PROJECT OPTIMIZE

Achieving the Global Vision for Future Immunization Supply and Logistics Systems: Action Plans

September 2012

OPTIMIZE

Immunization systems and technologies for tomorrow

PATH

World Health Organization

This report was commissioned by project Optimize: Immunization Systems and Technologies for Tomorrow, a World Health Organization and PATH collaboration. The report was authored by the members of the priority area working groups.

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Abbreviations

AMP	Agence de Médecine Préventive
AEFI	adverse events following immunization
CCL	cold chain and logistics
DCVMN	Developing Countries Vaccine Manufacturers Network
EPI	Expanded Programme on Immunization
EVM	effective vaccine management
HCWH	Health Care Without Harm
HR4SCM	human resource for supply chain management
HWA	Health Workforce Alliance
IAPHL	International Association of Public Health Logisticians
IFMPA	International Federation of Pharmaceutical Manufacturers and Associations
IPAC	Immunization Practices Advisory Committee
MOF	ministry of finance
MOH	ministry of health
NGO	nongovernmental organization
NITAG	National Immunization Technical Advisory Group
NRA	national regulatory authority
PAHO	Pan American Health Organization
PATH	Program for Appropriate Technology in Health
PDP	product development partnership
RHSC	Reproductive Health Supplies Coalition
PtD	People that Deliver Initiative
PQS	Performance, Quality and Safety (standards of WHO)
SAGE	Strategic Advisory Group of Experts
SCM	supply chain management
SOP	standard operating procedure
TBD	to be determined
UN	United Nations
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund
VPPAG	Vaccine Presentation and Packaging Advisory Group
WAHO	West Africa Health Organization
WHO	World Health Organization

Achieving the 2020 Global Vision for Immunization Supply and Logistics Systems: Action Plans

Immunization programs today are embarking on a period of unprecedented growth. New vaccines are being introduced and strategies to reach new target groups are being deployed. At the same time, other health programs are expanding their work and setting up their own supply chains to distribute commodities such as bednets; condoms; antiretroviral drugs; medications for reproductive health, tuberculosis, and malaria; micronutrients; and reagents for diagnostic assays.

The vaccine supply and logistics systems used in most countries were developed thirty years ago. It is now essential to put in place the necessary improvements and technologies in supply systems to deliver valuable products safely, effectively, and efficiently, so that existing and new vaccines and other health commodities reach the people who need them. It is also important that the vaccine products that flow through these systems are optimized for the contexts in which they will be shipped, stored, and used.

Under the auspices of the Cold Chain and Logistics Task Force led by the United Nations Children's Fund (UNICEF) with a temporary secretariat housed at project Optimize, a broad group of partners and stakeholders including nongovernmental organizations (NGOs), industry, the World Health Organization (WHO) and UNICEF, GAVI Alliance members, and national governments developed a common vision for the future of immunization supply systems. This vision statement detailed below is meant to form a platform behind which key partners at all levels—country, regional, and global—can align their work and efforts.

Vision statement: By 2020, state-of-the-art supply systems meet the changing needs of a changing world in order to enable the right vaccines to be in the right place, at the right time, in the right quantities, in the right condition, at the right cost.

Stakeholders described five priority areas that must be strengthened before the vision can be achieved. These five areas and the desired state for each area are described below:

1. Vaccine products and packaging

Vaccine products and their packaging are designed with characteristics that best suit the needs and constraints of countries.

2. Immunization supply system efficiency

Immunization supply systems are designed to maximize effectiveness, agility, and integration with other supply systems, and to support continuous system improvement through learning, innovating, and leveraging synergies with other sectors.

3. Environmental impact of immunization supply systems

The environmental impact of energy, materials, and processes used in immunization supply systems from the international to local levels is assessed and minimized.

4. Immunization information systems

Immunization information systems help staff plan and manage immunization activities and resources while ensuring that adequate quantities of vaccines are always available to meet demand.

5. Human resources for immunization logistics

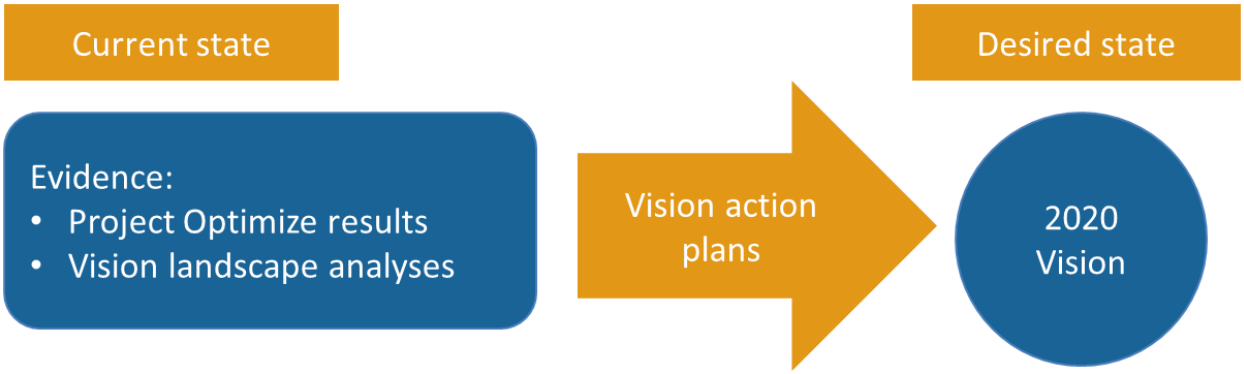
Human resources policies provide immunization supply systems with adequate numbers of competent, motivated, and empowered personnel at all levels of the health system to overcome existing and emerging immunization supply challenges.

For each of these areas, a working group of experts was established to:

- Take stock of relevant work already underway through the efforts of stakeholders and document this work in landscape analysis summaries (also referenced below).
- Identify gaps (pieces of evidence and activities) that must be addressed in each priority area.
- Develop an action plan to address the identified gaps.
- Assess which organizations or partners would be best placed to tackle each of the items in the action plan.

Toward the end of 2012, the vision statements, landscape analyses, and action plans were finalized and initial steps have been taken to implement the action plans. See Figure 1 for an overarching framework for the action plans. As feasible, the work will purposefully align with the Decade of Vaccines activities and plans.

Figure 1. Framework for the 2020 action plan



The following action plans were produced by each area's working group members (see appendix A) representing a wide variety of organizations and project imperatives. The action plans were further consolidated by project Optimize to enable partners to review all the action plans together. This document should be read in the context of the broader 2020 vision work—please see Developing a Vision for Immunization Supply Systems in 2020: Landscape Analysis Summaries for further information.

1. Vaccine products and packaging

1.1. Current gaps

After conducting a landscape analysis to better understand activities underway by all global stakeholders that influence the characteristics of vaccine products and packaging for developing countries, the working group identified several gaps that need to be addressed to realize the vision of future immunization supply and logistics systems:

- Increased involvement is needed from national immunization programs in research and feedback to inform vaccine product profiles.
- Appropriate tools and information must be available to enable countries to strengthen national decision-making and ensure that the vaccine products they purchase have attributes that meet country needs.
- Movement is needed toward a situation in which vaccine purchasers value innovation by basing purchase decisions on cost-per-dose-delivered rather than on price alone.
- Manufacturers' efforts to provide products with the desired attributes must be facilitated to ensure continued innovation in vaccine technologies.

1.2. Desired state and action plan

Desired state: Vaccine products and their packaging are designed with characteristics that best suit the needs and constraints of countries.

The following action plan recommends specific activities that will help close identified gaps and achieve the desired state for vaccine products and packaging. For each proposed or ongoing activity, an appropriate organizational lead and partner organizations are proposed.

1.2.1 Vaccine products meet internationally recognized standards of quality and safety

In general, the high quality of vaccine products purchased through United Nations (UN) agencies is attributable to the attention and resources focused on vaccine prequalification by WHO, support to national regulatory authorities (NRAs), and heightened interest of vaccine producers in supplying products to the UN agencies. For countries that directly purchase vaccine products, maintaining this standard of quality is straightforward to implement if prequalified vaccines are purchased and if well-established, international procurement guidelines are followed. For nations that produce their own vaccines, pursuit of WHO prequalification standards or the equivalent will ideally be sought. One area in particular need of bolstering is vaccine safety monitoring in lower-income countries—including national adverse events following immunization (AEFI) surveillance, investigation, response, and coordination with global authorities. Vaccine producers can also play a stronger role in post-marketing surveillance.

Table 1. Action plan for maintaining quality and safety of vaccine products

Activity	Description	Potential partners
Strengthen capacity of NRAs		
Enable countries to implement expedited review of imported, prequalified vaccines in recipient countries.	Support countries that procure vaccines mainly through UN agencies and want an expedited vaccine licensure procedure. Emphasize recommended licensing timelines and expectations with relevant NRAs.	WHO (lead), country NRAs, WHO regional offices, and UNICEF and WHO country offices.
Support the African Vaccine Regulatory Forum.	Support countries that wish to participate in the African Vaccine Regulatory Forum, a scientific advisory body of experts who assist regulators in Africa.	WHO (lead), country NRAs, WHO regional offices, and UNICEF and WHO country offices.
Support the Developing Countries' Vaccine Regulators Network.	Support the Developing Countries' Vaccine Regulators Network's role to strengthen NRAs' regulatory capacity for evaluation of clinical trial proposals and data through expertise and exchange of relevant information.	WHO (lead) and NRAs from Brazil, China, Cuba, India, Indonesia, Republic of Korea, Russia, South Africa, and Thailand.
Achieve WHO standards of quality and safety		
Support WHO prequalification of vaccines.	Support the prequalification process to determine acceptability, in principle, of products from different sources for supply to UN agencies.	WHO (lead), country NRAs, UNICEF, and PAHO.
Implement commitments from manufacturers for post-marketing surveillance of newly introduced vaccines.	Secure pharmaceutical companies' commitments to adequately invest in post-marketing surveillance of new vaccines after their introduction in developing countries.	Bill & Melinda Gates Foundation and other donors supporting vaccine development (lead), country NRAs, vaccine manufacturers, and PDPs.
Implement countries' commitments to monitor and evaluate newly introduced vaccines.	Support country NRAs and MOHs to adequately invest in Phase IV monitoring of new vaccines after introduction.	Country NRAs (lead), WHO and UNICEF country offices, WHO Programme for International Drug Monitoring, Global Advisory Committee on Vaccine Safety, Brighton Collaboration (supported by the Bill & Melinda Gates Foundation), and Council for International Organizations of Medical Sciences.

MOH = ministry of health; NRA = national regulatory authority; PAHO = Pan American Health Organization; PDP = product development partnership; UN = United Nations; UNICEF = United Nations Children's Fund; WHO = World Health Organization.

1.2.2 Mechanisms for dialogue between the public sector and manufacturers to reach consensus about product attributes are institutionalized

Today there is greater attention on the need for up-front dialogue to define and prioritize vaccine product attributes in the early stages of the product development process. One positive trend to help

ensure that vaccine products and packaging meet the needs of developing-country immunization programs is the creation of the Vaccine Presentation and Packaging Advisory Group (VPPAG). This group serves as a global forum for discussion and consensus-building between public-sector and industry stakeholders about desired vaccine product attributes. In addition, many private-sector vaccine producers and vaccine PDPs are putting increasing efforts into market research and other assessments aimed to help define target product profiles for specific vaccines. Finally, some vaccine producers are holding consultations with the VPPAG and/or other groups of stakeholders to help inform decision-making around product specifications. These efforts are all steps in the right direction.

Two areas for improvement stand out in this ongoing dialogue about vaccine product attributes. The first is the need for a readily available evidence base for decision-making. Data must often be gathered on an ad-hoc basis, or decisions are made in the absence of solid data. Greater availability of country data on vaccine management challenges that could be mitigated by vaccine product attributes would be extremely useful. Such data could include vaccine wastage rates categorized by cause (e.g., expiry, heat or freeze exposure, breakage, need to discard at the end of the session), cold chain capacity analyses, vaccine-specific session sizes, AEFIs due to specific program errors, and patient or health worker concerns.

A second area for improvement is the need to better connect with those who handle and administer vaccines to seek their opinions and address their concerns about vaccine product attributes. Even with increased Internet and telecommunications connectivity, large gaps remain between health workers who prepare and administer vaccine products and those who design, develop, and produce vaccine products. Conducting market research interviews and surveys in developing countries is outside the scope and capability of most vaccine manufacturers. When attempts to conduct such research are made, they are usually conducted by international agencies, NGOs, or consultants. While such research is valuable in improving vaccine product attributes, care must be taken to not overburden those whose core responsibility is to provide health care. Creative methods to more regularly and efficiently communicate with health care workers and logisticians should be identified to include their voices in the public- and private-sector dialogue and ensure that their needs and concerns are taken into account when developing vaccine product profiles.

Table 2. Action plan for improving dialogue between the public sector and manufacturers

Activity	Description	Potential partners
Build the evidence base in countries for appropriate product attributes		
Enable vaccinators, logisticians, and EPI managers to identify challenges of vaccine storage, distribution, preparation, administration, and waste management.	Build evidence base to identify vaccinators' challenges and product attributes that would help resolve these challenges. Existing tools and reports (e.g., cold chain inventories, AEFI reports, effective vaccine management reports) and new tools can be used for this purpose.	EPI managers (lead), WHO regional offices, UNICEF and WHO country offices, country NRAs, vaccinators, logisticians, and NGOs.

Activity	Description	Potential partners
Seek means to gather and disseminate key data from countries to inform vaccine product profiles and other decisions.	Share evidence base with vaccine and device developers and product profile decision-makers to influence their processes.	WHO (lead), WHO regional offices, UNICEF and WHO country offices, VPPAG, GAVI, and NGOs.
Facilitate direct dialogue between the public and private sectors		
Support VPPAG as a forum for public- and private-sector dialogue and a standing committee of WHO's Immunization Practices Advisory Committee.	Support and strengthen this forum for industry and public-sector dialogue on vaccine product presentation and packaging and as a mechanism to respond to industry requests for guidance.	WHO (VPPAG secretariat, lead), UNICEF, WHO, GAVI, John Snow Inc., PATH, US Centers for Disease Control and Prevention, vaccine and device manufacturers, and PAHO.
Create an in-country mechanism to exchange information between the public sector and those developing product profiles for vaccines and devices.	Identify key in-country stakeholders available to highlight issues and respond to inquiries about product profile needs and preferences—communications could occur by email, phone, or video.	NITAGs or equivalent (leads), country NRAs, EPI managers, MOH, MOF, UNICEF and WHO country offices, NGOs, civil society organizations, and vaccine and device developers.
Use annual forums such as the Global Immunization Meeting, the New and Underutilized Vaccines Implementation Meeting, and WHO regional partner meetings to exchange ideas between global and national representatives.	Use existing forums to gather opinions and data from stakeholders regarding value-added attributes and presentations for products to meet country program needs.	VPPAG (WHO) or others developing product profiles (leads); UNICEF, GAVI, WHO and UNICEF regional offices, and MOH representatives.
Promote product-specific roundtables with vaccine and device manufacturers as needed.	Promote product-specific roundtables with vaccine producers or device manufacturers for discussion and information exchange on specific product attributes and presentations.	Vaccine and device developers and manufacturers (leads); VPPAG, WHO, UNICEF, GAVI, and MOH representatives.
Promote information exchange between stakeholders in the public and private sectors through TechNet.	Support the use of TechNet as a forum for dialogue between public and private sectors on product attributes and presentations.	TechNet21 (lead), WHO, UNICEF, GAVI, UNICEF and WHO country offices, EPI managers, NGOs, vaccine and device developers, and logisticians.

Activity	Description	Potential partners
Improve direct dialogue between EPI managers and vaccine and device manufacturers.	Hold workshops with regulators, EPI managers, and manufacturers to review vaccine product, storage, and distribution issues in countries to explore opportunities for industry to help meet challenges.	IFPMA and DCVMN (leads); EPI managers, NRAs, UNICEF and WHO country offices, vaccine manufacturers.

AEFI = adverse events following immunization; DCVMN = Developing Countries Vaccine Manufacturers Network; EPI = Expanded Programme on Immunization; IFMPA = International Federation of Pharmaceutical Manufacturers and Associations; MOF = ministry of finance; MOH = ministry of health; NGO = nongovernmental organization; NITAG = National Immunization Technical Advisory Group; NRA = national regulatory authority; PAHO = Pan American Health Organization; UNICEF = United Nations Children's Fund; VPPAG = Vaccine Presentation and Packaging Advisory Group; WHO = World Health Organization.

1.2.3 Guidance on product attributes preferred by developing countries is provided and followed by vaccine and device manufacturers

Vaccine and device makers need greater clarity on product specifications for low-income countries. Pressure to reduce prices in these markets makes the addition of beneficial, yet more costly, features a risky business for suppliers. The earlier that signals can be sent from the public sector identifying which product attributes are essential, the better. Providing clear specifications levels the playing field for manufacturers and helps to ensure that countries receive the products they need.

A process has evolved to generate *generic* product specifications for vaccines through the VPPAG's generic Preferred Product Profile for vaccines and the WHO's Programmatic Suitability of Vaccine Candidates for Prequalification requirements. However, there is currently no standardized way to ensure that *specific* product specifications are created for new vaccines and devices that reflect the contexts in which these products will be used. In some instances, target product profiles have been generated by PDPs such as the Malaria Vaccine Initiative. In other instances, the VPPAG has created target product profiles (for example for pneumococcal conjugate vaccine) at the request of industry and/or GAVI. Finally, WHO currently plays a lead role in developing specifications for stand-alone delivery devices through the performance, quality, and safety process. Defining and standardizing such a process is recommended for new vaccines and delivery devices that are important to developing-country markets.

Table 3. Action plan for providing guidance on product attributes for vaccine and device manufacturers

Activity	Description	Potential partners
Define standards for appropriate generic product attributes to meet country needs		
Provide an overview of desired vaccine presentation and packaging specifications to product developers.	Maintain and update the generic Preferred Product Profile for vaccines.	VPPAG (lead), WHO, UNICEF, GAVI, NGOs, International Federation of Pharmaceutical Manufacturers Association, DCVMN, vaccine and device manufacturers, and donors.

Activity	Description	Potential partners
Provide clear guidance to industry on vaccine product attributes relevant to all new vaccines, including mandatory WHO prequalification features.	Address industry concerns and finalize and maintain WHO's Programmatic Suitability for Prequalification requirements.	WHO (lead), IPAC, VPPAG, UNICEF, and GAVI.
Define product-specific standards early in the product development process to meet developing country needs		
Develop specific target product profiles for vaccines.	Gather and translate the evidence base (outlined in Table 2) into specific target product profiles.	PDPs and/or VPPAG (lead); WHO, UNICEF, GAVI, NGOs, vaccine manufacturers, and regulatory experts.
Integrate resources and guidance to develop specific target product profiles into PDPs.	Urge funders of PDPs to mandate conformity to generic Preferred Product Profile and to develop specific product profiles grounded in evidence from countries.	Bill & Melinda Gates Foundation and other donors sponsoring PDPs (leads); and PDPs.
Develop specific target product profiles for stand-alone delivery devices.	Gather and translate the evidence base (outlined in Table 2) into specific target product profiles.	WHO (lead), device developers and manufacturers, IPAC, NGOs, and regulatory experts.

DCVMN = Developing Countries Vaccine Manufacturers Network; IPAC = Immunization Practices Advisory Committee; NGO = nongovernmental organization; PDP = product development partnership; UNICEF = United Nations Children's Fund; VPPAG = Vaccine Presentation and Packaging Advisory Group; WHO = World Health Organization.

1.2.4 Streamlined tools and processes are available to assess trade-offs in product profiles and to inform purchase decisions

Product developers and product purchasers/users can make better decisions about product attributes when they have access to tools and processes that enable them to analyze data and assess impact. Often the same tools can be used for both sets of stakeholders. Examples include tools to assess impact on cold chain capacity when a particular product is introduced into a country, or tools to assess the cost-effectiveness of introducing alternative product formats that have different impacts on vaccine wastage, vaccine effectiveness, health worker time to prepare, and/or coverage.

An increasing number of countries are procuring vaccines directly and could benefit from publicly available tools and information on product characteristics, in addition to price and procurement data, to inform their decision-making.

Table 4. Action plan for generating tools and processes to address trade-offs and inform decision-making

Activity	Description	Potential partners
Identify gaps in existing decision-making tools		
Review existing tools with countries and identify needed tools, including econometric tools to assess trade-offs and measure the cost-benefits of one option over another.	Evaluate the utility of existing tools (listed below) and determine additional tools needed: • Logistics Planning Tool. • Comprehensive Multiyear Plan for Immunization Tool. • Vaccine Presentation Assessment Tool. • Vaccine Management Assessment Tool. • Logistics 2 EPI Log Forecasting Tool. • Vaccine Post-Introduction Evaluation Tool. • Vaccine Store Volume Calculator and Large Store Analysis Tool.	WHO (lead), GAVI, EPI managers, logisticians, UNICEF and WHO country offices, and NGOs.
Enable development of new tools based on evidence of need, driven by specific demands from countries.	Enable development of specific tools according to country needs identified through countries' systematic review of existing and missing tools.	WHO (lead), GAVI, EPI managers, logisticians, UNICEF and WHO country offices, and NGOs.
Assess and adapt usefulness of PAHO ProVac Vaccine Program Costing Tool.	PAHO cost-effectiveness tool contains new program costing and budget impact analysis functionalities to allow countries to assess impact of vaccine introduction on the cold chain. The usefulness of the tools should be explored in countries in other regions.	WHO (lead), PAHO, ProVac, Supporting National Independent Immunization and Vaccine Advisory Committees, EPI managers, logisticians, MOHs, MOFs, and UNICEF and WHO country offices.
Consolidate existing and new decision-making tools		
House decision-making tools, including econometric tools, in a single place to optimize access.	Several decision-making tools are available and some tools appear to have overlapping functionality—consolidating essential tools in a single place would facilitate access.	WHO (lead), NITAGs, EPI managers, logisticians, UNICEF, UNICEF and WHO country offices, and NGOs.

EPI = Expanded Programme on Immunization; MOF = ministry of finance; MOH = ministry of health; NGO = nongovernmental organization; NITAG = National Immunization Technical Advisory Groups; PAHO = Pan American Health Organization; UNICEF = United Nations Children's Fund; WHO = World Health Organization.

1.2.5 Continued innovation in vaccine technologies occurs and manufacturers' efforts to provide products with the desired attributes are facilitated

The vaccine industry is conservative by necessity because the target populations for vaccines are healthy individuals and most often children. There is strong interest among many stakeholder groups for new vaccine technologies to address immunization program issues such as needlestick injuries,

hazardous waste disposal, large storage and transport volumes, and potential for user error. However, even when obvious technical solutions can be found, they often add cost to the product. Manufacturers that advance value-added technologies for vaccines are often at a disadvantage, especially when purchase decisions are made by price alone. Uptake of novel vaccine technologies has not been positive thus far. The process outlined in this action plan should help to advance obvious vaccine product attributes and technologies that have been favorably assessed by public-sector stakeholders and built into product profiles. However, further work is needed to provide firmer purchase commitments to industry and to continue to encourage revolutionary technology solutions that could improve immunization effectiveness, safety, and coverage.

Table 5. Action plan for facilitating manufacturers' efforts to provide products with desired attributes

Activity	Description	Potential partners
Securing donor and country commitments to desired product attributes		
Demonstrate added value of desired product attributes to donors and countries purchasing vaccine products.	Convince donors and countries of the value of the desired product attributes by producing cost-benefit evidence.	PDPs, VPPAG, and/or WHO (for vaccine delivery devices, leads); UNICEF, WHO, UNICEF and WHO country offices, NGOs, and GAVI.
Strengthen national decision-making capacity for vaccine product purchasing		
Strengthen NITAGs' ability to advise governments on purchase decisions and influence the market.	Support NITAGs' role to make evidence-based technical recommendations to the national government.	MOHs (lead), WHO, UNICEF, EPI managers, logisticians, UNICEF and WHO country offices, and NGOs.
Promote government accountability for immunization.	Urge parliamentarians to become increasingly accountable for immunization budgets.	Sabin Institute (lead), EPI managers, MOHs, and MOFs.
Push mechanisms		
Secure donor commitments to invest in development of desired product attributes.	Convince donors to share the risk in innovation with industry by investing in development of desired product attributes.	TBD (lead), GAVI, EPI managers, logisticians, UNICEF and WHO country offices, and NGOs.
Pull mechanisms		
Secure donor commitments to purchase vaccines with desired attributes.	Convince donors to share the risk in innovation with industry by generating demand for products with desired attributes.	TBD (lead), GAVI, Bill & Melinda Gates Foundation, and bilateral donors.
Bind UN procurement agents to agreed-upon target product profiles for each product to best meet country needs.	Mandate conformity to target product profiles for procurement by UN agencies in order to secure commitment of countries, their donors, and manufacturers.	PAHO (lead), UNICEF Supply Division, WHO, and country NRAs.

Activity	Description	Potential partners
Facilitate manufacturers' efforts to develop preferred product attributes (e.g., meets WHO's Programmatic Suitability for Prequalification requirements).	Consider facilitating manufacturers' efforts to develop preferred product attributes (i.e., by guaranteeing a higher share of supply contracts to manufacturers who meet preferred product attributes).	UNICEF Supply Division, PAHO (lead), GAVI, Bill & Melinda Gates Foundation, bilateral donors, vaccine and device manufacturers.
Find mechanisms to improve cohesion between product attributes for low-, middle-, and high-income markets to render the low-income markets more attractive.	The more attractive the product attribute is in multiple markets, the more interest manufacturers will have in its development—ensuring that product attributes for low-income countries are of interest in other markets can act as an incentive.	TBD (lead), WHO, GAVI, VPPAG, IPAC, purchasing authorities from middle- and high-income markets, vaccine and device manufacturers.

EPI = Expanded Programme on Immunization; IPAC = Immunization Practices Advisory Committee; MOF = ministry of finance; MOH = ministry of health; NITAG = National Immunization Technical Advisory Group; NGO = nongovernmental organization; NRA= National Regulatory Authority; PAHO = Pan American Health Organization; PDP = product development partnership; TBD = to be determined; UN = United Nations; UNICEF = United Nations Children's Fund; VPPAG = Vaccine Presentation and Packaging Advisory Group; WHO = World Health Organization.

2. Immunization supply system efficiency

2.1 Current gaps

A landscape analysis on immunization supply system efficiency identified four domains where knowledge and information gaps exist and need to be addressed.

2.1.1 Vaccine supply and logistics systems that maximize effectiveness and agility

Vaccine supply and logistics systems in most developing countries were designed 30 years ago when vaccines were limited in number (only about five or six antigens) and very cheap. Today we have six to eight additional vaccines currently in use or ready to be introduced in vaccination programs and they are much more expensive. While important progress has been made in new vaccine development, supply systems have not kept up with changes. Countries are beginning to outgrow the carry capacity of existing supply systems. In order to manage change and prepare systems for the future, new solutions are needed to maximize the effectiveness and agility of vaccine supply systems. In recent years, several new innovations have been adopted in the private sector and some have been shown to improve these desired attributions. These innovations include:

- Regional distribution hubs to manage the growing pipeline of vaccines.
- Innovative, last-mile transport solutions for health workers.

- Innovative cold chain equipment that enables programs to handle larger volumes, reach areas without electricity, or minimize temperature deviations.[1]
- Temperature monitoring and immunization information systems that provide real-time monitoring data on storage temperatures, stock levels, and consumption to inform management decisions and increase efficiencies (also see priority area number 4 below)

Remaining gaps to explore and document in more depth are listed below.

2.1.2 Supply systems that are more integrated with wider health supply systems

In the past, vaccines were among a small group of health commodities that required cold chain and have therefore operated in a vertical fashion independently from other health commodity supply chains. With more and more health commodities being managed by countries, with the growing trend to scale up central medical stores, and with the increasing number of temperature-sensitive drugs and other health commodities, countries are beginning to experiment with integrating multiple supply chains to gain efficiencies and make better use of limited resources. Unfortunately, little guidance exists on how to undertake this successfully. Knowledge gaps in this area include:

- Identifying and analyzing the models of successfully integrated health commodity supply chains in the world and sharing lessons learned on best practices.
- Developing guidance on optimal design and management oversight of an integrated supply system.

2.1.3 Supply systems that continually adapt to changes through ongoing monitoring, learning, and innovation

Although equipment and temperature monitoring and maintenance are already part of most vaccine supply systems, these functions are often neglected or difficult to carry out. Many countries would benefit from new ideas and methods of monitoring temperatures, maintaining refrigeration and vehicles, and managing systems for effective ongoing operations. Specific gaps to address in the short term include:

- Technological and management solutions for temperature monitoring and computerized monitoring of stock levels, distribution, and consumptions as part of required quality assurance processes during in-country transport and storage of vaccines.
- Innovative funding mechanisms to ensure that recurrent expenses for vehicle maintenance and cold chain equipment are covered.

2.1.4 Supply systems that leverage synergies with other sectors including the private sector

Most public-sector vaccine logistics systems are managed entirely within the government health sector and/or parastatal companies. Some countries have found, however, that certain functions of the logistics and supply systems can be outsourced to private-sector companies. This requires additional

[1] For example, larger capacity vaccine refrigerators that can cope with unreliable electricity are needed at the subnational level in response to increasing vaccine volumes. In provincial stores there is a gap in capacity between the largest currently available vaccine refrigerators (200 liters net) and the smallest cold rooms supplied by UNICEF (typically 10 m^3 with a net vaccine capacity on the shelving units of around 1,500 liters).

managerial oversight, but can save time and money while reaching additional health centers in a timely manner. More information is needed on outsourcing and reverse logistics options, including:

- Analysis and feasibility of transport back-loading and/or reverse logistics options.
- Innovative distribution systems for vaccines and immunization supplies.
- Evidence showing the value of and best practices for public-private partnerships in various aspects of vaccine supply and logistics systems.

2.2 Desired state and action plan

Desired state: By 2020, immunization supply systems are designed to maximize effectiveness, agility, and integration with other supply systems. They support continuous system improvement through learning, innovation, and leveraging synergies with other sectors.

To achieve this desired state, immunization programs must explore alternative vaccine supply system design for these to be more efficient, dynamic, and synergistic with other health sector supply chain systems. Because efficiency can be achieved through systems—better design, management, and operations—and through better equipment, these two areas have separate action plans.

Table 6 focuses on general immunization supply system efficiency, and Table 7 focuses on equipping the vaccine cold chain.

2.2.1 Immunization supply system efficiency

Table 6 highlights key actions required to address the major gaps relating to supply system efficiency.

Table 6. Action plan for improving immunization supply system efficiency

Activity	Description	Potential partners
Support ongoing work		
Technical assistance.	Provide ongoing support to countries to undertake initial and follow-up EVM assessments and to implement their EVM improvement plan.	GAVI (lead), WHO, EVM assessors, and national governments.
Innovation.	Facilitate Bill & Melinda Gates Foundation Grand Challenges Explorations call for proposals (through Immunization Innovation Fund) to address knowledge gaps related to supply system efficiencies.	Bill & Melinda Gates Foundation (lead) and global partners.
Ongoing landscaping.	Conduct continuous horizon scanning and landscape analyses of projects, demonstration, and other related activities that contribute to the evidence and knowledge base for supply system efficiencies. This should be done within immunization, within the health sector outside immunization, and outside the health sector altogether (including the commercial sector).	WHO (lead), UNICEF, and other global partners.

Activity	Description	Potential partners
	Set up a database of all countries' current system designs (including elements of integration, outsourcing, and delivery-based work).	
Development of tools and guidelines	Foster development of tools that support countries in implementation of existing supply chain solutions (e.g., streamlining or outsourcing). Develop a companion EVM guide that helps countries translate their supply chain baseline assessment to a desired state action plan.	WHO (lead), UNICEF, and other global partners.
Policymaking	Promote existing but not widely implemented supply chain solutions through policymaking bodies (e.g., IPAC), and promote relevant policy changes.	WHO (lead).
Communications and advocacy	Conduct ongoing dissemination of horizon scanning and landscape analysis findings. Disseminate developed guidelines, tools, and methods.	TechNet (lead) through WHO, UNICEF, and TechNet members.
Streamlined and delivery-based design		
Innovation	Develop supply chain network design tools/models for improving international supply chain system design (from manufacturer to country). Develop supply chain network design tools/models that help countries assess the best network design to achieve their desired state in terms of streamlined and delivery-based systems for vaccines and temperature-sensitive products.	Project Optimize (lead), PATH, WHO, UNICEF, and other global partners.
Operations research	Document evidence base of international streamlined and delivery-based supply chain systems (e.g., public regional hubs for vaccines—UN Humanitarian Response Depot and Fiji vaccine hubs for the West Pacific small island states). Document evidence base of national streamlining and delivery-based systems (e.g., moving warehouse, Delivery Team Topping Up models, or VillageReach models). Map all procurement and supply chain processes and determine which aspects could be optimized (lean methodology).	CCL taskforce, WHO, UNICEF, and academic researchers. UNICEF Supply Division and national procurement agencies.
Financing	Review performance-based funding mechanisms for supply chains and their application to vaccines and immunizations.	Academic researchers.

Activity	Description	Potential partners
	Advocate for continued and strengthened GAVI support for vaccine supply chain systems. Analyze cost benefits of streamlined and delivery-based designs in the context of new vaccine introduction.	GAVI and Decade of Vaccines Collaboration. WHO, PATH, and Vaccine Modeling Initiative.
Development of tools and guidelines	Develop country guidelines on the why's and how's of streamlined and delivery-based design systems Develop relevant SOPs.	Project Optimize, WHO, UNICEF, and CCL taskforce.
Technical assistance	Support country assessment for streamlining and delivery-based systems using the various tools and guidelines.	Global partners.
Policymaking	Review the national policy and regulatory environment that would favor changes toward more streamlined and delivery-based supply system network designs. Make relevant policy recommendations at immunization forums (e.g., IPAC or SAGE).	WHO.
Developing synergies between supply chains and streamlining (when relevant)		
Evaluation	Draw lessons from country experiences in developing synergies between health supply chains and in streamlining within vertical supply chains. Analyze options for integrating storage and distribution of vaccines within other relevant health commodity supply chains.	Academic researchers.
Operational research	Model the potential impact and demonstrate added value of integration with other supply systems. Model the potential impact and demonstrate value of streamlining scenarios. Develop methodologies to assess cost and benefits of developing synergies between supply chains and streamlining.	Vaccine Modeling Initiative and PATH.
Policymaking	Review the national policy and regulatory environment that would be conducive to development of synergies between health supply chains. Make relevant policy recommendations at immunization forums (e.g., IPAC or SAGE).	TBD.

Activity	Description	Potential partners
Development of tools and guidelines	Develop country guidelines on streamlined, delivery-based design and developing synergies between various health supply chains. Develop relevant SOPs.	WHO.
Building evidence on back-load or reverse logistics systems		
Operational research	Review costs and benefits of reverse logistics for immunization. Conduct feasibility assessments of reverse logistics for immunization. Review existing experiences of transport back-loading in immunization, health, and the commercial sector. Map all public and private transportation capacities in countries and identify potential partnerships.	TBD.
Development of tools and guidelines	Develop relevant guidelines to support countries in implementation of reverse logistics strategies or back-loading opportunities.	TBD.
Evaluation	Conduct pilot projects to evaluate proof of concept and value proposition for reverse logistics and back-loading.	TBD.
Policymaking	Review the national policy and regulatory environment that would be conducive to implementation of reverse logistics. Make relevant policy recommendations at immunization forums (e.g., IPAC or SAGE).	TBD.
Seeking synergies with private-sector/NGOs/civil-society organizations		
Evaluation	Review in-country opportunities to leverage synergies through public-private partnerships (e.g., outsourcing). Outsourcing needs to be better evaluated for each function and type of outsourcing. Advice should then be provided to countries based on evidence regarding advantages, potential risks, and issues to be addressed in order to maximize likelihood of success.	TBD.
Guidelines and tool	Develop guidelines to support countries in establishing public-private partnerships to enhance supply system efficiencies and adequately manage contracts.	TBD.

Activity	Description	Potential partners
Program management	Promote management of performance-based contracts.	WHO and UNICEF.
Evaluation	Ensure regular assessments so that EVM practices remain at desired levels.	WHO (lead) and GAVI.
Monitoring	Identify key performance indicators to help monitor countries' progress toward their desired states. Support countries in setting up monitoring systems through key performance indicators. Continuously monitor key performance indicators and regular analyses to identify the need for corrective actions.	TBD.
Program management/ development of tools and guidelines	Manage supply systems through SOPs.	TBD.
Training and capacity-building	Promote ongoing training, supportive supervision, and innovation. Map existing academic (pre-service) training opportunities on supply chain management and provide support to help them create tracks devoted to health supply systems.	TBD.

CCL = cold chain and logistics; EVM = effective vaccine management; IPAC = Immunization Practices Advisory Committee; NGO = nongovernmental organization; SOP = standard operating procedure; SAGE = Strategic Advisory Group of Experts; TBD = to be determined; UNICEF = United Nations Children's Fund; WHO = World Health Organization.

2.2.2 Equipping the cold chain

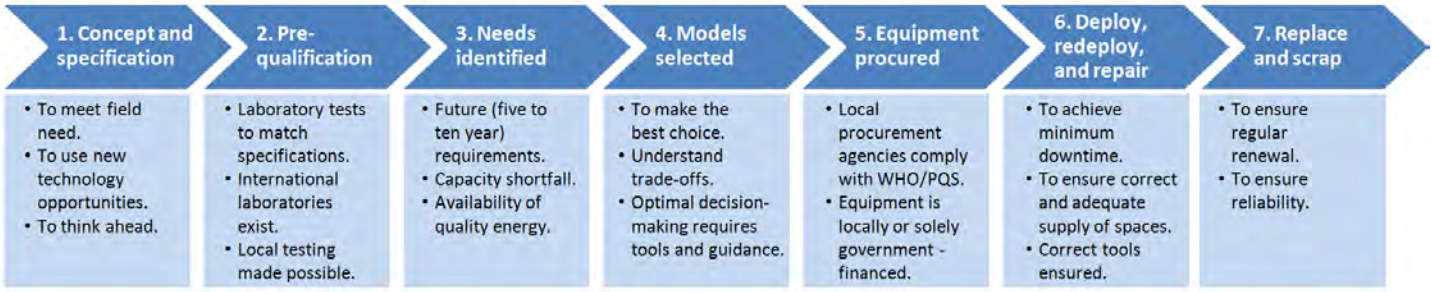
By 2020, vaccines and temperature-sensitive drugs should be managed by speedy, efficient, and flexible supply systems. This means that cold chain equipment needs to perform better and consume less energy and monitoring systems need to provide data to inform management decisions and increase efficiencies.

The single greatest determinant of the vaccine cold chain is the packed volume (format) and thermostability of the vaccines themselves. By 2020, several new vaccines will be introduced and the trend toward decreased doses per container will continue. Increased vaccine volumes will be offset by minimized packaging containers, decreased vaccine wastage, the ability to keep certain heat stable antigens at controlled ambient temperature for part of their shelf life, and improved inventory control. The ultimate goal that will transform cool chain technology requirements beyond 2020 is to develop compact, single-dose formats of stable vaccine to be given with as few administration contacts as possible.

In the meantime, the cold chain system remains the backbone of routine and supplementary immunization services and offers opportunities to move other heat-sensitive health products as well.

The equipment, and to some extent transport, follow the same path from concept to disposal presented in Figure 2.

Figure 2. Process of equipping the cold chain from concept to disposal



There are several types of equipment that are currently being evaluated by project Optimize, including the following:

- Reefers for international vaccine sea freight.
- Large cold rooms for future primary store needs.
- Mini-cold rooms to replace multiple refrigerators in district stores.
- Higher performance ice-lined refrigerators for 4 to 24 hours of electricity.
- Containers for primary transport of vaccine.
- Electric vehicles and solar photovoltaic generation to offset fossil fuels.
- Use of phase-change material packs to avoid freezing and retain cold life.
- Battery-free solar photovoltaic refrigeration where there is no electricity.
- Passive cooling of vaccine at periphery to replace refrigerators.

The following action plan specifies the steps that must be taken to ensure that new equipment needs are identified, specified, created, selected, procured, deployed, maintained, and replaced on an ongoing basis.

Table 7. Action plan for equipping the cold chain

Activity	Description	Potential partners
Cold chain equipment		
Enable concept and specification	Establish a permanent resource to solicit innovation from industry and catalyze new requirements (and PQS standards, when needed). Find a way to develop equipment market forecasts to incentivize investments by industry in appropriate equipment.	CCL taskforce (lead), cold chain equipment manufacturers, WHO/PQS, GAVI, and UNICEF.

Activity	Description	Potential partners
Make prequalification procedures easier	Develop ways to make laboratory testing accessible to smaller manufacturers in low-income countries. Implement formal PQS mechanisms for systematic post-market evaluation.	TBD. WHO (lead).
Identify country needs	Encourage countries to form policies on the routine disposal of old or poorly performing equipment. Help countries anticipate equipment needs over a longer time horizon (e.g., 5 years). Integrate immunization equipment planning with other temperature-sensitive biologicals and drugs.	HCWM (lead) and other global partners. PATH (lead), UNICEF, WHO, and other global partners. National governments (lead).
Select models	Ensure market availability and optimal selection of appropriate equipment.	WHO, manufacturers, and other global partners.
	Select equipment based on programmatic and whole-life costs instead of price alone. Create a cool chain equipment informational website hub.	Country managers and national procurement agencies. CCL taskforce (lead), TechNet21, WHO, UNICEF, and manufacturers.
Procure equipment	Raise procurement compliance with WHO/PQS prequalification standards in countries that use their own domestic products by targeting local procurement agencies. Advocate for boiler-plate national regulation of procurement. Propose testing in national laboratories. Provide for field monitoring performance where laboratories do not exist. Develop and validate retro-fit kits to improve domestic refrigerator performance.	NITAGs, national procurement agencies, NRAs, and AMP.
Deploy, redeploy, and monitor performance	Identify and validate monitoring technologies. Ensure quality of rational equipment replacement and expansion planning.	UNICEF (lead) and CCL taskforce. UNICEF country offices.

Activity	Description	Potential partners
Replace and scrap	Monitor and obtain field feedback on the quality and lifetime of equipment models. Outsource repair services. Develop infrastructure to improve installation and repair services.	UNICEF (lead). National governments.

AMP = Agence de Médecine Préventive; CCL = cold chain and logistics; HCWM = Health Care Without Harm; NRA = national regulatory authority; PQS = Performance, Quality and Safety; UNICEF = United Nations Children's Fund; WHO = World Health Organization.

3. Environmental impact of immunization supply systems

3.1 Current gaps

The working group's landscape analysis of the environmental impact of immunization supply systems revealed the following gaps that need to be addressed before realizing the vision of future immunization supply systems.

First, there is a lack of concrete information about the economic value of making environmentally sound decisions in logistics system design. Economic research is needed to quantify the intangibles, show the balance between up-front investment and savings in running costs, and take into account the carbon credit value.

The analysis also revealed that while innovative software tools use newly digitized global location information to optimize logistics transport legs, to date these tools have been used primarily in the private sector. More work is needed to apply available geographic information system tools and increase the efficiency of developing-country logistics systems.

The topic of waste management is critical when evaluating environmental impact of immunization systems. While much of the medical waste work in developing countries has focused on general medical waste, there may be opportunities to apply lessons learned to immunization logistics. Furthermore, a holistic approach to reducing waste in logistics systems should ensure that the right quantity and quality of the product is accepted into the system in the first place. Excess waste can result from over-ordering, moving the product to locations where it cannot be stored or used properly, and accepting the product with inadequate shelf life. Raising capacity for accurate quantification, product redistribution, and proper acceptance procedures can strengthen logistics systems and ultimately reduce the amount of waste for disposal.

Globally, there have been recent advances in low-emission, hybrid, and electric vehicles, and further research is needed regarding how these vehicles could help increase the efficiency of logistics systems. Also related to transportation efficiency, there is a lack of work on light-weighting loads carried in the immunization logistics system. Reducing weight and volume of vaccine loads could result in cost savings and reduced environmental impacts. Two approaches for this are streamlining packaging to reduce volumes and redesigning vaccine carriers and cold boxes to reduce the refrigerant-to-vaccine ratio by increasing insulation efficiency.

The difficulty of collecting the highly distributed waste in logistics systems is a huge barrier to efficient waste treatment and disposal. Further work on reverse logistics for waste collection and centralized treatment could help improve the environmental impact of immunization.

To reduce and optimize packaging of vaccines and supplies, it would help to ensure a feedback loop about cold chain conditions all the way back to manufacturers. Generating better information about product conditions during shipping and upon arrival and sharing this information with manufacturers could result in improved packaging by reducing manufacturers' tendency to over-pack.

Finally, advocacy is needed to ensure that environmentally responsible technologies have a path into the developing-country immunization marketplace. Consideration of factors beyond purchasing cost should be encouraged. Current quality regulation and purchasing systems should be examined to see what opportunities exist to broaden decision-making. This applies to different categories of technologies including cooling technologies, vehicles, and power systems.

3.2 Desired state and action plan

Desired state: The environmental impact of energy, materials, and processes used in immunization supply systems from the international to local levels is assessed and minimized.

The following proposed characteristics serve as working hypotheses to help characterize the vision of an environmentally rational supply chain:

- Vaccine thermal stability is increased and true stability utilized in order to raise storage temperatures where permitted, reduce cooling capacity requirements, and enable alternatives to air transport.
- Packaging requirements are minimized to reduce natural resources consumed and storage space requirements.
- The reduction of distances and time for shipping are considered a critical criterion for determining where vaccine and related products are sourced.
- Distribution vehicles are carefully selected, driven, and maintained for journeys that have been planned to minimize energy requirements while maximizing service life.
- Energy efficiency strategies, beginning with informed product selection and continuing through ongoing maintenance, are implemented to reduce energy requirements.
- Renewable energy sources are used to replace fossil fuels to reduce resource depletion and decrease pollution.
- Innovative product development in refrigeration and transportation provides purchasers with more efficient, reliable, and durable equipment choices for the vaccine cold chain.
- Countries have clear policies, strategies, and funded plans for waste management that include disposal of immunization and daily medical waste as well as repair, reuse, and recycling provisions for packaging and equipment.

3.2.1 Greening the immunization logistics chain

Table 8 outlines the action plans for "greening" or reducing the environmental impact of the immunization logistics chain.

Table 8. Action plan for greening the immunization logistics chain

Activity	Description	Potential partners
Policy development and application		
Conduct economic analysis to understand benefits and trade-offs of a green logistics chain.	Commission a study to better understand the economic implications of greening the immunization logistics chain.	Academic researchers, professional associations, Global Environment Fund, and UNEP.
Develop an environmental framework for evaluating system changes, products, suppliers, and/or service providers with regard to environmental metrics.	Incorporate findings from economic analysis (above). Identify contributing factors and determine methods of measuring them. Identify trade-offs between factors and establish methods for balancing and evaluating within a complex system.	WHO and UNICEF.
Encourage policy changes within global stakeholder organizations (WHO headquarters and Regions, UNICEF, GAVI) to increase environmental decision-making.	Work to define and seek opportunities to advance environmental criteria for product reviews and/or listings. Identify mechanisms for increasing consideration of environmental factors in purchasing decisions. Include environmental criteria in country evaluation tools such as EPI Review and Effective Vaccine Management. Identify opportunities to leverage existing mechanisms with bilateral funders.	UNICEF Supply Division and PAHO Revolving Fund; WHO Immunization, Vaccines, and Biologicals division; WHO headquarters and regions/UNICEF; GAVI; WHO Performance, Quality, and Safety program; UNEP/ Global Environment Facility; and HCWH.
Encourage policy changes within countries to increase environmental decision-making.	Work within MOH immunization programs and ministries in charge of environment to increase environmental decision-making. Share knowledge gained about market incentives or cost savings that could result in environment-friendly system changes. Share the environmental framework in row 2 (above) to demonstrate how options can be evaluated for environmental impact.	National environmental NGOs, Ministries of Environment, World Bank.
System innovation		
Develop, demonstrate, and scale up immunization system innovations that are environmentally responsible.	Using emerging information and frameworks, review data generated by project Optimize and others regarding system innovations that increase efficiency: • Streamlining distribution (reducing warehousing levels).	WHO (lead), academic researchers, PATH, UNEP, Bill & Melinda Gates Foundation, other donors, and TechNet21.

Activity	Description	Potential partners
	• Integrating vaccine warehouses with warehouses for temperature-sensitive medical products. • Just-in-time warehouse management and distribution principles. • Waste reduction and substitution of toxic materials with more environment-friendly materials. • Outsourcing to third-party logistics companies. • Dissemination of pro-environment system innovations and identification of countries for further demonstrations or scale-up. • Support adoption of pro-environment system innovations through seed funding, technical support, etc. Disseminate country success stories.	
Review shipping guidelines.	Perform temperature monitoring studies to determine whether there is excess cold life in vaccine packaging configurations for shipping from manufacturers to countries. Based on temperature study results, design packaging configurations that result in lighter and smaller loads while still maintaining safe cold chain temperatures (e.g., if temperature studies show excess cold life, then perhaps less ice/water could be shipped with some increase in lightweight insulation). Improve temperature tracking and feedback so companies can optimize packaging for lightest weight with confidence in results (real-time tracking with web access to data). Review results and status of global controlled temperature chain activities to explore safe opportunities for maintaining shipping temperatures higher than 2°C to 8°C.	WHO, VPPAG, CCL taskforce, US Centers for Disease Control and Prevention, and PATH.
Develop and propagate geographic information system tools for immunization logistics route optimization.	Document requirements for immunization logistics route optimization software. Identify software currently used inside or outside immunization logistics that meet requirements. If none exists, encourage development through challenge grants or direct collaboration.	PATH, WHO/PQS, academic researchers, TransAid, Riders for Health, and UNICEF regional and country offices.

Activity	Description	Potential partners
	Evaluate tools and document impact on system fuel efficiency and cost. Disseminate findings and provide guidance and tools for country uptake. If impact deemed significant, engage WHO headquarters and regions/UNICEF to integrate geographical information systems tools into technical support and procurement systems.	
Develop a decision basis for choosing alternative-energy vehicles (electric, electric hybrid, natural gas, other).	Commission a study to determine when alternative vehicles make environmental sense for immunization logistics systems, taking into account performance and price of available vehicles, electrical power sources for charging, and typical route length and road conditions. Engage with WHO/UNICEF to discuss development of international guidelines to promote use of alternative vehicles and integrate technology into technical support and procurement systems. Disseminate findings at appropriate forums.	WHO, Riders for Health, and TransAid.

EPI = Expanded Programme on Immunization; MOH = ministry of health; NGO = nongovernmental organization; PAHO = Pan American Health Organization; UNICEF = United Nations Children's Fund; UNEP = United Nations Environment Programme; VPPAG = Vaccine Presentation and Packaging Advisory Group; WHO = World Health Organization.

3.2.2 Improving medical waste management

The following table shows actions that are required to achieve the desired state of vaccine supply chains in terms of the environmental impact of medical waste management.

Table 9. Action plan for improving medical waste management

Activity	Description	Potential partners
Policy development and application		
Increase accountability for medical waste funding imperative among global stakeholders.	Convene and support an international task force with a WHO or UNICEF secretariat to coordinate collective support provided to national governments on medical waste management. Quantify funding available and the proportion of vaccination programs that include waste management funding—set targets for improvement. Lobby to increase international-level funding for medical waste solutions by funders such as GAVI and bilateral funders who support immunization.	WHO/UNICEF (lead), GAVI, bilateral agencies, other donors, World Bank, and HCWM.

Activity	Description	Potential partners
	Evaluate a "buyer-pay" system that would provide countries with waste management funding as a required percentage of medical supply donations or immunization program investments by donors.	
System innovation		
Develop collection system innovations (reverse logistics) to allow more efficient treatment of waste through consolidation of waste from multiple sites	Review literature for reports of countries or communities operating safe and successful systems of waste transfer for collective treatment. Identify barriers to successful implementation: logistic, political, or philosophical. Visit successful programs and develop guidelines using best practices and address barriers identified. To demonstrate implementation of guidelines, conduct pilot programs in one or more countries that are not using a collective waste treatment system. Publish guidelines, preferably in collaboration with WHO headquarters and regions and/or UNICEF. Disseminate guidelines and pilot program results in public forums. Train consultants to provide technical consultation for countries interested in adopting safe collective treatment systems and identify mechanisms for countries to pay for this support, perhaps through GAVI system strengthening funds.	WHO, UNEP, HCWM, World Bank, and ministries of environment.
Improve warehouse management and ordering procedures to ensure the right quantities at the right time and place, in order to minimize waste in the system	Investigate forecasting, ordering, intake, and distribution practices—how they contribute to minimizing product waste, toxic materials, and volume. Identify problematic materials (toxic, hard to recycle, etc.) at all stages in the vaccine development and provision chain and promote safer substitutes. Highlight and publish information about countries that are doing this well. Develop and publish best practices in a guideline format, preferably in collaboration with WHO and/or UNICEF. Develop and implement training to disseminate guidelines and best practices.	HCWM (lead) and global immunization partners.

Activity	Description	Potential partners
	Set up an ongoing mechanism with WHO headquarters and regions and/or UNICEF for countries to access technical support and training. Work with UNICEF and other bulk purchasers to ensure incorporation of best practices in their procurement policies.	
Develop mass campaign waste management system solutions.	Identify partners who regularly support or conduct mass campaigns (e.g., WHO, individual countries, EPI). Review literature for examples of safe, innovative, and successful campaign waste management practices. Consider visiting a campaign to document best practices. Identify innovative technologies and practices that have/could have a positive effect on waste management practices in campaigns. Identify barriers to successful implementation (e.g., logistic or financial). Develop guidelines using best practices found and addressing barriers identified. Conduct pilot programs in one or more countries to demonstrate implementation of guidelines and evaluate effectiveness and safety. Publish guidelines, preferably in collaboration with WHO and/or UNICEF. Disseminate guidelines and results of pilot programs in public forums, directing attention toward publications and forums that focus on campaigns. Train consultants to provide campaign waste management technical consultation and identify funding sources for in-country capacity-building.	Polio and measles eradication initiatives, WHO/EPI, and HCWM.
Determine how to significantly reduce landfill waste in immunization systems (elements may include recycling, repurposing, etc.).	Quantify and qualify the health, economic, and environmental burden associated with inadequate medical waste management in a particular region. Demonstrate knowledge of waste management practices in a region, existing stakeholder capabilities, infrastructure capacity, and waste management policies. Identify limitations and gaps in existing waste management systems.	WHO, UNEP, HCWH, World Bank, UNEP/Global Environment Facility, and ministries of environment.

Activity	Description	Potential partners
	Develop a short- and long-term strategy for strengthening and advancing a system toward a minimal/no-landfill waste environment. Outline/define enabling requirements for technologies (both product and infrastructure) that guarantee safety, scalability, and cost-effectiveness. Recommend and evaluate options for new system design that ensures scalability. Specify how to ensure sustainability of a new system (i.e., local economic development and leveraging of and integration with existing structures/stakeholders). Publish results and recommendations, if possible with endorsement from WHO headquarters and regions/UNICEF/GAVI.	
Implement improved medical waste practices outlined in national guidelines for waste management developed in the President's Emergency Plan for AIDS Relief countries over the last decade.	Assess progress of implementing improved practices in the President's Emergency Plan for AIDS Relief countries with recent National Guidelines for Medical Waste Management. Understand drivers behind countries that have implemented improved practices vs. barriers in countries where they have not been implemented. Include economic and local/regional industrial factors as well as policy and governance. Work in countries that have not yet implemented improved practices to overcome barriers and move forward. If indicated by analysis results, work at the global level to strengthen incentive systems and/or penalties to help drive implementation of improved practices in national medical waste management. In countries where it is advantageous to harness knowledge and impetus from the Environmental Ministry, Ministry of Local Development, or other government departments involved in waste infrastructure, engage them in work with the MOH to improve medical waste management practices. Work to measure impact and safety in countries after they have implemented improved waste management practices. Publish and disseminate results.	USAID and US Centers for Disease Control and Prevention.

Activity	Description	Potential partners
Technology development		
Encourage development and use of environment-friendly waste treatment technologies.	Develop requirements for safe, environment-friendly waste treatment equipment and devices. Publish requirements and engage with equipment/device manufacturers to encourage development of new and modification of existing equipment to meet requirements. Identify potential collaborators through a broad scan of companies in the industry. Engage through public forums and individual collaboration. Possibly publish a broad call for new technologies to encourage innovation by organizations not necessarily identified in the manufacturer scan. Coordinate pilot demonstrations of promising technology and support scale-up activities for successful pilots. Engage with WHO headquarters and regions and UNICEF to incorporate a system within existing product specification and procurement systems to reward safe products with environmental attributes through recognition and/or procurement preferences.	HCWM.
Identify and pilot innovative technologies and practices for waste treatment with value reclamation (for example, recycling, biogas systems, etc.).	Assess waste treatment landscape of technologies that result in value reclamation, either available or under development. For available technologies, seek to understand what drives the market and where they are used successfully, and then develop case studies. Based on the analysis above, determine factors in medical waste treatment scenarios that would indicate environments conducive to the technologies. Pilot one or more technologies in country settings, using the research above to choose likely favorable settings. Evaluate effectiveness and safety. Publish results. If successful, replicate and scale up systems and technologies.	PATH and HCWM.

Activity	Description	Potential partners
Reduce and optimize packaging materials.	Engage with the industry group that is working on guidelines for vaccine packaging (i.e., VPPAG). Work to review VPPAG's generic product profile to reevaluate recommended intermediate packaging and possibly revise with an environmental approach. Building on the VPPAG publication *Sustainability in Vaccine Packaging*, engage in these next steps: • Work with UNICEF/WHO headquarters and regions to develop requirements for package minimization and green material specification for vaccines. • Implement the above requirements for vaccines purchased through UNICEF Supply Division or PAHO Revolving Fund. • Provide support to national governments who want to implement similar requirements in vaccine procurement systems. • Work on disseminating information about green packaging technology and practices among developing-country vaccine manufacturers, possibly making use of the Developing Country Vaccine Manufacturers Network. • Evaluate potential areas to reduce export shipping material weight and volume while maintaining cold chain performance. • Evaluate effectiveness of environment-friendly alternatives for shipping insulation materials for international vaccine shipments. Engage packaging and medical device industry to check for innovations, getting them involved (not just vaccine industry).	VPPAG members, WHO/UNICEF regional offices, UNICEF Supply Division, PAHO Revolving Fund, and DCVMN.

DCVMN = Developing Countries Vaccine Manufacturers Network; EPI = Expanded Programme on Immunization; HCWM = Health Care Without Harm; MOH = ministry of health; PAHO = Pan American Health Organization; PQS = Performance, Quality and Safety; UNICEF = United Nations Children's Fund; VPPAG = Vaccine Presentation and Packaging Advisory Group; WHO = World Health Organization.

4. Immunization information systems

4.1 Current gaps

After documenting work currently underway to improve immunization information systems, the working group was able to identify gaps between the desired and current state that need to be addressed. This effort has already led to a tangible outcome as the Bill & Melinda Gates Foundation Grand Challenges Explorations adopted a number of these gaps (for information systems and other areas of vaccine logistics) in its call for proposals.

The preliminary gaps identified are as follows:

4.1.1 Generic last-mile logistics information systems

Many applications exist to control stock at central and regional levels, but there are few "last-mile solutions" suitable to be deployed affordably and sustainably at the service level and also integrated into central systems. Furthermore, most last-mile applications are designed for a specific type of commodity and lack the level of abstraction required to make them useful for all commodities (such as immunization, antiretrovirals, essential medicines, etc.) in use at the service level.

A challenge lies in demonstrating an innovative, low-cost, low-maintenance solution that would meet the basic logistics information needs for at least two health commodities (one of which should be vaccines) at the intermediate and lowest levels of a supply chain for a low-income country. Basic information needs include:

- The ability to register receipts, issues, and physical on-hand stock.
- The ability to reorder based on historical consumption data.
- The ability to keep track of stock at all nodes in the system (and have upward, downward, and lateral visibility of stock).

With additional valuable features providing:

- The ability to access and analyze historical data.
- The ability to report immunization coverage.

4.1.2 Scalability and sustainability of a logistics management information system in specific country settings

There is a lack of in-country skills to plan for, design, implement, and sustain information systems projects. A challenge exists in demonstrating how a logistics management information system could be scalable and sustainable at the national level in a large country (with a population of 20 million or more).

This may include exploring the following parameters:

- Skills and profiles that would be needed.
- Total cost of ownership model.
- Five-year plan and budget.

- Funding mechanisms.

4.1.3 Hardware

Many of the small-scale projects we documented rely on the use of personal mobile phones. While these provide excellent opportunities for fast and flexible development and deployment because they are so cheap and ubiquitous, there seems to be little effort spent on developing devices that are built specifically for their intended purpose. In the for-profit world, these devices (e.g., point-of-sales equipment) are very common, rugged, and reliable. Exploration is warranted regarding whether the public health world would also benefit from similar designs or solutions.

4.2 Desired state and action plan

Desired state: Immunization information systems help staff plan and manage immunization activities and resources while ensuring that adequate quantities of vaccines are always available to meet demand.

The objective of this action plan is to define how to move from the current state to the desired state, as illustrated in the Figure 3.

Figure 3. Current and desired states of immunization information systems

The following characteristics serve as working hypotheses to help describe the desired state of future information systems.

Information systems are integrated. Vaccines and other health commodities are managed through an integrated information system, meaning that subcomponents of this system are interoperable. Furthermore, information for planning and performance management of logistics is accessible by other health information systems.

Decision-making is supported. Staff has the capacity to analyze and use information that is routinely available for evidence-based decision-making.

Data is captured at its origin. Data about individual records (e.g., vaccines, immunization records, and cases) is accurately captured and digitized at the place where these events occur, and aggregated or disaggregated information is made directly available to appropriate users at all levels.

Information systems are flexible. Logistics management information systems have robust core capabilities, yet can accommodate health system variations based upon the local context. The design is adaptable to different contexts, programs, and changes over time as needs evolve.

Design is driven by user needs. Logistics management systems are designed to meet the broad requirements of end users, managers, planners, recipients of health services, and other stakeholders.

Information systems are affordable and secure. The total cost of ownership of logistics management systems is easily understood so decision-makers can evaluate the wider cost implications of adopting an information system across the health system. Logistics management information systems are designed for implementation and use in low-resource settings and are designed to be maintained and supported effectively and must always be available within the environmental constraints. They are also designed to protect data from unauthorized use and disclosure with varying levels of user access.

Systems apply a consistent design framework. Logistics management information systems take advantage of standards, common data, common software applications and technologies, and are properly supported by clear design and user documentation.

The table below outlines the plan of action to reach these goals. Members of the working group wish to point out that while this set of action points focuses on information systems, immunization systems are operating in a broad context, and programmatic strategies will take into account many objectives. Within this context, it is hoped that the action points and related activities can support the movement of all immunization strategies.

Table 10. Action plan for strengthening immunization information systems

Activity	Description	Potential partners
Making better use of existing innovations		
Document learning from successfully scaled systems.	Stock Management Tool and District Vaccine Data Management Tool—Microsoft Excel-based tools developed by WHO for monthly reporting. Vaccination Supplies Stock Management, a Microsoft Access-based tool developed at WHO's Regional Office for the Eastern Mediterranean for warehouse management that is widely implemented but only at central level and larger subnational stores. Sage, a commercially available integrated information system that was bulk-licensed to several Francophone African countries and used at national and subnational stores for stock keeping and accounting (in essential medicines program rather than for vaccines).	Many partners (multilaterals, bilaterals, countries, GAVI, civil society, academia, and commercial sector) would need to play complementary roles in this work plan. However, certain aspects also require strong coordination.

Activity	Description	Potential partners
Promoting innovation in information systems for developing country health sector		
Innovate.	Create a forum/community for developers, public health experts, and end users. Develop an open-source modular immunization information system. Launch an industry challenge.	Many partners (multilaterals, bilaterals, countries, GAVI, civil society, academia, and commercial sector) would need to play complementary roles. However, certain aspects also require strong coordination.
Applying innovative ideas and solutions		
Help countries overcome barriers to adopting and managing information systems.	Improve knowledge and understanding of available alternatives and how they would solve the country's problems and challenges. Find ways to help countries negotiate licensing contracts. Make cost and complexity of custom-made software more transparent. Improve technical expertise at central levels for running and maintaining new information systems.	Many partners (multilaterals, bilaterals, countries, GAVI, civil society, academia, and commercial sector) would need to play complementary roles. However, certain aspects also require strong coordination.
Foster collaboration.	Create a forum/community for developers, public health experts, and end users to discuss problems and potential solutions. Develop an open-source modular immunization information system. Launch industry challenge for development or adaption of information systems for low-resource settings that will be commercialized with business models for developing countries and their donors.	Many partners (multilaterals, bilaterals, countries, GAVI, civil society, academia, and commercial sector) would need to play complementary roles. However, certain aspects also require strong coordination.
Demonstrate.	Create and maintain a repository of meaningful projects. Facilitate the continued demonstration of good ideas. Select a few different systems and approaches.	Many partners (multilaterals, bilaterals, countries, GAVI, civil society, academia, and commercial sector) would need to play complementary roles. However, certain aspects also require strong coordination.

Activity	Description	Potential partners
Improving information and communications technology policy		
Scale.	Help countries understand total cost of ownership. Ensure available financing for information system projects (initial and maintenance).	Many partners (multilaterals, bilaterals, countries, GAVI, civil society, academia, and commercial sector) would need to play complementary roles. However, certain aspects also require strong coordination.

WHO = World Health Organization.

5. Human resources for immunization logistics

5.1. Current gaps

The goal of the landscape analysis was to identify gaps that need to be addressed to realize the vision of future immunization supply systems. The preliminary gaps identified are outlined below.

5.1.1 Recognition and motivation

Supply chain managers are currently not considered a critical factor of success for health operation and lack recognition, career paths, and other incentives. The need for improved logistics expressed at the district/peripheral level is not a seen as a priority at the central/national levels.

There are few champions for this field that often remains marginal in most international meetings. Contrary to other technical areas, there is no clear evidence demonstrating the benefits of recognition and incentives in terms of savings and improved staff performance. Furthermore, initiatives promoting the professionalization of supply chain managers often raise concerns on the part of some health workers, such as pharmacists, district administrative officers, and others. In such a context, the poor performance of supply chain management (SCM) systems further reduces staff motivation—not only among supply chain managers, but among all health care personnel. The status of low- and middle-income country supply chain managers is in marked contrast to their status in developed countries, where supply chain managers must have advanced technical skills and qualifications and are widely recognized as instrumental to organizational decision-making and success.

5.1.2 Competence

In developing-country public health systems, SCM competencies are not subject to a consensus similar to competency frameworks of other health professionals such as pharmacists or nurses. One of the consequences is that SCM does not have an outline of the profession's key characteristics, notably pre-service training and adequate certifications that are entry points for newcomers and provide recognition and career opportunities. In addition, the individual's capacity to adapt to new models and technologies is limited. Cross-cutting competency frameworks for SCM have been developed that could benefit integrated logistics as well as other areas, but they have not been implemented in developing countries to date. Finally, training opportunities are scarce and have limited impact on the individuals actually in charge of logistics.

5.1.3 Numbers

There are few positions to meet the needs of SCM and logistics and even fewer people to fill the existing positions. A critical mass of trained supply chain managers would be necessary to address most of the gaps listed here, and to serve as a reference for other health workers in charge of logistics functions, however such a cadre does not currently exist. As a result, it is difficult to find the right individuals to fill positions in the immunization supply systems at all levels. Worse, the closer one gets to the peripheral level, the less attention is dedicated to SCM. As a result, last-mile logistics are always a challenge.

5.1.4 Synergies

Health programs are too compartmentalized (split into "silos") to make the best use of the limited available human resources. For example, the GAVI Alliance has no capacity-building program in SCM, whereas such a program exists at the Global Fund to Fight AIDS, Tuberculosis and Malaria. At the district/peripheral level, there are often not enough people able to deal with logistics challenges. This is even truer with respect to creating synergies between private and public sectors. Finally, there is a dire lack of networks that would enable individuals in charge of logistics and professional supply chain managers (in public and private sectors) to share experience and learn from each other.

5.2 Desired state and action plan

Desired state: Human resources policies provide immunization supply systems with adequate numbers of competent, motivated, and empowered personnel at all levels of the health system to overcome existing and emerging immunization supply challenges.

Although this priority area seems immunization-focused, human resource policies support the overarching vision for immunization supply systems—particularly the second focal area which deals with "integration with other supply systems" and "synergies with other sectors." This implies that human-resource policies will provide health systems with personnel that have the necessary competencies to carry out synergistic SCM for all public health products.

The need for work in this area stems from the fact that governments and their partners are investing huge amounts of money in procuring equipment, drugs, vaccines, and other health products for public health programs in order to reach positive health outcomes. All this investment and the health outcomes could be put at risk if public health programs are not provided with supply chain managers with necessary technical and managerial skills to: (1) properly use and maintain this equipment and (2) efficiently store, distribute, and use products in order to support health service delivery.

Priority area 5 seeks to rally partners around the above vision and advise them about the ways and means to reach the above desired status. These actions could be grouped under the six categories (see Figure 4) proposed by the WHO department on Human Resources for Health.

Figure 4. Components of human resource management system

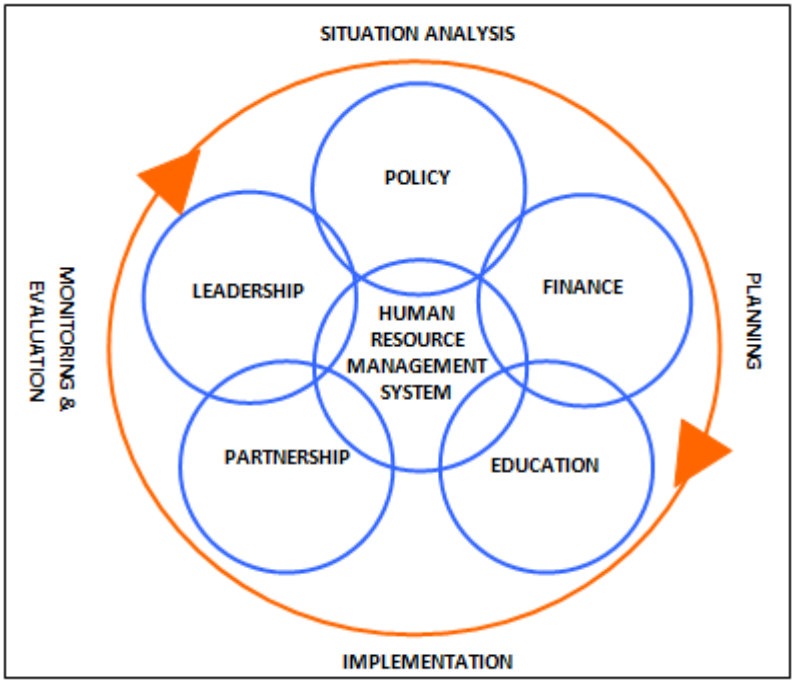


Table 11 below provides examples of activities that could be undertaken under each of the above categories. These activities are mainly drawn from the priority activity list, which came out from the Global Harmonization and Positioning Conference organized in Geneva by the People that Deliver Initiative (PtD). These activities will first take place at the global level, then the regional and country levels. The timeline for implementing these actions will be split between the short term (2011–2012) and medium term (2012–2020).

PtD and other initiatives and organizations are already involved in the effort to promote the issue of human resource for supply chain management (HR4SCM). The Human Resources for Immunization Logistics working group aims not to duplicate these efforts. Instead, our objective will be to support and catalyze efforts by preparing a work plan, organizing discussions among interested partners, and other activities.

As a priority, this working group will focus its efforts on ensuring that HR4SCM is included among the Decade of Vaccines initiative's priorities during the ongoing discussions. In addition working group members will seize every opportunity with collaborating countries, institutions, and partners to advocate strongly in favor of HR4SCM and promote this action plan.

Table 11. Action plan for improving human resource performance for vaccine logistics and supply chains

Activity	Description	Potential partners
Policy		
Competency framework.	Establish a model competency framework for health SCM. Support regional advocacy efforts to encourage countries to adopt model competency framework.	PtD, RHSC, HWA, IAPHL, and other global, regional (e.g., WAHO), and national stakeholders.
Certification.	Identify ways to formally endorse or accredit global-level courses based on standard criteria.	Global, regional, and national stakeholders: PtD, HWA, and IAPHL.
Supportive environment for supply chain personnel in the health sector.	Provide recognition, incentives, and motivation for health supply chain personnel. Implement a career track for in-country health supply chain managers.	Global, regional, and national stakeholders: WHO Regional Committees of Health Ministers, WAHO and similar organizations, and ministries of health and education.
Leadership		
SCM champions and advocates.	Develop advocacy materials to professionalize SCM and strengthen human resource capacity.	Global, regional, and national stakeholders: PtD, RHSC, and HWA.
Professional networking.	Build regional-level professional networking and mentoring opportunities. Identify opportunities for regional-level networking, mentoring, and communities of practice.	Global, regional, and national stakeholders: WHO and UNICEF regional offices, PtD, AMP, Bioforce, and IAPHL.
Risk analysis and mitigation		
Analysis of risks and their mitigation strategies at the global level and regional level.	Enable proper funding and procurement by ministries of health.	Global, regional, and national stakeholders: PtD, RHSC, and HWA.
Finance		
Resource mobilization.	Make financing mechanisms available for SCM human resources.	Global, regional, and national stakeholders: MOHs; GAVI; The Global Fund to Fight AIDS, Tuberculosis and Malaria; and the World Bank.

Activity	Description	Potential partners
Education		
Preservice supply chain training opportunities for all cadres.	Connect global efforts to regional resources and activities. Link demand and availability efforts with regional activities, including organizations, universities, and private-sector activities/initiatives.	Global, regional, and national stakeholders: PtD, RHSC, IAPHL, WAHO and other similar organizations, and WHO and UNICEF regional offices.
Continuing professional development for cadres involved in SCM.	Adapt global resources relevant to developing SCM workforce excellence to better fit regional context.	Global, regional, and national stakeholders: WAHO and other similar organizations, WHO and UNICEF regional offices, Bioforce, and AMP.
Training institutions capacity to prepare health supply chain managers.	Conduct mapping exercise of current SCM capacity-building activities and resources.	Global, regional, and national stakeholders: PtD, RHSC, IAPHL, and WAHO and other similar organizations.
Partnerships		
Committees for donor coordination.	Advocate placing HR4SCM high on the agenda of global institutions and initiatives (e.g., Global Health Workforce Alliance, Global Fund, GAVI, or Decade of Vaccines).	Global, regional, and national stakeholders: WHO, UNICEF, and PtD.
Development of public-private partnerships.	Engage professional associations in networking and mentoring activities.	Global, regional, and national stakeholders: PtD, IAPHL, Bioforce, and AMP.
Mechanisms and processes for regional (inter-country) cooperation.	Facilitate documentation and dissemination of evidence base for HR4SCM strengthening activities. Support information clearinghouse related to health HR4SCM.	Global, regional, and national stakeholders: WAHO and other similar organizations, WHO and UNICEF regional offices, Bioforce, and AMP.

Activity	Description	Potential partners
Human resource management systems		
Develop human resource policies to attract and retain supply chain managers (workforce planning for SCM, recruitment, hiring, and deployment).	Build upon, develop, and make available tools, methodologies, and processes to promote baseline assessments and human resource policies. Conduct HR4SCM baseline assessment. Work with focus countries to set up small-scale projects to strengthen SCM. Use lessons from assessments and small-scale projects.	Global, regional, and national stakeholders: PtD, and WHO and UNICEF regional offices.
Conduct performance management.	Work within larger human resource reforms and supply chain efforts to provide motivators—working and living condition improvements, performance-based incentives, and access to needed tools and resources.	Global, regional, and national stakeholders: WHO Regional Committees of Health Ministers, WAHO and similar organizations, and ministries of health, education, and finance.

AMP = Agence de Médecine Préventive; HR4SCM = Human resources for supply chain management; HWA = Health Workforce Alliance; IAPHL = International Association of Public Health Logisticians; MOH = ministry of health; PtD = People that Deliver Initiative; RHSC = Reproductive Health Supplies Coalition; SCM = supply chain management; WAHO = West Africa Health Organization.

Appendix A: Priority area working group members

Table 1. Working group members, priority area 1: Vaccine products and packaging

Name	Institution
Debra Kristensen, Group lead dkristensen@path.org	PATH
Sheila Cattell	GlaxoSmithKline (VPPAG IFPMA representative)
Rudolf Eggers	WHO
Ibrahim El-Ziq	UNICEF Supply Division
Shawn Gilchrist	Consultant
Bertrand Jacquet	UNICEF Supply Division
Judith Kallenberg	Clinton Health Access Initiative
Souleymane Kone	WHO Expanded Programme on Immunization
Osman Mansoor	UNICEF Program Division
Drew Meek	WHO Quality, Safety, and Standards Team
Jules Millogo	Merck Vaccines
Gisele Corrêa Miranda	Bio-Manguinhos/Fiocruz (VPPAG DCVMN backup representative)
Yalda Momeni	UNICEF Supply Division
Ann Ottosen	UNICEF Supply Division
Jon Pearman	GAVI Alliance
Olga Popova	Crucell
Raja Rao	Bill & Melinda Gates Foundation
Hardeep Sandhu	US Centers for Disease Control and Prevention
Inder Jit Sharma	Serum Institute of India (VPPAG DCVMN representative)
Robert Steinglass	John Snow Inc.
Simona Zipursky	PATH

DCVMN = Developing Countries Vaccine Manufacturers Network; IFPMA = International Federation of Pharmaceutical Manufacturers Association; UNICEF = United Nations Children's Fund; VPPAG = Vaccine Presentation and Packaging Advisory Group; WHO = World Health Organization.

Table 2. Working group members, priority area 2: Immunization supply system efficiency

Name	Institution
Patrick Lydon, Group lead lydonp@who.int	WHO
Beatriz Ayala-Ostrom	Freelance Procurement and Supply Chain Consultant
Magali Babaley	WHO

Name	Institution
Sarah Bourhill	Pharmaceutical Healthcare Distributors for South Africa
Brent Burkholder	US Centers for Disease Control and Prevention
Malcolm Clark	Management Sciences for Health
Ousman Dia	John Snow Inc.
Modibo Dicko	WHO
Mike Harrigan	Pharmaceutical Healthcare Distributors for South Africa
Alexis Heaton	John Snow Inc.
David Lee	Management Sciences for Health
John Lloyd	PATH
Tina Lorenson	PATH
Osman Mansoor	UNICEF
Ian McConnell	Clinton Health Access Initiative
Ishmael Muchemenyi	Pharmaceutical Healthcare Distributors for South Africa
Kshem Prasad	Apt Progress for Sustainable Development
Rémy Prohom	Consultant
Raja Rao	Bill & Melinda Gates Foundation
Judith Roberts	Development Consultant
Oliver Sabot	Clinton Health Access Initiative
Adama Sawadogo	WHO/Democratic Republic of the Congo
Robert Steinglass	John Snow Inc.
Xavier Tomsej	USAID
David Ulrich	Abbott Laboratories
Prashant Yadav	University of Michigan

Table 3. Working group members, priority area 3: Environmental impact of immunization supply systems

Name	Institution
Joanie Robertson, Group lead jrobertson@path.org	PATH
Laila Akhlaghi	John Snow Inc.
Dave Ausdemore	US Centers for Disease Control and Prevention
Laurent Dedieu	Médecins Sans Frontières
Victoria Gammino	US Centers for Disease Control and Prevention

Name	Institution
Andrew Garnett	Consultant
Tom Layloff	Management Sciences for Health
Carla Lee	US Centers for Disease Control and Prevention
Steve McCarney	PATH
Gisele Corrêa Miranda	Bio Manguinhos/Fiocruz
Francis (Kofi) Nyame	Management Sciences for Health
Jude Nwokeki	Management Sciences for Health
Bocar Sada Sy	Services de l'énergie en milieu Sahélien
Ruth Stringer	WHO/Health Care Without Harm
Ranjini Srikantiah	Becton Dickenson
Diana Edgil	USAID

Table 4. Working group members, priority area 4: Immunization information systems

Name	Institution
Jan Grevendonk, Group lead jgrevendonk@path.org	PATH
Anup Akkihal	Logistics for Global Good
Richard Anderson	University of Washington
Kyle Duarte	Management Sciences for Health
Marta Gacic Dobo	WHO
Leah Hasselback	VillageReach
Susie Lee	GAVI Alliance
David Lubinski	PATH
Hardeep Sandhu	US Centers for Disease Control and Prevention
Jaspal Sandhu	Gobee Group
David Sinegal	Consultant
Allen Wilcox	VillageReach
Justin Yarrow	Clinton Health Access Initiative

Table 5. Working group members, priority area 5: Human resources for immunization logistics

Name	Institution
Modibo Dicko, Group lead dickomo@who.int	WHO
Véronique Brossette	Bioforce
Philippe Jaillard	Agence de Médecine Préventive
Hamadou Dicko	Agence de Médecine Préventive
Serge Ganivet	WHO/Regional Office for Africa
Alain Grall	Syskalis
Richard Jabot	Médecins Sans Frontières
David Lubinski	PATH
Kshem Prasad	APT Progress
Claudio Politi	WHO
Kevin Pilz	USAID/Commodity Security and Logistics
Pamela Steele	UNICEF
Benoît Silve	Bioforce