The human papillomavirus vaccination: a review of the cost-effectiveness studies

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Abstract

Background. The Human Papillomavirus (HPV) is one of the most common sexually transmitted viruses, its infection with certain subtypes is the primary cause of cervical cancer. Several countries conducted specific cost-effectiveness evaluations toward HPV vaccination. The constant growth of healthcare demand, in an economic context characterized by limited resources, requires that the decision-making process be based on the comparison of alternative choices. This study offers an overview of the published cost-effectiveness studies about HPV vaccination.

Bibliographic Retrieval Method. The research was performed on the scientific databases MEDLINE and SCOPUS in order to find out journal articles focused on cost-effectiveness of the HPV vaccination. The rational for any exclusion criteria of data in the search is mainly due to lack of relevance to cost-effectiveness information.

Results. The literature results were presented according to different groupings of countries worldwide. A total of 24 articles were finally retrieved. In spite of the different models and assumptions, most studies showed the cost-effectiveness of vaccination; only two studies considered the vaccination as not cost effective.

Conclusion. HPV vaccination may determine a cost reduction for country-specific National Health Systems. However, the cost-effectiveness of universal HPV vaccination still remains an open debate. It is important that economic analysis of universal HPV vaccination adopts large perspectives than is the case with the existing literature, focusing on the critical issues that still exist in many areas. Reducing cost, increasing duration of efficacy, and integrating vaccines into existing screening and treatment procedures in a cost-effective manner are of crucial importance even as they are a major challenge. Clin Ter 2014; 165(6):e426-432. doi: 10.7417/CT.2014.1787

Key words: cervical cancer, cost-effectiveness, decision-makers, Human Papillomavirus, HPV vaccination, prevention

Background

The Human Papillomavirus (HPV) is one of the most common sexually transmitted viruses. The chronic infection with certain subtypes of HPV is the primary cause of cervical cancer and its precancerous lesions. At least 50% of the adult population is infected with this virus during their lifetime (1-3).

HPV has been overwhelmingly associated with cervical cancer, the incidence of this malignancy is deemed as surrogate indicator of HPV infection: this can easily be justified because the worldwide HPV prevalence in cervical cancer has been estimated between 85 and 99% (4). Cervical cancer is the third most common cancer in women, and the seventh overall. According to International Agency for Research on Cancer (IARC) more than 85% of the global burden occurs in developing countries, where it accounts for 13% of all female cancers. Screening has resulted in significant decrease in the incidence in developed countries whereas in developing countries the results have been marginal. High-risk regions are Eastern and Western Africa (Age Standardized Rates [AGR] greater than 30 per 100,000), Southern Africa (26.8 per 100,000), South-Central Asia (24.6 per 100,000), South America and Middle Africa (ASRs 23.9 and 23.0 per 100,000 respectively). Rates are lowest in Western Asia, Northern America and Australia/New Zealand (ASRs less than 6 per 100,000). Cervical cancer remains the most common cancer in women only in Eastern Africa, South-Central Asia and Melanesia (5).

Infection with one of the few oncogenic HPV types is a necessary cause of invasive cervical cancer; more than 118 different HPV types have been isolated and sequenced, about 40 of these are known to infect the genital tract and 12 are classified as carcinogens (6). Prophylactic HPV vaccines offer a promising way to prevent cervical cancer and other HPV related cancers both in the developed and in the developing countries. Two HPV vaccines have been pre-qualified by the World Health Organization (WHO) and approved by national governments in many countries: a bivalent vaccine (BV) that protects against infection with two HPV types (16 and 18) causing 70% of cervical cancer cases worldwide, and a quadrivalent vaccine (QV) that protects against HPV types 16 and 18, but also against two HPV types (6 and 11) which cause almost all cases of anogenital warts (GW) (7). The WHO recommends a 3-dose vaccine schedule, compre-
The cost-effectiveness of HPV vaccination

The constant growth of healthcare demand, in an economic context characterized by limited resources, requires that the decision-making process be based on the comparison of alternative choices. Several countries conducted specific cost-effectiveness evaluations on HPV vaccination; the WHO recommends that the cost-effectiveness of HPV vaccination is established before it is offered as part of national vaccination programmes (9). The aim of this study is to provide an overview of the published literature on the cost-effectiveness studies in the different countries.

Bibliographic Retrieval Method

The literature research was performed on the scientific databases MEDLINE (including Medline, Medical Literature analysis and Retrieval System Online) and SCOPUS in order to find out journal articles focused on cost-effectiveness of the HPV vaccination.

The identification of eligible articles was carried out analyzing the title and abstract of the articles yielded by the search; the full text of all the potential papers was retrieved and read in order to identify the final works to be consider for the review. The research was restricted to the English language and has been updated to September 2014. The rational for any exclusion criteria of data in the literature search is mainly due to lack of relevance to cost-effectiveness information.

Type of indicators

Nowadays, the availability of health care interventions exceeds considerably society’s capacity to pay for them. Cost-effectiveness analysis is a method to analyze the costs and consequences associated with health-related technologies, services, and programs. This method incorporates and complements evidence of effectiveness. Cost-effectiveness analysis compares the costs of interventions per health outcome achieved (e.g., “cost per case identified” or “cost per life year gained”). Cost-utility analysis (CUA) is a specific type of cost-effectiveness analysis in which results are expressed as “cost per quality-adjusted life year” (QALY) (10), that is the net resource costs of an intervention per year of life saved. With the increasing cost of vaccine products, cost-effectiveness analyses are needed to justify new programs, especially because long-term, recurrent expenditures are involved. Although not always cost-saving, immunization programs generally compare well with other health interventions (11, 12). In the cost-effectiveness analysis the use of incremental cost-effectiveness ratio (ICER) is recommended, an health economics equation to provide a practical approach to decision making regarding health interventions. ICER is the ratio of the change in costs to incremental benefits of a therapeutic intervention or treatment (13).

Results

The searches were presented according to different groups of countries worldwide.

Extra European countries

In the United States (US), HPV vaccine administration occurs mainly through pediatric and family medicine primary-care providers; a publicly funded program “Vaccines for Children” provides vaccine at no charge to children aged ≤18 years who are uninsured or meet eligibility criteria. Coverage rates have increased each year since the introduction in 2006 (14). Chesson et al. (15) found the cost per QALY gained by adding routine vaccination of 12-year-old girls to existing screening practices ranged from US$ 3,906 to US$ 14,723 under base-case parameter values (depending on the model version applied) and depending on factors assumed: herd immunity, HPV types targeted by the vaccine, and whether the benefits of preventing anal, vaginal, vulvar, and oropharyngeal cancers were included. In the best and worst case scenarios (when all the parameters were set to values more favorable and less favorable to vaccination, respectively), the cost per QALY gained was lower than US$ 0 and up to US$ 122,976, respectively. Another study (16) includes the effectiveness of HPV vaccination for women older than 30 years who are screened; the benefits seem to be small. Compared with current screening that uses sensitive HPV DNA testing, HPV vaccination is associated with less attractive cost-effectiveness ratios in this population than those for other, well-accepted interventions in the US. On the assumption of lifelong immunity for vaccination, the cost-effectiveness ratio of vaccination of 12-year-old girls was US$ 43,600 per QALY gained, as compared with the current screening practice. Should immunity wane after 10 years, the cost of vaccination of preadolescent girls exceeded US$ 140,000 per QALY, and catch-up strategies were less cost-effective than screening alone (17).

As well as in US, in Canada, HPV vaccine has been available since 2006. School-based HPV vaccination programs delivered by public health agencies began in 2007, and all provinces and territories had publicly funded programs in place by 2009. Year of introduction, target age groups, and dosing schedules varied across provinces and territories; however, all offered HPV vaccine, free of charge, to girls in at least one of grades 4 to 9 (ages 9-15 years). Ten of the 13 jurisdictions offered the vaccine to more than one grade as part of a time-limited catch-up program (18,19). Vaccinating 12-year-old girls against by BV and QV is estimated to cost the health provider CAN$ (Canadian Dollars) 31,000 and CAN$ 21,000 per QALY-gained, respectively. Results were most sensitive to age at vaccination, duration of vaccine protection, vaccine cost and QALY-lost due to GW, and were least sensitive to the medical costs. Using CAN$ 40,000 per QALY-gained as strong evidence for cost-effectiveness, HPV vaccination is estimated to be cost-effective under a wide range of parameter assumptions and vaccination scenarios. The main benefit of vaccination will consist in reducing cervical cancer mortality. However, unless screening is modified, the treatment costs saved through vaccination will be insignificant compared to the cost of HPV immunization (20).
Quadrivalent HPV female vaccination can be a cost-effective public health intervention that can substantially reduce the burden of cervical diseases and GW in Brazil. The model projected that the vaccination would reduce the incidence rates of HPV 6/11/16/18-related cervical cancer, Cervical Intraepithelial Neoplasia (CIN1), CIN2/3, and female GW by 94% to 98% at year 100. Routine vaccination in combination with a catch-up vaccination could prevent approximately 163,000 cases of cervical cancer, 48,000 deaths from this malignancy, 2.3 million cases of CIN 2/3, and 11.4 million GW in the next 50 years. The ICER for female vaccination strategies ranged from US$ 219 to US$ 450 per QALY gained (21).

In the Taiwanese setting, the ICER was US$ 23,939 per life year gained or US$ 13,674 per quality-adjusted life year (QALY) gained given the discount rate of 3%. HPV mass vaccination using the BV was estimated to dominate vaccination using the QV. The model estimated that the BV led to an additional, undiscounted, 11,484 CIN 1, 1,779 (+34.3% respect to QV) CIN 2/3, 188 (+29.0% respect to QV) CC, and 69 (+29.0% respect to QV) CC deaths prevented compared with the QV, while the QV prevented 4,150 genital wart (+71%). This resulted in an additional 768 QALY and 11.6 million new Taiwan dollars costs saved for the BV versus the QV after discounting (22, 23).

A Markov model is used to simulate the natural history of HPV infection in a cohort of Mexican women to evaluate the cost-effectiveness of the cervical cancer screening strategy: using only vaccination (US$ 45 for three doses) as a preventive measure was a very cost-effective strategy. The QV could reduce the probability of persistent HPV-16/18 infection by at least 60%, which would result in a near-proportional reduction in HPV-16/18-associated invasive cervical cancer and CIN 3. The strategy of vaccination with traditional screening of Pap test every 3 years produced higher cost by a lower performance of cervical cytology, at a cost of US$ 15,935 per life-year. The cost-effectiveness of the vaccination strategy was highly sensitive to age of vaccination, duration of vaccine efficacy, and cost of vaccination. The results of this study could be of great value in decision-making for the implementation of an HPV vaccine as a public health policy in Mexico provided that the cost of each dose will be, at most, US$ 15, combined with HPV testing, the new strategy of national secondary prevention program (24).

The ICER of adding HPV vaccination to the screening programme in South Africa (25) ranged from US$ 1,078 to US$ 1,460 per QALY gained and US$ 3,320 to US$ 4,495 per life year saved, mainly depending on whether the study was viewed from a health service or a societal perspective. Using discounted costs and benefits, the threshold analysis indicated that a vaccine price reduction of 60% or more would make the vaccine plus screening strategy more cost-effective than the screening only approach.

In India, if high coverage of pre-adolescent girls with a low cost HPV vaccine that provides long-term protection is achievable, vaccination followed by screening three times per lifetime is expected to reduce cancer deaths by half, and be cost-effective. Assuming 70% of coverage, mean reduction in lifetime cancer risk was 44% (range, 28-57%) with BV alone, and 21-33% with screening three times per lifetime. Combining vaccination and screening three times per lifetime provided a mean reduction of 56% (vaccination plus 3-visit conventional cytology) to 63% (vaccination plus 2-visit HPV DNA testing). At a cost per vaccinated girl of US$ 10 (per dose cost of US$ 2), pre-adolescent vaccination followed by screening three times per lifetime using either visual inspection with acetic acid or HPV DNA testing, would be considered cost-effective using the country’s per capita gross domestic product (GDP, US$ 3,452) as a threshold (26).

Although cervical cancer is a frequent cancer in women worldwide, its reported incidence is low in Saudi Arabia, ranking number 12 between all cancers in females and accounts only for 2.4% of all new cases, despite the lack of national screening programs. The high cost of the vaccine would make it not cost-effective in the Kingdom of Saudi Arabia and a preliminary evaluation would suggest that there is no reason to institute either screening or vaccination if Saudi Arabia truly has such a low incidence of cervical cancer (27).

The quadrivalent HPV vaccine is not cost-effective in Iran. The model compared the cohort of all 15-year-old girls alive in the year 2013 with and without vaccination. The cost per QALY, which was found based on the assumption for the vaccination of 15-years old girl to current situation was 439,000,000 Iranian Rial rate (IRR) (US$ 16,475). By considering the key parameters in the sensitivity analysis, value varied from 251,000,000 IRR (US$ 9,420) to 842,000,000 IRR (US$ 31,600) (28).

The cost-effectiveness analysis of different human papillomavirus vaccines in Singapore, showed for the BV, the prevention of 197 cancers with an ICER of SGS (Singapore Dollars) 12,827 per life-year saved. Comparing the BV to the QV, the ICER was SGS 12,488 per life-year saved. However, the cost per QALY saved for the QV compared to no vaccine was SGS 9,071, while it was SGS 10,392 for the BV, with the QV dominating the BV due to the additional QALY effect from reduction in genital warts (29).

Reductions in vaccine price will greatly improve cost-effectiveness in New Zealand (NZ). The current HPV vaccination programme has an estimated cost-effectiveness of NZS (New Zealand Dollars) 18,800/QALY gained compared to the status quo in NZ prior to 2008 (no vaccination, screening alone) and using the purchasing power parities of the Organisation for Economic Co-operation and Development (OECD), about US$ 9700/QALY (US$ 6,900 to $33,700) gained. The ICER of an intensive school-based programme for girls, compared to the current situation, was US$ 33,000/QALY gained. Mandatory vaccination appeared least cost-effective (ICER compared to school-based of US$ 117,000/QALY gained, but with wide 95% uncertainty limits from US$ 56,000 to US$ 220,000). All interventions generated more QALYs per 12-year-old for Māori (indigenous population) and people living in deprived areas (range 5-25% greater QALYs gained) (30).

The main findings of the previous studies are shown in Table 1.

European Countries

In Europe, recommendations for HPV vaccination in
females have been introduced in nearly all Western European countries with some of them also offering national or regional funding programs.

In the United Kingdom (UK) mathematical models provide a means for extrapolating results beyond clinical trials and exploring the long-term impact of vaccination on outcomes; the public health benefits of BV, within the context of an effective screening programme, may be substantial with a large reductions not only in cervical cancer incidence and mortality, but also in the prevalence of precancerous lesions and associated diagnostic tests and treatments (31). Besides, vaccinating 12 year-old schoolgirls with a QV at 80% coverage is likely to be cost-effective at a willingness to pay threshold of £30,000 (€37,700) per QALY gained, if the average duration of protection from the vaccine is more than 10 years. Implementing a catch-up campaign of girls up to age 18 is likely to be cost-effective. A BV with the same efficacy against human papillomavirus types 16 and 18 may be as cost effective as the QV although less effective at a willingness to pay threshold of £30,000 per LYG.

A Netherlands study (33), taking non-cervical cancers and cross-protection into account, estimated the maximum health and economic benefits of vaccinating 12-year-old girls against infection and found an ICER of €5,815 per QALY gained. The ICER proved to be most sensitive to vaccine price, discounting rates, costs of cervical cancer and to variation in the disutility of cervical cancer. Evidence on cross-protection and protection against precancerous lesions of the vulva and the vagina supports the idea that health and economic benefits of vaccinating against HPV goes beyond cervical cancer only.

A cost-effectiveness analysis in Switzerland showed that adding QV could prevent over lifetime 62% of cervical cancers and related deaths, 19% of CIN 1, 43% of CIN 2, 45% of CIN 3 and 66% of GW. ICER were estimated to be CHF (Swiss Franc) 45,008 (€37,046) per Life Year Gained (LYG) and CHF 26,005 (€21,405) per QALY gained.

The results presented in a Belgian study indicate that extending HPV vaccination with the BV, in combination with screening, to adult and young adult women post-sexual debut could provide a substantial reduction in cervical cancer disease burden, compared with screening alone. The model estimated that vaccinating a cohort of 100,000 girls at age 12 would prevent 646 cancer cases over a lifetime (102 non-HPV-16/18) with a cost-effective ratio (CER) of €9,171/QALY. Vaccinating at age 26 would prevent 340 cancers (40 non-HPV-16/18) with a CER of €17,348/QALY and vaccinating at age 40 would prevent 146 cancer cases (17 non-HPV-16/18) with an CER of €42,847/QALY. Until age 33 the ICER remained under the highly cost-effective threshold (1xGDP/capita) and beyond age 40 under the cost-effective threshold (3xGDP/capita) (35).

In Austria, vaccinating 65% of 9-year-old boys and girls would result in a 70% decrease in HPV infections in both sexes, avoiding 9,500 cases of GW annually and 431 HPV 16/18-related cancers. This strategy would be cost-effective with base case analysis of €26,701/QALY gained for cervical cancer only, €15,820/QALY also including vaginal/ vulvar cancers and GW, and €10,033/QALY also considering anal, oropharyngeal and penile cancers, with an ICER ranging from €2,500 to €21,000/QALY in sensitivity analyses (36).

In Norway, the vaccination for girls and women aged 12-24 years shown a reduction in the incidence of HPV 6/11/16/18-related GW, CIN and cervical cancer by 94, 92% and 92% by year 100, respectively. The cost-effectiveness ratio for this strategy when compared with vaccinating girls before the age of 12 years was only €8,272 per QALY gained. According to this model and assumptions, the implementation of a QV national program, could reduce the incidence of cervical cancer, CIN and GW at a cost-effectiveness ratio within the range accepted as cost effective (37).

A US Markov model was adapted to the Italian context, with the assumption of 80% vaccine coverage rate under base case, lifetime duration of protection in a cohort of girls aged 12 years and discount rates of 1.5% and 3% for health benefits and costs, respectively, and estimating direct medical costs. The QV in association with the current screening programme would prevent 1,432 cases of cervical cancer (63.3%) and 513 deaths (63.4%) compared to screening

Table 1. Economic evaluation for Extra European countries.

<table>
<thead>
<tr>
<th>SETTING</th>
<th>COST EFFECTIVENESS VALUE</th>
<th>AGE OF GIRLS</th>
<th>TYPE OF VACCINE</th>
<th>VACCINATION COVERAGE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>US$ 3,906 to US$ 14,723*</td>
<td>12</td>
<td>QV/BV</td>
<td>70</td>
</tr>
<tr>
<td>United States</td>
<td>US$ 43,600*</td>
<td>12</td>
<td>BV</td>
<td>25-75</td>
</tr>
<tr>
<td>Canada</td>
<td>CAN$ 21,000*</td>
<td>12</td>
<td>QV/BV</td>
<td>90</td>
</tr>
<tr>
<td>Brazil</td>
<td>US$ 219 to US$ 450**</td>
<td>12</td>
<td>QV</td>
<td>85</td>
</tr>
<tr>
<td>Taiwan</td>
<td>US$ 13,674**</td>
<td>12</td>
<td>BV</td>
<td>100</td>
</tr>
<tr>
<td>Mexico</td>
<td>US$ 68***</td>
<td>12</td>
<td>QV</td>
<td>100</td>
</tr>
<tr>
<td>South Africa</td>
<td>US$ 1,078 to US$ 1,460 **</td>
<td>12</td>
<td>QV/BV</td>
<td>60-100</td>
</tr>
<tr>
<td>India</td>
<td>IS 1,780*</td>
<td>12</td>
<td>BV</td>
<td>70</td>
</tr>
<tr>
<td>Singapore</td>
<td>SG$ 12,488**</td>
<td>12</td>
<td>QV/BV</td>
<td>100</td>
</tr>
<tr>
<td>New Zealand</td>
<td>NZ$ 18,800*</td>
<td>12</td>
<td>BV</td>
<td>56-93</td>
</tr>
</tbody>
</table>

*Cost per QUALY gained; **ICER. *** LyRs. QV: Quadrivalent vaccine; BV: Bivalent vaccine.
only, with an ICER of €9,569 per additional QALY gained. The sensitivity analysis highlighted the cost per QALY gained ranged from €2,781 to €48,122 and remained under the commonly acceptable threshold of €50,000 (38). Besides, a previous study found that the economic attractiveness for QV seemed to be dependent upon the age of women vaccinated and the number of cohorts selected. The decision analysis performed in this study suggested the optimal level of funding required to effectively reduce HPV-induced morbidity and mortality in Italian women (39).

Table 2 summarizes findings for European countries.

**Discussion**

To date, epidemiological and economic models to determine the cost-effectiveness of HPV vaccines have been used by government policy-makers in many countries. Our overview of the economic studies shows that HPV vaccination may yield benefits in terms of avoided costs for country-specific National Health Systems (NHSs). Although estimates depend on the assumptions made, the cost-effectiveness of vaccination against HPV for pre-adolescent girls has been confirmed by a large body of studies, which have been designed to evaluate different vaccination strategies. Although studies differ in their conclusions about the optimal age for catch-up vaccination, many found that catch-up becomes increasingly less cost-effective over the age of 18 years. All immunization programs could be evaluated in terms of their safety and population effectiveness; in addition, public health authorities must be accountable to taxpayers (40, 41). Nevertheless, current studies suffer from a number of limitations: they vary in the types of models used (such as dynamic, static or hybrid) as well as assumptions about the decision problem (such as vaccine price, perspective, outcomes included, vaccine coverage and decision making threshold). The previous parameters are often the most important determinants of the cost-effectiveness of HPV vaccination. The differences between models is that transmission dynamic models capture the indirect protection resulting from immunization (herd-immunity effects), whereas static models omit it. Herd immunity effects depend on the extent to which vaccination prevents transmission of infection in the population. The hybrid modeling approach uses dynamic models to represent transmission and herd immunity effects and static models to represent progression of disease and screening (42). Therefore, direct comparison of study results may be challenging. Furthermore, another study (43) claims that clinical trials have provided only speculative benefits, and the long-term risks of the vaccine have not been established. Pap screening will still be required in vaccinated women hence HPV vaccination programs are not cost-effective, and may do more harm than good, in countries where regular Pap screening and surgery have already reduced the burden of this disease. The identification of the most cost-effective cervical cancer screening strategies should be a future priority in HPV-related disease prevention.

An open debate remains the cost effectiveness of universal HPV vaccination. Few countries have recommended male vaccination: USA, Canada, Austria, and Australia. A careful cost effective modeling has preceded these decisions showing that when the burden of disease in men is included in the models then, depending upon coverage, vaccine price, and other factors male vaccination can become cost-effective (44). A recent review of the economic literature has concluded that universal vaccination may not be cost-effective (45). However, the conclusions drawing may be inaccurate for other authors. The critiques moved are the cost-effectiveness of a three-dose schedule of vaccination, while the use is moving towards a two-dose schedule; the lacking of comprehensive health impacts; the inadequate explanation of methods for capturing values beyond health gains and health system costs and, finally, it seems that efforts capture a small proportion of non-health values (46).

According to the European Center for Disease Prevention and Control (45), future evaluation by the decision-makers in various countries of the results obtained by the next generation of intervention programs will focus on the critical issues that still exist:

- previous experience in gender-restricted vaccination programmes has demonstrated a substantially lower effectiveness than universal vaccination;
- limiting vaccination to girls might increase the psychological burden on girls by confirming a perceived inequality of the sexes;
- even if all girls were immunized, the HPV chain of transmission would still be maintained through men who have sex with men (MSM);
- the cost-effectiveness of including boys in HPV vaccination programs should be re-assessed in view of the
increased reduction, due to universal vaccination, of the economic burden of HPV related diseases in both sexes.

Recently, the Papillomavirus Rapid Interface for Modelling and Economics (PRIME) model to assess cost-effectiveness and health effects of vaccination of girls against HPV was validated; this model showed that the vaccination of a cohort of 58 million 12-year-old girls in 179 countries prevented 690,000 cases of cervical cancer and 420,000 deaths during their lifetime (mostly in low-income or middle-income countries), at a net cost of US$ 4 billion. HPV vaccination was very cost effective (with every disability-adjusted life-year averted costing less than the gross domestic product per capita) in 156 (87%) of 179 countries (47).

This review is not without limitations. The results of our study come from several modeling exercise with the limitation of such approach; however, extensive sensitivity analyses conducted allow a better understanding of the limitations of these results. In addition, cost estimates were built on the basis of various assumptions, and there also was a lack of uniformity within the same setting, in the costs associated with diagnosis and treatment. On the other hand, given the duration for the development of an HPV lesion and for ethical issues, only models are at this point available to estimate the entire potential benefit of HPV vaccination. Comparison between studies is difficult due to the large range of screening coverage rates used, as well as the use of comparators varying in screening methods; furthermore, vaccine safety has been reported mainly for women. Finally there is a lack of consensus for the appropriate threshold for cost effectiveness.

In conclusion, these achievements pose questions for the decision-makers, modeling studies have produced consistent conclusions regarding the cost-effectiveness of HPV vaccination. However, economic evaluations on HPV vaccination could be considered long-term forecasting, projecting short-term clinical evidence into the distant future on the basis of various assumptions and estimates, most of them highly optimistic, making these models not completely useful for public policy purposes (48). The way in which a decision maker should interpret and potentially use thresholds to help set policy depends upon several factors, including the different ways in which thresholds can be estimated. For local context, the criterion for understanding cost-effectiveness should have some relation to the budget available for allocation (49). It is important that economic analysis of universal HPV vaccination adopts large perspective than is the case with the existing literature; uncertainties still exist and results achieved may lead inappropriate conclusions. In this regard, cost-effectiveness analysis can be a tool in helping decision makers to choose the most effective intervention in the context of limited health care resources. Reducing cost, increasing duration of efficacy, and integrating vaccines into existing screening practices and treatment procedures in a cost-effective manner are of crucial importance even as they are a major challenge (50).

References


