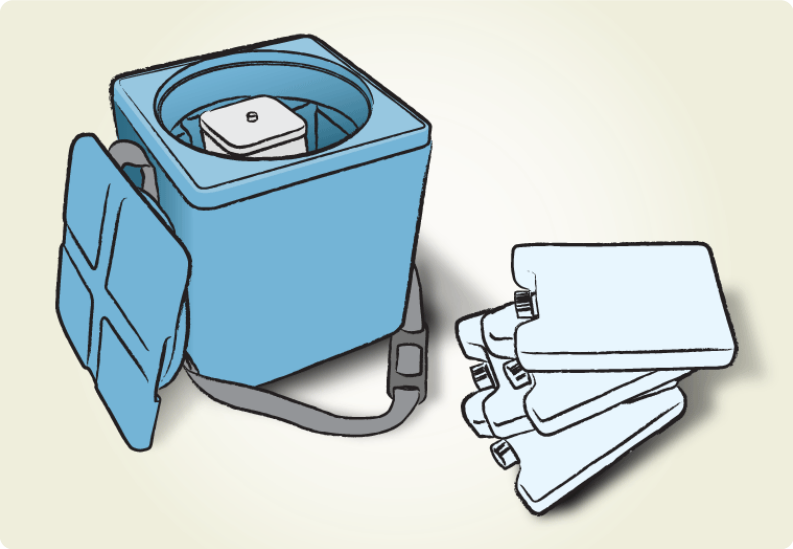
Vaccine Carriers: Are They Meeting Stakeholders' Needs?



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Purpose of research

PATH conducted this research to learn how vaccine carriers are currently used in the vaccine supply chain and whether they are meeting the needs of health system stakeholders. The research included a literature review and an electronic survey to collect input from global and national stakeholders who have expertise with passive vaccine carriers or cold-chain logistics. Limited research has been published on vaccine carriers and their acceptability. We conducted the electronic survey to enhance our understanding of stakeholders' views on how well vaccine carriers are meeting the needs of immunization programs. The opinions of these stakeholders will help advance future vaccine carrier designs and improve the ability of health workers to meet the needs of their communities.

Methods for stakeholder survey

PATH collected rapid input from a range of vaccine supply chain stakeholders by developing and posting an online survey. The questions were aimed at understanding stakeholder priorities, acceptability, scenarios of use, and suggested design improvements for vaccine carriers. Although the questions were not personal, the online format provided anonymity for respondents. The responses were primarily in multiple choice or Likert scale format. Where possible, comments boxes with questions were provided to encourage participants to offer detailed responses.

PATH provided the following definitions for survey participants:

- *Vaccine carriers*: Insulated containers that are prequalified by the World Health Organization (WHO). They are used with coolant packs to transport vaccines from health facilities with refrigeration to outreach sessions where refrigeration and ice are unavailable. They are typically carried by a single health worker traveling on foot or by other means, where the combined journey time and immunization activity last from a few hours to a whole day. Generally, vaccine carrier capacity can range from .8 L to 3 L. A complete list of prequalified carriers and their specifications can be found in the WHO Performance, Quality and Safety catalogue.[1]
- *Outreach*: The delivery of immunization services to people who cannot easily get to health facilities with refrigeration.

The survey was made publicly available and was posted on two cold-chain logistics forums: TechNet-21 and the International Association for Public Health Logisticians. At the time of this report writing, the survey has been open to participants for more than one month and remains open. In total, 29 participants responded. However, 15 of the 29 respondents completed only introductory questions and were therefore excluded from the results. The following findings reflect the responses of 14 participants whose self-identified roles in the vaccine supply chain are shared in Table 1. Collectively, these respondents represent experience across 16 countries in sub-Saharan Africa, the Middle East, Eastern Europe, and Southern Asia.

Table 1. Respondent roles in the vaccine supply chain.

Role	Number of respondents
Expanded Programme on Immunization management team	4
Health worker	1
Supply chain expert/cold chain expert	6
Other	3

Key findings

Overall vaccine carrier features

Participants were asked to rank the following vaccine carrier features in order of importance:

- Cold-life duration
- Durability
- Organization of the internal vaccine compartment
- Price
- Shape
- Vaccine capacity
- Weight

Many of the respondents ranked cold-life duration as the most important feature while several respondents also highly ranked vaccine capacity, durability, and organization of the internal vaccine compartment. Most participants ranked price and shape of the carrier as the least important features. The importance of weight was distributed across the spectrum of rankings by respondents.

When participants were asked to rate the acceptability of features (cold-life duration, durability, carrying handles, lid seal, vaccine capacity, weight, and size) on a five-point scale from very acceptable to very unacceptable, nearly all participants rated the features between neutral and very acceptable. Of the 13 respondents who answered this question, two rated vaccine capacity in the unacceptable range, one rated the carrying handles as very unacceptable, and one rated the size as unacceptable.

Two respondents noted the impact of introducing additional vaccines to the system and the tradeoffs that must be considered:

> *With additional vaccines introduced into the routine immunization, vaccine carriers need to have enough capacity but yet be portable to enable health workers to carry them to distant places.*
>
> *A combination of factors contributes to the quality and design preference (e.g., if the carrier must be transported by hand or on the back of a bike/moto). The basic carrier was relatively sufficient, but there may now be insufficient space with the additional new vaccines. If the carriers are not stored properly, foam pads get lost, the handle may break/detach, ice packs may not fit properly.*

Ease of use

Several respondents described vaccine carriers as generally easy to use, although one respondent noted that this depends on proper maintenance. While some respondents noted that cleaning the carriers is easy, one suggested that a smooth exterior would make cleaning easier. One respondent suggested that the carrier should be easy to open, and another respondent shared that sometimes "the lid is too tight when it absorbs moisture, particularly when the inner cover of the lid is peeled off."

Storage and transportation

When asked how easy it is to store vaccine carriers, many repondents offered that their shape and stackability make them easy to store. One respondent suggested that it should be possible to hide the handle "on the body so that cube-sized boxes can be stored and transported easily." Interestingly, one participant responded to this question by discussing the risk of freezing within the carriers, indicating that there is "need for a bag or some means to keep vaccines from touching icepacks. Storage can now be a problem due to the increased quantity of vaccines with new vaccines (e.g., rota, PCV) [being introduced]."

Participants were asked about ease of transporting vaccine carriers. Several participants responded that they are easy to transport, citing the shoulder strap, the flexibility of the carrier, and the shape, which "can be fairly easily attached and stacked on the back of a bike if there are not a lot of other commodities to carry." However, other respondents shared that the shoulder strap is uncomfortable when used "for more than a few minutes," and that it would "cause some burning sensation on the shoulders." One participant suggested adding foam to the strap or reducing the weight by using lighter insulation. Additionally, one participant shared that transportation by bicycle/motorcycle on rough roads could cause the vaccines to break.

When asked how many individual vials are transported in vaccine carriers during an outreach visit, all participants responded that ten or more vials are transported, and most responded that 20 or more vials are transported.

Respondents shared that there are typically many carriers available at district- or provincial-level hospitals, while there are very limited numbers of carriers at lower-level facilities such as health centers, clinics, and health posts. Respondents also reported that there are several carriers available at the national referral hospitals.

Durability

When asked how long vaccine carriers remain functional, nearly all participants reported a duration of less than five years. Multiple participants noted that this time frame is dependent on how the carriers are stored. One participant offered that some carriers are "not durable," and another shared that they "have seen very old cardboard polio campaign vaccine carriers used as defaults due to lack of other carriers." In fact, many of the participants agreed that other types of equipment are used for immunization outreach: One participant cited that "boxes or bags" are used. A health care worker frankly stated, "We use what we have."

Preferences, problems, and suggested improvements

Participants were asked what they liked about the vaccine carriers that they were familiar with. Responses included stackability, durability, transportability, weight, and cold-life duration. When asked what problems or complaints they had regarding the vaccine carriers, several respondents addressed the capacity of the carriers. One respondent shared, "Volume capacity is no [longer] enough given the fact that we introduce more vaccines in single-dose vials." Some respondents identified the weight of the carriers as problematic. Other respondents shared that temperature fluctuations are a challenge because of the extreme heat and a lack of health worker understanding on the importance of keeping vaccine carrier lids closed.

Participants were asked what they would change about vaccine carriers if they could. Several participants suggested increasing the capacity and others emphasized the importance of using lighter-weight material. One respondent specifically addressed this tradeoff to "increase volume but maintain portability." Respondents also suggested that carriers be made easier to open. Many of the respondents offered suggestions related to temperature control. Some respondents suggested the addition of a temperature monitor. One respondent would make the carriers "keep cold longer." Another suggested the addition of a "compartment or sleeve to keep vaccines from touching ice packs."

Immunization sessions

Participants were asked about the typical length of an outreach visit. Nearly all respondents selected ten hours or less, although one respondent selected three days or more. When asked who most commonly uses vaccine carriers, participants most frequently selected Expanded Programme on Immunization (EPI) vaccinators, nurses, and community health workers.

Participants were also asked their approximation of the percentage of vaccinations given in each of the following scenarios: health facility, campaigns, national immunization days, and outreach sessions. Although responses were fairly evenly divided across all scenarios, a slightly higher number of participants selected national immunization days as the scenario where higher rates of vaccines are given and health facilities as scenarios where lower percentages of vaccines are given. One participant provided particularly helpful insights:

> *This is mixing scenarios. Generally, in peri-urban and rural areas, routine immunization is given in a fixed post/facility, with about 15 to 20 percent of the population targeted for outreach (if farther than 5 or 10 km from the facility). In bigger or more rural health areas, outreach may be higher (e.g., 30 to 35 percent). Campaigns and NIDs [national immunization days] are not generally for routine immunization. However, these campaigns require extra vaccine carriers, depending on the target population.*

Analysis and recommendations

Survey responses reflected that, overall, vaccine carriers have worked well and have met the needs of stakeholders. However, as noted by several respondents, as more vaccines and single-dose vial presentations are being introduced into the EPI, specific features of vaccine carriers, particularly vaccine

capacity, need to be reconsidered. This feedback aligns with results from a survey about issues and perceptions related to presentation and packaging of the human papillomavirus vaccine, in which more than half of the interview participants perceived space requirements for storage and transportation to be a challenge with single-dose vials.[2] Any increase to vaccine capacity needs to be balanced with maintaining transportability: as more vaccines are carried, the weight of the filled carriers must continue to be low enough to allow them to be transported easily over distance by foot. As one respondent put it:

> *Making them larger will not help with the problem of transporting by hand or bike if they cannot be easily carried or stacked. Nurses are not weight-lifters, and there are other commodities and documents that have to be transported to sites as well.*

Notably, as more vaccines are crowded into carriers, the impact on temperature control needs to be considered. Many respondents ranked cold-life duration as the most important feature and some suggested the addition of a temperature monitor. Yet interestingly, the majority of respondents noted outreach was less than 10 hours in duration, well below the 15-hour cold-life specifications for short-range vaccine carriers. It may be prudent to evaluate the impact on cold life of including fewer ice packs in the short-range vaccine carrier. There was one respondent who noted that outreach can be a three-day process. More data are needed to understand how common the need is for vaccine carriers that maintain 2°C to 8°C temperatures for these longer periods.

Maintaining cold enough temperatures is important, but so is preventing freezing of the vaccines. Concern over freezing was expressed in several survey responses, and a review of the literature revealed that the risk of freezing is a serious issue.[3] Given that many of the newer vaccines are single-dose, sensitive to freezing, and considerably more expensive than traditional EPI vaccines, it will be critical to ensure that carriers provide adequate protection against ice packs that are not properly conditioned and that place vaccines at risk of freezing. In 2012, project Optimize, a PATH and WHO collaboration, piloted a freeze-safe vaccine carrier in Vietnam. Advantages of the carrier were its ability to protect vaccines from being frozen thereby reducing vaccine wastage. In addition, the prototype simplified health care worker conditioning protocols as frozen ice packs could be used.

Reevaluating the design of vaccine carriers presents an opportunity to improve the factors that have been identified as acceptable but could be improved, such as ease of opening the lid and comfort for carrying by foot. Stakeholders felt that vaccine carriers were durable and easy to store and stack. Padding the shoulder strap or otherwise increasing the comfort of carrying the vaccine carrier would improve its acceptability. Other beneficial design changes include organizing the internal vaccine compartment, making lids easier to remove, and making the exterior easier to clean. One respondent did note that “they begin to wear out from the neck and break in pieces, exposing the foam insulating it.” Surprisingly, among these survey respondents, the price of carriers was one of the least important criteria.

Several student groups have embraced the challenge to improve the design of vaccine carriers in recent years. Students from Carnegie Mellon University developed a design that incorporates features of a lightweight, sturdy backpack into a carrier with a temperature control system that carefully maintains and monitors temperature with two temperature probes.[4] Students from the Georgia Institute of Technology developed a hexagonal configuration, which reduces the volume of the carrier but maintains the interior capacity for vaccines.[5] Recently, a student from the National Institute of Design in India designed a carrier with increased internal vaccine capacity, decreased overall volume and weight, and improved

usability and organization of vials in the carrier. The designer recommended HDPE (High Density Poly Ethylene) because of his claim that it is stronger and more resistant to higher temperatures.[6] Currently, most carriers use LLDPE (Linear Low Density Polyethylene) plastic. Additionally, the Rural Vaccine Delivery System Routine Immunization Kit, which won the I Design Award for Medical Equipment and Devices Design in India in 2012, includes features such as a temperature monitoring mechanism, a work surface, and storage for medical waste and medical essentials.[7] Innovative designs such as these should be further evaluated for feasibility.

The body of literature on vaccine carriers is currently limited. Although this survey's findings represent the views and experiences of a small number of participants and all information is anecdotal, this survey provides valuable insights to improve understanding of current uses of vaccine carriers and the needs of users.

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