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Original Research Article

Cost-effectiveness analysis of hepatitis B vaccination versus treatment

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Abstract

Purpose: The aim of this study is to evaluate the cost-effectiveness of vaccination against hepatitis B compared to the treatment of those who became sick.
Methods: Data on time spent by each healthcare provider with a patient who has presented to the clinic to be vaccinated or treated for hepatitis B infection werecollected from the clinic. This time was converted to cost. The cost of drugs and vaccines with consumables were also collected. This data was used to construct a stochastic Monte Carlo model from the perspective of the clinic using a time frame of one year. The model reports the cost savings associated with policy change from treatment to vaccination. Sensitivity analysis was performed by varying data input by ±50%. P-values less than 0.05 were interpreted as significant.
Results: To adequately cover treatment cost NGN11,000.00 needs to be budgeted per person compared to about NGN3,400.00 needed to fund vaccination. This was found to be significant at $p<0.05$. Cost savings are in the range of NGN6,750 – 8,000 per person vaccinated while total cost savings to switch policy from treatment to vaccination will be NGN110-130milliom.
Conclusion: Vaccination of staff dependents and retirees is a more cost effective option in the management of hepatitis B compared to the current strategy of treatment of these individuals when they contract the disease. The cost savings which can be applied in other areas of need is about NGN120million.

Keywords: Cost savings, budget strategy, hepatitis B surface antigen, healthcare evaluation

Indexing: Index Copernicus, African Index Medicus

Introduction

Hepatitis B disease can be acute or chronic and results due to a highly infectious pathogen called hepatitis B virus. It is asymptomatic in the early stage of the infection and most adult onset of the infection resolve spontaneously. Roughly 350million people globally are chronic carriers while the annual death rate is 750,000 of which half the deaths is attributed to liver cancer[1-6]. Transmission of the virus can be sexual, contact with body fluids and blood, use of infected needles, traditional circumcisions and blood transfusion. However, in hyperendemic areas, perinatal and horizontal transmissions have been reported as the most common route of transmission [7].

Nigeria has high endemicity for hepatitis B infection and the prevalence has been reported to be between 7-25%. About 15-40% of infected patients will develop liver failure, hepatocellular carcinoma or cirrhosis especially when hepatitis B virus DNA levels in the blood is >2 X 10^3IU/ml. It has also been reported that awareness of the disease amongst healthcare workers is low [3, 8-17]. Vaccination is the most effective way of controlling hepatitis B virus infection. Treatment usually involves the use of interferon alpha and antiviral medications which are usually expensive [18].

Resources for healthcare are usually limited and decision makers are looking for efficient ways of allocating funds to reduce wastage and yet provide effective healthcare. Most oil firms in Nigeria provide free medical services to their staff with the hope of reducing man-hour loss, increase productivity and thus improve their bottom line. A particular oil firm in Warri, Nigeria, has a policy of providing hepatitis B vaccination for all its staff but does not do so for staff dependents and retirees but pay all treatment-related cost for them if they become ill as a result of hepatitis B infection. Cost-effectiveness analysis is a pharmacoeconomic model that can aid decision makers in resource allocation and policy formulation [19].

Therefore, the objective of this study is to evaluate the cost-effectiveness of vaccinating all staff dependents and retirees against hepatitis B versus treatment using real world data obtained directly from the firm's clinic. If the analysis shows that the current policy or strategy of treatment rather than prevention is not cost effective, then it will be replaced by vaccination of all staff dependents and retirees so that cost savings derived from the new policy can be diverted to other healthcare areas that need more funding hence increase quality and quantity of life.

Methods

Setting

This study was carried out in the clinic of an oil firm located in Warri, Nigeria. The firm allocates a healthcare budget to the clinic annually for retirees, staff and their dependents. Thus it pays the cost of treatment of all retirees and dependents of its staff. All staff of the company are vaccinated for free in the clinic. The firm has 14,999 dependents and 1395 retirees giving a total of 16,394 non-staff patients who are treated for free if they have hepatitis B infection but the current policy is that they are not covered for vaccination.

Data Collection

A structured data collection sheet was used for data collection. The time each patient spent with a healthcare provider was obtained with the aid of a stopwatch. Salaries of healthcare providers that have contact with the patients were collected from the accounts department. Costs of consumables such as methylated spirits, syringes and cotton wool, hepatitis B vaccine, and drugs used in patient vaccination and management were obtained from the pharmacy department. Costs of laboratory investigations were provided by the medical laboratory scientist who screened patients for hepatitis B surface antigen and viral load. Historic data on vaccination efficacy, hepatitis B treatment, relapse, referrals and hospital stay was obtained from clinic records and patients' casenotes.

Data Analysis

In this analysis cost of vaccination and treatment include just the direct cost from the perspective of the budget holder which is the clinic in this case. Hence lost man hours and transportation costs were excluded. The time frame for this analysis was one year. Therefore, cost of drugs, consumables like syringes, cotton wool and methylated spirits including cost of medical personal attending to patients were computed. The cost of healthcare provider time (nurse, pharmacist, doctor and laboratory scientist) was estimated from the time the staff spends on attending to the patient and the minimum and maximum staff salary (using uniform distribution) for a specific profession assuming 8hrs of work per day per healthcare personnel. Thus, totaldirect cost of vaccination and treatments beyond drug expenses was fully accounted for. Since historic patient data did not show any vaccine failure the efficacy of vaccination was set at 100% for those that were vaccinated in this real world analysis.

The collected data was used in constructing a stochastic Monte Carlo model (Figure 1) with the aid of Vanguard Studio 5.0 (Cary, NC) to calculate the cost-effectiveness of vaccination compared to the normal treatment of Hepatitis B accounting for relapse occurrence. The model runs 1,000 simulations and output results in mean ± SD. Sensitivity analysis to evaluate the robustness of the model was done by adjusting input parameters by ±50%.The model reports the cost-effectiveness of each option and calculates the cost savings derived per person receiving healthcare coverage; total savings for all patients and budget per person required to cover any of the options was also reported. The abbreviations and cost data input used for model construction are shown in Table 1.In the previous one year, 48 of the dependents and retirees had hepatitis of which 28 had ahigh viral load that required

Table 1: Input Data used in model construction

Abbreviations	Description	Data input (NGN)	Distribution
Cntt	Cost of nursing time during treatment	34,999.76 – 139,991.04	Uniform
Cntv	Cost of nursing time for vaccination	156.24 – 624.99	Uniform
Cpt	Cost of pharmacist's time during treatment	9,999.36 – 59,996.16	Uniform
Cdt	Cost of doctor's time	34,997.76 – 139,991.04	Uniform
Clstt	Cost of lab scientist time for treatment	416.66 - 1666.66	Uniform
ClstV	Cost of lab scientist time for vaccination	208.33 - 833.33	Uniform
Cntv	Cost of nursing time for vaccination	156.24 -624.99	Uniform
DrugCost	Cost of drugs used in treatment	5,000,000.00	Fixed
LabCost	Cost of laboratory investigation	87,940.00	Fixed
CostScreen	Cost of screening	940.00	Fixed
VacCost	Cost of Vaccine	1500.00	Fixed
Consumb	Cost of consumables	30.00	fixed

Table 2: Other input data and assumptions from historic data

Description	Abbreviation	Value
Number of patients used in this evaluation	Npatients	16,394 (14,999dependants + 1,395retirees)
Proportion with hepatitis B virus	Nil	0.293%
Proportion identified with virus that needs treatment	Nil	58.33%
Estimated proportion of treated patients that relapse	Nil	17.85%

Table 3: Formulae used in model construction

Abbreviations	Description	Formulae
MedStaffCost	Medical Staff Cost for treatment	Cntt + Cpt + Cdt + Clstt
TreatCost	Total treatment cost per patient	MedStaffCost + DrugCost + LabCost
MedStaffCostV	Vaccination Staff Cost	CntV + ClstV
VaccnCost	Total Cost of Vaccinating a person	MedStaffCostV + CostScreen + VacCost + Consumb
NRtreatment	Number of patients to treat	Npatients x 0.293% x 58.33%
NRelapse	Number of patients that relapse	Nrtreatment x 17.85%
Costrelapse	Repeat treatment due to relapse	Nrelapse x TreatCost
CostToption	Total cost due to treatment option	(TreatCost x NRtreatment) + Costrelapse
CostVoption	Total cost of vaccination option	VaccnCost x Npatients
CEt*	Cost Effectiveness of treatment option (Control)	CostToption/Npatients
CEv*	Cost Effectiveness of vaccination option (Alternative)	CostVoption/Npatients
Savingspp	Cost savings per patient (ICER)	CEv – Cet
TotalSavings	Total cost savings based all potential patients	CostToption - CostVoption

**Also represents budget per patient required per person to adequately fund the respective options*

treatment to be initiated. Of the 28 treated 5 had a relapse. This information was used in calculating the proportions of those with hepatitis B and relapse rate (See Table 2). Table 3 shows the formulae used in model construction. Inferential analysis was done using Student t-test with the aid of GraphPad Instat 3.0 that reports exact p-values. P-values <0.05 were reported as significant.

Results

After running 1,000 Monte Carlo simulations, it was found that there is a probability of about 80% that the oil firm will need to provide a budget of NGN10,600.00 or more per person to treat retirees and dependents that will need treatment for hepatitis B. A 100% probability

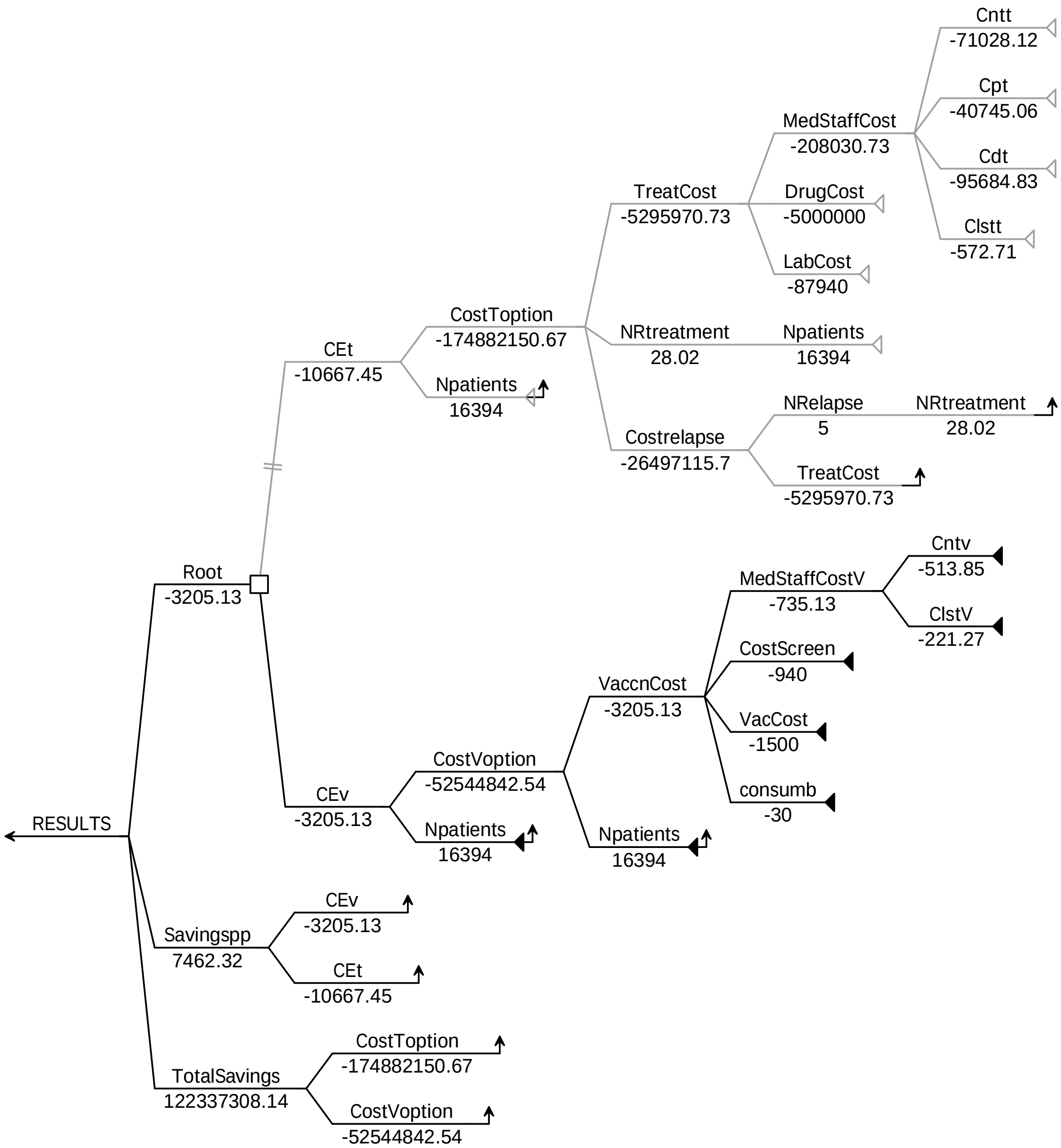

Figure 1: A stochastic Monte Carlo model comparing treatment of hepatitis B versus vaccination

exists that the required budget per person that is covered for free hepatitis B treatment is greater than NGN10,450.00 as shown in Figure 2. The amount needed to guarantee treatment coverage for all appears to be NGN11,000.00 per person.

There is a probability of 80% that costs savings will be NGN7,500.00 or less per patient vaccinated. The range is NGN6,750.00 – 8,000.00 (Figure 3). That cost savings will be less than NGN6,750.00 per patient seems unlikely. Total cost savings by adopting vaccination of retirees and dependents will be in the range of NGN110 – 130million. The probability that it will be less than NGN120million is 50%. A 0% probability seems to exist that total cost savings will be less than NGN110million as shown in Figure 4.

Figure 5 shows the sensitivity graph derived by increasing or reducing input parameters by ±50%. The cost of drugs used in treatment has the greatest influence on total savings derived as a result of vaccination. Even if drug cost is reduced by 50% the vaccination option still dominates with a cost savings of about NGN45million. Thus the model is robust.

The mean savings per person evaluated by this model is NGN7,291.29 ± 244.54 while the total savings derived from adopting the new strategy of vaccinating all retirees and staff dependents is

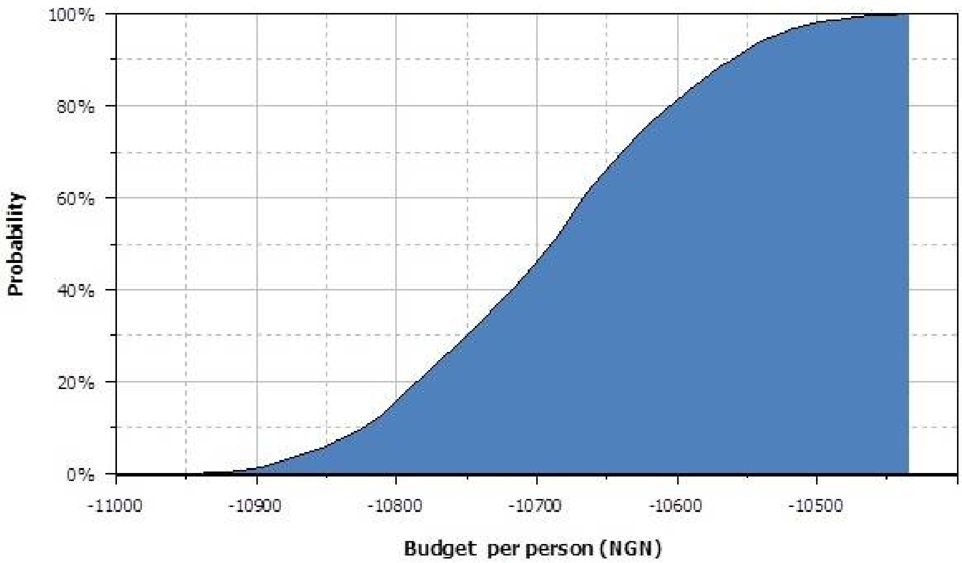

Figure 2: Probability that a specific amount budgeted per person will be adequate for treatment

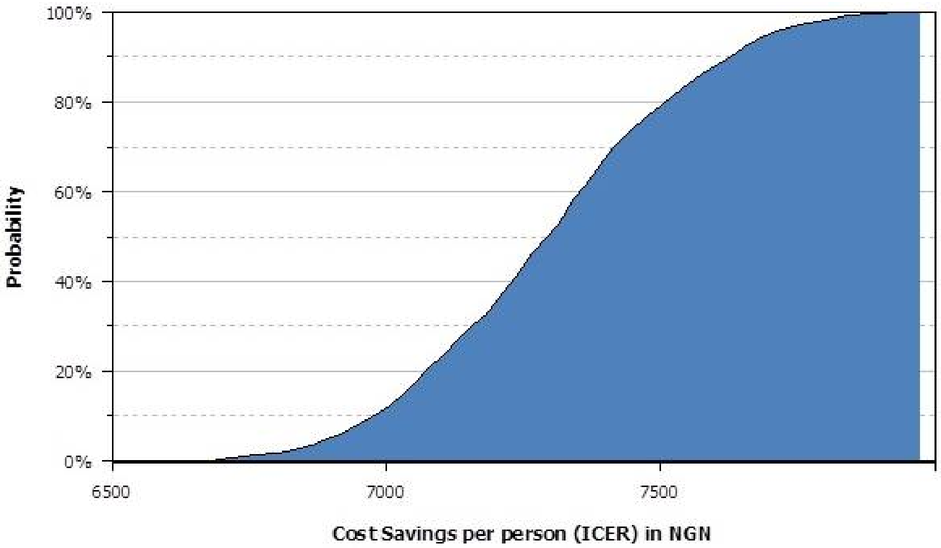

Figure 3: Probability of actual cost savings being the specific amount shown per person

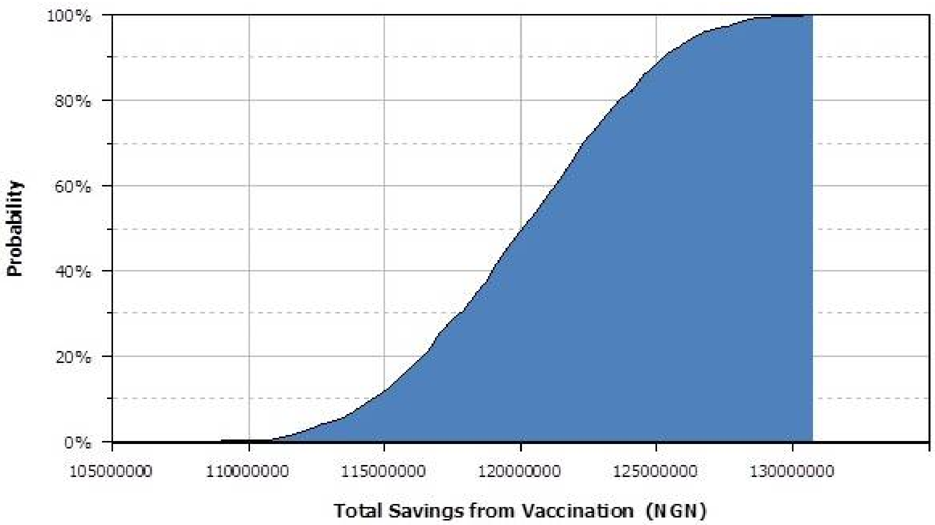

Figure 4: The probability that cost savings from vaccination will be of a specific amount

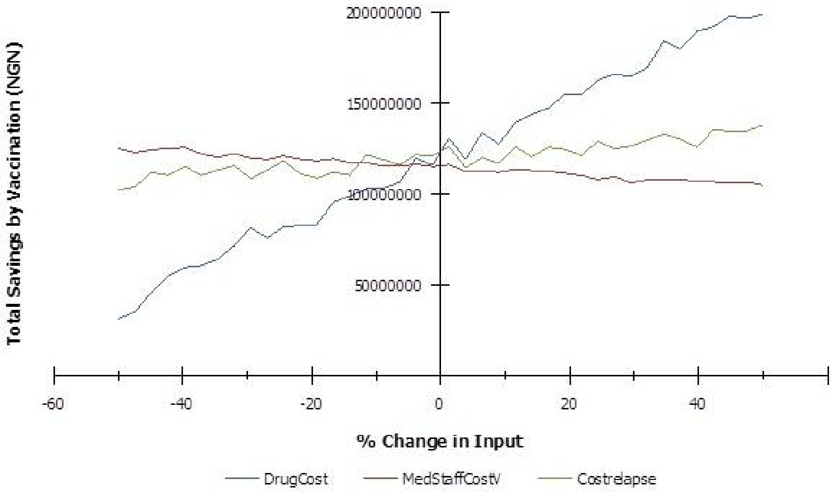

Figure 5: Sensitivity Analysis of Important model inputs

NGN120,000,644.62 ± 4,062,295.63. The amount of money the oil firm is required to budget per person covered (Cost-effectiveness of vaccination) to fund vaccination is NGN3,382.61 ± 228.92 while that needed to fund treatment in the current strategy (Cost effectiveness of treatment) is NGN10,693.62 ± 99.24. This appears to show that there is a significant difference or reduction in expenditure if the vaccination option is adopted for staff dependents and retirees ($P<0.0001$, $t = 926.61$)

Discussion

Several studies have evaluated the economic value of hepatitis B vaccination using different types of models that used different perspectives and time frames. Despite these variations in model structure and analytic frame they all found hepatitis B vaccination to be a cost savings approach in line with the results reported in this study [20-23].

The strength of the model used in this analysis is its simplicity which makes it useful to decision makers. It is usually an accepted norm that the probability of using a model in decision making increases with its simplicity. However, limitations associated with models do exist. On the basis of the real world data, available vaccination option had no failure but another important point to note is that the time frame used for this analysis was one year. Since hepatitis B vaccine confers long-term protection of about 20 years against clinical and chronic infections, a more complex model would have included longitudinal gains acquired over the extended period of protection. Since this is not done this model is a conservative one. Cost savings reported here will be less than what will actually accrue on the long run [20,21].

Conclusion

Vaccination of staff dependents and retirees is a more cost effective option in the management of hepatitis B compared to the current strategy of treatment of these individuals when they contract the disease. The cost savings which can be applied in other areas of need is about NGN120million.

Competing Interests

There is no conflict of interest associated with this study.

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