Effectiveness and Cost Comparison of Two Strategies for Hepatitis B Vaccination of Schoolchildren

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ABSTRACT

Context: In 1994, immunization against hepatitis B was implemented in schools in Quebec, targeting grade 4 students. In 1996-1997 and 1997-1998, one Local Community Service Centre (CLSC) replaced the school-based program in its district with vaccination offered in community clinics after school hours. The aim of the current study was to compare the effectiveness and costs of school-based and clinic-based programs.

Methods: Vaccination coverage data were collected in the CLSC with the clinic-based program (CBP), and in three matched CLSCs with a school-based program (SBP), from 1994 to 2000. Surveys were conducted to estimate costs to parents, to schools and to CLSCs in 1997-1998.

Results: With the implementation of the CBP, the vaccination coverage fell to 73%, compared with over 90% in the SBPs. Coverage increased to 90% when the CBP was abandoned. Costs to the CLSC were not much lower in the CBP. Societal costs were $63 per student vaccinated in the CBP, and ≤$40 in the SBPs.

Conclusion: Results demonstrate the advantage of a SBP over a CBP for the immunization of schoolchildren.

La traduction du résumé se trouve à la fin de l'article.

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In 1994, a school-based hepatitis B vaccination program targeting grade 4 students was implemented in the Province of Quebec.[1] School nurses from Local Community Service Centres (CLSC) provide vaccination during school hours in all schools in their territory. In 1996, for organizational reasons, the authorities of one CLSC in the Montérégie Health Region decided to offer vaccination at special vaccination clinics after school hours. When this decision was made, it was assumed that costs to the health system would be reduced, and that coverage of the target population would be minimally affected.

Many studies, mostly descriptive, have examined school-based hepatitis B vaccination for its feasibility or practical aspects,[2-7] and some economic analyses looked at the costs of hepatitis B vaccination for different populations.[8-14] Only two studies examined costs of school-based vaccination programs, and both were on hepatitis B vaccination.[15,16] One study found the cost per dose of a school-based program to be significantly less than that of a HMO-based program; however, vaccine coverage was not measured in this study.[15] The second study found the costs of a school-based hepatitis B vaccination program to be lower than administration during regular health visits (estimated in another economic evaluation).[11,16] Review of the scientific literature found little evidence of the effectiveness of school-based strategies for improving vaccine uptake other than laws or regulations requiring vaccination for school entry.[17-20]

Starting from the quasi-experiment conducted by one CLSC in Montérégie, we performed a study aimed at comparing the effectiveness and costs of a community clinic-based program (CBP) versus a school-based program (SBP) for vaccinating school-aged children against hepatitis B.

METHODS

Study population

Montérégie is the second largest of the 18 health regions in the Province of Quebec. Public health services are provided by 19 CLSCs. From the beginning of the provincial immunization program against hepatitis B in 1994, Grade 4 students were eligible and immunization was offered at

school during school hours. Parents were contacted via letters sent from school with information on the hepatitis B vaccination program and consent forms. Follow-up phone calls were done by school nurses for children not having the returned consent forms. No hepatitis B vaccine was provided by physicians in the region.

In 1996, one CLSC in the region, in agreement with the local school board, decided to offer vaccination by appointment at three different times for each dose: two on Saturdays between 9 am and 4 pm at one community site and one on Wednesday nights between 4 and 9 pm at another community site. Parents were contacted via letters from school. Children had to be accompanied by an adult at the time of vaccination. Consent was obtained during the first dose appointment. Parents of children who had not received the first dose or missed an appointment were contacted by phone for a catch-up visit appointment. Recalls were also done before clinics.

This clinic-based program affected two cohorts (1996-1997 and 1997-1998) of approximately 1,000 students each in 18 schools. When preliminary results from this study were available, in 1998, it was decided to return to the school-based strategy. For the 1997-1998 school year, we used a quasi-experimental design for comparison of vaccination coverage and costs that were measured in the territory with a clinic-based program (C-CLSC), and in 3 other territories in the region with a school-based program (S-CLSC 1 to 3). The control group selected was the 3 CLSCs in Montérégie providing the best match for a set of six sociodemographic variables, and using the method of the lowest distance proposed by Matusita.[21] Demographic data were obtained from the 1996 census. Table I describes the study populations.

TABLE I

Study Population in the Four CLSCs in the Montérégie Region (Quebec)

Characteristic	C-CLSC†	S-CLSC 1‡	S-CLSC 2‡	S-CLSC 3‡
Total population (all ages)§	77,040	109,295	76,875	55,300
Population density/km²§	1221.9	1919.1	338.7	383.3
Percentage of population with low income§	12.6	12.5	10.2	8.5
Number of primary schools‖	18	24	15	16
Number of Grade 4 students‖	1054	1441	1211	781
Percentage of Grade 4 students vaccinated in 1995-1996	86	92	91	91

† C-CLSC with a clinic-based vaccination program in 1996-1997 and 1997-1998, but a school-based program in 1994-1995, 1995-1996, 1998-1999 and 1999-2000
‡ S-CLSCs with a school-based vaccination program from 1994 to 2000
§ 1996 Canadian census
‖ School cohort eligible for hepatitis B vaccine program, 1997-1998 data obtained from school nurses from CLSCs

Vaccination coverage

The proportion of children receiving three doses of hepatitis B vaccine was used as an indicator of program effectiveness. Rates of seroprotection (defined as anti-HB levels ≥ 10mUI/ml) are 99% in 9-year-old children who received three pediatric doses of hepatitis B vaccine.[22] Data on the number of students targeted and the number who received the 3-dose schedule in 6 successive cohorts from 1994 to 2000 were provided by the person in charge of the hepatitis B immunization program in each CLSC.

Costs

Program costs were assessed from a societal perspective and included direct and indirect costs to parents, to schools, and to CLSCs.[23] Only costs that may differ in a school-based or clinic-based strategy were considered. Therefore, vaccine purchase costs and management costs supported by the Ministry of Health and by the Regional Department of Public Health were not measured. For the same reason, after-care time required by the parents, e.g., due to vaccine-adverse events, was not measured.

Three data sources were used to estimate vaccine administration costs in 1997-1998, corresponding to the second year of the CBP. *i) Costs to the CLSC*: a self-administered questionnaire was completed in June 1998 by the person responsible for hepatitis B vaccination in each CLSC. Costs included were staff salaries, volunteer workers' time, and running expenses (travel, phone calls, meals, etc.). *ii) Costs to schools in the SBP*: a postal self-administered questionnaire was completed in May 1998 by school principals from a random sample of 24 schools (8 for each CLSC) stratified by school size. Costs included were staff time for the program, volunteer workers' time and extra charges for photocopies, etc. Response rate was 71% (17/24). *iii) Costs to parents*: a self-administered questionnaire was completed during the 15-minute post-vaccination observation period by parents who came with their child for the third dose of vaccine in April 1998. Parents were asked about transportation costs, babysitting costs and time lost from work and daily activities to bring their child to the clinic. Response rate was 90% (694/772).

For costs borne by parents, actual costs were used when available, or estimated by using substitution costs or available salary scales. The average cost to parents of a clinic visit was estimated using: i) transportation costs (using the CAA-Quebec norm of 35¢/km) for parents who came to the vaccination clinic by car, and by using actual costs for parents who came by bus or taxi; ii) babysitting costs for parents who paid money for babysitting for the clinic visit; iii) costs for time lost for all parents who took their child to the clinic; iv) costs for time lost for parents who lost work time, in excess of the time considered in iii) e.g., time needed to go back and forth from work to home to take the child to the clinic. Work time and parental time were valued at the current hourly minimum wage of $6.80 in Quebec. In the CBP, the average cost for a single clinic visit was multiplied by 3 for 3 doses, and applied to the vaccine-covered population. In the SBP, the average cost for a single clinic visit was applied to the small proportion of the population requiring a catch-up visit. In fact, only a few students missed one of the scheduled doses (for instance, because they were sick on the day of vaccination). Therefore only a small proportion needed a catch-up visit. Except for the volunteer work in the CBP, actual CLSC costs were reported. Time for volunteer work was valued at the minimum wage. Costs for schools were calculated using the average wage from provincial scales for each employment category. For other expenses, actual costs were reported. Volunteer work was again calculated at minimum wage.

No statistical analyses were conducted considering the limited number of observation units (one subject in the CBP and three in the SBP), and because we were in presence of all the population rather than a sample.

TABLE II

Costs of Grade 4 Hepatitis B Vaccination Program in the Four CLSCs in the Montérégie Region (Quebec), School Year 1997-1998

Characteristic	C-CLSC†	S-CLSC 1‡	S-CLSC 2‡	S-CLSC 3‡
Costs to CLSC ($)	21,319	34,669	22,260	23,585
Costs to schools ($)	–	8795	5497	5863
Costs to parents ($)	27,188	763	47	540
Total program costs ($)	48,507	44,227	27,804	29,988
Number of students completely vaccinated§	772	1324	1121	743
Vaccination coverage (%)	73	92	93	95
Mean costs to CLSC ($/student vaccinated)	27.61	26.18	19.86	31.74
Mean costs to schools ($/student vaccinated)	–	6.64	4.90	7.89
Mean costs to parents ($/student vaccinated)	35.22	0.58	0.04	0.73
Unit costs ($/student vaccinated)	62.83	33.40	24.80	40.36

† Clinic-based program
‡ School-based program
§ 3 doses of hepatitis B vaccine administered

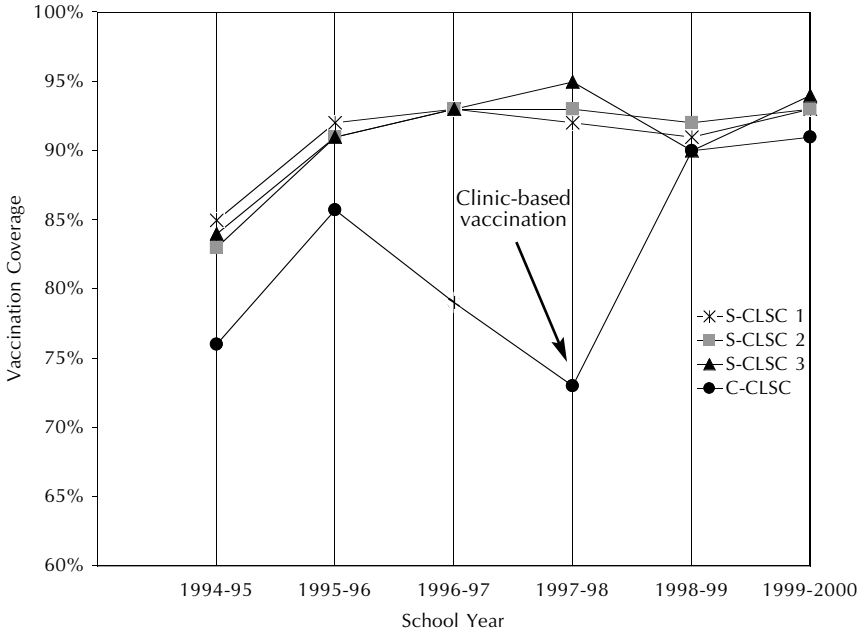

Figure 1. Vaccination Coverage* Against Hepatitis B in the Four CLSCs in Study, School Years 1994-1995 to 1999-2000

* Three doses of vaccine. No data are available for year 1996-1997 in C-CLSC.

Legends
S-CLSC : School-based program from 1994 to 2000
C-CLSC : Clinic-based program in 1996-1997 and 1997-1998, but a school-based program from 1994 to 1996 and from 1998 to 2000

RESULTS

Vaccination coverage

Vaccination coverage of grade 4 students in the 4 CLSCs during the school years 1994-1995 to 1999-2000 is shown in Figure 1. In the 3 CLSCs using a school-based approach, vaccination coverage was 85% or less in the first year of the program, and increased to over 90% in the following years. Vaccination coverage was somewhat lower in the C-CLSC during the first two years of the program, and a marked decline (73%) was observed after implementation of CBP. When the SBP was resumed in 1998-1999, coverage increased immediately to reach figures close to those in the control group.

Vaccination costs

Estimates of program costs in the 4 CLSCs in the school year 1997-1998 are presented in Table II. Costs to CLSCs were slightly lower with the CBP than with the SBP. There was no cost to the school in the C-CLSC, and costs to schools represented approximately 25% of the costs to CLSCs in the control group. In the C-CLSC, 93% of parents came to the vaccination clinic by car, 2% by bus or taxi, 3% had to pay for babysitting, and 2% had to take time off work. The mean direct costs to parents per vaccine administration were $3.06 (transportation and babysitting), and indirect costs were valued at $8.68, for a total of $11.74. With the SBP, costs to parents were minimal, and were mostly associated with catch-up visits to the CLSC for children who did not receive one dose at school. Because vaccination coverage in the C-CLSC was much lower than in the control group, the average societal cost to vaccinate a child was about twice as high in the CBP than in the SBP.

DISCUSSION

The results of this study demonstrate the advantage of a school-based strategy for immunization of schoolchildren against hepatitis B. Reduction of costs to the CLSC was minimal with the CBP, and total societal costs were much higher with the CBP than with the SBP, driven mostly by parental costs. Furthermore, decreased accessibility had a dramatic effect in reducing vaccination coverage to an unacceptably low level of 73%.

Our findings are consistent with those of a study comparing the costs of a school-based hepatitis B vaccine delivery program with those of a vaccine delivery program associated with a network health maintenance organization (HMO) in Denver, Colorado.[15] Total costs per dose were $31 for the school delivery system, and directs costs were $68 in the HMO network, increasing to $118 when parental work absenteeism was taken into account. However, the effect of the two strategies on vaccination coverage was not measured in this study. To our knowledge, this is the first time the effect of differential vaccine accessibility in a SBP versus a CBP has been rigorously assessed quantitatively. In the study on a school-based program in Kansas City, 82% of students received a complete hepatitis B vaccination, but data were available for only 73% of them. No control group was used, and a comparison was done with the vaccine coverage of 8%, probably previously assessed on other cohorts of students.[16]

In the present study, costs estimates were based on questionnaires completed by parents (90% response rate), by program coordinators in CLSCs, and by school

principals (71% response rate, which is higher than the response rate of 64% achieved in a study using a comparable methodology).[16] Some degree of imprecision and bias could not be excluded in our cost study because some data were collected retrospectively. If costs were missed in the CBP, it would reinforce our results in favour of a SBP. On the other hand, if costs were omitted in the SBP, they would have to be very significant to fill the large gap between SBP and CBP, and then reverse our conclusions. However, costs to CLSCs for vaccine administration in schools ranged from $22 to $35 per dose, which is close to the figure of $33 (Canadian) measured in a study of a hepatitis B vaccination program for grade 6 students in British Columbia in 1994.[10] Some items related to vaccine promotion were taken into account in the British Columbia study but not in the Quebec study. In our study, the replacement cost for the time parents spent at the CLSC clinic was based on minimum wage, which is a conservative approach. The use of the Canadian mean income to value this item would have increased the societal advantage of the school-based program.

We also preferred a conservative approach for estimation of actual cost per fully immunized child because costs for children who received only one or two doses were not considered. In fact, costs relative to the vaccination of children who received one or two doses must have been included in the costs to the CLSCs and schools, then overestimating the costs per child fully immunized in the SBP, while they were not included in the costs to the parents in the CBP. Parents who came with their child for the first or second dose of vaccine, and did not complete the schedule might have more problems dealing with the vaccination clinic (i.e., babysitting, missing work). However, overestimation of costs in the SBP and underestimation of costs in the CBP would reinforce our conclusion in favour of a SBP.

In the late 1990s in Quebec, there was a debate on the merits of the school-based strategy for the hepatitis B immunization program, and alternatives were considered for vaccine delivery. The results of this study sent a clear message regarding the low effectiveness and efficiency of a CBP, and the SBP is no longer questioned. In the future, however, new combination vaccines may render an infant immunization strategy more attractive than the present schoolchildren strategy for the prevention of hepatitis B in Canada.

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RÉSUMÉ

Contexte : Un programme de vaccination contre l'hépatite B existe au Québec depuis 1994 où les élèves de 4e année sont vaccinés à l'école. En 1996-1997 et 1997-1998, un Centre local des services communautaires (CLSC) a remplacé le programme scolaire dans son territoire par la vaccination offerte lors de cliniques communautaires spéciales, après les heures de classe. Le but de cette étude était de comparer l'efficacité et les coûts sociétaux du programme de vaccination offert à l'école et celui lors de cliniques communautaires.

Méthode : L'étude fut réalisée dans le CLSC offrant la vaccination en clinique (VC) et dans trois CLSC appariés offrant la vaccination en milieu scolaire (VS). Les couvertures vaccinales furent comparées de 1994 à 2000. Des enquêtes furent menées pour décrire les coûts assumés par les parents, les écoles et les CLSC pour l'année 1997-1998.

Résultats : La couverture vaccinale obtenue par la VC en 1997-1998 a chuté à 73 % alors qu'elle était supérieure à 90 % dans le groupe contrôle. Le taux de vaccination a augmenté à plus de 90 % lorsque la VC a été abandonnée. La VC n'a pas entraîné de réduction importante des coûts pour le CLSC. Le coût sociétal par élève vacciné par la VC a été de 63 $, mais ≤40 $ avec la VS.

Conclusion : Ces résultats démontrent les nets avantages d'offrir la vaccination en milieu scolaire.