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Review

Assessing the economic benefits of vaccines based on the health investment life course framework: A review of a broader approach to evaluate malaria vaccination

Dagna Constenla *

Johns Hopkins Bloomberg School of Public Health, 855 N Wolfe St, Suite 600, Baltimore, MD 21205, United States

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ABSTRACT

Background: Economic evaluations have routinely understated the net benefits of vaccination by not including the full range of economic benefits that accrue over the lifetime of a vaccinated person. Broader approaches for evaluating benefits of vaccination can be used to more accurately calculate the value of vaccination.
Methodology: This paper reflects on the methodology of one such approach – the health investment life course approach – that looks at the impact of vaccine investment on lifetime returns. The role of this approach on vaccine decision-making will be assessed using the malaria health investment life course model example.
Results: We describe a framework that measures the impact of a health policy decision on government accounts over many generations. The methodological issues emerging from this approach are illustrated with an example from a recently completed health investment life course analysis of malaria vaccination in Ghana. Beyond the results, various conceptual and practical challenges of applying this framework to Ghana are discussed in this paper.
Discussion and conclusions: The current framework seeks to understand how disease and available technologies can impact a range of economic parameters such as labour force participation, education, healthcare consumption, productivity, wages or economic growth, and taxation following their introduction. The framework is unique amongst previous economic models in malaria because it considers future tax revenue for governments. The framework is complementary to cost-effectiveness and budget impact analysis. The intent of this paper is to stimulate discussion on how existing and new methodology can add to knowledge regarding the benefits from investing in new and underutilized vaccines.

1. Introduction

The influence of health on economic development and growth is one of the better known relationships in economics. Several studies have shown that investing in health can improve both the quality and quantity of human capital in developed and developing countries [1–4]. In a 2002 publication, the World Health Organization (WHO) *Commission on Macroeconomics and Health* emphasized the important relationship between health and economic growth [5], suggesting that investing in health can help some of the poorest countries to achieve the Millennium Development Goals (MDG) of poverty reduction. In their 2005 paper, Suhrcke and colleagues [3] described the driving forces behind health as an investment ideal, indicating that policy makers who are invested in improving the economy (e.g. labour market) need to consider investing in health as health can impact the economy in several ways: (i) improved productivity, decreased absenteeism; (ii) increased labour force participation; (iii) higher-level education; and (iv) savings and investment.

With specific respect to malaria, several studies have assessed the impact of malaria on macroeconomic parameters [6–9]. These studies have shown that countries with severe malaria have lower economic growth than their neighbouring countries with no reported malaria. In contrast, countries that have successfully reduced or completely eliminated malaria burden have grown faster than their neighbours. In the absence of malaria, many economies have experienced 1.25% higher growth than those that are malaria endemic [6].

* Tel.: +1 410 955 1074.
E-mail address: dconste1@jhu.edu

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Microeconomic studies tell a similar story in which indirect costs in terms of lost productivity are often found to be greater than the direct costs of treating malaria, while the impact of malaria on education further impairs human capital accumulation preventing economic growth [10,11]. While these studies are useful for allocating resources to achieve a particular program goal, they cannot be used to inform how investing in a particular vaccine program can influence the broader economy.

Plasmodium falciparum (P.f.) malaria is a leading cause of morbidity and mortality in sub-Saharan Africa (SSA), causing 300–500 million infections and over one million deaths annually, particularly among children younger than five years [12,13]. Malaria incidence and mortality vary widely across SSA, both between and within countries, and depends on various factors including the endemicity[i] of the country and region.

Malaria transmission provides a barrier to national economic growth and poses a constant threat to health, well-being and economic stability to millions of poor people worldwide. Among young children in Ghana, the incidence of acute malaria infection range from 0.4 to 1.2 episodes per child per year [14]. The incidence of severe malaria is reported at 0.02 episodes per child per year in a community setting in Ghana. An estimated 6.6 deaths per 1000 (<5 y) and 1.1 deaths per 1000 (all ages) are reported annually. Hospital-based studies reported case fatality ratios of 3.5–11.2%. All of the population (100%) in Ghana live in high endemic areas (>1 per 1000) [14].

The economic burden of malaria is substantial because of lost earning and costs associated with treatment. Indirect costs (e.g. lost productivity) typically exceed the direct costs of malaria and comprise a major component of the overall cost burden of malaria. The magnitude of the cost burden is even higher when considered in relation to national income [15]. In 1998 in Tanzania, total expenditure on malaria was estimated at $64.6 million, which equals to 1.1% of the gross domestic product (GDP) (39% of healthcare expenditure). A more recent study [16] estimated that malaria consumes 3.4% of Tanzanian GDP or $240 million annually. Based on a threshold for catastrophic expenditure defined as 5% of non-food expenditure, healthcare costs for malaria are catastrophic for many households [17]. Out-of-pocket expenditures averaged $2.30 per malaria episode in South Africa and $6.50 in Mozambique, representing a mean of 39% of mean non-food expenditure in Mozambique and 1.4–3.5% in South Africa, and was generally higher as a proportion of expenditure for poorer households than better off households in both countries [18].

In this paper we describe a framework that measures the impact of a health policy decision on government accounts over many generations. The methodological issues emerging from this approach are illustrated with examples from a recently completed health investment life course analysis of malaria vaccination in Ghana [19]. The methodological issues of this approach and the conceptual and practical challenges of applying this method in different settings are discussed based on this example.

2. Broader economic impact of vaccination

While many studies have aimed to quantify the economic benefits of vaccination, few have considered the full range of economic benefits associated with vaccination such as the potential full and downstream impact on growth and development, education, productivity, social equity, and other indirect yet important effects [20]. Missing these effects overlooks the true value of vaccines. Given the high cost of new vaccines and the number of new vaccines that are entering the market over the next decade, better understanding of the value of vaccination will play a critical role in decision-making regarding policy-making and funding. When valuing the full range of economic benefits of vaccination, it is helpful to consider three key concepts of an economic evaluation described below: scope, perspective and measurement approach.

2.1. Scope

The scope of an economic evaluation can range from very narrow to very broad. The majority of economic evaluations of vaccination to date use cost effectiveness analysis and focus on cost per disability-adjusted life year (DALY) averted or quality-adjusted life year (QALY) gained. While DALY is a composite measure of overall disease burden, expressed as the number of years lost due to ill health, disability or early death, QALY is a measure of disease burden that considers quality and quantity of life lived. An economic evaluation designed to reduce the transmission of malaria might use *DALYs averted* as an appropriate indicator of benefit. Estimates of benefit might be based on aggregate average of disability and mortality, which would require detailed review of disease epidemiology, structure of the health system, information about the impact of the intervention under evaluation, and health outcomes and costs measured.

On the other hand, an evaluation focused on improved cognition and education would require a detailed breakdown of the cognitive ability of an individual that will be measured as verbal and non-verbal cognitive ability. For education outcomes it would require information about the rate of school enrolment, drop out and absenteeism, and years of schooling, where possible. In a study of this kind, we would need to consider the use of several tests of motor skills, visuomotor integration, and visual perception (e.g. Fine Motor Skills: Pegboard (Wide Range Assessment of Visual Motor Abilities—WRAVMA); Visuomotor Skills: Beery Developmental Test of Visual Motor Integration (VMI)) to determine whether the intervention (e.g. vaccine) has impacted on the outcome of the disease.

The selection of the scope is based on the study question, the degree of precision required to address the study question and the time and resources required to produce a detailed account of the benefits of vaccination. Other elements that define the scope of the economic evaluation include the approach used to the evaluation; the type of data to evaluate and the manner in which these data are collected; whether the study approach is multidisciplinary in nature (i.e. how are data being pulled together—prospective and retrospective data collection from what settings?); whether the evaluation is empirical in nature (i.e. are primary data being collected or are data model-derived and reliant on secondary data sources?). The scope of the study is generally driven by the availability of information and the need to bring information together for policy.

2.2. Perspective

The decision on which costs and effects to include in an economic evaluation is governed by the perspective being adopted in the analysis. The most frequent perspectives are those of the patient, the health care system and society at large. The first two perspectives are narrow perspectives that focus solely on costs incurred within the health sector [21] and by individuals in terms of out-of-pocket expenditures. The latter is the societal perspective in which all costs and consequences are taken into account regardless of whose budget is affected or where in society they occur. The

[i] Endemicity is defined as the level of P.f. infection in a population. High endemicity is 10–1000 infectious bites per year or about 800 clinical attacks per 1000 persons per year. Moderate endemicity is 0.25–10 infectious bites per year or about 200 clinical attacks per 1000 persons per year (*Source:* Edith Roset Bahmanyar personal communication, April 15 2012).