Cost-Effectiveness of Hepatitis B Screening in a Mental Health Institution

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In 1982, the Ohio Department of Health Screening established guidelines for hepatitis B screening and vaccination for intermediate mental health care facilities. The present study was developed to evaluate the cost-effectiveness of these guidelines. Data from an intermediate mental health care institution in Champaign/Urbana, Illinois, were used. The analysis considered the direct costs and benefits accrued over a 3-year period and a range of transmission rates. At a 3-year transmission rate of 0.030, the screening and vaccination policy cost $7300 per case of hepatitis B avoided (or $345,800 per hepatitis B fatality avoided). At a more likely 3-year transmission rate of 0.271, the screening and vaccination policy cost $300 per case of hepatitis B avoided (or $12,100 per hepatitis B fatality avoided). Either way, the active prevention policy compares very well with the amounts of money spent by the US Government on other life-saving programs. A general cost-effectiveness model is given that can be adapted for institution-specific analyses at other mental health care facilities. *J Fam Pract 1991; 32:45-48.*

There are millions of mentally retarded (developmentally handicapped) citizens in the United States today; thousands are maintained in intermediate and long-term facilities. In 1982 the Ohio Department of Health Screening established guidelines for hepatitis B screening and vaccination in intermediate facilities.[1] These criteria were developed from the work of the Centers for Disease Control.[2] Research has confirmed a rate of hepatitis B as 4 to 20 times that of the general population.[3–9] In the spirit of recent research[9,10] that focused on cost-effectiveness issues in hepatitis B screening and vaccination, a research project was conducted to evaluate the Ohio guidelines from a cost-effectiveness perspective.

Included in the Ohio guidelines were recommendations for the use of a particular vaccine[1,11] for previously unexposed citizens. To identify the unexposed, a two-stage process was recommended. The first stage was a test for antibody to hepatitis B core antigen, indicating past disease. If negative, no further testing would be required, only the vaccine. If positive, no vaccination was required, but a screening test for hepatitis B surface antigen (looking for active disease) was recommended. A positive hepatitis B surface antigen test would be an indication of active disease, and treatment would be necessary. A negative test for surface antigen would indicate past (but not currently active) disease.

The focus of the present study was to begin to look at the cost-effectiveness of screening retarded citizens for hepatitis B and the use of the recommended vaccine in seronegative individuals. Given the wide variance of populations in different intermediate and long-term facilities across the country, it was decided to study one particular institution in detail and to provide a general cost-effectiveness model that practitioners at other institutions could easily adapt for their particular situation.

Methods

The study was undertaken in Champaign, Illinois, on a population of mentally handicapped citizens. The facility studied has 60 beds, 59 of which were filled at the time of the study. The severity ratings for mental status ranged from mild to profound. Multiple causes for impairment were noted. Some patients also had developmental handicaps. The group was of both sexes. The breakdown of subjects by sex and race was unremarkable (7 black; 24 female). Rooms prior to the study were all semiprivate. Meals were taken cafeteria-style. Sexual contact, includ-

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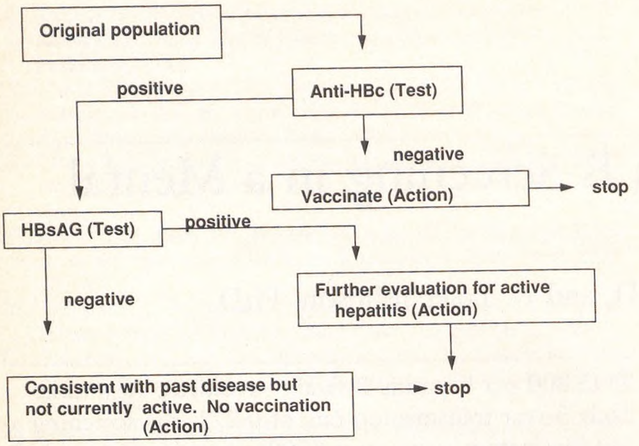

Figure 1. Strategy to screen for and vaccinate against hepatitis B in a group of developmentally handicapped residents of an intermediate care facility.

ing heterosexual and homosexual behavior, was not restricted (although not encouraged) in the facility.

The screening strategy is fully described in Figure 1. The equations given in Table 1 were used in comparing a screening and vaccination policy (ie, a policy conforming to the Ohio guidelines) with a hands-off policy of no screening or vaccination. These equations show how to calculate the direct costs, expected number of hepatitis B cases, and expected number of fatal hepatitis B cases associated with each of the two policies. Table 1 also contains the definitions of the variables used in the equations.

A 3-year period was chosen for the analysis because the vaccine is thought to be effective for at least 3 years.[11] All cost estimates were converted to 1988 dollars.

Using the definitions displayed in Table 1, the morbidity marginal cost-effectiveness ratio used for comparing the screening and vaccination strategy with the hands-off strategy is expressed as $(S_C - H_C)/(S_{HepB} - H_{HepB})$. The mortality marginal cost-effectiveness ratio is expressed as $(S_C - H_C)/(S_{Mort} - H_{Mort})$. Sensitivity analyses were performed by varying t (the transmission rate) and C_{HepB} (the direct cost of care for one case of hepatitis B), and then observing the effects of this variation on the marginal cost-effectiveness ratios.

Several simplifying assumptions have been made in this study. For instance, it was assumed that the screening tests are perfectly accurate, an assumption that has been made by others in past analyses.[9] Also, it was assumed that there are no side effects from the tests and vaccine. While there have been reports of minor, transient side effects, there have been no reports of serious consequences.[9,11,12] Several other assumptions will be addressed in the Discussion section of this paper.

Results

In the studied population of 59 persons (N = 59), 38 were negative at the initial screening ($n_{HBcn} = 38$). These patients were vaccinated after screening. The remaining 21 persons were positive for anti-HBc ($n_{HBcp} = 21$). This subpopulation showed 19 with nonactive disease; the other two persons were positive for active hepatitis and were treated. In the present study the cost of a hepatitis B core antigen test was \$28 ($C_{HBc} = 28$), the cost of vaccine was \$150 per person ($C_v = 150$), and the cost of the hepatitis B surface antigen test was \$20 ($C_{HBs} = 20$).

The 3-year transmission rate was approximated to be 0.087 ($t = 0.087$). This figure was obtained by simply converting the typical annual rate given by Mulley et al[9] into a 3-year rate. The vaccine effectiveness was taken to be 0.875 ($e = 0.875$).[11] The 3-year mortality rate was estimated at 0.021 ($m = 0.021$).[12] This estimate of m includes deaths caused by fulminant hepatitis and cirrhosis following hepatitis; because of the 3-year time frame of the analysis, this estimate excludes consideration of heptocellular carcinoma that might be attributable to hepatitis B.

The direct medical cost for a case of hepatitis B was estimated at \$608 ($C_{HepB} = 608$). This value was obtained by taking the base case cost estimate of \$454 from the 1982 article by Mulley et al[9] and then translating that figure into 1988 dollars at an inflation rate of 5%.

The estimates of the variables given above (and summarized in Table 1) provide for a base case analysis. Under this base case, S_C equals \$8024, H_C is \$2018, S_{HepB} equals 0.415, H_{HepB} is 3.318, S_{Mort} equals 0.009 and H_{Mort} is 0.070. The morbidity marginal cost-effectiveness ratio, therefore, is (8024 − 2018)/(0.415 − 3.318), meaning that the screening and vaccination policy costs about \$2100 for each case of hepatitis B avoided. Furthermore, the mortality marginal cost-effectiveness ratio equals (8024 − 2018)/(0.009 − 0.070); in other words, the screening and vaccination policy costs approximately \$98,500 for each avoided hepatitis B death.

Considering the extremely high incidence of hepatitis B in the mentally handicapped population, there is some question whether the transmission rate is actually 0.087. In the article by Mulley et al[9] transmission rates in institutions for the mentally retarded are reported in the range of 0.030 to 0.271. (The annual rates from Mulley et al are converted to 3-year rates here.) Other studies[3-8] indicate rates even higher than 0.271. A sensitivity analysis should thus include values for t that are varied over a range from 0.030 to 0.271. Another potentially informative sensitivity analysis is needed because our base case

Table 1. Definitions of Variables, Equations, and Base Case Values

Variable Definition (and Base Case Value)

N	Size of study population (59)
n_{HBcn}	Number of people with negative core antigen test results (38)
n_{HBcp}	Number of people with positive core antigen test results (21)
C_{HBc}	Cost of hepatitis B core antigen test ($28)
C_{HBs}	Cost of surface antigen test ($20)
C_v	Cost of recommended vaccine ($150)
C_{HepB}	Direct cost of caring for one case of hepatitis B ($608)
t	Three-year hepatitis B transmission rate* (0.087)
m	Three-year hepatitis B mortality rate (0.021)
e	Effectiveness of vaccine† (0.875)
S_C	Direct cost of screen and vaccinate policy
S_{HepB}	Expected number of hepatitis B cases under screen and vaccinate policy
S_{Mort}	Expected number of deaths due to hepatitis B under screen and vaccinate policy
H_C	Direct cost of hands-off policy
H_{HepB}	Expected number of hepatitis B cases under hands-off policy
H_{Mort}	Expected number of deaths due to hepatitis B under hands-off policy

Equations

$$S_C = (N)(C_{HBc}) + (n_{HBcn})(C_v) + (n_{HBcp})(C_{HBs}) + (t)(1-e)(C_{HepB})(n_{HBcn})$$

$$S_{HepB} = (t)(1-e)(n_{HBcn})$$

$$S_{Mort} = (S_{HepB})(m)$$

$$H_C = (t)(n_{HBcn})(C_{HepB})$$

$$H_{HepB} = (t)(n_{HBcn})$$

$$H_{Mort} = (H_{HepB})(m)$$

That is, t is the proportion of previously unexposed patients who will develop hepatitis B over a 3-year period.
†*For example, if e = 1, then the vaccine prevents all disease cases; if e = 0, then the vaccine is worthless for disease prevention.*

estimate of C_{HepB} is low compared with other values reported in the literature.[13] The median direct cost of caring for a case of hepatitis B reported in the article by Dandoy and Kirkman-Liff[13] is $2000. Adjusting this median value to 1988 dollars gives an estimate of $2553 for C_{HepB}. Table 2 presents the results of this two-way sensitivity analysis in which t and C_{HepB} were systematically varied.

Table 2. The Sensitivity of Cost-Effectiveness Ratios to Changes in Transmission Rate and Cost of Hepatitis B Care

3-Year Trans-mission Rate	Low Cost of Care ($608) Morbidity	Low Cost of Care ($608) Mortality	High Cost of Care ($2553) Morbidity	High Cost of Care ($2553) Mortality
0.030	$7300	$345,800	$5300	$253,200
0.059	3400	160,300	1400	67,700
0.087	2100	98,500	100	5900
0.115	1400	67,600	*	*
0.143	1000	49,100	*	*
0.169	800	36,800	*	*
0.196	600	28,000	*	*
0.221	400	21,300	*	*
0.246	300	16,200	*	*
0.271	300	12,100	*	*

Note: Ratios have been converted into 1988 dollars and rounded to the nearest $100.
**At these transmission rates, the screen and vaccination policy cost less and produced more health benefits than the nonintervention policy.*

Discussion

Even if the 3-year transmission rate is taken to be 0.030 rather than the more likely (according to the weight of the evidence in the literature) 0.271, the cost per life saved by the screening and vaccination policy is well within the range of values reported in the life valuation literature.[14,15] If the 3-year transmission rate is 0.087 or 0.271, then the screening policy is a bargain, compared with the amount the government spends on other life-saving programs.[14,15] Table 3 gives just a few examples of the amounts the government has spent per life saved. The values in the table are taken from Graham and Vaupel[15] and adjusted to 1988 dollars. Graham and Vaupel note that many of the environmental health programs sponsored by the government cost several million dollars per life saved. Therefore, even in the case wherein t and C_{HepB} are least favorable for the screening and vaccination policy, the cost per life saved is well within past governmental practice.

Certain assumptions were made in the cost-effectiveness model to avoid complicating an already convincing analysis. These assumptions are conservative in that they tend to make the screening and vaccination policy seem more expensive and less beneficial than it truly is: (1) the

Table 3. Examples of Mortality Cost-Effectiveness Ratios for Selected US Government Policies

Governmental Policy	Mortality Cost-Effectiveness Ratio ($)
Mandatory passive seatbelts	5600
Control of stationary air-pollution sources*	70,400
Dietary programs	143,500
Pertussis vaccine	422,100
Furniture flame retardant	562,800
55-mph speed limit	1,688,500
Control of acrylonitrile (2 ppm)	4,953,000
Control of benzene (97%)	72,000,000

Note: Examples taken from Graham and Vaupel,[15] then translated into 1988 dollars and rounded to the nearest $100.
**Based on the 1970 Clean Air Act.[15]*

occupational risk of contracting hepatitis B was set to zero, (2) the risk for visitors to the institution was set to zero, and (3) no adjustment was made for the pain and suffering associated with a case of hepatitis B.

It was assumed as well that all cases of death from cirrhosis following hepatitis (estimated from the work of Simon[12]) would occur within the 3-year period of this analysis. If this assumption is wrong, however, then it is not conservative. Still, sensitivity analysis shows this matter to be inconsequential for the conclusions of the present study. If, for example, one half of these cirrhosis deaths occur after the 3-year period, then the cost-effectiveness ratios reported in this study would double. Even with this extreme adjustment, the cost-effectiveness of the screening and vaccination strategy compares very well with the values reported in Table 3.

The present report ignores an option explored by Mulley et al.[9] They analyzed a strategy under which all patients would be vaccinated without first being screened. Analysis of this option revealed that under all variables studied, it always cost more and never produced more benefits than the screening and vaccination policy.

Researchers at other mental health institutions may find that their prevalence rates and costs differ drastically from those used here. In that case, the general cost-effectiveness model presented in this paper can be used for their institution-specific analyses.

In summary, the screening and vaccination strategy recommended by the Ohio Department of Health Screening for the prevention of hepatitis B proved cost-effective for the studied mental health institution.

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