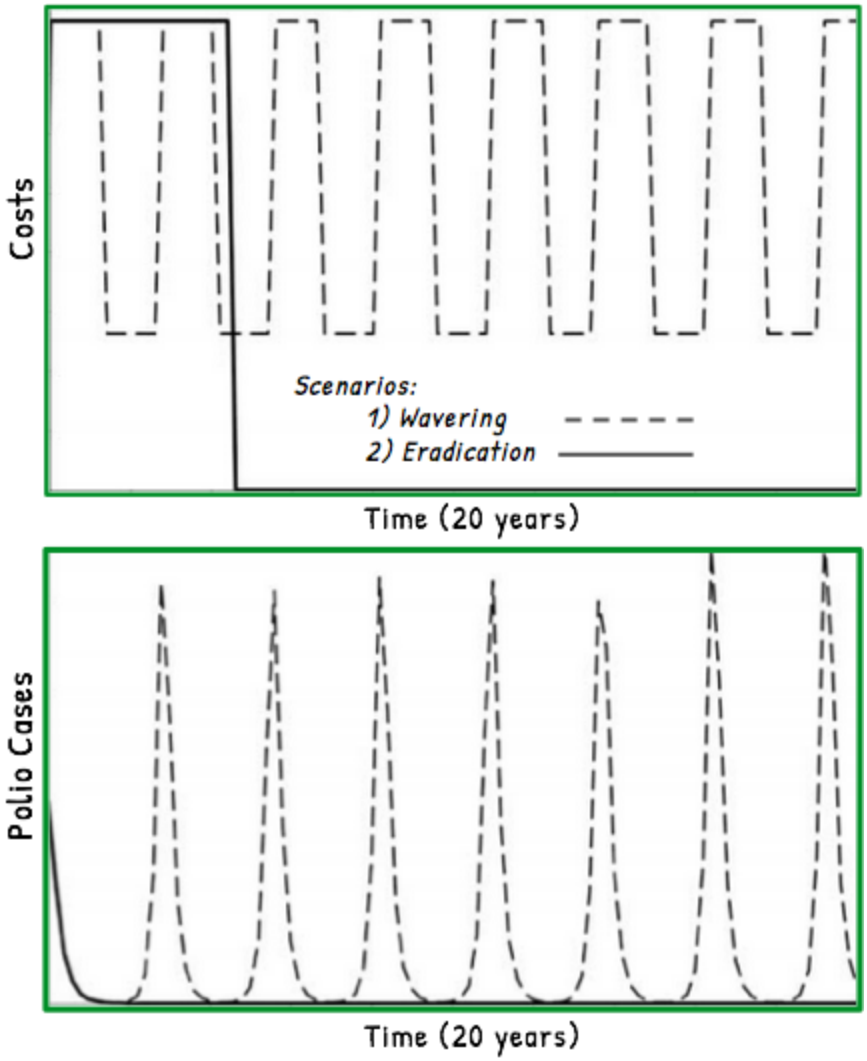

Figure 2: A wavering commitment to the Global Poliovirus Eradication Initiative (GPEI) will result in an oscillating pattern in the outbreaks of poliovirus and higher costs over time than continuing to pursue eradication. Source: Thompson and Duintjer in Wiley InterScience[1]

Modeling Results Increase Fund Raising

In Kim Thompson's words, "Polio eradication is a major project and it needs stable financing." This message resonated with the partners, who continue to undertake major fundraising efforts to finish the job. Notably, the Gates Foundation and other implementers of eradication efforts, like the WHO and UNICEF, raised $4 billion in 2013 toward global poliovirus eradication using work from the Kid Risk, Inc. model to support the business case.

"Investing now to eradicate polio is an economic imperative, as well as a moral one," said Dr. Tachi Yamada, president of the Bill & Melinda Gates Foundation's Global Health Program, in a 2010 press release. "This study presents a clear case for fully and immediately funding global polio eradication, and ensuring that children everywhere, rich and poor, are protected from this devastating disease."[3]

Systemic Insights Lead to Changing Policies

Working collaboratively extended the impacts of the modeling effort, which go beyond the economics. In 2005, the Kid Risk, Inc. model illustrated that "speed trumps coverage with respect to outbreak response." This insight led to a 2006 global policy change that required outbreak response strategies with quicker impact, which has reduced delays in the system.

As a result, the average time it takes to confirm a case has been reduced by 50%, from 42 days to 21 days, which demonstrates effective implementation of the policy change, as well as the power of systems thinking to impact effective outcomes.

Systems Dynamics Approach Drives High Impact Change

For their work on these systemic insights, Thompson and Duintjer Tebbens received the System Dynamics Society Jay Forrester Award in 2008. Additionally, the CDC-Kid Risk, Inc. collaborators recently won the 2014 Edelman Award from the Institute for Operations Research and the Management Sciences (INFORMS).

This work demonstrates the power of integrating system dynamics with other analytical tools to gain a better understanding of complex systems and the importance of collaborative model building for engaging stakeholders effectively and creating change.

Thanks to Dr. Kimberly Thompson for taking the time to speak with us and Dr. Mark Pallansch for responding to our questions.

References:

1. Thompson, Kimberly and Radboud J. Duintjer Tebbens. "Using System Dynamics to Develop Policies That Matter: Global Management of Poliomyelitis and Beyond."

Systems Dynamics Review Vol 24 No 4 (2008): 433-449. Wiley InterScience. http://kidrisk.org/images/SDR.24.4.433.pdf

2. Tebbens, Radboud J. Duintjer, Mark A. Pallansch, Stephen L. Cochi, Steven G.F. Wassilak, Jennifer Linkins, Roland W. Sutter, R. Bruce Aylwarde, and Kimberly M. Thompson. "Economic Analysis of the Global Polio Eradication Initiative." *Vaccine* 29 (2011): 334-343. http://www.who.int/immunization/sage/10_eonomic_analysis_gpei_DuintjerTebbens_Vaccine_2010_10_26_apr_2011.pdf
3. Thompson, Kimberly. "Economic Benefits of the Global Polio Eradication Initiative Estimated at $40-50 Billion." *EurekAlert.* Kid Risk Inc., 2010. http://www.eurekalert.org/pub_releases/2010-11/kri-ebo111910.php

More Information:

Thompson, Kimberly M., and Radboud J. Duintjer Tebbens. 2007. Eradication versus control for poliomyelitis: an economic analysis. Lancet 369:1363-1371

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