

OVERVIEW

Ocean shipment of vaccines

Opportunities and risks

Project Optimize is a collaboration between the World Health Organization and PATH to identify ways in which supply chains can be optimized to meet the demands of an increasingly large and costly portfolio of vaccines. In consideration of the volatile global economy, growing costs of airfreight, and the risk associated with diminished air cargo capacity, project Optimize evaluated ocean freight as a potentially secure and economic alternative method to transport vaccines. This evaluation did not address vaccine transport with oceanic ferry services or short sea shipping lanes, such as those in Western Europe or Southeast Asia, but instead focused on container ships transporting long distances.

Optimize's objectives were to assess the potential cost savings of transitioning to an ocean-based method of vaccine shipment from an airfreight-based method, and to assess whether recent innovations in actively refrigerated sea cargo containers, called reefers, could reliably prevent the risk from exposure to temperature extremes during long ocean journeys. Ocean shipping may become even more compelling as petroleum supplies diminish and there is increased attention to fuel efficiency. The current petroleum supply is estimated as a 30-year reserve, and today, transportation is almost completely reliant (95%) upon petroleum products.¹

Furthermore, while measuring the environmental impact of transportation is complex, ocean shipping is the most carbon-efficient mode of cargo transport available and produces fewer grams of exhaust gas emissions for each ton of cargo transported than air, rail, or road transport.² This evaluation presents the economic, technical, and regulatory issues of ocean



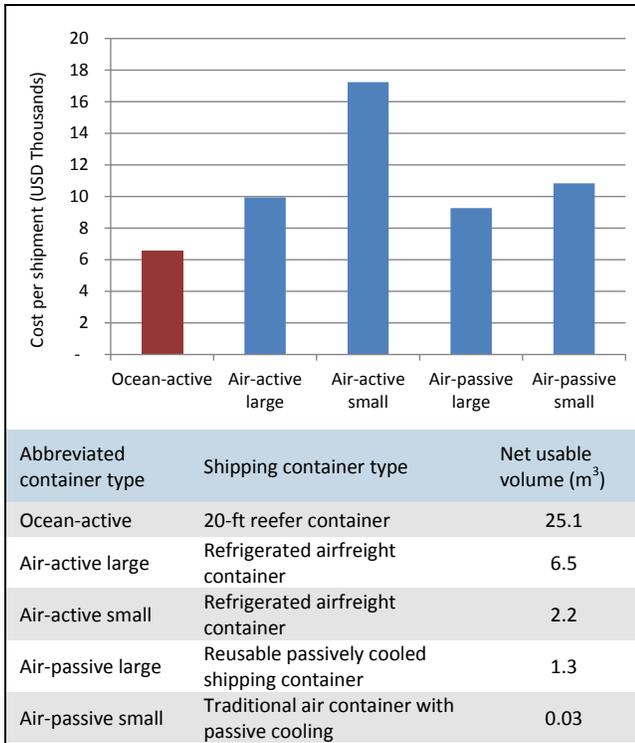
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shipment of time- and temperature-sensitive vaccines as a foundation for ongoing discussion on the opportunities and risks of this alternative international shipping method.

Initial economic comparison

To evaluate the costs of various shipping methods, shipping rates were obtained for a fixed volume and value of vaccine transported from Belgium to South Africa. Total transport costs using five different international shipping methods demonstrate that an ocean reefer is less expensive than actively or passively cooled air transport options even when only a quarter of the 20-foot reefer container is utilized (see Figure 1).

Figure 1. Cost comparison of five shipping methods.



Further cost considerations

While there are potentially significant cost savings to be found from the initial cost model, there are additional criteria that are likely to affect the overall cost to implement this alternative vaccine transport method.

Shipment volume

Considering the complexities of consolidating different vaccines from different manufacturers into a single shipment, ocean transport is likely to be used to transport a homogenous shipment of vaccine from a single manufacturer. With a single vaccine shipment capable of transporting 1.9 million single-dose vials of pentavalent vaccine, a country must have a significantly large population to fully utilize the shipping volume of a 20-ft reefer container. It is possible that an interregional warehouse serving the vaccine needs of several countries could make ocean shipment a viable option for less populous countries. However, the Optimize cost comparison suggests that the ocean shipment of vaccines will still be less expensive than air transport when 10 to 15 percent of the reefer volume is utilized, which makes this transport method a potential economic option for smaller countries.

Access and security costs

In addition to the costs of the actual cargo shipment are potential terminal security fees, or shipping company services such as real-time temperature monitoring,^{3,4} or back-up power. A 20-foot reefer container of new vaccines such as rotavirus or pentavalent will hold a shipment value of approximately \$1.8 million and \$2.8 million, respectively; therefore requiring additional security measures.

Restriction of ocean transport to available direct routes

Cross-docking during ocean shipment of vaccines significantly adds to the costs and risks of this method of transport. Thus, it is likely that the ocean shipping of vaccines will only have cost-savings and be secure for countries with easy access to seaports on a direct trade line with vaccine manufacturers.

Potential risks at ocean ports

While airfreight business has been slow to recover from the economic downturn, ocean-freight markets are showing growth in shipping volumes in most regions.⁵ A major shipping line reported a growth rate in reefer sales of 10% per year from 2004 to 2011. (Globally, there are about 1 million reefer containers out of a fleet of about 31 million of all types of ocean cargo containers.⁶) There is a rapid increase in the availability of reefer plug-in points at ports, including most ports in Africa. However, despite the increasing availability of reefers and reefer plug-ins at ports, there are several areas for concern for vaccine handling at these ports, including:

- Port agents may not be trained for handling vaccines and other biological products.
- There may not be reliable mechanisms to deter and control theft and other criminal activities common at ocean ports.
- Severe congestion is common for trucks arriving for in-country pickup, and the delay in collection of vaccines from the port may be one of the most significant threats to vaccine temperature requirements.



Dr. Jean-Paul Rodrigue, Dept. of Global Studies & Geography, Hofstra University, 2010

Reefer stacking area in Maher Terminal, Newark, New Jersey.

Reefer container technology

Reefer containers have evolved to be well-controlled active refrigeration technologies. All of the major shipping companies have worked with their preferred reefer manufacturer to provide options for customers of high-value, time-temperature products and can provide (for an additional fee) access to real-time temperature monitoring solutions.



Example of reefer design.

However, there are still risks from reefer container failure that must be managed by the shipping company and by their customers. The Pharmaceutical Cold Chain Interest Group at the Parenteral Drug Association formed the Temperature Controlled Sea Containers task team, which has published industry guidelines that include steps needed to identify a qualified ocean shipping company with adequate reefer technologies, prequalification procedures, temperature control capabilities, reliable power supplies, and route planning expertise.⁷

Ocean shipping companies' concerns with vaccine shipments

Cost is not always the most important driver in supply decisions. While ocean freight companies are offering special services for high-value reefer cargo, these preventative measures highlight the potential risks of using ocean freight for vaccines. These precautions include using only preapproved reefers that have passed an extended pre-trip inspection, eliminating low-performing ports, and carefully selecting vessels with reefer spare parts and optimal routing that controls not only transit time but also ensures reliable ports and avoids transshipment (Hapag-Lloyd, unpublished data, 2011).⁸

Determination of liability for ocean freight has been dramatically impacted by the 2010 Rotterdam Rules. These rules are an international standard that puts the burden of liability on the shipping company, and they apply from the reception of goods by the carrier to the point of delivery. The impact is to broaden the limits of liability, potentially extending the carriers' responsibilities to the actions of subcarriers, stevedores, and terminals. Ocean freight companies must now ensure that the inland service provider is subcontracted to a provider that can handle time- and temperature-sensitive freight because they are now responsible for the product until it reaches destination. As a consequence of the Rotterdam Rules, it is unclear whether ocean freight companies will be willing to take responsibility for a 20 foot reefer with US\$2 million worth of vaccines.

Recommendations

Despite the challenges and risks, there are cost and environmental reasons for further investigating the ocean-based method. With continued volatility in the global economy and increasing fuel prices, the existing traditional airfreight method of shipping may become less sustainable, and it will become important to identify how to successfully use the ocean-based method.

Route design should be investigated for:

- Feasible shipping lanes.
- Availability of containers.

- Pallet/container configurations.
- Impact on vaccine manufactures.

Qualification requirements should be investigated for:

- Reefer container prequalification specifications.
- Shipping lane qualification.
- Temperature performance and alarms.
- Standard operation procedures.
- Security and theft.
- Liability issues.
- On-shore monitoring.
- Emergency planning.

These investigations are needed to better assess the operational feasibility of ocean shipping of vaccines. Several of the largest vaccine manufacturers are already conducting test shipments. Thus, this accumulated experience will enable them to recognize the specific shipments and routes that offer sufficient benefits (versus risks) to justify ocean shipment rather than air shipment. The single greatest question, however, is whether the size of the shipment necessary to fully utilize a container proves too great a risk of loss and replacement to

become a preferred alternative to the air-based method. Until the vaccine industry conducts full investigations and until there is a high degree of confidence in the processes of port handling and the transferring of vaccine to its final destination, the ocean shipping of high-value, vulnerable vaccines will remain in the pipeline.

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