Cost-effectiveness of hepatitis B vaccination of prison inmates
Pisu M, Meltzer M I, Lyerla R

Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology
Vaccination against hepatitis B virus (HBV) was studied.

Type of intervention
Primary prevention.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised a hypothetical cohort of prison inmates.

Setting
The setting was a prison. The economic study was carried out in the USA.

Dates to which data relate
The effectiveness data were obtained from studies published between 1980 and 1996. No dates for resource use were reported. The price year was 1998.

Source of effectiveness data
The effectiveness evidence was derived from published studies and the authors' assumptions.

Modelling
A decision tree model was constructed to evaluate the costs and benefits of the two strategies (vaccination versus no vaccination) in a hypothetical cohort of 1,000 inmates entering prison at age 25 years. A series of three doses of vaccine were administered, but only a fraction of inmates actually received all three doses. A proportion of individuals who were not protected by the vaccine or not vaccinated was infected during incarceration or after release. Recidivism was also modelled and the infected inmates developed symptomatic or asymptomatic disease, which could lead to death or chronic illness. The benefits of preventing secondary transmission to sexual partners or household contacts were not considered in the analysis.

Outcomes assessed in the review
The outcomes assessed from the published studies were:

the prevalence at intake;
the incidence during and after incarceration;

the percentages of inmates receiving one, two or three doses of the vaccine;

the vaccine protection rate after one, two or three doses;

the probability of release after 2, 5, 10 or 15 years;

the rate of recidivism in the first, second or third year from release.

In addition, the probabilities of acute disease and chronic liver disease were assessed. Acute disease included asymptomatic infection, symptomatic/hospitalised/fulminant/death, symptomatic/hospitalised/fulminant/no death, symptomatic/hospitalised/not fulminant, and symptomatic/not hospitalised. Chronic liver disease included chronic active hepatitis, chronic persistent hepatitis, cirrhosis and hepatocellular carcinoma.

**Study designs and other criteria for inclusion in the review**
The designs of the primary studies were not reported. A formal review of the literature was not performed.

**Sources searched to identify primary studies**
Not stated.

**Criteria used to ensure the validity of primary studies**
Not stated.

**Methods used to judge relevance and validity, and for extracting data**
Not stated.

**Number of primary studies included**
The effectiveness data were derived from 11 primary studies.

**Methods of combining primary studies**
A narrative method appears to have been used to combine the primary studies.

**Investigation of differences between primary studies**
Not stated.

**Results of the review**
The prevalence at intake was 20%.

The incidence rate was 1% during incarceration and 7% after incarceration.

Ten per cent of the inmates received one dose of the vaccine, 20% received two doses, and 70% received three doses.

The vaccine protection rate was 35% after one dose, 85% after two doses, and 95% after three doses.

The probability of release was 10% after 2 years, 27% after 5 years, 35% after 10 years, and 39.8% after 15 years.

The rate of recidivism was 18.6% in the first year from release, 17.4% in the second year, and 20.8% in the third year.
The probability values were 60% for asymptomatic infection, 0.13% for symptomatic/hospitalised/fulminant/death, 0.06% for symptomatic/hospitalised/fulminant/no death, 4.6% for symptomatic/hospitalised/not fulminant, and 35.2% for symptomatic/not hospitalised.

The probability values for chronic active hepatitis, chronic persistent hepatitis, cirrhosis and hepatocellular carcinoma were all 0.225.

**Methods used to derive estimates of effectiveness**
The authors made some assumptions that were used in the decision model.

**Estimates of effectiveness and key assumptions**
The main assumptions were:

- the mean age of the hypothetical inmate was 25 years;
- an individual could not become infected, inside or outside the prison, after the age of 45 years;
- the sentences spent in prison were 2, 5, 10 and 20 years;
- individuals spent at least one year outside prison before re-incarceration;
- the recidivists served a second sentence as long as the first one;
- those re-incarcerated for the third time served a life sentence;
- vaccinated inmates were not vaccinated again when re-incarcerated.

**Measure of benefits used in the economic analysis**
The benefit measure used in the economic analysis was the number of infections averted with the vaccination and no-vaccination strategies. It was obtained from the decision model. The two scenarios considered were infections occurred during incarceration (prison perspective) and infections occurred during and after incarceration (health care provider perspective).

**Direct costs**
A 3% discount rate was used since the costs were incurred in more than two years. The unit costs were not analysed separately from the resource quantities, but the unit cost of a vaccine dose was reported. The costs included in the economic evaluation were for the vaccine dose and the treatment of acute disease and chronic liver disease. The costs to the prison, such as security during hospitalisation and the transportation of inmates to the hospital and medical providers, were not included. The prison perspective considered only those costs that were incurred while the inmates were incarcerated, while all the costs (regardless of when they occurred) were considered under the perspective of the health care system. Several assumptions were made in order to evaluate resource consumption. The costs of disease were estimated from a study by Margolis et al. (see Other Publications of Related Interest). The price of the vaccine was assumed to be $40. The costs were updated to 1998 prices using the medical care component of the Consumer Price Index.

**Statistical analysis of costs**
The costs were treated deterministically in the base-case.

**Indirect Costs**
The indirect costs were not considered.
Currency
US dollars ($).

Sensitivity analysis
Sensitivity analyses were conducted to evaluate the robustness of the estimated cost per infection averted to variations in prevalence at intake, cost of the vaccination ($40, $30 and $20 per dose) and vaccine series completion (all inmates receiving one dose of vaccine versus all inmates receiving three doses of vaccine). Threshold analyses were also performed to find the value of inputs above or below which the vaccination strategy was cost-saving with respect to the no-vaccination option. Inputs such as the cost of symptomatic cases or chronic liver disease, discount rate, vaccine dose cost, incidence of HBV during and after incarceration, and prevalence at intake, were considered. The impact of all inputs related to recidivism was estimated. Finally, scenarios in which all inmates remained in prison for life, or stayed for a short-term and never returned, were examined.

Estimated benefits used in the economic analysis
In the cohort of 1,000 prison inmates, under the prison scenario, there were 10 infections with vaccination and 75 with no vaccination.

Under the health care provider scenario, there were 30 infections with vaccination and 230 with no vaccination.

Cost results
In the cohort of 1,000 prison inmates, under the prison scenario, the total costs were $116,000 with vaccination and $89,000 with no vaccination.

Under the health care provider scenario, the total estimated costs were $137,000 with vaccination and $255,000 with no vaccination.

Synthesis of costs and benefits
An incremental cost-effectiveness analysis was carried out to combine the costs and benefits of the two vaccination strategies. The incremental cost per infection averted with the vaccination programme, compared with the no-vaccination option, was $415 under the prison scenario. The vaccination programme was dominant (more effective and cheaper) under the health care provider scenario. This conclusion held under the different scenarios considered in the sensitivity analysis. In particular, in the case of low rates of prevalence and low costs of vaccine, the vaccination programme was cost-saving even from the perspective of the prison.

Authors’ conclusions
The vaccination programme against hepatitis B virus (HBV) was cost-saving from the perspective of the health care system. The authors, therefore, believe that the costs of the intervention should be borne by the health care system rather than by the prison, for whom the programme not only leads to more benefits but also to increased costs. The authors estimated that, if all 381,646 prison inmates in 1998 with sentences longer than one year were vaccinated, then the cost-savings to the health care system would be approximately $45,000,000 over 20 years.

CRD COMMENTARY - Selection of comparators
The rationale for the choice of the comparator was clear. The option of no vaccination was selected as it represented the current practice in most prisons in the USA. It was also chosen to evaluate the active value of the vaccination strategy. Details of the type of vaccine were not reported. You should decide whether it represents a valid comparator in your own setting.
Validity of estimate of measure of effectiveness
The effectiveness analysis used data that were derived mainly from published studies. However, a formal review of the literature was not undertaken and details of the primary studies (e.g. design, study population, time horizon) were not given. The primary study estimates were combined using narrative methods, but it was not clear whether the authors took the impact of differences in the primary studies into consideration when combining the effectiveness estimates. The authors also made some assumptions to construct the decision model and to define incarceration patterns. Most of the estimates used in the decision model were investigated in the sensitivity analysis. The analysis did not consider the impact of vaccination on secondary transmission. The authors stated that this factor would further enhance the beneficial effects of the vaccination strategy. The authors also noted that the impact of inmate mortality arising from causes other than HBV was not considered, and that this may have had a negative effect on the estimated benefits of the vaccination programme.

Validity of estimate of measure of benefit
The benefit measure was the number of HBV cases averted among the cohort of prison inmates. This was obtained using the decision model, which was described in detail and reported graphically in the article. This measure represents the natural end point of the vaccination programme, but its use means that it could be difficult to compare the benefits of the study intervention with those obtained with other vaccination programmes implemented by the health care system.

Validity of estimate of costs
Two perspectives were adopted in the economic evaluation. It appears that all the relevant categories of costs have been included and analysed accordingly. The authors admitted that some prison costs were not included in the analysis. The unit costs and the quantities of resources used were not analysed separately. In addition, the cost of the vaccine was based on an assumption. The remaining categories of costs were derived from a published study. Resource use was also estimated on the basis of assumptions. The price year was reported, thus making reflation exercises in other settings feasible. The costs were treated deterministically in the base-case, but sensitivity analyses were carried out on several cost inputs. Threshold analyses were also performed. The indirect costs were not included, but the authors stated that their inclusion would have favoured the vaccination option.

Other issues
The authors compared their findings with those from other studies evaluating the cost-effectiveness of HIV vaccination programmes in prison. The authors stated that comparisons with other interventions were unfeasible because most analyses did not focus on the perspective of the prison. The issue of the generalisability of the study results to other settings was not addressed and the external validity of the analysis was low. This was also due to the use of US-specific data. The authors noted some limitations of their study, which were mainly related to the lack of reliable data. However, conservative assumptions were made and extensive sensitivity analyses were carried out to evaluate the robustness of the study results.

Implications of the study
The study results suggest that "the health care system as a whole is more likely than the prison system to benefit from vaccinating inmates entering prison against hepatitis B". Thus, further collaboration between the prison and society health care systems would provide economic benefits for society and advantages for the prison. The authors noted that an important finding of the analysis is that vaccination may be cost-saving from the perspective of the health care system, even if only one dose of vaccine was administered. This result is of particular importance for the vaccination of inmates who stay in jail for less than one year.

Source of funding
None stated.