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How much does it cost to get a dose of vaccine to the service delivery location? Empirical evidence from Vietnam's Expanded Program on Immunization

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ABSTRACT

Few studies document the costs of operating vaccine supply chains, but decision-makers need this information to inform cost projections for investments to accommodate new vaccine introduction. This paper presents empirical estimates of vaccine supply chain costs for Vietnam's Expanded Program on Immunization (EPI) for routine vaccines at each level of the supply chain, before and after the introduction of the pentavalent vaccine.

We used micro-costing methods to collect resource-use data associated with storage and transportation of vaccines and immunization supplies at the national store, the four regional stores, and a sample of provinces, districts, and commune health centers. We collected stock ledger data on the total number of doses of vaccines handled by each facility during the assessment year.

Total supply chain costs were estimated at approximately US$65,000 at the national store and an average of US$39,000 per region, US$5800 per province, US$2200 per district, and US$300 per commune health center. Across all levels, cold chain equipment capital costs and labor were the largest drivers of costs. The cost per dose delivered was estimated at US$0.19 before the introduction of pentavalent and US$0.24 cents after introduction. At commune health centers, supply chain costs were 104% of the value of vaccines before introduction of pentavalent vaccine and 24% after introduction, mainly due to the higher price per dose of the pentavalent vaccine.

The aggregated costs at the last tier of the health system can be substantial because of the large number of facilities. Even in countries with high-functioning systems, empirical evidence on current costs from all levels of the system can help estimate resource requirements for expanding and strengthening resources to meet future immunization program needs. Other low- and middle-income countries can benefit from similar studies, in view of new vaccine introductions that will put strains on existing systems.

1. Introduction

The public health impact of vaccines in reducing childhood morbidity and mortality has become increasingly clear in the past decade, spurring both global and national interest in introducing new and underutilized vaccines into national immunization programs in low- and middle-income countries. As more opportunities emerge, the introduction of new lifesaving vaccines is likely to double the number offered in routine immunization programs. Countries will need to allocate resources not only to procure new vaccines, but also to strengthen the supply chain that supports national immunization programs. In particular, vaccine supply chains will require increased financial investment and efficiencies to accommodate more vaccines and larger volumes passing through the system [1].

Abbreviations: BCG, *Bacillus* Calmette–Guérin; DTP, diphtheria–tetanus–pertussis; DTwP, diphtheria–tetanus–whole-cell pertussis; EPI, Expanded Program on Immunization; FITG, fully immunized target group; kwh, kilo watt hours; MOH, ministry of health; PATH, Program for Appropriate Technology in Health; PQS, Performance, Quality and Safety; VND, Vietnamese Dong; WHO, World Health Organization.

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Assessments of the costs of national supply chains in low- and middle-income countries can inform policymakers on the need to invest in improving systems if countries are to meet future immunization needs and reduce costs. These assessments also provide essential cost data for use in vaccine cost effectiveness studies. To date, information is lacking on country-level indicators, and on how supply chain systems and their costs evolve over time.

Several studies have estimated the cost of non-vaccine commodity supply chains [2–4] and a few others have done so for the vaccine supply chain [5–7]. One study for Vietnam focused on costing the supply chain in a single district, without including costs from the national or regional levels [5]. As part of the World Health Organization (WHO)/PATH project Optimize [8], cost modeling for the vaccine supply chain for Vietnam's Expanded Program on Immunization (EPI) was performed in order to understand the costs of the system, from the national level to the lowest level.

Based on WHO coverage estimates, Vietnam has a well-functioning vaccine supply chain that supports coverage rates of over 90% for most of the EPI vaccines [9]. Local manufacturers produce several vaccines and deliver them either to the national cold store or directly to the four regional cold stores. Imported vaccines such as the pentavalent vaccine (diphtheria–tetanus–pertussis [DTP], hepatitis B [HepB], *Haemophilus influenzae* type B) arrive at the national cold store before transport to regional stores. Vaccines then move through four tiers of Vietnam's health system and are stored at the regional, provincial, and district levels before going to the commune health centers. Generally, vaccines are only supplied to the commune level for one to three days per month for immunization activities which are held on one day of the month. During the rest of the month, vaccines are not stored at the commune level, except in some remote communes where vaccine refrigerators have been provided or to enable the timely administration of the HepB birth dose. Vietnam continues to introduce new vaccines into the EPI and in mid-2010, the country introduced the pentavalent vaccine.

Our objective was to document the resources used in Vietnam's supply chain for routine vaccines and to estimate the costs of the supply chain from the national level to the service delivery points. We estimated the costs of the existing supply chain with its strengths and weaknesses and did not attempt to cost an ideal supply chain. The study considered only the costs that the government bears, not any costs to households.

2. Material and methods

2.1. Conceptual framework

The conceptual framework for estimating supply chain costs captures the costs associated with its procurement, transportation, and storage functions [2–4]. The procurement function includes quantification or demand estimation, developing and managing contracts, placing and processing orders, and receiving or clearing orders. The transportation function includes moving goods from one facility to another, and the storage function entails warehousing the commodities. This analysis focused on two of these three functions, as shown in Fig. 1. We included labor costs related to some of the procurement functions in the storage function. We categorized the storage and transportation costs as shown in Fig. 1, noting that not all levels of the supply chain perform both functions. We captured costs for transporting and storing EPI vaccines for routine immunization of children under 1 year of age, as well as immunization supplies, such as injection and reconstitution syringes and safety boxes.

2.2. Study design

We conducted field visits for data collection between October 2009 and February 2010 and also in January 2011. During these two collection waves, we gathered data from the national EPI store (in Hanoi), all four EPI regional stores (considered as primary stores for the North, Center, South, and Central Highland regions), five provinces, 15 districts, and 32 commune health centers. The sample was chosen to ensure that at least one province from each region was included. We used a convenience sample of facilities where other assessments or interventions were being carried out by project Optimize. Staff were interviewed at each facility using questionnaires that were designed to capture the functions and inputs shown in Fig. 1. Stock data were collected from stock ledgers or registers. Unit prices for resources were obtained from sources outlined in Appendix A. We used the ingredients costing method [10] to estimate the costs associated with each supply chain function.

2.3. Cost categories

2.3.1. Storage function costs

These included the costs associated with the depreciated value of cold chain equipment; energy costs for running the equipment; equipment maintenance and repair costs; cost of labor time for estimating demand, preparing orders and placing stock orders, receiving or issuing stock, and daily stock management; and infrastructure costs for the space used for vaccine storage. The immunization supplies storage costs included labor and infrastructure costs. Detailed methods on how each cost category was estimated are in Appendix A.

2.4. Transport function costs

These included labor costs for staff involved in distributing or collecting vaccines, depreciation of vehicles, vehicle fuel costs, vehicle repairs and maintenance costs, and insurance costs for vehicles. If other organizations were contracted to provide transportation or if health staff vehicles or public transport were used, these costs were included.

2.5. Annual throughput

Throughput was defined as the total number of EPI vaccine doses received by each facility and was calculated by summing the number of vaccine doses received over one year, using data from the vaccine stock ledgers. For the few commune health centers and districts where stock ledger data were not available, we employed standard methods that use population, vaccine coverage rates, and wastage rates data collected from each facility [11]. We estimated the annual volume and value of vaccines received at each facility by multiplying the number of doses of each vaccine by the volume and price per dose, respectively, and summing across all vaccines.

2.6. Data analysis

An Excel-based spreadsheet model was developed to estimate costs by multiplying the quantity of resources used by the unit prices of the resource. A detailed explanation of how the costs were estimated is provided in Appendix A. We estimated the total annual supply chain costs and the total costs by function and input type at each level of the supply chain. All cost estimates exclude the value of the vaccines. A discount rate of 3 percent was used to estimate the economic life of capital. Costs and throughput were measured for one year and are expressed in 2011 US dollars (US$). An average exchange rate of 18,919 Vietnamese Dong per US$ was used [12].