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Using Gross National Product to Calculate Acceptable Immunisation Costs

Deploying Cost-Effectiveness Calculations in Reverse

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Contents

Potential cost effectiveness is often calculated by modelling studies before a vaccination programme is introduced. A general guideline is that the total cost involved in saving each life-year must be less than the productivity of that life – the per capita gross national product (GNP) of the country.[1] However, there is great variation in how costs are calculated. The direct cost of hepatitis B immunisation from the perspective of the government that pays for the intervention has been calculated by one group of authors[1] to be $US10.50 per dose for countries with the highest GNP (2000 values), while another group[2] has calculated the cost to be $US68.08 per dose from the perspective of the provider in the US (health maintenance organisations [HMOs]) and $US108.08 from the societal perspective (1999 values). Such large variations in the calculated cost makes health economic evaluation appear imprecise.

In this paper, instead of calculating costs in monetary terms, we looked at the known benefits of the vaccination programme in terms of life years saved, against the GNP and arrive at a cost that would be acceptable. For the purpose of this paper we consider a hepatitis B vaccination programme in India.

1. Methods

The Indian Council of Medical Research (ICMR) Cancer Registry suggests that 5000 cases of hepatocellular carcinoma (HCC) occur due to hepatitis B each year in India.[3] On average, 21 life-years are lost to each case of hepatocellular carcinoma.[4] Twenty-five million people are born each year in the country and each of them will need three doses of hepatitis B vaccine.

The life-years lost (21 years) to each case of HCC was multiplied by the total number of deaths due to hepatitis B-induced HCC (5000) to arrive at a figure for the total life-years that can be saved by vaccinating against hepatitis B. The cost of the immunisation programme was divided by the total life-years saved, to arive at a value in terms of cost per life-

Table I. Calculating acceptable immunisation costs

Total life-years lost[4]	21[a] × 5000[b] = 110 000
Birth rate in India[6]	25 million
At 3 doses per child, total number of doses needed	25 million × 3 = 75 million
Per capita gross national product (GNP) of India[5]	$450
The cost for the total number of doses needed if the cost of 1 dose of vaccine and its administration = 'x'	75 million multiplied by 'x'
The acceptable price of the vaccine must be less than the GNP × life-years saved divided by the number of vaccine doses required	'x' < GNP × life-years saved divided by the number of doses of vaccine needed i.e. 'x' < $450 × 110 000 divided by 75 million = $0.66/dose
At a 3% discount rate for a gain of 21 years occurring 45 years in the future	0.66/5.4 = **$0.122**

a Life-years saved by preventing 1 case of hepatocellular cancer.

b Number of lives saved.

year saved and this cost was compared with the GNP.

2. Results

The per capita GNP in India was $US450 in the year 2000.[5] The acceptable price of the vaccination (x) must be less than the per capita GNP multiplied by the life-years saved, divided by the number of vaccine doses required. For 110 000 life-years saved and the 75 million doses required, the cost of the vaccine and its administration must be less than $0.66 per dose. At a 3% discount rate (looking at a present value for 21 years saved as a result of preventing premature death at the age of 45 years), this cost must be divided by a factor of 5.4. The acceptable cost, therefore, becomes $0.122 per dose (table I).

3. Discussion and Conclusions

In cost-effectiveness analyses, the cost of an intervention can be calculated in terms of dollars per life-year saved.

There are regional differences in the incidence of hepatocellular cancer among hepatitis B carriers ranging from no HCC deaths in 5135 carrier-years' follow-up in Canada to 494 HCC per 100 000 carrier-years among men in Taiwan.[7] Projections for India using the Taiwan data suggest that 180 000 persons die in this country from hepatitis B-related disease;[4] such projections are considered inappropriate.[6] The present calculations are based on the ICMR Cancer Registry figures i.e. that the nationwide incidence of HCC due to hepatitis B is 5000 per year in India. These are the figures relied upon by the Indian Association for Study of the Liver (INASL) in their consensus statement on hepatitis B prevention.[8]

If the benefits of the programme are clearly defined in terms of life-years gained, then the other figures used in the calculation – the birth rate, numbers of doses of vaccine required and the GNP of a country – are precise. We suggest that nations may find this concept of calculating 'acceptable costs' useful in deciding whether to embark on a vaccination programme. It may also be used in negotiating vaccine supply costs with producers.

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