Policy Analysis of Cervical Cancer Screening Strategies in Low-Resource Settings
Clinical Benefits and Cost-effectiveness

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Cervical cancer is a leading cause of cancer-related death among women in developing countries. In such low-resource settings, cytology-based screening is difficult to implement, and less complex strategies may offer additional options.

Objective To assess the cost-effectiveness of several cervical cancer screening strategies using population-specific data.

Design and Setting Cost-effectiveness analysis using a mathematical model and a hypothetical cohort of previously unscreened 30-year-old black South African women. Screening tests included direct visual inspection (DVI) of the cervix, cytologic methods, and testing for high-risk types of human papillomavirus (HPV) DNA. Strategies differed by number of clinical visits, screening frequency, and response to a positive test result. Data sources included a South African screening study, national surveys and fee schedules, and published literature.

Main Outcome Measures Years of life saved (YLS), lifetime costs in US dollars, and incremental cost-effectiveness ratios (cost per YLS).

Results When analyzing all strategies performed as a single lifetime screen at age 35 years compared with no screening, HPV testing followed by treatment of screen-positive women at a second visit, cost $39/YLS (27% cancer incidence reduction); DVI, coupled with immediate treatment of screen-positive women at the first visit was next most effective (26% cancer incidence reduction) and was cost saving; cytology, followed by treatment of screen-positive women at a second visit was least effective (19% cancer incidence reduction) at a cost of $81/YLS. For any given screening frequency, when strategies were compared incrementally, HPV DNA testing generally was more effective but also more costly than DVI, and always was more effective and less costly than cytology. When comparing all strategies simultaneously across screening frequencies, DVI was the nondominated strategy up to a frequency of every 3 years (incremental cost-effectiveness ratio, $460/YLS), and HPV testing every 3 years (incremental cost-effectiveness ratio, $11 500/YLS) was the most effective strategy.

Conclusion Cervical cancer screening strategies that incorporate DVI or HPV DNA testing and eliminate colposcopy may offer attractive alternatives to cytology-based screening programs in low-resource settings.
opposing countries and used the model together with country-specific data to conduct a policy analysis comparing the clinical benefits and cost-effectiveness of different cervical cancer screening strategies in black South African women.

**METHODS**

We developed a state transition computer-based model to simulate the natural history of HPV-induced cervical neoplasia and cervical cancer screening, diagnosis, and treatment in a cohort of previously unscreened 30-year-old black South African women. Model outcomes included life expectancy and lifetime costs. Comparative performance of different screening strategies was measured by the incremental cost-effectiveness ratio, defined as the additional cost of a specific screening strategy, divided by its additional clinical benefit, compared with the next least expensive strategy.° We adopted a societal perspective (ie, all costs and benefits are included regardless to whom they accrue). Time preference was incorporated by discounting costs and benefits 3% annually. The implications of alternative assumptions regarding the natural history of cervical neoplasia, effectiveness of screening and treatment, prevalence of HIV, and direct medical and time costs were evaluated in sensitivity analyses.

**Natural History Model**

Health states in the model incorporate cervical disease status, human papillomavirus (HPV) infection status, and human immunodeficiency virus (HIV) infection status. Each month, women can progress or regress in their cervical disease; those at lowest risk of disease progression have no detectable or low-risk HPV DNA and have no HIV infection; those at highest risk of disease progression have detectable high-risk types of HPV DNA and are in later stages of HIV infection. Each month, women who are HIV-infected may progress in their HIV disease. Not shown are women who may die from acquired immunodeficiency syndrome, cervical cancer, or other causes. SIL indicates squamous intraepithelial lesions.

![Figure 1. Overview of the Model](image)

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Persistently HPV-infected and be at greatest risk.° The HPV status also depends on the presence of HIV coinfection, with HIV-infected women having a higher prevalence of HPV than those who were not HIV infected.° In each cycle, women who are HIV-infected can progress in their HIV disease. Women face competing mortality risks from acquired immunodeficiency syndrome (AIDS), cervical cancer, and other causes.

**Screening Model and Screening Strategies**

Screening strategies were distinguished by the number of clinical visits, the use of 1 or 2 screening tests, screening frequency, and ages to target for screening. Screening tests included DVI, cervical cytology using a conventional Papanicolaou smear, and HPV DNA testing using a high-risk HPV probe (Hybrid Capture II; Digene Corp, Gaithersburg, Md). Three-visit strategies, the standard of care in most developed countries, include an initial screening evaluation, a second visit for a diagnostic workup incorporating colposcopy and biopsy in women with positive test results, and a third visit for treatment of women with confirmed SIL. Two-visit strategies incorporate a visit at which screening takes place followed by a second visit at which women with positive test results undergo treatment, without evaluation by colposcopy. One-visit strategies, (ie, screen and treat on the same day) incorporate immediate treatment in all screen-positive women. In strategies incorporating a combination of 2 tests, women with an abnormal result on either test are considered screen positive. The sensitivity and specificity of the combination of DVI and cytology were 96% and 82%, respectively; for DVI and HPV, they were 97% and 75%, respectively, and for HPV and cytology, they were both 86%. In strategies incorporating 2 sequential tests, women with an abnormal result on the first test undergo a second test, and only those with positive results on both tests receive treatment. The sensitivity and specificity of DVI followed by cytology were 50% and 99%, and 65% and
98% for HPV followed by cytology, respectively. Screening could be conducted 1, 2, or 3 times per lifetime or at any specified interval.

The following assumptions were made: (1) all women suitable for outpatient treatment receive cryotherapy; (2) among women undergoing cryotherapy, 10% receive no benefit and another 10% develop recurrent disease within 1 year; (3) 5% of women receiving cryotherapy have minor symptoms (eg, discharge, bleeding, and minor infection requiring a clinic visit and oral antibiotics), and 1% have a more serious complication (eg, infection or bleeding) requiring 1 to 2 days of hospitalization; (4) all screen-positive women undergo DVI prior to cryotherapy thus allowing those with a 4-quadrant lesion or suspicious cancer to be referred to a physician; (5) 10% of screen-positive women have a 4-quadrant lesion or suspicious cancer and are referred to a physician—those with cancer undergoing a loop electrosurgical excision procedure (50%), conization (25%), or no treatment (25%); (6) 2% of all women with high-grade disease have undetected microinvasive cancer or adenocarcinoma in situ; (7) one third of women with microinvasive cancer or adenocarcinoma in situ are undetected, one third are referred to a physician, and one third are treated with cryosurgery; (8) women with microinvasive cancer, inappropriately treated with cryotherapy, receive no clinical benefit from the procedure; (9) women with false-negative results are only detected if they develop symptoms from invasive cancer; and (10) there is a 15% loss to follow-up with each visit.

Clinical Data

Table 1 summarizes values (and plausible ranges) used for the base case. Clinical parameters were obtained from our South African screening study, as well as extrapolated from a systematic literature review, with preference given to our South African screening study, as well as extrapolated from a systematic literature review, with preference given...
to studies with larger sample sizes, well-defined control groups, and longer follow-up. If estimates from studies particularly relevant to our target population were not within this plausible range, the range was widened to accommodate them.

**Natural History**

We estimated the probabilities of SIL progression and regression using 2 methods. First, transition probabilities conditional on HPV that were available from the literature were extrapolated. For probabilities conditional on HIV, data from a previously published analysis of cervical cancer screening in HIV-infected women were used. The probability of high-grade SIL progression to invasive cancer was estimated using simulation techniques as described previously. A second method was used to estimate transition probabilities conditional on HPV that were not directly available from the literature. First, clinical studies lacking HPV status of individual women were used to derive overall mean transition probabilities for a hypothetical population of women, some of whom would be expected to acquire and clear HPV, and some of whom would be expected to develop persistent HPV.

Second, a series of equations were used to split out these mean population probabilities into HPV-specific probabilities, based on the relative risk of SIL in women with HPV (compared with the relative risk of those without HPV) and HPV prevalence. Finally, the model was calibrated such that the projected lifetime risk of cervical cancer in unscreened women was consistent with published data.

Based on the mean prevalence rates of HPV (22% overall) and HIV (8% overall) reported in the South Africa screening study and the probability of HPV in HIV-infected women compared with those who were not infected with HIV (ie, the rate ratio), we estimated that 78% of all detectable HPV was attributable to women who were not HIV infected. If all detectable HPV was attributed to those with HIV infection, we estimated that 78% of all detectable HPV was attributable to women who were not HIV infected. We used a rate ratio of 3.8 for the base case (ie, the probability of HPV in HIV-infected vs uninfected women), and established a plausible range of 3.5 to 5.6, based on published studies, including 2 conducted in Africa. Similar methods were used to estimate the proportion of SIL and invasive cancer attributable to HIV-infected women and those who were not.

**Mortality Rates**

Stage-specific survival rates for cervical cancer were based on data from a tertiary referral center in Cape Town and published literature, although data from the National Cancer Institute’s Surveillance, Epidemiology, and End Results Survey were used in the sensitivity analysis. Estimates for competing mortality from age-, sex-, and race-adjusted causes were obtained from life tables developed by the World Health Organization for South Africa. Separate all-cause mortality rates for the HIV-infected and uninfected sectors of the population were required for sensitivity analyses. For these analyses, we used 1989-1991 lifetables for black females to represent the sector without HIV infection and the most conservative survival rates from previously validated natural history models for the sector with HIV infection.

**Costs**

Microcosting techniques were used to estimate direct medical and nonmedical costs (Table 2). Country-specific data expressed in 1999 South African Rand were converted to US dollars at an exchange rate of R6.2/$1. We used the Representative Association of Medical Schemes recommended scale of benefits for the public sector as a surrogate for most direct medical costs. The cost of the HPV test was based on the quoted price of the test kit for developing countries and manpower and indirect costs of similar laboratory tests. We also included the costs of treatment complications and physician referrals of women ineligible for cryotherapy. Resource use associated with each stage of cervical cancer was based on clinical protocols from 2 regional hospitals and the literature. Costs of hospitalization and radiation therapy were estimated from a cost-comparison study conducted at the University of Cape Town, and we assumed chemotherapy would not be available. For HIV-infected women, data from the World Bank were used to estimate the cost of treating opportunistic infections and providing palliative care.

Estimates of time spent traveling, waiting, and receiving health care and the cost of transportation were based on 2 national surveys. Time was valued using survey data in which...
RESULTS

Cost-effectiveness of Cervical Cancer Screening at Different Intervals

The discounted lifetime costs and life expectancy of strategies performed at different screening intervals, beginning at 35 years of age, are shown in Figure 2. Cervical cancer screening increased discounted life expectancy by 0.84 to 3.50 months, depending on the screening strategy. The cost-effectiveness of moving from one screening strategy to another more costly alternative is represented by the difference in cost divided by the difference in life expectancy associated with the 2 strategies. Strategies lying on the efficiency curve dominate those lying to the right of the curve because they are more effective and either cost less or have a more attractive cost-effectiveness ratio than the next best strategy. A cost-effectiveness ratio is shown for each nondominated strategy and is the reciprocal of the slope of the line connecting the 2 screening strategies under comparison; this slope is steeper when the net gain in life expectancy is greater.

Table 2. Selected Costs: Base-Case Values and Ranges Used in Sensitivity Analyses

<table>
<thead>
<tr>
<th>Variable</th>
<th>Base-Case Public Sector Cost†</th>
<th>Range‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screening test†</td>
<td></td>
<td></td>
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<tr>
<td>Cervical cytology (conventional Papanicolaou test)</td>
<td>57.90 9.30</td>
<td>7.00-12.00</td>
</tr>
<tr>
<td>Direct visual inspection</td>
<td>10.00 1.61</td>
<td>0.50-3.00</td>
</tr>
<tr>
<td>HPV DNA hybrid assay</td>
<td>53.00 8.55</td>
<td>5.00-20.00</td>
</tr>
<tr>
<td>Health care costs†</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Screening visit</td>
<td>30.00 4.81</td>
<td></td>
</tr>
<tr>
<td>Cryotherapy visit</td>
<td>70.00 11.29</td>
<td></td>
</tr>
<tr>
<td>Extended clinic visit</td>
<td>105.30 16.98</td>
<td></td>
</tr>
<tr>
<td>Diagnostic workup and treatment§</td>
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<td></td>
</tr>
<tr>
<td>Colposcopy</td>
<td>123.10 19.85</td>
<td></td>
</tr>
<tr>
<td>Biopsy(s)</td>
<td>82.00 12.22</td>
<td></td>
</tr>
<tr>
<td>Cost of histologic analysis</td>
<td>105.20 16.97</td>
<td></td>
</tr>
<tr>
<td>LEEP</td>
<td>100.30 16.18</td>
<td></td>
</tr>
<tr>
<td>Cost of histologic analysis</td>
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<td></td>
</tr>
<tr>
<td>Cryotherapy</td>
<td>63.80 10.30</td>
<td></td>
</tr>
<tr>
<td>Minor complications</td>
<td>105.30 16.98</td>
<td></td>
</tr>
<tr>
<td>Major complications</td>
<td>1200 193.55</td>
<td></td>
</tr>
<tr>
<td>Conization (cold knife)</td>
<td>246.20 39.71</td>
<td></td>
</tr>
<tr>
<td>Selected patient time costs, mean (range), min</td>
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<td></td>
</tr>
<tr>
<td>Screening visit, 15 (5-30) min</td>
<td>0.62 0.10</td>
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</tr>
<tr>
<td>Colposcopy visit, 20 (15-40) min</td>
<td>0.83 0.13</td>
<td></td>
</tr>
<tr>
<td>Cryotherapy visit, 20 (15-40) min</td>
<td>0.83 0.13</td>
<td></td>
</tr>
<tr>
<td>Treatment with radical hysterectomy, 8546 min</td>
<td>352.90 56.93</td>
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</tr>
<tr>
<td>Treatment with radiation therapy, 7770 min</td>
<td>320.90 51.76</td>
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</tr>
<tr>
<td>Travel to clinic, 112 (90-244) min</td>
<td>4.62 0.74</td>
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<tr>
<td>Travel to referral center, 168 (90-336) min</td>
<td>6.94 1.12</td>
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</tr>
<tr>
<td>Wait, 45 (36-90) min</td>
<td>1.86 0.30</td>
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</tr>
<tr>
<td>Transportation time for average clinic visit</td>
<td>3.5 0.56</td>
<td></td>
</tr>
<tr>
<td>Selected total treatment costs (direct medical and time costs)</td>
<td>141.10 22.70</td>
<td></td>
</tr>
<tr>
<td>Cryotherapy in patients suitable for outpatient treatment</td>
<td>141.10 22.70</td>
<td></td>
</tr>
<tr>
<td>Local invasive cervical cancer</td>
<td>12 155 1960</td>
<td>980-2940</td>
</tr>
<tr>
<td>Regional invasive cervical cancer</td>
<td>8161 1316</td>
<td>658-1974</td>
</tr>
<tr>
<td>Distant invasive cervical cancer</td>
<td>7162 1155</td>
<td>577-1732</td>
</tr>
<tr>
<td>Cost of HIV-related health care</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment of opportunistic infections</td>
<td>1854 299</td>
<td></td>
</tr>
<tr>
<td>Palliative care</td>
<td>3.1 19</td>
<td></td>
</tr>
</tbody>
</table>

#HPV indicates human papillomavirus; SIL, squamous intraepithelial lesion; LEEP, loop electrosurgical excision procedure; and HIV, human immunodeficiency virus.

*Estimates expressed in 1999 South Africa Rand and converted to US dollars at an exchange rate of R6.2/$1.2.$

†Plausible ranges +/- 25% of the base-case value unless otherwise indicated.

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in a lower reduction in cervical cancer incidence compared with a 1-visit DVI or 2-visit HPV strategy.

All screening tests may not be equally available in low-resource settings, and certain screening tests may be selected for programmatic reasons. For example, in some regions, it may be difficult to provide the ongoing training necessary for performing DVI. There are a number of ways in which HPV DNA testing could be incorporated into the screening strategy in low-resource settings. In addition to the 2-visit clinician-collected strategy used in the base case, one could consider using HPV testing of self-collected samples. Another feasible strategy is rapid processing of clinician-collected samples in the clinic, allowing screening and treatment at the same visit. Assuming these 3 strategies were equally accessible, a 1-visit strategy with clinician-collected samples was more effective and less costly than either of the 2-visit strategies. However, in the absence of a 1-visit strategy, a 2-visit single lifetime screen using a self-collected sample for HPV would cost only $26/YLS compared with no screening.

Cost-effectiveness of Once in a Lifetime Screening
While Figure 2 provides insight into the relative efficiency of different screening strategies, the majority had cost-effectiveness ratios beyond the threshold of the poorest countries. Therefore, we conducted an analysis comparing the screening strategies when performed only once in a lifetime, at 35 years of age (Table 3, upper half). Compared with no screening, a 1-visit DVI strategy reduced the incidence of cancer by 26%, increased life expectancy by 0.84 months, and was associated with lower overall mean total lifetime costs. A 1-visit strategy using a clinician-collected sample for HPV reduced cancer incidence by 32% and, compared with the DVI strategy, increased life expectancy by 0.19 months for $118/YLS. All 2-visit strategies and the 3-visit strategy using cervical cytology were dominated by a 1-visit HPV DNA testing strategy because they cost more, although they were less effective. All strategies that incorporated 2 screening tests, either in combination or sequentially, either cost more and were less effective (ie, thereby eliminated by strong dominance) or had a less attractive cost-effectiveness ratio than other more effective strategies (ie, thereby eliminated by weak dominance). These single-lifetime strategies, when targeted to women younger than age 30 years or older than age 45 years, were never as cost-effective as targeting women in their mid-to-late 30s.

Because these screening strategies may not be equally available in low-resource settings, their cost-effectiveness ratios also were calculated by comparing the incremental costs and benefits of each strategy with no screening (Table 3, lower half). With the exception of a single-lifetime DVI, the cost-effectiveness ratios ranged from $14 to $147/YLS, each compared with no screening.

Sensitivity Analysis
Results were most sensitive to the natural history of SIL, sensitivity, and cost of the screening tests, cost of cancer care, and HPV prevalence. However, when we varied these parameters one at a time (ie, 1-way sensitivity analysis) over a plausible range, the rank ordering of screening strategies did not change.

We conducted a series of sensitivity analyses in which 2 and 3 variables were varied simultaneously (ie, 2- and 3-way sensitivity analysis). The choice between using a 2-visit clinician-collected HPV strategy or a single-visit DVI performed once in a lifetime depended on 3 things: test cost, test sensitivity, and the cost-effectiveness threshold (ie, willingness to pay for a YLS). Given a cost-effectiveness threshold of $5/YLS, a 1-visit DVI was nearly always preferred to a 2-visit HPV DNA testing. If the cost-effectiveness threshold is $50/YLS, a 1-visit DVI was only preferred to a 2-visit HPV testing if the sensitivity of DVI exceeded 58%, and all other variables were held constant. At this cost-effectiveness threshold,
2-visit HPV testing was preferred to DVI when the cost of HPV testing was reduced by approximately 25%.

The overall results were minimally sensitive to reasonable changes in the prevalence of HPV and HIV. When the prevalence of HIV was varied from 5% to 30%, the incremental cost-effectiveness of 2-visit HPV testing ranged from $70 to $110/YLS, compared with DVI. Over this entire range, 1-visit DVI remained cost saving.

COMMENT

For South African women similar to those in our cohort, a single-lifetime screen with DVI or HPV DNA testing coupled with immediate cryotherapy for those with positive results compared with no screening reduced the incidence of cervical cancer by 26% to 32% and cost less than $50 per woman. In agreement with other study results, we found that targeting this single lifetime screening to unscreened women 35 years of age provided the best balance between clinical benefits and costs.31,37,40

One-visit strategies were more effective and less costly than 2-visit strategies. Single-visit strategies eliminated the costs involved with the second visit and, more importantly, eliminated the loss to follow-up that occurred with each additional visit. Traditional 3-visit strategies were least cost-effective.

Introducing 1- and 2-visit strategies that eliminate colposcopic evaluation and treat all screen-positive women may have important implications. Both DVI and HPV testing have a relatively low specificity, and therefore, a substantial number of women without histopathologic evidence of cervical disease will undergo treatment (eg, cryotherapy). Our model incorporates the known clinical and economic consequences resulting from immediate treatment and, even when the false-positive rate of DVI or HPV testing increases to 20%, our results were robust. This is because the known adverse health effects of cryotherapy are minimal compared with the 5% lifetime risk of cervical cancer that is estimated for black South African women.32 In developing countries, such as the United States, the cost-effectiveness of screening is sensitive to changes in specificity because of both the costly diagnostic work triggered by an abnormal test result and the frequency with which screening is conducted.33 In contrast, in the 1- and 2-visit strategies we evaluated, women are screened a limited number of times, and if they are screen positive, they undergo a single relatively inexpensive intervention (eg, cryotherapy). We emphasize, however, that additional studies are needed to establish the efficacy and complications of cryotherapy when performed without colposcopy in low-resource settings.

South Africa provides a relatively high level of care to women with cervical cancer, and our results, in part, reflect the averted high costs of this care with screening. However, even when cancer costs were reduced by 50%, a 1-visit strat-

Table 3. Discounted Costs, Mean Life Expectancy, and Incremental Cost-effectiveness of Cervical Cancer Screening Once in a Lifetime in South African Women at 35 Years of Age*

<table>
<thead>
<tr>
<th>Screening Strategy</th>
<th>Mean Lifetime Costs, US $</th>
<th>Incremental Costs, US $†</th>
<th>Mean Life Expectancy, y</th>
<th>Mean Gain in Life Expectancy, 9 mo‡</th>
<th>Reduction Cervical Cancer Incidence, %</th>
<th>Cost-effectiveness Ratio, US$/YLS†</th>
</tr>
</thead>
<tbody>
<tr>
<td>No screening</td>
<td>40.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Strategies Compared Incrementally‡</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1-Visit strategies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DVI</td>
<td>39.19</td>
<td>−0.81</td>
<td>19.169</td>
<td>0.84</td>
<td>26</td>
<td>Cost saving</td>
</tr>
<tr>
<td>HPV testing</td>
<td>41.13</td>
<td>1.94</td>
<td>19.185</td>
<td>0.19</td>
<td>32</td>
<td>118</td>
</tr>
<tr>
<td>2-Visit strategies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-collected HPV</td>
<td>41.61</td>
<td>0.48</td>
<td>19.161</td>
<td>−0.29</td>
<td>23</td>
<td>Dominated§</td>
</tr>
<tr>
<td>DVI followed by HPV</td>
<td>41.77</td>
<td>0.64</td>
<td>19.139</td>
<td>−0.55</td>
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<td>Clinician-collected HPV</td>
<td>42.90</td>
<td>1.13</td>
<td>19.172</td>
<td>−0.16</td>
<td>27</td>
<td>Dominated§</td>
</tr>
<tr>
<td>Cervical cytology</td>
<td>44.19</td>
<td>3.06</td>
<td>19.151</td>
<td>−0.41</td>
<td>19</td>
<td>Dominated§</td>
</tr>
<tr>
<td>3-Visit strategies</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cervical cytology</td>
<td>46.44</td>
<td>5.31</td>
<td>19.143</td>
<td>−0.50</td>
<td>17</td>
<td>Dominated§</td>
</tr>
<tr>
<td>Strategies Each Compared With No Screening§</td>
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<tr>
<td>1-Visit strategies</td>
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<td>1.03</td>
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<td>DVI followed by HPV</td>
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</tbody>
</table>

*YLS indicates years of life saved; DVI, direct visual inspection; HPV, human papillomavirus DNA testing using a high-risk HPV probe.
†The difference in cost divided by the difference in life expectancy for each strategy compared with the next best strategy. All strategies are assumed to be equally available.
‡Strategies shown cost more but were less effective than 1-visit HPV testing and were therefore dominated.
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CERVICAL CANCER SCREENING STRATEGIES IN LOW-RESOURCE SETTINGS

egy using DVI performed once in a lifetime was less than $50/YLS. Varying the prevalence of HIV infection had a negligible impact on the cost-effectiveness ratio or rank ordering of the single-lifetime screening strategies, in part, because we assumed women with symptomatic AIDS would not be screened. Moreover, the AIDS epidemic has had less of a dramatic impact on women in older age groups—the life expectancy of the average black South African woman who reaches 35 years of age exceeds 25 years. The averted mortality in this group of women drives our results.

Although cost-effectiveness analysis can help illustrate the tradeoffs with different policy alternatives, it serves as only 1 input to decision making. Qualitative considerations may be important when selecting one screening strategy over another. In some countries, treating screen-positive women without histopathologic evidence of cervical disease may be inconsistent with societal values, despite that, at least in the case of HPV testing, screen-positive women are at significant risk for developing cervical disease. In other settings, because of a low cultural acceptance of pelvic examinations, HPV testing of self-collected vaginal specimens may be the most attractive strategy. Finally, implementing screening programs based on DVI or HPV testing requires different types of resources, and the relative availability of these resources in different settings will affect the choice of strategy.

Our analysis has several limitations. First, data were combined from multiple sources that varied in study design and entry criteria, and surrogate markers (eg, SIL) evaluated in relatively short-term clinical studies were used to extrapolate long-term consequences. In addition, the up-front costs of initiating new screening programs or of providing ongoing training and supervision of clinicians practicing DVI were not included, since these costs are relatively unknown and will likely be region specific. In fact, the relative attractiveness of implementing DVI or HPV testing will depend on country-specific human and economic programmatic resources. Second, the effectiveness of interval screening using DVI or HPV testing has not been fully evaluated, and we assumed that the sensitivity of these tests remained constant. However, the impact of this assumption was minimized by focusing on the 1-visit screening strategies. Third, our results may not be generalizable to countries other than South Africa. Country-specific differences in many of our assumptions will need to be incorporated into independent analyses. Note that our most general results were robust despite varying many of the parameters expected to differ between geographic regions.

Cervical cancer screening is but 1 of many public health issues competing for resources in developing countries, and therefore, the optimal screening strategy will ultimately depend on the cost-effectiveness threshold of a given setting. For countries with cost-effectiveness thresholds below $2 or $3/YLS, a single lifetime screen using DVI coupled with immediate treatment may be the only feasible strategy. For countries that can afford up to $50/YLS, a single-lifetime screen using HPV is also an attractive option. The cost-effectiveness of both of these screening strategies compares favorably with other public health interventions in low-resource settings, such as childhood immunizations and AIDS prevention programs. Because these strategies offer enormous public health impact, clinical studies to evaluate the long-term consequences of the use of immediate cryotherapy and to identify the real world barriers to implementing less complex screening programs should be given the highest priority.

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CORRECTIONS

Incorrect Affiliation Description: In the Letters entitled “Outcomes of a Trial of HIV-1 Immunogen in Patients With HIV Infection” published in the May 2, 2001, issue of THE JOURNAL (2001;285:2191), the author affiliation description was incorrect. On page 2191, the sentence that read “ASG Inc is a provider of information technology consulting services” should have read “ASG is a provider of clinical research, data management, and statistical services to the pharmaceutical industry.”

Error in Text and Table: In the Original Contribution entitled “Long-term Effects of an Early Childhood Intervention on Educational Achievement and Juvenile Arrest: A 15-Year Follow-up of Low-Income Children in Public Schools” published in the May 9, 2001, issue of THE JOURNAL (2001;285:2339-2346), there was an error in the text and in the table. On page 2342, in Table 2, the zeros in the last 2 columns of the last 2 rows should have been P<.001. In the third column of the text, the paragraph above the heading “Outcome Variables,” the last sentence that reads “The mean per child expenditures in 1996 for 1 year of preschool and 1 year of school-age participation are $4350 and $15.00.” should read “The mean per child expenditures in 1996 for 1 year of preschool and 1 year of school-age participation are $4350 and $1500.”

Incorrect Word: In the Letters entitled “Overuse of Administrative Data to Measure Underuse of Care” published in the February 14, 2001, issue of THE JOURNAL (2001;285:735-736), an incorrect word, “biannual,” was placed in the text. On page 735, the sentence that read “Nonetheless, a recent cost-effectiveness analysis concluded that biannual eye examinations were appropriate for low-risk individuals with type 2 diabetes.” should have read “Nonetheless, a recent cost-effectiveness analysis concluded that biennial eye examinations were appropriate for low-risk individuals with type 2 diabetes.”


Incorrect Wording: In the Letters entitled “Industry Support of Researchers in Universities and Academic Medical Centers” published in the May 9, 2001, issue of THE JOURNAL (2001;285:2324-2325), there was incorrect wording in a sentence. On page 2324, in the second column, third paragraph, the sentence that read “The economics of low-margin computer chip markets are forcing companies to scale back their basic university-supported research and they are focusing on increasing productivity.” should have read “The economics of low-margin computer chip markets are forcing companies to scale back their university-supported basic research and they are focusing on increasing productivity.”

Incorrect Spelling of Author’s Last Name: In the Letters entitled “Helping Patients Integrate Research Evidence” published in the November 22/29, 2000, issue of THE JOURNAL (2000;284:2595), the author’s last name was misspelled. On page 2595, the author’s last name “Kritiansen” should have been “Kristiansen.”