

SEPTEMBER 2016

WORKSHOP SUMMARY

**[ADVANCING THE VALUE
OF VACCINES RESEARCH
AGENDA]**

Summary of the background, event, and outcomes



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Introduction

Vaccines have an extraordinary record of preventing disease and death from a multiplicity of infectious agents [1]. They also have remarkable potential for further protecting and promoting good health. Recent research highlights numerous ways in which economists and policymakers have failed to account for the full benefits of vaccine programs, suggesting these programs have been substantially undervalued and that many decisions regarding vaccination adoption and scale-up, and investment in vaccine discovery and development, have not been well founded [2-13]. Moreover, past data analyses conducted to assess and compare vaccine costs and vaccine benefits have not been sufficiently customized to key features of epidemiological, economic, institutional, and country contexts, and to the nature and quality of the data at hand. Failures here, which abound in the literature, undermine the validity of many empirical analyses and the conclusions they reach.

The current data on the benefit-costs of vaccines (e.g., datasets, surveys) available to researchers and policymakers often do not capture all of the inputs necessary to estimate the full impact of vaccinations on individuals, families, communities, and national economies [9]. More specifically, data are not routinely collected on the costs of illness, including medical, non-medical, and opportunity costs, incurred by families with relatives who are ill with vaccine-preventable diseases. Additionally, the macroeconomic consequences of vaccination as they relate to labor productivity and economic growth

(including foreign direct investment, domestic savings and investments, labor participation and productivity, and economic growth) are not easily captured by current long-term study designs. To improve the validity of vaccine assessments, a critical next step is for researchers to be able to quantify these benefits and make them publicly available.

Policymakers need tools and data to help them evaluate the role that vaccines can play in specific epidemiological, health system, and economic contexts. When forced to choose between competing needs, policymakers – especially those in ministries of finance and development – need information that outlines the returns on investments for vaccination as compared to investments in other areas within the health sector and across other sectors (e.g., education, tourism, labor, etc.). In the absence of comprehensive data on vaccine-specific benefits in each setting, the application of traditional cost-effectiveness and cost-benefit analyses only yields a partial picture of the potential benefits that immunization programs can deliver.

Cognizant of the need for evidence-based decision-making tools, the Harvard T.H. Chan School of Public Health convened leading experts in the field of vaccination research for a workshop on April 26-27, 2016, with the purpose of identifying barriers impeding evaluations of the economic impact of immunization and formulating potential solutions to these problems. The workshop's discussion produced a prioritized list of questions for future research (included in the body of this document), which will help guide investments in this area. The long-term goal of the workshop was to spark data-driven research that will produce the information required by policymakers to make evidence-based decisions to optimize resource allocation in health and vaccination programs. The workshop, as well as its preparation and follow-up, was conducted with the support of the Bill & Melinda Gates Foundation. The following sections of this paper describe how this workshop fits within the context of other recent meetings on the value of vaccination, summarize the proceedings, and provide an overview of the meeting's key outcomes.

Background: Evolution of Thought across Value of Vaccination Meetings

The workshop summarized in this paper was the most recent in a line of meetings on the value of vaccination held in recent years.¹ Research in this arena has progressed significantly from each meeting to the next. The value of vaccination workshop held in Toronto in 2011 included the presentation of the Bärnighausen et al. framework for broad vaccine benefits [14]. This framework was further developed at a meeting in Geneva in 2012, where a list of good practice guidelines to better capture the impact of vaccination also emerged. At a meeting in France in 2013, participants made a number of short-term, medium-term, and long-term recommendations for future study on the value of vaccination. These included identifying additional existing data sources, encouraging the collection of data on the value of a statistical life, and tying value of vaccination data collection to vaccine trials in phases III and IV. Recommendations from the 2013 meeting in Sydney and 2014 meeting in Bangkok included developing standardized methods for evaluating the social and economic impacts of vaccines. Participants at the

¹ Summaries of value of vaccination meetings in [Switzerland \(2012\)](#) and [France \(2013\)](#) are publicly available. Meetings in the years Canada (2011), Australia (2013), and Thailand (2014) are not.

Bangkok meeting also asserted the importance of presenting data and results in a manner that is relevant to key policymakers.

The most recent workshop described in this summary – held in Boston in the spring of 2016 – built on the outcomes and recommendations of each of the five preceding meetings. Many of the research questions generated during this meeting seek to quantify the magnitude of effects that were first proposed in the Bärnighausen et al. framework, and built on proposals for future research made at the meeting in France [14]. Finally, participants at the 2016 workshop designed research questions likely to yield useful data for policymakers making real-world decisions.

Summary of Keynote Address and Opening Remarks

The workshop began with a keynote address from Dr. David Salisbury. He examined the intersection of vaccination policy, politics, and public health in the United Kingdom. The central theme was that policy decisions concerning the implementation of immunization programs are rarely made outside of a political context; it is important to keep this reality in mind when building the evidence base for defining the value of vaccination.

In his opening remarks, Dr. David Bloom discussed the evolution of conceptual thinking about the value of health interventions – and vaccination in particular – that has occurred in recent years. He summarized the growing body of evidence indicating that improvements in population health can drive economic development, just as economic development can lead to improvements in population health. The supposition that vaccination may have broader economic benefits – beyond averted medical costs and direct health gains – emerged out of an awareness of this reciprocal relationship between health and income. Over the past decade, researchers have developed frameworks that attempt to account for the full effects of vaccination, including long-term productivity gains, reduced nosocomial infections and comorbidities, community externalities, and greater social equity.

Evidence from early studies has already indicated that some of these hypothesized vaccine benefits can be supported empirically. However, significant challenges remain when it comes to generating meaningful and reliable data to properly assess the full value of vaccination. Many of the proposed effects of vaccination have diffuse paths of causation (e.g., education also contributes to enhanced productivity), which can make it difficult to quantify the magnitude of vaccination's discrete impact. In addition, the magnitudes of these effects are often context-dependent. Value of vaccination analyses should ideally be conducted in a manner that properly accounts for variations in disease profiles, epidemiology, economic circumstances, and policy and institutional contexts. If researchers can answer these challenges by producing more precise and more nuanced data, policymakers will be more likely to consider broader effects when making decisions regarding vaccination. In the absence of these data, there is a real possibility that policymakers will underfund immunization programs relative to the benefits they confer.

To facilitate the development of appropriate data for policy makers, the meeting constituted panels to discuss various aspects of this issue. These included four different perspectives: research, industry, policy, and delivery. Each session included three panelists and one moderator. Participants were asked to consider two specific questions, detailed below, in their discussions.

Research Perspective

Moderator	Dr. Steven Black , Professor of Pediatrics in the Center for Global Health University of Cincinnati Children’s Hospital
Panelist	Dr. Stephane Verguet , Assistant Professor of Global Health Harvard T.H. Chan School of Public Health
Panelist	Dr. Dagna Constenla , Associate Scientist Johns Hopkins Bloomberg School of Public Health
Panelist	Dr. Mark Jit , Reader in Vaccine Epidemiology London School of Hygiene & Tropical Medicine

Question 1: What are the two most critical challenges for researchers to tackle in building the body of evidence for the value of vaccination?

The panelists emphasized the importance of continuing to accumulate long-term and context-specific evidence on the value of vaccination and suggested opportunities for conducting future research while identifying several challenges. Recommendations for future research included conducting more longitudinal studies on the economic impact of vaccination, adding economic endpoints (including non-traditional indicators such as developmental and educational outcomes) to clinical trials for vaccines, and making use of “natural experiments” when they arise (e.g., the staggered rollout of the pentavalent vaccine against diphtheria, tetanus and pertussis, hepatitis B and Haemophilus influenzae type b in India). The panelists also emphasized that research should be conducted in a fashion that is specific to the context in which it will be applied. Ideally, the data used in policy decisions concerning immunization will be specific to the relevant contexts in terms of geography and biology. Challenges to existing and future research include a lack of standardized methodologies and measures and the difficulty of determining how to monetize broader vaccine benefits for economic evaluations.

Question 2: What can/should researchers do to translate their research to other disciplines and stakeholders?

The panelists emphasized the importance of understanding the needs of end users for research findings and suggested some possible means by which study results may be translated into useful information for policymakers. The panelists agreed that having an awareness of who uses the data produced by value of vaccination studies can help guide the direction of research. That way, they can better tailor research questions to ensure that their analyses address the needs of their audience. Ideas for translating evidence into useful information for policymakers include building evidence that can be applied in cost-effectiveness analyses (which is the framework currently used by most policymakers), determining how to monetize vaccine benefits for use in benefit-cost analyses when optimizing resource use beyond the healthcare budget, and making greater use of multi-criteria decision analyses.

Industry Perspective

Moderator	Dr. Mark Steinhoff , Visiting Professor at Harvard Medical School and Professor of Pediatrics and Director of the Children’s Global Health Center Cincinnati Children’s Hospital
Panelist	Dr. Baudoin Standaert , Head of the Global Health Economic Program GSK Vaccines
Panelist	Dr. Craig Roberts , Associate Vice President in the Center for Observational and Real-World Evidence Merck
Panelist	Dr. Jose Noguera , Dengue Vaccination Policy and Advocacy Director – Americas Sanofi-Pasteur

Question 1: How can the vaccine development and manufacturing industry work with other stakeholders in the vaccine community to strengthen research on the value of vaccination?

Panelists confirmed that industry leaders are interested in the issue of appropriate valuation of vaccinations. Research that appropriately demonstrates the value of vaccination helps industry members to better prioritize among vaccines in development and support stronger arguments when bringing their products to ministries of health and finance. Panelists discussed the possibility of collaborating with researchers on economic follow-up of clinical vaccine trials. While the panelists saw some value in this type of research, they emphasized that the primary objective of clinical trials is to measure the efficacy and safety of vaccines, and thus the trial design and statistical power may not meet the needs of economic assessment. Results may also not be generalizable beyond the study population. Panelists furthermore highlighted the importance of having non-industry partners take the lead in conducting this type of research, since industry research teams must address specific regulatory obligations.

Question 2: What does the vaccine industry need from other stakeholders to engage in more dynamic research collaborations?

The panelists agreed that considering industry members as partners in promoting public health is one of the most important ways to advance further research in the field. They emphasized that researchers and industry leaders share a common interest, and cited trust as a key ingredient in successful partnerships. The panelists called for increased transparency in research – including increased access to data. Some of the areas the panelists said they would like to see addressed in future research included methods to address public trust in vaccines, affordability and prioritization of vaccines, and social preferences.

Policy Perspective

Moderator	Dr. Jeffrey Kwong , Associate Professor, Department of Family and Community Medicine, Dalla Lana School of Public Health at the University of Toronto; Senior Scientist, Institute for Clinical Evaluative Sciences
Panelist	Dr. Bruce Y. Lee , Associate Professor of International Health, Director of the Global Obesity Prevention Center Johns Hopkins Bloomberg School of Public Health
Panelist	Dr. Sachiko Ozawa , Assistant Scientist, International Health Economics Johns Hopkins Bloomberg School of Public Health
Panelist	Dr. Sarah Pallas , Economist, Global Immunization Division U.S. Centers for Disease Control and Prevention.

Question 1: What are the biggest unanswered research questions that policymakers need for well-founded recommendations on specific vaccinations and vaccination programs?

One panelist posed the question of whether evidence on the economic value of vaccination contributes to increased investment in immunization. Up to this point in time, it has appeared that evidence on the broader value of vaccination may be a necessary – but not sufficient – condition to encourage increased investment. Therefore, researchers should determine what other information is needed and direct their efforts accordingly. Panelists also emphasized the importance of establishing a context for interpreting value of vaccination evidence. This may include demonstrating how vaccines compare against other means of achieving similar health and development objectives, such as investment in clean water and sanitation. Comparisons may involve return on investment or benefit-cost analyses.

Question 2: What are two lessons that policymakers should learn based on epidemiology and vaccination decisions in recent years?

Panelists posited that vaccines and diseases need to be considered as part of a complex system that is not fully understood. Without a better understanding the system, research and policy interventions are likely to produce temporary rather than lasting solutions. To be effective, vaccine evaluations should incorporate both traditional and nontraditional methodologies, make use of multiple measures to assess value, and consider value in the context of how vaccines interact with other interventions. Panelists also emphasized the importance of recognizing that other factors besides the economic value of vaccinations are regularly considered in policy decisions. These factors include issues of affordability, political risk, and decision-maker incentives. Finally, panelists cited a series of challenges in translating value of vaccination research into policy that have emerged in recent years. These challenges include explaining the relative merit of different valuation methodologies, communicating uncertainty ranges, and the persistence of data gaps.

Delivery Perspective

Moderator	Dr. Mira Johri , Professor, Department of Health Management, Evaluation and Policy University of Montreal
Panelist	Mr. Robert Steinglass , Director, Immunization Center JSI Research & Training Institute, Inc.
Panelist	Dr. Deborah Atherly , Global Program Leader for Vaccine Access and Delivery, Director of Health Economics and Outcomes Research PATH
Panelist	Ms. Cara Janusz , Manager, ProVac Initiative Pan-American Health Organization

Question 1: What types of questions should value of vaccination research endeavor to answer to improve vaccine delivery?

Panelists emphasized that vaccines do not have a positive value unless they are delivered. They also said that delivery of immunizations has become more complicated in recent years. Reasons for this include the increase in number of vaccines that require more than one dose, the expanding range of age groups targeted for vaccine interventions, and the fact that ensuring vaccine coverage is not enough to make an impact – it is also important to ensure that vaccines are potent, safe, and delivered in an efficient and timely manner. The panelists warned that it is important to remain aware of the potential for vaccine uptake to have unintended consequences. For example, without adequate messaging, delivery of the malaria vaccine may result in decreased use of bed nets. Multiple panelists stressed the persistence of inequities in vaccine delivery. Geography, gender, wealth, and a number of other factors contribute to these inequities. Finally, the panelists noted the importance of considering multiple factors when making policy decisions about vaccine delivery. These factors may include economic evidence, vaccine effectiveness, and equity implications, among others.

Question 2: What role can vaccine delivery stakeholders play in increasing communication and collaboration between stakeholders?

Panelists discussed the role those working in the vaccine delivery field can play in forming community partnerships and acting as decentralized advocates for release of operational funds to conduct vaccination. They also emphasized the importance of having health workers and communities share responsibilities and actively monitor vaccination services.

Prioritized List of Questions for Future Research

The meeting then broke into small group-work sessions to identify a prioritized list of questions for future research with participants in the three groups being asked to concentrate on one of three types of data: 1) existing survey data, 2) existing non-survey data, and 3) new data sources.

After developing a list of potential questions, participants in each group voted to identify the highest priority questions for future research. For each prioritized question, participants identified the expected timeframe for the research; the necessary resources for collecting, analyzing, and applying the

findings from the proposed research; the next steps to begin answering the research question; and any important considerations for the future.

Once the groups had developed their lists of prioritized questions and identified the relevant information about the proposed research, participants reconvened as one group and shared the results of this exercise. Below are two lists: one which identifies the prioritized research questions that emerged and another which describes additional research questions identified by the small groups. The order of the questions does not follow a ranking system.

Table 1: High-Priority Research Questions

Question	Proposed timeframe	Resources required	Next steps	Future considerations
Existing survey data				
What contribution does vaccination make to gross domestic product (GDP) growth across a range of countries and income groups?	18 to 24 months	Team of 5 or fewer people to: identify data sets, conduct a literature review, build/run/refine model, identify data gaps, define assumptions, and collect data	Identify relevant data sets from sources such as the World Bank, CCT datasets, RCTs, country-level partnerships and data Develop a model that allows measurement of past impact and estimation of future impact.	Consider novel data sources (e.g., Google trends)
What are the magnitudes of the intergenerational impacts of vaccination on health, economic, and cognitive outcomes across a range of countries and income groups?	Retrospective: 1 year Prospective: 20+ years	Team of 5 or fewer full-time researchers; data	Identify countries where relevant datasets exist. Review possible methodologies (e.g., siblings, cross-sectional, modelling, etc.)	Need to work closely with countries involved Likely to use "Google-like" big data
Can we formulate and collect readily available indicators of broad economic outcomes?	5 years	Experts in the field; the World Bank; African and Asian development banks	N/A	N/A
What is the relationship between vaccination and fertility outcomes?	2 years	Family planning databases; demographic surveys; country and household data sets; census data; administrative records	Quantify the role of vaccination in the decline of fertility; develop a statistical model that corrects for confounding, etc.	There are past and current examples of members of the public being misinformed and concerned that certain vaccines cause infertility so when communicating this research, clearly state that the vaccines themselves do not cause infertility.

Existing non-survey data				
How would you establish the linkage between direct benefits and longer term externalities, such as the impact of seasonally variable infectious diseases on health system capacity and impact on quality of care for other conditions?	5-10 years	Data; financing; partnerships	Start where there is data: e.g., dengue, rotavirus, and influenza	N/A
What broader economic outcomes from (publicly) funded RCTs and clustered trials are currently taken into account? (retrospective/prospective)	1-3 years	Access to data via funders; databases for registered trials	N/A	Engagement with trial funders to create list of broader economic outcomes to be included in new trials
New data				
Using an ethnographic approach to answer, "How do households experience the illness of a child with a vaccine-preventable disease? How do households respond to vaccine introduction?"	1-2 years	Locally sensitive ethnographies	Pilot and validate tools, choose countries and vaccine preventable diseases, collect data, ideally before and after vaccine introduction.	N/A
What are the economic implications of using vaccines to slow antimicrobial resistance?	2-5 years	Funding, partnership, data, and modelling	Look at: antibiotic usage patterns as it relates to pneumococcus, respiratory syncytial virus (RSV), C. difficile, norovirus, E. coli, K. pneumoniae., S. aureus	Decreasing antibiotics for pneumonia and otitis media; data are more accurate in HIC; see if resistant strains are included in the multi-valent vaccinations like the 10- and 13-valent pneumococcal vaccines
What are the drivers (political, institutional, procedural, etc.) of vaccination policy-making and where are the critical intervention points (case study-based)? Subtitle: How influential are value data?	6 months or longer	Interviews with political scientists and policy makers; observation of ongoing decision making; social scientists/anthropologists to conduct the research	Identify case studies retrospective and prospective; examine "rational" and "irrational" cases	Blinded in reporting to optimize participation and minimize litigation risk

Designing ideal value of vaccination questionnaire leveraging existing studies with broader economic impact of vaccination	1-2 years	Repositories of existing tools; adaptation existing materials	Linking with disease reduction evaluation research; developing "ideal" questionnaire; pilot testing	Use (uptake) of the tools
How do graduating Gavi countries make decisions regarding vaccines? What are the trade-offs (e.g., staying in budget)?	4-5 years (work could be conducted by a PhD student)	Context and decision-making matrix; stakeholders/settings/analyses/data needs for decisions with CBA or CEA; country documents	N/A	N/A
What are the factors impacting value of vaccination assessment regarding vaccines among non-technical decision-makers?	1-2 years	Tools from other fields that have looked at political/executive decisions	Adaptation of tools; mapping existing data; data collection	Building on existing data; speaking to decision-makers

Table 2: Additional Research Questions to be Further Developed

- How do we render the value of a statistical life comparable across incomes (across or within countries) when individuals have different abilities to pay (i.e., marginal utilities of income)?
- What data are most likely to drive political support for vaccination in chosen contexts? And what role does emotional framing/advocacy play in political decision-making?
- What is the magnitude of the intergenerational benefit of vaccination?
- Can we map out specific direct and indirect health effects of vaccination that lead to social and economic effects?
- What evidence of the broader benefits of vaccination may enhance public trust in vaccines?
- Can we establish a standard for the quantification of the broader impact of vaccination measured against the value of a statistical life in different contexts and with adjustments made for education?
- Can we clearly establish who needs what data and when they need them in order to facilitate timely policy-making and implementation?
- Can we measure the value to a pharmaceutical company choosing to invest in developing one vaccine over others? For both producers and consumers, what may be the implications of advancing the definition of vaccination value on the prioritization of vaccine discovery and development?
- How can the time from licensure to decision-making and implementing (or not implementing) a vaccine be minimized? And can we measure the lost value of delayed decision-making, implementation, and coverage optimization?
- What is required to optimize the overall programmatic impact of vaccination?
- Can we conduct a landscape analysis of value of vaccination data?
- What is the impact of vaccination on household savings and consumption?
- Can we develop guidelines for situating value of vaccination studies on top of vaccine introduction studies?

Discussion

Beyond the specific outcomes of the panels and small group exercises detailed above, several key themes emerged from the workshop. Much of the discussion centered on how to respond to the need for better tools and data in the realm of value of vaccination research.

Several participants commented on the comparative utility of benefit-cost analyses (BCAs) and conventional cost effectiveness analyses (CEAs). CEAs are typically undertaken by policymakers when deciding how to allocate resources within a fixed healthcare budget. However, some participants contended BCA should be regarded as a superior tool for determining how to optimize resource allocation within budgets that cover multiple sectors (including, but not limited to, healthcare), and that this type of holistic thinking is preferable in the realm of policymaking. There was general consensus among workshop participants that researchers need to deal with the informational demands imposed by their audiences. In the short run, researchers must be prepared to work with available data to address the

questions posed by ministries of health and finance and other decision-making entities. This will most likely involve continuing to supply data for, and carrying out, CEAs. Nevertheless, several participants expressed the view that in the long run, researchers should take steps to apprise these stakeholders of the additional virtues of benefit-cost analyses in broader budgetary situations and work to identify new sources of evidence that are better suited for conducting these evaluations.

With respect to BCAs, one participant noted that attempts to compare the value of a statistical life across different income settings can be ethically difficult. These comparisons often imply that the value of a person's life depends, in part, on their income. Researchers should be cognizant of the potential ethical challenges inherent in these types of analyses.

Given the continued importance of CEA for making arguments suited to policymakers, it may be worth attempting to improve on the methodology employed in these studies. Extended cost-effectiveness analysis, which takes into account the dimensions of equity, distributional consequences (e.g. per socio-economic status, geographical setting), financial risk protection, and poverty reduction benefits into economic evaluations, is one approach to enhancing traditional CEA [15, 16]. Multi-attribute decision models represent another potentially useful tool in this domain. Finally building models of complex systems may serve as an alternate approach to understanding the value of vaccination.

With respect to new data, both conditional cash transfer programs and randomized control trials may provide new sources of information for studying vaccines. RCT data seem promising, but it is clear that they have significant limitations because of non-random selection into RCTs and because many end with control groups receiving the treatment, which can make matters difficult when it comes to distinguishing between long-term outcomes. Vaccine RCTs have a few significant disadvantages in providing evidence of broad vaccine value, including limited ability to measure and detect herd effects through population vaccination, limited generalizability due to differences in infectious disease epidemiology and process of care across countries, and a limited number of infectious events that would occur prospectively in a reasonably-sized prospective trial population. Alternatively, natural experiments and observational datasets suitably adjusted for confounding provide additional opportunities for prospective analysis.

There may also be possibilities to improve upon the types of observational data that are routinely collected. For example, linking data sets on immunization with data sets on education may provide opportunities for researchers to quantify some of the broader benefits of vaccination. Also, when infectious disease surveillance is well-established within a country, the impact of vaccination is often large enough that it may be detected through longitudinal surveillance. A complete understanding of the economic impact of the infectious disease locally, prior to implementation of a vaccination program, can then be used to attribute economic gains associated with disease reduction or elimination. Ultimately, multiple research methods, including mathematical modeling and long-term epidemiological surveillance, will be necessary for countries to be able to measure and attribute the source of gains in health, economics, and social welfare that may be completely or partially due to vaccination. These types of data may be collected in post-licensure studies. Other types of data collection vehicles, such as RCTs, are not designed to capture these indicators.

Apart from the importance of identifying quality tools and data for research, other general takeaways include:

- Forming strong partnerships among stakeholders will be essential for continuing progress in the arena of value of vaccinations research. Academics, policymakers, and those responsible for vaccine delivery need to consider the role of industry representatives as important collaborators for moving forward on the value of vaccination.
- Evidence on the value of vaccinations must be collected and communicated in ways that are appropriate to the context and the audience. When assessing the value of vaccination in comparison with other interventions, countries must consider the unique epidemiological, financial, and health system contexts they face. In many respects, the middle-income countries are the ones most at risk of struggling to maintain vaccination programs because they are often too rich to qualify for aid (such as Gavi assistance), and they may be too poor to finance vaccination on their own.
- The field would benefit from the establishment of a working group on data pertaining to the value of vaccination. A small team could conduct an inventory of available data, assess its quality, and make recommendations for collecting a new generation of data that is better suited to addressing the most pressing questions that need to be answered. Fundamentally, the role of data is to serve as a solution to a problem or a question. If the problem or the question changes, the data need to evolve in a corresponding fashion. This is clearly what needs to happen in the vaccination arena.
- Analyses of the value of vaccination need to account for the complexity of immunization strategies and the quality of vaccines themselves at the point where they are delivered.
- It is worth considering the broader benefits of non-vaccination interventions alongside the broader benefits of vaccination. However, it is likely that the ratio of full to narrow benefits for vaccines is higher than it is for most other health interventions, such as those for NCDs.
- Researchers must continue expanding the taxonomy for the value of vaccinations, capturing more of both the positive and negative effects of immunization. New examples of effects that came up during the workshop included the potential for decreased bed-net use following the introduction of a malaria vaccine and the role combination vaccines could play in reducing the cost of delivery. Given the ultimate goal of allowing policymakers and other stakeholders to make informed decisions when it comes to vaccination, these are all factors worth considering, and researchers must do their best to continue cataloguing externalities and unintended consequences as they become apparent.

Finally, the results of this workshop indicate that value of vaccinations research enjoys increasing interest across the vaccine research community, and that such research could make a material difference to the development, prioritization, and delivery of vaccines. Demonstrating the full value of vaccination is not a routine topic, but the potential payouts in terms of improved population health and economic wellbeing are well worth the effort.

Workshop Summary and Conclusions

The main outcome of the 2016 workshop was the prioritized list of research questions detailed in the Summary of Small Group Work section. Other primary outcomes included a background paper covering a review of recent literature, the results of a survey of experts in the field of vaccines research (also detailed in the background paper), and this paper, a version of which will be submitted for publication in a leading academic journal.

The workshop has also yielded a series of noteworthy secondary outcomes. Within a month of the workshop's conclusion, multiple attendees began developing specific research proposals from ideas that emerged during the meeting. In addition, several researchers have begun to collaborate across disciplines and institutions in a manner that would likely not have occurred without the workshop. Overall, attendees expressed satisfaction with the role the workshop played in allowing for the interchange of ideas and in promoting new research ventures. Finally, workshop participants – including David Bloom, Bruce Y. Lee, Saad Omer, and Baudouin Standaert – are currently working with the publisher Elsevier to explore the creation of a new academic journal dedicated to the assessment of health technologies and interventions, such as vaccines.

Appendix: Workshop Participants

Name	Institution
Deb Atherly	PATH
Steven Black	University of Cincinnati Children's Hospital
David Bloom	Harvard T.H. Chan School of Public Health
Logan Brenzel	Bill & Melinda Gates Foundation
Daniel Cadarette	Harvard T.H. Chan School of Public Health
Marcia Castro	Harvard T.H. Chan School of Public Health
Angela Chang	Harvard T.H. Chan School of Public Health
Dagna Constenla	Johns Hopkins Bloomberg School of Public Health
Victoria Fan	University of Hawaii
Cara Janusz	PAHO
Mark Jit	London School of Hygiene & Tropical Medicine
Mira Johri	University of Montreal
Alexander Khoury	Harvard T.H. Chan School of Public Health
Jeff Kwong	University of Toronto
Joel Lamstein	John Snow, Inc.
Bruce Y. Lee	Johns Hopkins Bloomberg School of Public Health
Arindam Nandi	CDDEP
Jose Noguera	Sanofi-Pasteur
Saad Omer	Emory University
Sachiko Ozawa	Johns Hopkins Bloomberg School of Public Health
Sarah Pallas	U.S. Centers for Disease Control and Prevention
Pauline Paterson	London School of Hygiene & Tropical Medicine
Allison Portnoy	Harvard T.H. Chan School of Public Health
Carlos Riumallo Herl	Harvard T.H. Chan School of Public Health
Craig Roberts	Merck & Co, Inc.
David Salisbury	Chatham House
JP Sevilla	Data for Decisions
Baudouin Standaert	GSK
Robert Steinglass	JSI Research & Training Institute, Inc.
Mark Steinhoff	Cincinnati Children's Hospital
Jessica Sullivan	Harvard T.H. Chan School of Public Health
Inge van der Putten	Maastricht University
Stephane Verguet	Harvard T.H. Chan School of Public Health
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