Cost-Effectiveness Of Cervical Cytologic Examination During Pregnancy

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Background: We undertook a study to determine the cost-effectiveness of performing routine cervical cytologic examination during pregnancy.

Methods: The costs generated by doing routine prenatal cervical cytologic examination were calculated based on chart review in a family practice setting. A consecutive sample of 523 patients giving birth during 1990 was used. Analysis was done on 423 of those patients with prenatal Papanicolaou smear results recorded. Cost savings from detection of curable disease and utility of the test in terms of well-years saved were calculated from published statistics using a single-step Markov process to model the population at risk.

Results: For patients of all ages using a discount rate of 5 percent, the cost generated by prenatal cervical cytologic examination was $146,400 per well-year of life saved. Age stratification showed cost per well-year to range from $321,600 for patients aged 15 to 19 years to $48,800 for those aged 35 to 39 years.

Conclusions: Routine prenatal cervical cytologic examination is significantly less cost-effective than the most commonly done medical procedures. If medical funding is limited, elimination of this test should be considered for women with normal findings on cervical cytologic examinations within the previous 2 to 3 years. (J Am Board Fam Pract 1993; 6:537-45.)

The recommendation to perform routinely a prenatal Papanicolaou smear gained widespread acceptance in the United States in the late 1950s. Its value in detecting cervical neoplasia had been established, and the initial prenatal examination was cited as an opportune time to obtain this test. Physicians at the time tended to treat malignant and premalignant disease aggressively and without delay regardless of pregnancy.

Since then, changes in medical practice, as well as changes in the population of women of reproductive age, have combined to reduce the need for this procedure. Greater knowledge about the generally indolent course of cervical intraepithelial neoplasia (CIN) has made clinicians more comfortable with waiting until after delivery to treat. This willingness to delay treatment now even extends to microinvasive disease. Instead of treatment, repeated colposcopic examinations are done during the pregnancy for patients with CIN to check for advancement of the lesion. As a result of more widespread screening, the prevalence of invasive cervical carcinoma has decreased and women are more likely to have Papanicolaou smears done at times other than during prenatal care. Consequently, the fear expressed by physicians in the 1950s that patients would not submit to such examinations outside of pregnancy has been reduced. Criteria for adequacy of the Papanicolaou smear have also become more defined recently, with many authorities suggesting repeating the smear if endocervical cells are not present. Because gestation markedly increases the percentage of these suboptimal smears, the costs generated by this procedure are also increased.

Patients in whom invasive carcinoma is found at less than 20 weeks' gestation can still benefit from this test, but only if they consent to immediate, definitive treatment, resulting in loss of the pregnancy. Generally, pregnancies in which invasive cancer is discovered later than 20 weeks' gestation are allowed to proceed to at least the point of fetal viability and often to term. For cases treated definitively in early pregnancy, benefit would only apply to those patients whose disease would have become incurable during the course of the pregnancy.

These issues suggest that Papanicolaou smears done during pregnancy have less utility and gen-
erate higher follow-up costs than smears done in nonpregnant patients. We present findings from a cost-effectiveness study of this procedure.

**Methods**

**Cost-Effectiveness Model**

The general formula for the net health care costs ($\Delta C$) of a program or practice is as follows:\(^{26}\):

$$\Delta C = \Delta C_{Rx} + \Delta C_{SE} - \Delta C_{Morb} + \Delta C_{Rx \Delta LE}$$

In this formula, $\Delta C_{Rx}$ includes all direct health care costs arising from the program. For our study it included the cost of the initial Papanicolaou smear as well as the costs of all procedures, such as repeat smears and colposcopic examinations, done as a result of the initial smear. $\Delta C_{Morb}$ is the monetary savings resulting from the prevention or alleviation of disease. $\Delta C_{SE}$ includes all health care costs associated with adverse side effects of treatment. As the Papanicolaou smear and colposcopic examination are generally considered to be benign procedures, $\Delta C_{SE}$ was assumed to be zero. $\Delta C_{Rx \Delta LE}$ refers to the cost of treating future disease occurring in patients whose lives were saved by the original treatment. It has been proposed that this term should apply only to future medical costs directly resulting from the same disease process as originally addressed.\(^{27}\) In our study we assumed that CIN or cancer detected and cured as a result of the prenatal Papanicolaou smear does not result in any future medical costs from the same disease process; therefore, we did not include this term in our analysis. The total $\Delta C$ obtained by this calculation is then divided by the number of well-years of life gained by doing the procedure to give the cost-effectiveness ratio.

Our analysis considered a hypothetical cohort of 100,000 pregnant women. The study was conducted from the point of view of an organization, such as an insurance company or governmental agency, that is expected to pay a fee-for-service bill for this procedure. A comprehensive health maintenance organization could also apply this study design, substituting its own internally determined costs for doing the procedures in question. The costs generated by the routine prenatal Papanicolaou smear ($\Delta C_{Rx}$) were calculated from data provided by a chart review in a family practice setting. Cost savings from detection of curable disease ($\Delta C_{Morb}$) and utility of the test in terms of well-years saved were calculated from published statistics. These figures were recalculated assuming that no prenatal smear was done. Both scenarios assumed that a postpartum Papanicolaou smear was obtained. Modeling of this population was done using a single-step Markov process. The Markov process is a standard way to model a population at risk for cancer.\(^{28}\) It considers the probabilities of patients existing in any of a number of initial disease states and then uses the rates of transition between these states to describe how the population changes over time.

**Calculation of $\Delta C_{Rx}$**

To determine the costs generated by the prenatal Papanicolaou smear, it was necessary to obtain reliable data regarding the percentage of abnormal and inadequate smears in the pregnant population. There is an extensive literature concerning CIN diagnosed during pregnancy, but we found no large series reporting the baseline results of prenatal Papanicolaou smears in general. For this reason, we performed a chart review of prenatal records for all newborns delivered on the Family Practice Service at Silas B. Hays Army Community Hospital, Ft. Ord, California, from 1 January 1990 to 31 December 1990. Results of the initial prenatal Papanicolaou smear, as well as repeat smears and colposcopies, were recorded. We believed that, although most prenatal care in the US is charged on a lump sum basis, true costs for initial Papanicolaou smears and any repeat smears or colposcopies required during pregnancy could be estimated from the corresponding charges for nonpregnant patients. Charges to patients for these procedures were obtained from two private practices in northern California (telephone communication with L. Hall and J. Yeash, March 1992), using the lesser of the charges in the analysis. The charge for the initial prenatal Papanicolaou smear was estimated at $25, which reflected only the charge for laboratory interpretation and handling. The charge for physician appointment time was not included in this figure, as the Papanicolaou smear is done during the initial prenatal physical examination, which generally includes a pelvic examination. The charge for a repeat Papanicolaou smear, requiring a separate or extended return visit, was estimated at $70. The colposcopy charge was estimated at $150.
We assumed that all suboptimal and inadequate Papanicolaou smears were repeated once during the pregnancy. All patients with smears showing squamous atypia without obvious cause or CIN were assumed to undergo a single colposcopic examination during the pregnancy. The total numbers of Papanicolaou smears and colposcopic examinations generated by these assumptions were calculated. By multiplying the number of procedures by the cost for each procedure and summing the results, the total projected cost generated by prenatal screening cervical cytology was calculated. This figure was then divided by the total number of patients to give an average cost per patient.

**Calculation of \( \Delta C_{\text{Morb}} \)**

The prevalence of CIN and cancer of the cervix in US women of childbearing age was obtained from a study of more than 1 million women receiving Papanicolaou smears at Planned Parenthood clinics from 1981 through 1983.\(^29\) Yearly transition rates between CIN I to III and invasive cancer were obtained from the National Center for Health Services Research cost-effectiveness study of cervical cytology, reported by Schweitzer and Luce.\(^30\) These baseline prevalence and transition rates are shown in Table 1. Only initial disease states that would prompt treatment or further evaluation based on the results of the initial prenatal Papanicolaou smear were considered. These disease states were mild-to-moderate dysplasia (CIN I to II), severe dysplasia or carcinoma in situ (CIN III), and invasive carcinoma. Assumptions used in calculating \( \Delta C_{\text{Morb}} \) were as follows:

1. If discovered and treated at the time of the initial prenatal Papanicolaou smear, 90 percent of invasive cervical cancers are curable; 10 percent are incurable.
2. If allowed to progress without treatment until the postpartum period, 60 percent of invasive cancers will be curable; 40 percent will be incurable.
3. Of all women with initial prenatal Papanicolaou smears showing dysplasia or carcinoma in situ (CIN I to III) who will progress to invasive carcinoma during the pregnancy, one-third will have invasion diagnosed early in the pregnancy and will be willing to undergo definitive treatment during the pregnancy. Two-thirds will receive definitive treatment after delivery, either because of later diagnosis or unwillingness to terminate the pregnancy for treatment.

4. Of all women with invasive cervical cancer diagnosed at the time of the initial prenatal Papanicolaou smear, 80 percent will receive early definitive treatment; 20 percent will choose to receive treatment after delivery.

5. The average cost of definitive treatment for a patient with incurable invasive carcinoma of the cervix is $10,000. The average total cost of medical care for a patient with incurable cervical carcinoma is $100,000.

An example of the calculation of \( \Delta C_{\text{Morb}} \) for initial disease state \( H_3 \) (CIN I to II) is shown below:

\[
H_3 = \text{probability that the initial Papanicolaou smear will show CIN I to II} = 0.0215
\]

\[
a_{35} = \text{probability of initial disease state } H_3 \text{ progressing to invasive carcinoma (disease state } H_3 \text{ in 1 year} = 0.004
\]

For a population of 100,000 pregnancies:

\[
(100,000)(0.0215) = \text{number of patients with CIN I to II on initial Papanicolaou smear} = 2150
\]

\[
(2150)(0.004) = \text{number of patients with CIN I to II progressing to invasive carcinoma during the next year} = 8.6
\]

If no prenatal Papanicolaou smear done:

\[
(8.6)(0.6) = \text{number of curable invasive cancers arising from initial disease state } H_3 \text{ diagnosed postpartum} = 5.16
\]

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**Table 1. Prevalence of Initial Disease States and Transition Rates to Invasive Cancer (All Ages).**

<table>
<thead>
<tr>
<th>Initial Disease State</th>
<th>Prevalence*</th>
<th>Transition Rate to Invasive Cancer per Year†</th>
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<tbody>
<tr>
<td>H₁: CIN I-II</td>
<td>0.0215</td>
<td>0.004</td>
</tr>
<tr>
<td>H₄: CIN III</td>
<td>0.0018</td>
<td>0.05</td>
</tr>
<tr>
<td>H₅: Invasive cancer</td>
<td>0.00001</td>
<td>1.0</td>
</tr>
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*Data from Sadeghi et al.\(^29\)
†Data from Schweitzer and Luce.\(^30\)
\(^{\circ}\)Cervical intraepithelial neoplasia.
(8.6)(0.4) = number of incurable invasive cancers arising from initial disease state \( H_3 \) diagnosed postpartum = 3.44

Total cost of treating invasive cancer arising from initial disease state \( H_3 \) if no prenatal Papanicolaou smear done:

\[
(5.16)(\$10,000) + (3.44)(\$100,000) = $395,600
\]

Number of curable invasive cancers arising from initial disease state \( H_3 \) if prenatal Papanicolaou smear is done = (total invasive cancers)(1/3 treated early)(90 percent curable) + (total invasive cancers)(2/3 treated late)(60 percent curable):

\[
(8.6)(1/3)(0.9) + (8.6)(2/3)(0.6) = 6.02
\]

Number of incurable invasive cancers arising from initial disease state \( H_3 \) if prenatal Papanicolaou smear is done = (total invasive cancers)(1/3 treated early)(10 percent incurable) + (total invasive cancers)(2/3 treated late)(40 percent incurable):

\[
(8.6)(1/3)(0.1) + (8.6)(2/3)(0.4) = 2.58
\]

Total cost of treating invasive cancer arising from initial disease state \( H_3 \) if prenatal Papanicolaou smear is done:

\[
(6.02)(\$10,000) + (2.58)(\$100,000) = $318,200
\]

Savings resulting from early diagnosis of invasive cancer by the prenatal Papanicolaou smear (initial disease state \( H_3 \)):

\[
\Delta C_{Mark}(H_3) = $395,600 - $318,200 = $77,400
\]

**Calculation of Life-Years Saved**

This calculation was made based on an average age of 30 years for pregnant women found to have invasive cervical cancer.\(^{9,29,31}\) At age 30 years, white US women have an average life expectancy of 50.2 years, while black US women have an average life expectancy of 45.7 years.\(^{32}\) Assuming a population that is 88 percent white and 12 percent black, the average female life expectancy at age 30 is 49.66 years. For women with incurable cervical carcinoma, average life expectancy was estimated at 3 well-years. The overall difference in life expectancy between curable and incurable disease was therefore 46.66 well-years. At a discount rate of 5 percent,\(^{26}\) the difference in life expectancy was 18.85 discounted well-years. The difference in number of curable cases of invasive cancer discovered with and without the prenatal Papanicolaou smear for each initial disease state was determined. This figure was then multiplied by the difference in life expectancy between curable and incurable cases to give a total number of life-years saved by doing the prenatal Papanicolaou smear.

Therefore, for initial disease state \( H_3 \) in a population of 100,000 pregnant women:

1. Number of curable cases of invasive cancer with the prenatal Papanicolaou smear = 6.02
2. Number of curable cases of invasive cancer without the prenatal Papanicolaou smear = 5.16
3. Total life-years saved (discounted at 5 percent) = (6.02-5.16)(18.85 years) = 16.21 years

**Results**

We reviewed 523 prenatal records, of which 423 (82 percent) had prenatal Papanicolaou smear results recorded. The average age of our sample was 24.8 years, and 86 percent of the sample were gravida 1, 2, or 3. Racial distribution was 66 percent white, 15 percent African-American, 7 percent Hispanic, 7 percent Asian, and 5 percent other or not recorded. Ninety-one percent of the patients were married, and 9.4 percent reported a history of sexually transmitted diseases. Thirteen percent were smokers, and 9.8 percent reported a history of abnormal Papanicolaou smears. The standard method of obtaining Papanicolaou smears during pregnancy in our hospital is by using a cotton swab for the endocervix and a wooden spatula for the ectocervix. Of the Papanicolaou smears recorded, 266 (63 percent) were interpreted as adequate (containing endocervical cells), 144 (34 percent) were suboptimal (not containing endocervical cells, but otherwise acceptable for interpretation), and 13 (3 percent) were inadequate. Three hundred ninety-four smears (95 percent) showed no evidence of abnormality, 16 (4 percent) showed squamous atypia without apparent cause, 3 (0.7 percent) showed inflammatory atypia, and 3 (0.7 percent) showed CIN.

Total costs generated by the prenatal Papanicolaou smear in our sample were \( \$24,205 \). This
figure represented an average cost of $57.20 per patient. For a population of 100,000 pregnant patients, the total cost generated by the prenatal Papanicolaou smear ($\Delta C_{P}$) comes to $5,720,000.

The total savings resulting from early diagnosis of invasive cervical cancer ($\Delta C_{B}$) was $180,000 for a population of 100,000. Undiscounted well-years saved came to 93.32 years, which corresponded to 37.7 years when discounted at 5 percent per year. These calculations, using the assumptions mentioned in the Methods section and a discount rate of 5 percent per year, produced a cost-effectiveness ratio for all ages of $146,400 per well-year. As the incidence of cervical carcinoma rises through the childbearing years, an age-stratification analysis was done by recalculating the cost-effectiveness ratio using age-specific values for prevalence of the various disease states from the Planned Parenthood Study and adjusting for differences in life expectancy at different ages. Calculation of costs and well-years gained were otherwise done using the same values and assumptions mentioned in the Methods section. The results of the age-stratification analysis are shown in Table 2.

### Sensitivity Analysis

Sensitivity analysis shows how the cost-effectiveness ratio changes as the underlying assumptions are varied. Table 3 shows the results of increasing and decreasing the various assumptions and baseline statistics.

An age-stratified recalculation of the cost-effectiveness ratio was also done using a different set of baseline data for the incidence of CIN III and invasive cancer. These data were collected by the Surveillance, Epidemiology, and End Results (SEER) program in Atlanta, Georgia, during 1981–1983. The cost per year of life saved for ages 15 to 24 years was $174,700; for ages 25 to 29 years, $87,100; for ages 30 to 34 years, $58,400; and for ages 35 to 44 years, $71,900.

### Discussion

Any cost-effectiveness study relies heavily on the assumptions used in the calculations. We tried to make our baseline assumptions as accurate as possible, realizing that accurate figures are not always available or that conflicting data might be present. In particular, statistics regarding the behavior of invasive carcinoma left untreated are not avail-

<table>
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<th>Table 3. Sensitivity Analysis.*</th>
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<tr>
<td>Variable</td>
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<tr>
<td>Baseline case</td>
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<tr>
<td>Cost of Papanicolaou smear and colposcopy</td>
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<tr>
<td>Percentage of initial smears requiring repeat (baseline value = 36.4%)</td>
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<tr>
<td>Prevalence rates for CIN and invasive cancer</td>
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<td>Transition rates to invasive cancer</td>
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<td>Cost of treatment of curable and incurable invasive cancer</td>
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<tr>
<td>Percentage of cases of invasive cancer incurable at time of diagnosis</td>
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<tr>
<td>Percentage of women undergoing early definitive therapy for invasive cancer with initial smear showing CIN (baseline value = 33%)</td>
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<tr>
<td>Discount rate for future costs and well-years</td>
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</tbody>
</table>

*Values are obtained by changing one variable or assumption at a time and recalculating the cost-effectiveness ratio holding all other variables and assumptions at their baseline values as described in the Methods section.

1Cervical intraepithelial neoplasia.
able. As our calculation of the health effects of letting an invasive cancer go untreated for up to 1 year was instrumental in determining the life-years saved, this weakness was unavoidable in our study. We believe that the baseline assumptions used in our analysis, however, are reasonable and in fact might exaggerate somewhat the aggressiveness of this tumor and the effectiveness of the prenatal Papanicolaou smear as a tool to diagnose it at a curable stage. For example, the higher the percentage of invasive lesions discovered at a curable stage by the prenatal Papanicolaou smear, the more cost effective it will appear in our analysis. We therefore tried to be conservative (favoring the performance of the smear) in our assumption that 90 percent of invasive cervical cancers discovered by the initial prenatal Papanicolaou smear are curable. Greater than 80 percent of these cancers in women younger than 35 years are stages I-A and I-B. The cure rate for stage I-A is essentially 100 percent; for I-B it is 80 to 90 percent. The assumption that after 1 year the average rate of cure of an untreated tumor falls to 60 percent is equivalent to saying that the average tumor discovered postpartum would be at stage II.

We could find no data on actual percentages of women found to have invasive carcinoma during pregnancy who elected to undergo early definitive treatment versus delaying treatment until after delivery. The literature of the past 10 to 15 years certainly seems to indicate widespread acceptance of delaying treatment until at least fetal viability and often to term for those women found to have invasive carcinoma in the last half of their pregnancy. For women with invasion diagnosed at the time of the initial Papanicolaou smear, faced with the choice of definitive treatment resulting in loss of the current pregnancy, as well as permanent sterilization, we believe that at least 20 percent of these patients would elect to continue the pregnancy. Our assumption that one-third of women with initial Papanicolaou smears showing CIN I to III and progressing to invasion during pregnancy will have their condition diagnosed early enough and be willing to undergo early definitive therapy represents what we believe to be a very conservative estimate. This assumption takes into consideration that if the initial Papanicolaou smear showing CIN is done at 8 to 12 weeks of gestation, progression to invasion must take place within 8 to 12 weeks for the invasive lesion to be diagnosed by 20 weeks' gestation. If, as we suspect, the actual fraction of women experiencing this rapid progression is less than one-third, the prenatal Papanicolaou smear would be shown to be even less cost effective than our baseline calculations indicate, as shown in the sensitivity analysis.

We acknowledge that the cost of definitive treatment for a patient with curable invasive carcinoma of the cervix, as well as total cost of medical care for a patient with incurable carcinoma, is likely to vary widely depending on other patient characteristics, medical care setting, and region of the country. For this reason we attempted to make estimates that would reflect a large monetary savings from early diagnosis and cure versus delayed diagnosis and lack of cure, thus favoring performance of the prenatal Papanicolaou smear. Our estimate of $10,000 for treatment of curable invasive carcinoma would represent average total cost of a hysterectomy, which is the treatment generally used for tumors up through stage II-A. Our estimate of $100,000 for cost of medical care for a patient with incurable carcinoma is meant to be on the high side, producing a large cost savings of $90,000 for each case diagnosed at a curable stage. It should be noted that varying these assumptions had a minimal effect on the final cost-effectiveness ratio, as shown in the sensitivity analysis.

Another important factor in our final result is the validity of the data for prevalence of CIN and invasive carcinoma, as well as the transition rates between these disease states. We believe that the data from the large Planned Parenthood sample are appropriate for this analysis for several reasons. The sample size was greater than 1 million, and it was collected from nearly 200 sites across the United States. Also, the population screened was of childbearing age and can be assumed to be sexually active. It is possible that this sample might be skewed toward women of lower socioeconomic status or those with multiple sexual partners. If this skewing is present, then incidence of sexually transmitted disease and CIN would be expected to be high. The effect of this would be to favor the performance of the prenatal Papanicolaou smear by making it appear more cost effective.

As the Planned Parenthood data only reflected Papanicolaou smear results, it is possible that they underestimated the prevalence of more advanced lesions, such as CIN III and invasive cancer. For
this reason we recalculated the results using the figures for CIN III and invasive cancer from the SEER program, which was an attempt to create a population-based database for cancer in the metropolitan Atlanta area. These figures represented incidence rates in an unselected population. Results from these data were similar to those from the Planned Parenthood figures.

We believe that the very thorough cost-effectiveness study by Schweitzer and Luce is the best available source of transition rates between levels of CIN and invasive cancer. It must be noted, however, that these rates were initially calculated from data obtained in the late 1950s. Their data included information on women with Papanicolaou smears for CIN that was evidently not treated. Data collected from 1962 to 1983 by Nasiell, et al. on women with cervical dysplasia who were without treatment suggested that transition rates to more severe dysplasia and invasion might actually be lower than those used for our analysis. Lower transition rates would result in a higher cost-effectiveness ratio, arguing against doing the prenatal Papanicolaou smear.

The costs generated by the prenatal Papanicolaou smear were derived from data obtained in a military family practice setting. This setting was distinguished by full employment and a comprehensive health care delivery system. There could understandably be questions regarding the generalizability of this sample to the US population as a whole. It should be noted that most (we estimate greater than 90 percent) of these patients were not active-duty soldiers but family members of soldiers. The data from our chart review were used only to determine the percentage of repeat testing Papanicolaou smears and colposcopies expected in a pregnant population. The percentage of suboptimal and inadequate smears requiring repeat in our sample is remarkably similar to the figure of 40.9 percent reported in 110 pregnant patients by Hamblin, et al. They reported the largest previous series we found on this information in a civilian setting.

The practice of discounting future expenditures and well-years gained is standard in cost-effectiveness analysis. Discounting corrects results for the difference in value between dollars spent now and the same number of dollars spent at some point in the future. For example, consider a situation with an option to spend $10,000 on a medical intervention now or spending $10,000 on an intervention 10 years in the future. It must be realized that investing the money now at a constant, real (adjusted for inflation) interest rate of 5 percent per year will in 10 years produce a total of ($10,000 × (1.05)^{10})$ = $16,289. Similarly $10,000 spent 10 years from now is equivalent to $10,000/(1.05)^{10}$ = $6,139 spent today. For the ratio between money spent and well-years saved to remain constant, well-years must also be discounted at the same rate. Discounting of well-years does not imply that years of life saved in the future are intrinsically any less valuable than years saved now, but to maintain the validity of the cost-effectiveness ratio and to make it comparable with ratios calculated for other procedures (most of which use a discount rate of 5 percent per year), this correction must be made. As all costs of the prenatal Papanicolaou smear are incurred now, rather than in the future, no discounting was done for costs.

The sensitivity analysis indicated how the cost-effectiveness ratio changes when our assumptions were varied. As discussed previously, we attempted to give the prenatal Papanicolaou smear the "benefit of the doubt" by making our baseline assumptions favor the performance of this test whenever possible. The sensitivity analysis therefore represented the variability of the cost-effectiveness ratio around conservative baseline assumptions. It can be seen that the ratio is fairly sensitive to the cost of the Papanicolaou smear and colposcopy, the prevalence rate of CIN and invasive cancer, the transition rates from CIN to invasive cancer, the percentage of cases of invasive cancer incurable at the time of diagnosis, the percentage of women undergoing early definitive therapy for invasive cancer, and the discount rate. The ratio is quite insensitive to the cost of treatment of invasive cancer and moderately insensitive to the percentage of initial smears requiring repeat.

There is no absolute figure for what constitutes a cost-effective procedure. The most that can be done is to rank tests and therapies for which this type of analysis has been done. The recommendation might be made then that, given a limited budget for health care, procedures costing more than a certain number of dollars per well-year saved are too expensive to be funded. The ratio for the prenatal Papanicolaou smear is considerably greater than those for other commonly done
procedures. Procedures studied within the past 10 years, including initial monotherapy of mild-moderate hypertension with propranolol, coronary artery bypass grafting, thrombolytic therapy with streptokinase in an 80-year-old patient, and cervical cytology in elderly women, have shown cost-effectiveness ratios ranging up to $30,000 per year of life saved (discounted at 5 percent). For women older than 25 years, the cost per year of life saved incurred by the prenatal Papanicolaou smear is comparable with that of adding yearly mammography to a yearly breast examination for women younger than 50 years, a recommendation that has been criticized from an economic viewpoint. The risk of developing cervical cancer for any particular group of women determines whether Papanicolaou smear screening should be done at all. The length of time taken for detectable preinvasive disease to develop into invasive cancer is the determining factor in deciding how frequently cancer screening should be done. The question of the need for prenatal Papanicolaou smears is basically part of the question of frequency of screening. During the past 12 years, recommendations have been made suggesting that the routine yearly Papanicolaou smear itself can be eliminated in favor of every 2 to 3 years following 3 consecutive normal yearly smears. A prenatal Papanicolaou smear would therefore not be necessary unless the patient had not been screened previously according to these guidelines. That these guidelines have been controversial as well as the firmly established nature of the prenatal Papanicolaou smear in US medical practice, contributes to the widespread routine performance of this test. There is currently some controversy whether women who are at high risk for developing cervical cancer are also at high risk for developing a rapidly progressive variety of the disease. If these women are at higher risk for rapidly progressive disease, then such risk factors as coitus at an early age and multiple sexual partners would suggest the need for more frequent screening. This study shows that for women younger than 25 years, performing a routine prenatal Papanicolaou smear generates costs of greater than $140,000 for every well-year of life gained. For older women, these costs decrease but are still quite high for a screening procedure. While we believe our baseline assumptions tended to favor the prenatal Papanicolaou smear, it should be emphasized that the final cost-effectiveness ratios were quite sensitive to changes in these assumptions. Our data should be applicable to most childbearing-age women in the US. Subsets of women who are believed to be at exceptionally high risk for developing rapidly progressive disease or who have not been previously screened by Papanicolaou smear might not be adequately represented by our analysis. For a patient who has had normal findings on a cervical cytologic examination within the previous 2 to 3 years and who can be reasonably expected to return for a postpartum Papanicolaou smear, the benefits of obtaining a prenatal smear appear to be quite small in relation to its cost. For this population, it seems well within an acceptable standard of care for this procedure to be eliminated.

References


