

# De Novo Establishment and Cost-Effectiveness of Papanicolaou Cytology Screening Services in the Socialist Republic of Vietnam

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**BACKGROUND.** Cervical carcinoma is the leading cause of cancer-related death among women in the developing world. The absence of cervical screening in Vietnam and other developing countries is due in large part to the perceived expense of implementing Papanicolaou cytology screening services, although, to the authors' knowledge, the cost-effectiveness of establishing such services has never been studied in a developing country.

**METHODS.** Using decision analytic methods, the authors assessed cost-effectiveness of Pap screening from a societal perspective in Vietnam, the world's 9th most populous developing country (estimated 1999 population, 79 million). Outcomes measured included life expectancy, cervical carcinoma incidence, cost per woman, and cost-effectiveness.

**RESULTS.** Total costs to establish a nationwide 5-year interval Pap screening program in Vietnam will average less than \$148,400 annually during the 10-year time period assumed necessary to develop the program and may be considerably lower if only high risk geographic areas are targeted. Maintenance costs will average less than \$0.092 annually per woman in the target screening population. Assuming 70% program participation, cervical carcinoma incidence will decrease from 26 in 100,000 to 14.8 in 100,000, and cost-effectiveness will be \$725 per discounted life-year. Several assumptions used in this analysis constitute biases against the effectiveness of Pap screening, which in reality may be significantly more cost-effective than reported here.

**CONCLUSIONS.** Contrary to widespread belief, Pap screening in developing countries such as Vietnam is extraordinarily inexpensive and appears to be cost-effective. Because prospects are uncertain regarding useful alternatives to the Pap test, the evidence-based argument for establishing conventional Pap screening services in developing countries such as Vietnam is compelling. Population-based conventional Pap screening services have been established de novo in Vietnam and are now operational. *Cancer* 2001;91:928–39. © 2001 American Cancer Society.

**KEYWORDS:** cervical carcinoma, Pap screening, Vietnam, developing country, cost-effectiveness analysis, quality control.

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Cervical carcinoma is the leading cause of cancer-related death among women throughout the developing world,<sup>1</sup> including the Socialist Republic of Vietnam.<sup>2</sup> The impact of this disease is likely to increase over time. Declining birthrates throughout the developing world, including Vietnam,<sup>3</sup> have induced a profound demographic transition that is leading to a shift in disease burden away from communicable diseases of childhood toward cancer and other diseases of adulthood.<sup>4</sup> On a global scale, cervical carcinoma is probably the most preventable form of cancer-related death among women. In 1947, before the widespread introduction of Pap screening, the incidence rate of invasive cervical carcinoma in the United States was 44 in 100,000,<sup>5</sup> which is similar to cervical carcinoma incidence rates reported today for many developing countries. By 1996, nationwide Pap screening efforts had reduced the incidence rate of invasive cervical carcinoma in the United States to 7.5 in 100,000.<sup>6</sup> In contrast, fewer than 5% of women in developing countries (where > 80% of new cases of cervical carcinoma occur) have ever received a Pap test.<sup>7</sup>

The Viet/American Cervical Cancer Prevention Project concluded Memoranda of Understanding in Hanoi in September 1996 and in Ho Chi Minh City in December 1998 to begin the development of Pap screening services in Vietnam. World Bank cost-effectiveness estimates previously had established cervical carcinoma prevention as a public health intervention warranting high priority in regions of the developing world with high rates of cervical carcinoma.<sup>8</sup> However, widespread belief persists that Pap screening in developing countries would be prohibitively expensive,<sup>9-11</sup> as the cost for a single Pap test in the developing world has been assumed to range between \$3 and \$10.<sup>12</sup> Vietnamese and international health policymakers had expressed reasonable concerns regarding financial requirements for Pap screening in Vietnam. In response to these concerns, each memorandum authorized a cost-effectiveness analysis for Pap screening in Vietnam. The objectives of our analysis, reported here, were to estimate budgetary and personnel requirements for a Vietnamese Pap screening program and to assess the likely impact of such a program on health outcomes in Vietnam. Our analysis also establishes a baseline from which to assess the cost-effectiveness of alternative screening methods in Vietnam, should such assessments be indicated in the future. Cervical carcinoma prevention services currently are being developed in Vietnam based on our cost-effectiveness analysis, and future studies will evaluate its predictive accuracy. Its immediate relevance derives from its usefulness as an essential evidence-based template from which this large develop-

ing country can begin to address a public health problem of considerable significance.

## METHODS

Cervical carcinoma prevention services currently are being developed in Vietnam in careful coordination with the emerging National Cancer Control Program.<sup>13,14</sup> Training in cytotechnology, cytopathology, gynecology, gynecologic oncology, and radiation oncology is ongoing and has been provided at Allegheny General Hospital in Pittsburgh, Kaiser Permanente (Northern California), Stanford University, the University of Iowa, the University of Texas Medical Branch at Galveston, and Washington University in Saint Louis to Vietnamese medical personnel from the Ho Chi Minh City Cancer Center, the Ho Chi Minh City Department of Maternal and Child Health Services, Hospital K in Hanoi, Da Nang General Hospital, and Hue Central Hospital. On-site training is ongoing and has been provided by volunteer delegations of American project consultants from Allegheny General Hospital, Bangor Medical Laboratories (Maine), the Brigham and Women's Hospital, Health Network Laboratories (Pennsylvania), Kaiser Permanente (Northern California and Oregon), the Massachusetts General Hospital, Oregon Health Sciences University, San Francisco State University, Spokane Medical Associates (Washington), Stanford University, the University of Alabama at Birmingham, the University of California at San Francisco, the University of Iowa, the University of Southern California, the University of Texas Medical Branch at Galveston, and Washington University in Saint Louis.

In Vietnam, two screening, treatment, and administrative networks have been established in Ho Chi Minh City (Southern Network) and in Hanoi (Northern Network). Centralization of these networks facilitates quality control efforts, reduces overhead costs, and assists in tracking the screened population. This cost-effectiveness analysis models the end effect of a hypothetical fully established Vietnamese cervical carcinoma prevention program. It is assumed that phased establishment of the program will occur over a period of 10 years, and that women between the ages of 30 and 55 (the target screening population) will have a Pap test every 5 years. Invasive cervical carcinoma is rare before the age of 30 years<sup>2</sup> or among postmenopausal women with a history of negative Pap tests.<sup>15,16</sup> Because the mean progression rate of a high grade squamous intraepithelial lesion (HSIL) to invasive cervical carcinoma is greater than 5 years,<sup>17,18</sup> a 5-year screening interval will detect most high grade lesions before they progress. In 2014, there will be 13,790,700 women in Vietnam between the ages of 30

and 55.<sup>19</sup> Therefore, 2.8 million women per year will have a Pap test.

### Decision Model

Our decision model has been described in detail previously.<sup>20</sup> In our cost-effectiveness analysis, 5-year interval Pap test screening, with follow-up for subsets of women with certain Pap test diagnoses, was compared with a no-screening strategy (the current situation). Pap tests are interpreted using Bethesda System terminology.<sup>21</sup> Women whose Pap tests show atypical glandular cells of uncertain significance (AGUS), HSIL, or invasive carcinoma are referred to colposcopy for biopsy and/or endocervical curettage.<sup>22</sup> Women with any other Bethesda System diagnosis receive no additional follow-up until the repeat test in 5 years.<sup>23</sup> If the cervical biopsy or endocervical curettage is interpreted as invasive carcinoma, the woman is referred out of the program for appropriate staging, treatment, and follow-up.

If the colposcopic biopsy or endocervical curettage shows cervical intraepithelial neoplasia (CIN) I or reactive changes, a follow-up Pap test in 5 years is performed.<sup>24</sup> If the colposcopic biopsy or endocervical curettage shows CIN II or CIN III, the woman is referred for a loop electrosurgical excision procedure (LEEP).<sup>25</sup> Although the relative efficacy of LEEP and cryosurgery for the suppression of high grade cervical disease is debated,<sup>26,27</sup> LEEP is chosen for its ability to produce the tissue specimen required both to distinguish invasive carcinoma from intraepithelial lesions and to provide cytohistologic correlation, which in developing countries is of critical importance for quality control efforts.<sup>28</sup> Loop electrosurgical excision procedure is chosen over other excisional treatment modalities (e.g., cold-knife cone excision) because of its lower cost and ease of use.<sup>29</sup> All women who have a LEEP are reevaluated after 1 week for possible treatment complications. If tissue from a LEEP is interpreted as CIN II or CIN III, women receive an annual Pap test for 5 consecutive years.<sup>24,30,31</sup> If there are no Bethesda System diagnoses of AGUS, HSIL, or carcinoma during this 5-year time period, these women are again followed up with Pap tests every 5 years. If surgical tissue from a LEEP is interpreted as invasive carcinoma, the woman is referred out of the program for appropriate staging, treatment, and follow-up.

A woman who does not have a Pap test may develop an invasive carcinoma and her survival depends on whether or not she receives treatment.<sup>32-35</sup> A woman who has a Pap test may not develop an invasive cervical carcinoma because 1) she does not have a preneoplastic lesion that could develop into an invasive carcinoma or 2) she has a preneoplastic lesion

**TABLE 1**  
Probabilities and Estimates Used in the Decision Model

Item	Probability or estimate
Probability of CIN II or III on cervical biopsy with Pap diagnosis of <sup>17,23,30</sup>	
HSIL	95%
AGUS	25%
LSIL	10%
ASCUS	8%
Benign or unsatisfactory	0.03%
Progression of HSIL to invasive carcinoma <sup>17,18</sup>	5% per year
Progression of HSIL to invasive carcinoma	
In 5.0 yrs <sup>17,18</sup>	20%
In 6.7 yrs	50%
In 8.3 yrs	80%
Cervical carcinoma incidence in Vietnam <sup>2</sup>	26 per 100,000
Life expectancy at birth of a woman in Vietnam <sup>19</sup> (yrs)	70 yrs
Mean age of cancer detection in Vietnam <sup>2</sup> (yrs)	50 yrs
Average rates of call for Bethesda System diagnoses <sup>40,41</sup>	
AGUS	0.3%
HSIL	0.4%
LSIL	1.6%
ASCUS	4.0%
5-year cervical carcinoma survival rate <sup>35</sup>	48%

HSIL: high grade squamous intraepithelial lesion; AGUS: atypical glandular cells of uncertain significance; LSIL: low grade squamous intraepithelial lesion; ASCUS: atypical squamous cells of uncertain significance.

that is detected by a Pap test and is effectively treated. A woman who has a Pap test still could develop an invasive cervical carcinoma if 1) she has a negative Pap test and develops an invasive cervical carcinoma during the interval time, or 2) she has a false-negative diagnosis (on either Pap test or colposcopy) and develops invasive cervical carcinoma during the interval time.

### Probabilities and Estimates

Not all HSILs progress to invasive carcinoma, and the literature reports a wide range of progression rates.<sup>17,18</sup> Although each different HSIL subtype has a different progression rate,<sup>36</sup> these rates were combined in this model. Assuming 5-year screening intervals, a proportion of "missed" HSILs will progress to cancer. Our model assumed a relatively rapid<sup>17,18</sup> mean progression time of 6.7 years, which constitutes a bias in favor of the no-screening strategy as more HSILs are missed as more rapid progression times are assumed. If an HSIL that would progress to cancer is missed on two screening examinations, then it is assumed that the HSIL would progress to cancer before the third examination. Lesions of CIN I were assumed not to progress to cancer.<sup>24</sup> There is a probability of a CIN II or CIN III given any Bethesda System diagnosis (Table 1).<sup>23,37</sup> The probability is greatest for HSIL and

lower for diagnoses of low grade squamous intraepithelial lesion (LSIL) and ASCUS. Although the cost-effectiveness of Pap screening increases in proportion to disease prevalence,<sup>30</sup> our model was based on the incidence rate of 26 in 100,000 reported from Ho Chi Minh City.<sup>2</sup> This figure, based on passive case finding, probably underestimates the burden of disease throughout southern Vietnam, where most Vietnamese reside. The incidence rate of cervical carcinoma, based on active case finding, among women who migrated from (predominantly southern) Vietnam to the United States is 43 in 100,000,<sup>38</sup> even though 50% of these women report having received at least one Pap test after their arrival in the United States.<sup>39</sup> The mean age at invasive cervical carcinoma detection was estimated from data obtained in Ho Chi Minh City to determine the gain in patient life expectancy for patients undergoing Pap screening. Vietnamese laboratory atypical rates were assumed to be the same as those in an average American laboratory.<sup>40,41</sup> Because American laboratory atypical rates reflect the prevalence of cervical disease in a low risk, previously screened population, Vietnamese laboratory atypical rates will likely be significantly higher than those assumed for this analysis. It is thereby assumed that Vietnamese laboratories will miss a significant proportion of high risk cervical disease, which constitutes a bias in favor of the no-screening strategy.

### Costs

Costs were categorized with regard to personnel salaries (Table 2), disposable supplies (Table 3), and equipment, space, and overhead (Table 4). Vietnam only recently has emerged from a half-century of internal and international conflict, and per capita income, as well as health care salaries, are among the lowest in the developing world. However, the ratio of public sector physician income to per capita income in Vietnam is roughly equivalent to the ratio of public sector physician income<sup>42,43</sup> to per capita income in the United States.<sup>44</sup>

To determine the number of personnel required in each work category, time motion studies (Table 5) were performed with regard to Pap test collection, laboratory services, treatment, and administration.<sup>45</sup> All costs were determined on a per-woman basis irrespective of whether any particular woman received treatment. Disposable supplies were costed per patient. All women screened incurred Pap test collection costs and cytology laboratory costs. All other costs were distributed evenly across the entire screened population. Only a low percentage of the screened population incurred gynecologic costs and follow-up costs (Table 1). It was assumed that clinic and labora-

**TABLE 2**  
Personnel Salaries (Partial Listing)

Category	Position	Salary per month (1999 U.S.\$)
Administration	Secretary	21
	Location manager	30
	Subdirector	90
Pap smear collection	Director	107
	Collector	42
	Public health outreach worker	40
	Driver and/or assistant	30
	Field manager	50
	Subdirector	90
	Director	107
Pathology laboratory	Secretary	21
	Secretarial manager	30
	Preparation technologist	42
	Preparation technologist manager	47
	Histotechnologist	42
	Histotechnologist supervisor	47
	Cytotechnologist	42
	Cytotechnologist supervisor	47
	Physician assistant	50
	Pathologist	70
	Director	107
Gynecologic office	Secretary	21
	Secretarial manager	30
	Physician assistant	50
	Gynecologist	70
	Director	107

tory space will be purchased and outfitted with new equipment. Space and overhead costs were calculated on a yearly basis. Equipment costs were calculated using 10-year depreciation rates. An exchange rate of 14,000 Vietnamese dong per U.S. dollar was used. All costs were discounted at a fixed annual rate of 3%.<sup>46,47</sup>

### Outcomes

For each strategy, the outcomes measured were patient life expectancy, invasive cervical carcinoma incidence, cost per patient, and cost-effectiveness.<sup>46,47</sup> It was assumed that a woman who did not have an HSIL, or who had an HSIL that was treated, or who had an HSIL that was not treated and did not develop into cervical carcinoma had a normal life expectancy. A woman who had an HSIL that developed into cervical carcinoma had a decreased life expectancy because her risk of dying from cervical carcinoma was increased. If an HSIL progressed to invasive cervical carcinoma, the patient's life expectancy depended on clinical stage at the time of diagnosis and whether or not she received treatment. Life expectancies were discounted at a fixed annual rate of 3%.<sup>48</sup> Cost-effectiveness was determined by using the no-screening strategy as the reference strategy. Cost-effectiveness of

**TABLE 3**  
**Disposable Supply Costs (Per Woman Screened or Treated,**  
**Partial Listing)**

Category	Item	Cost per woman (1999 U.S.\$)
Pap smear collection	Modified wooden Ayre spatula	0.04
	Lubricant	0.01
	Informational pamphlet	0.01
	Speculum cleanser (chlorine + autoclave)	0.01
	Alcohol fixative	0.04
	Gloves	0.01
Cytology laboratory	Pap smear stains	0.05
	Cover slip	0.04
	25 × 75-mm glass slide	0.03
	Mounting medium	0.02
	Alcohol	0.04
	Gloves	0.01
Gynecologic treatment	Reusable LEEP electrode	2.80
	Scratch/ground pad	0.02
	Lidocaine	0.35
	Syringe	0.05
	Needle	0.13
	Speculum cleanser	0.01
	Gloves	0.01
	Formalin	0.01
Pathology laboratory	Surgical pathology stains	0.03
	Cassette	0.02
	Curettage bag	0.01
	Paraffin	0.02
	Cover slip	0.04
	25 × 75-mm glass slide	0.03
	Mounting medium	0.02
	Alcohol	0.04
	Gloves	0.01
	Gynecologic follow-up	Speculum cleanser
	Gloves	0.01

LEEP: loop electrosurgical excision procedure.

the screening strategies was expressed as the additional cost required to gain a discounted year of life expectancy per patient.<sup>46,47</sup>

### Data Sources

Demographic data were obtained from the General Statistical Office of Vietnam in Hanoi. Probability data were obtained from a MEDLINE search of the literature published between 1960 and 2000. Cost data were obtained between December 1998 and December 1999 from the Ho Chi Minh City Cancer Center, the Department of Health Services of Ho Chi Minh City, Hospital K in Hanoi, the Department of Child and Maternal Health Services of Ho Chi Minh City, the Binh Thanh District Health Center of Ho Chi Minh City, and manufacturer catalogs. Time motion studies were performed at the Ho Chi Minh City Cancer Center and Allegheny General Hospital.

### RESULTS

In Table 6, the end effects, after a 10-year phased establishment period, of a 5-year interval Pap test screening program are shown. Gains in life expectancy and cost-effectiveness are compared with the no-screening strategy. Regardless of the level of participation by women in the target screening population, the cost per woman screened to establish cervical carcinoma prevention services is less than U.S. \$0.53. Even assuming large percentage increases in all costs, the cost per woman screened to establish cervical carcinoma prevention services remains less than U.S. \$1 (data not shown). The total cost to establish screening services for 2.8 million women will be \$1,204,000 if 60% of women in the target screening population participate in the screening protocol, and \$1,484,000 with 100% program participation. Costs per woman increase with higher levels of program participation due to increases in personnel requirements for the screening program. Cervical carcinoma incidence and mortality rates were reduced by 37% with 60% program participation, and by 58% with 100% participation.

In Table 7, health outcomes and personnel requirements during different phases of project establishment are outlined, assuming 70% program participation. After 10 years, the number of women screened per year will be constant, and after 12 years the maximum effect of the cervical carcinoma prevention service will be attained. Personnel numbers by various positions were determined from data in Tables 1 and 5.

In Table 8, health outcomes for Vietnamese women given different screening intervals are shown. As the screening interval increases, more women develop cervical carcinoma and more women die from cervical carcinoma. Assuming a 70% level of program participation, cervical carcinoma incidence and mortality rates were reduced by 27% with 10-year screening intervals, and by 43% with 5-year screening intervals. With 100% program participation, incidence and mortality rates were reduced by 58% with 5-year screening intervals.

### DISCUSSION

Contrary to widespread belief, Pap screening services in developing countries such as Vietnam are extraordinarily inexpensive. The total cost to establish a nationwide Pap screening program in the world's 9th most populous developing country will average less than 148,400 1999 U.S. dollars annually during the 10-year time period assumed necessary to develop the program. Because cervical carcinoma rates in northern Vietnam<sup>49,50</sup> are reported to be substantially lower

**TABLE 4**  
**Equipment, Space, and Overhead Costs (Partial Listing)**

Category	Item	Cost (1999 U.S.\$)
Pap smear collection	Clinic space required per Pap test collector FTE	9 m <sup>2</sup>
	Clinic space (purchase)	107/m <sup>2</sup>
	Overhead (telephone, electricity, janitorial services, pens, paper, etc.)	0.75/m <sup>2</sup>
	Speculum	4.50
Laboratory	Computer	1400
	Lab space required to prep and screen 10,000 Pap tests annually	20 m <sup>2</sup>
	Lab space (purchase)	180/m <sup>2</sup>
	Overhead	1/m <sup>2</sup> /mo
	Stain containers	50
	Microscope (per pathologist/cytotech FTE)	4000
	Cytotechnologist cubicle	200
	Pathologist office equipment	200
	Solvent recycler	12,000
	Tissue processor	10,000
	Storage box	15
	Scalpel handle	5
	Embedding mold	5
	Embedding station	7000
	Staining rack	5
	Scalpel blade	1
	Reagent containers	5
	Microtome	8000
	Fumehood	1500
	Microtome blade	200
Microtome blade sharpener	900	
Microtome bath	400	
Forceps	2.50	
Gynecologic treatment and follow-up	Clinic space required per gynecologist FTE	12 m <sup>2</sup>
	Clinic space (purchase)	107/m <sup>2</sup>
	Overhead	0.75/m <sup>2</sup> /mo
	Colposcope	3600
	Linens	5/FTE
	LEEP unit	3600
	Examination table	250

FTE: full-time equivalent; LEEP: loop electrosurgical excision procedure.

than in southern Vietnam, budgetary and personnel requirements will be significantly reduced if only high-risk geographic areas are targeted for screening. Maintenance costs will be driven primarily by disposable supply and salary expenses and will average less than \$0.092 per year per woman in the target screening population, an amount that appears affordable even without governmental subsidies as annual income in 1999 averaged \$300 per capita.<sup>51</sup>

At this level of investment, our decision analytic model predicts that cervical carcinoma incidence and mortality rates in Vietnam will be reduced by 37–58% after the 10-year program establishment period. Other published Pap screening models have predicted significantly greater benefits from 5-year interval Pap screening programs in developing countries.<sup>52,53</sup> Our model assumed a relatively rapid progression rate of HSIL to invasive cancer, relatively low prevalence rates

of disease in southern Vietnam, and relatively poor diagnostic performance by Vietnamese cytology laboratories. These constitute biases against the clinical effectiveness of Pap screening in Vietnam that, in reality, may be significantly more effective than predicted by our model. The level of participation by women in the target screening population will be of critical importance to overall program effectiveness (Table 6). To expeditiously extend screening services to the entire target screening population, we will not encourage Pap screening at intervals less than 5 years. Although a 5-year Pap screening interval does not conform to the standard of care in the United States, a 5-year interval Pap screening program initiated in Finland in 1963 has been associated with 80% reductions in both cervical carcinoma incidence and mortality rates.<sup>54</sup> After 5-year interval Pap screening has been extended to the entire target screening population in

TABLE 5<sup>a</sup>  
Time Motion Assessments<sup>45</sup>

Category	Task	Unit performance per hr
Pap smear collection Laboratory	Pap smear collection	4
	Accessioning	12
	Filing glass slides	30
	Preparation of Pap smear	15
	Grossing biopsy specimen	15
	Grossing LEEP specimen	3
	Cytotechnologist interpretation	7.5
	Cytopathologist interpretation	5
	Pathologist interpretation of biopsy	5
Gynecology office	Pathologist interpretation of LEEP	3
	Colposcopy with biopsy	2
	Colposcopy with LEEP	1
	Return office visit	4

LEEP: loop electrosurgical excision procedure.

<sup>a</sup> Table adapted, not reprinted from source.

Vietnam, reduced screening intervals may be encouraged, and women with low grade cervical abnormalities may be targeted for more thorough follow-up evaluation.

Assuming a 70% level of participation by women in the target screening population, the cost-effectiveness of Pap screening will be 725 1999 U.S. dollars per discounted life-year (Table 6). Pap screening appears to be cost-effective in Vietnam, although there currently is no consensus regarding levels of expenditure deemed absolutely cost-effective in the developing world. In the United States, a ratio of \$50,000 per discounted life-year gained is viewed as a reasonable expenditure that has been used as a gauge of cost-effectiveness.<sup>55</sup> In Scandinavia, Pap screening has been associated with an increase in the proportion of invasive cervical carcinomas detected at earlier, more curable stages of disease progression,<sup>56</sup> and with reduced costs for curative treatment in the screened population relative to the unscreened population.<sup>57</sup> Costs associated with the treatment and care of Vietnamese women with invasive cervical carcinoma were not included in our model. This is a bias that would appear, based on the Scandinavian experience, to favor the no-screening strategy. However, as experience with Pap screening in developing countries is still quite limited, the effects of screening on stage redistribution of cervical carcinoma in the developing world are not yet known. Socioeconomic costs associated with cervical carcinoma, such as lost work productivity due to disability, were not considered in our model. This also constitutes a bias that appears to favor the no-screening strategy and, in reality, Pap

screening in Vietnam may be significantly more cost-effective than described by this report. Due to projected reductions in mortality from diseases other than cervical carcinoma, life expectancy at birth for women in Vietnam is predicted to increase,<sup>58</sup> which in turn would increase the future cost-effectiveness of Pap screening in Vietnam.<sup>30</sup> However, future effects of the global pandemics of acquired immune deficiency syndrome (AIDS)<sup>59</sup> and tobacco addiction<sup>60</sup> on life expectancy among women in Vietnam are uncertain. In parts of Africa, AIDS is projected to shorten life expectancies by greater than 25% during the next 10 years.<sup>61</sup>

It generally is accepted that cervical carcinoma is caused by persistent infection of cervical epithelium by high risk subtypes of human papillomavirus (HPV),<sup>62</sup> a sexually acquired pathogen. Prophylactic vaccines targeting HPV-associated epitopes are being investigated as potentially definitive primary cervical carcinoma prevention strategies.<sup>63</sup> However, due to the prolonged lag time between initial HPV infection and the development of cervical carcinoma,<sup>17,64</sup> prospective efficacy trials for any candidate vaccines will require years if not decades to complete,<sup>65,66</sup> and an additional 20–30 years may elapse from the time any vaccine is first licensed to the time most of those in developing countries have access to it.<sup>67</sup> Moreover, HPV vaccines, even if fully immunogenic systemically, may fail to confer adequate mucosal protection for the cervical epithelium in which the virus induces neoplastic lesions<sup>65</sup> and therefore may ultimately fail to prevent cervical carcinoma.

Liquid-based cytology collection systems,<sup>10</sup> computer-assisted Pap screening equipment,<sup>68</sup> and biochemical methods for the detection of HPV nucleic acids<sup>69</sup> have been suggested as adjuncts/alternatives to the Pap test in low-resource settings. In Vietnam, the cost of disposable laboratory supplies required for each Pap test is \$0.19 (Table 3). In the United States, liquid-based collection systems (ThinPrep 2000; Cytoc-Sands Inc, Boxborough, MA) add \$9.75 in disposable laboratory supply costs to each Pap test, and computer-assisted Pap screening equipment (Auto-Pap 300QC; NeoPath Inc, Redmond, WA) adds \$5.00 to each Pap test,<sup>70</sup> in addition to considerable up-front equipment acquisition costs. Human papillomavirus DNA assays (Hybrid Capture II; Digene Inc, Gaithersburg, MD), the usefulness of which for primary screening purposes is debated,<sup>71–73</sup> currently are priced at approximately \$20.00 per test in the United States. (Averaged from a survey of large American commercial pathology laboratories.) These novel laboratory-based methods appear to be prohibitively cost-additive in Vietnam, although their cost-effec-

**TABLE 6**  
Health Outcomes of Pap Screening Given Different Levels of Participation by Women in Target Screening Population

Participation level	Invasive cervical carcinoma incidence per 100,000	Cervical carcinoma mortality per 100,000	Gain in life expectancy per woman (in discounted days)	Cost per woman (in 1999 U.S.\$)	Cost-effectiveness (in 1999 U.S.\$ per discounted life-year)
No screening (reference strategy)	26.0	13.5	—	—	—
60%	16.2	8.4	0.20	0.43	785
70%	14.8	7.7	0.23	0.45	725
80%	13.5	7.0	0.26	0.48	680
90%	12.2	6.3	0.28	0.50	651
100%	11.0	5.7	0.31	0.53	628

**TABLE 7**  
Health Outcomes and Selected Personnel Requirements during Different Phases of Prevention Project Establishment, Assuming Participation by 70% of Women in Target Screening Population

Year	No. of women screened per yr	Invasive cervical carcinoma incidence per 100,000	No. of Pap test collectors required	No. of cytotechnologists required	No. of gynecologists required
1	20,000	26.0	2	2	1
2	50,000	25.9	5	4	1
3	100,000	25.9	11	8	1
4	200,000	25.7	21	15	1
5	400,000	25.4	42	29	1
6	700,000	24.8	73	51	2
7	1,100,000	23.9	115	79	3
8	1,600,000	22.7	167	115	5
9	2,200,000	20.9	229	159	7
10	2,800,000	18.7	292	204	9
By this time, American participation in Vietnam's cervical cancer prevention program is no longer necessary. The Viet/American Cervical Cancer Prevention Project dissolves.					
11	2,800,000	16.4	292	204	9
12	2,800,000	14.8	292	204	9

tiveness has not yet been studied in any developing country. Some adherents to the widespread belief that conventional Pap screening would be prohibitively expensive in low-resource settings paradoxically suggest delaying the implementation of cervical screening in developing countries pending further refinement of these cost-additive adjuncts/alternatives.<sup>10</sup> Conversely, any of these novel methods could readily be phased into previously established conventional Pap screening programs should future cost-effectiveness studies find such modifications beneficial from a societal perspective.

Although the high false-positive rate of colposcopy appears to preclude its use as a primary screening tool,<sup>74</sup> visual screening techniques with lower test specificity have been advocated for primary screening in regions of the world where Pap screening is perceived as unlikely to become available.<sup>75-77</sup> Because

Pap screening is the best available strategy for cervical carcinoma prevention,<sup>78</sup> there is no justification for establishing visual screening programs in areas of the world, such as Vietnam, where Pap screening is perceived to be feasible. Although the geographic specification of such regions is largely a matter of debate,<sup>79</sup> visual screening programs currently are being established throughout the developing world.<sup>80</sup> Women with false-positive and true-positive visual screening test results undergo immediate cryosurgical treatment,<sup>81</sup> although the effects of large scale surgical overtreatment on health outcomes among women in developing countries are unknown. Visual screening techniques combined with ablative treatment methods produce no physical evidence on which to base meaningful program audits. Because effective methods for quality control of visual screening programs therefore are difficult to envision,<sup>82</sup> it probably will not

**TABLE 8**  
**Health Outcomes for Vietnamese Women Given Different Screening Intervals, Assuming Participation by 70% of Women in Target Screening Population**

Screening interval (yrs)	Invasive cervical carcinoma incidence per 100,000	Cervical carcinoma mortality per 100,000	Gain in life expectancy per woman (discounted days)
5	14.8	7.7	0.23
6.7	16.4	8.5	0.20
8.3	17.9	9.3	0.16
10	18.9	9.8	0.14
No screening (reference strategy)	26.0	13.5	—

be possible to monitor the successes or the failures of these programs outside of carefully controlled research settings. Ineffective quality control has been a deficiency of fundamental importance to the failure of Pap screening programs throughout the developing world.<sup>83</sup>

In the face of these findings and uncertainties, the evidence-based argument for establishing conventional Pap screening services in developing countries such as Vietnam becomes compelling. In September 1999, population-based Pap screening was instituted in the Binh Thanh District of Ho Chi Minh City at an initial screening velocity of 150 women per day. Pilot programs in Hue and in Da Nang were interrupted temporarily by catastrophic flooding throughout central Vietnam during the winter of 1999, which at its crest left Hue Central Hospital under 2 m of water. Population-based Pap screening was initiated in the Vinh Ninh District of Hue in September 2000. Pilot-scale screening continues in Hanoi as we assess whether or not cervical carcinoma in northern Vietnam constitutes a public health problem of sufficient magnitude to warrant the initiation of mass screening. As the nationwide program expands, the primary staffing needs (Table 7) will be for cytotechnologists, and for Pap test collectors who will work closely with a variety of community outreach organizations. Numeric requirements for gynecologists will be low. Expert technical assistance will be required for cytotechnology and cytopathology training. Costs of such assistance were not measured in this analysis, as international agencies, rather than Vietnamese society, have assumed these costs to date<sup>84</sup> and can be reasonably expected to continue doing so in the future.<sup>85</sup> The critical technical complexities of the screening program will focus on quality control maintenance in the cytology laboratories. Contemporary methods for cytology quality control have not yet been introduced to any significant extent in developing countries.<sup>86,87</sup> Focused, sequential sweeps of administratively pre-terminated districts throughout high risk provinces in

Vietnam will reduce the organizational complexity required to coordinate clinical access and laboratory workload with comprehensive community outreach efforts. Organized screening (i.e., regular invitation of defined target groups) generally is considered to be more effective than opportunistic screening,<sup>88</sup> and community outreach by lay health workers may be more effective in changing screening behavior than mass media campaigns.<sup>89</sup>

Disease prevention requires social change, which in turn requires the participation of those for whom the change is intended,<sup>90</sup> including demographic groups at high risk for disease, appropriate governmental authorities, and essential medical personnel. In Vietnam, as in the United States,<sup>90-93</sup> sociopolitical barriers to organizing the coalitions needed to secure such participation constitute the most critical obstacles to the expansion of cervical carcinoma prevention services and will remain so irrespective of the screening methodology eventually used in either nation.<sup>94</sup>

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