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Costs of introducing pneumococcal, rotavirus and a second dose of measles vaccine into the Zambian immunisation programme: Are expansions sustainable?

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ABSTRACT

Background: Introduction of new vaccines in low- and lower middle-income countries has accelerated since Gavi, the Vaccine Alliance was established in 2000. This study sought to (i) estimate the costs of introducing pneumococcal conjugate vaccine, rotavirus vaccine and a second dose of measles vaccine in Zambia; and (ii) assess affordability of the new vaccines in relation to Gavi's co-financing and eligibility policies.

Methods: Data on 'one-time' costs of cold storage expansions, training and social mobilisation were collected from the government and development partners. A detailed economic cost study of routine immunisation based on a representative sample of 51 health facilities provided information on labour and vaccine transport costs. Gavi co-financing payments and immunisation programme costs were projected until 2022 when Zambia is expected to transition from Gavi support. The ability of Zambia to self-finance both new and traditional vaccines was assessed by comparing these with projected government health expenditures.

Results: 'One-time' costs of introducing the three vaccines amounted to US$ 0.28 per capita. The new vaccines increased annual immunisation programme costs by 38%, resulting in economic cost per fully immunised child of US$ 102. Co-financing payments on average increased by 10% during 2008–2017, but must increase 49% annually between 2017 and 2022. In 2014, the government spent approximately 6% of its health expenditures on immunisation. Assuming no real budget increases, immunisation would account for around 10% in 2022. Vaccines represented 1% of government, non-personnel expenditures for health in 2014, and would be 6% in 2022, assuming no real budget increases.

Conclusion: While the introduction of new vaccines is justified by expected positive health impacts, long-term affordability will be challenging in light of the current economic climate in Zambia. The government needs to both allocate more resources to the health sector and seek efficiency gains within service provision.

1. Introduction

Gavi, the Vaccine Alliance was founded in 2000 and is now the largest external funding source for vaccines in low- and lower middle-income countries [1]. Introducing new vaccines requires substantial investments, not only in vaccine supplies, but also in 'systems costs', such as cold chain expansions [2,3]. Cost estimates of new vaccine introduction are vital both to Gavi and to recipient countries [4].

Zambia has introduced four new vaccines with Gavi support. The combined diphteria-tetanus-pertussis (DTP)-*Haemophilus*

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influenzae type B (Hib) vaccine was introduced in 2004. This was switched to DTP-hepatitis B-Hib ('pentavalent') vaccine in 2005. In 2009, a proposal was submitted for pneumococcal conjugate vaccine (PCV), rotavirus vaccine (RV) and a second dose of measles (MSD). Gavi approved PCV and MSD in 2010 and RV in 2011, following evidence of plans for cold chain expansions. However, PCV and MSD were only introduced in July 2013 and RV in November 2013. Delays were due to a measles outbreak in 2012, relocation of the Child Health Unit from the Ministry of Health to the new Ministry of Community Development, Mother and Child Health in 2011, delays in receiving the Gavi vaccine introduction grant, and delays in disbursements to sub-national levels [5].

A comprehensive study on the economic and fiscal costs of Zambia's routine immunisation services was undertaken in 2012–13, before introduction of the three new vaccines [6]. This was part of the multi-country 'Expanded Programme on Immunisation Costing (EPIC)" studies, which used a common, ingredients-based costing approach [7]. The study found that average costs per vaccine dose delivered totalled US$ 7.18, with markedly higher unit costs in rural than urban facilities.

Our study objectives were to estimate the incremental costs of introducing PCV, MSD and RV and evaluate affordability after cessation of Gavi support. Although 'one-time' vaccine introduction costs were calculated, the primary objective was to examine the longer-term economic costs.

1.1. Gavi eligibility criteria and co-financing policy

Gavi's current eligibility criteria, established in 2011, is Gross National Income (GNI) per capita of less than US$ 1500, which is adjusted annually for inflation to remain constant in real terms. In 2015, the threshold was US$ 1580 [8]. If GNI per capita increases above the threshold, the recipient country starts transitioning out of support [1].

Gavi's co-financing policy requires countries to co-procure a portion of their new vaccines and injection equipment. MSD is exempted from co-financing, but after five years countries must take on the full costs [9]. Countries are divided into groups according to GNI per capita, which serves as a proxy for ability to pay [10] (Table 1). The trajectory towards self-financing is achieved by annual increases in co-financing levels in the highest income groups. The ability of countries to shoulder the increasing financing requirements has been questioned and shown to vary substantially [11,12].

2. Methods

2.1. Incremental, economic costs of vaccine introductions

Economic costs were estimated in 2014 values, using an exchange rate of 6.18 Zambian Kwacha for one US$ [13] and adjusting earlier data by the Zambian Gross Domestic Product (GDP) deflator [14]. Economic costs were divided into 'one-time' and recurring. 'One-time' costs were expenditures specifically undertaken in preparation for the new vaccine introductions. Recurring costs were those that occur annually in the future. Capital costs were annualised using a 3% discount rate [15], but also presented without annualisation to show needed up-front expenditures.

The number of fully immunised children was approximated by the number reported to receive three doses of pentavalent vaccine (penta3). With 602,000 surviving infants and 86% penta3 coverage in 2014, this was 517,720 children [16]. Costs per capita were estimated using a 2014 population of 15,023,315 [17].

2.1.1. Vaccine and injection supplies

Vaccine costs were calculated by multiplying price per dose, coverage rate of the first dose, target population size, number of doses per child in the schedule and the vaccine wastage factor [18]. UNICEF 2014 vaccine dose prices were US$ 2.10 for RV, US$ 0.252 for MSD and US$ 7.00/3.50 for PCV [19]. According to the Advance Market Commitment for PCV, a certain quantity of doses is purchased for US$ 7.00 per dose and the remaining at the "tail price" of US$ 3.50 [20]. Since co-financing calculations are based on the tail price and as this will be the price Zambia will pay after Gavi transition, we used this price [21]. Freight charges for importing vaccines were 3%, 5% and 14% of the procurement value for PCV, RV and MSD, respectively [9]. 2014 vaccine coverage rates of the first doses of PCV and RV were assumed similar to DTP1 at 96% while coverage of MSD was 33% [16]. Vaccine wastage rates were assumed as 5% for both PCV and RV and 40% for MSD [22].

2.1.2. Cold storage equipment

Cold storage expansions were undertaken at national, provincial, district and health facility levels [23]. Several development partners contributed to this investment [2]. A proportion of the investments was allocated to the three new vaccines based on their relative packed volumes in the new schedule; 4.8 cm^3 per dose for PCV, 17.1 cm^3 for RV and 2.13 cm^3 for measles [19,24]. The WHO vaccine volume calculator showed that the new vaccines increased the required volume by 70%, from 81.3 cm^3 to 138 cm^3 per penta3

Table 1
Gavi co-financing policies 2008–2017.

	2008–2011	2012–2016	2017–
Country groups	1. Fragile 2. Poorest 3. Intermediate 4. Least poor	1. Low-income 2. Intermediate 3. Graduating	1. Initial self-financing 2. Preparatory transition 3. Accelerated transition
Initial co-financing levels per vaccine dose	▪ US$ 0.10 – US$ 0.30 ▪ Amounts differed for first and subsequent approved vaccines	US$ 0.20	US$ 0.20
Annual increase in co-financing per dose	15% for the least poor group	15% for the intermediate group	15% for the preparatory transition group
Trajectory for transitioning out of support	None specified	Graduating group: ▪ Linear increase to reach full vaccine price after 5 years	Accelerated transition group: ▪ Linear increase to reach full vaccine price after 5 years
Co-financing linked to vaccine price	No link	Graduating group: ▪ Paying linearly towards full vaccine price	Preparatory transition group: ▪ Co-financing for individual vaccine differ according to vaccine prices Accelerated transition group: ▪ Paying linearly towards full vaccine price