Cervical Cancer Screening Rates in the United States and the Potential Impact of Implementation of Screening Guidelines

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ABSTRACT The remarkable success achieved in cervical cancer prevention is largely attributable to cervical cytology screening, also known as the Papanicolaou (Pap) test. The American Cancer Society (ACS) revised screening guidelines for Pap testing in 2002. The impact of these changes on future numbers of Pap tests has not been assessed. Using National Health Interview Survey (NHIS) data to determine historical screening patterns, we extrapolate the numbers of Pap tests that would be performed through 2010, under 5 different scenarios of implementation of screening guidelines. From 1993 to 2003, there was a steady increase in the number of Pap tests, with an estimated 65.6 million Pap tests performed in 2003. Approximately two thirds of women born after 1930 reported having been screened within the previous year, and 85% within the previous 3 years. Fifteen percent of Pap tests were performed in hysterectomized women, most of whom, according to current guidelines, should not be screened. Based on population projections, if screening behavior remains unchanged, 75 million Pap tests will be performed in 2010. Full compliance with ACS guidelines would approximately halve the total number of tests to 34 million. Potentially, with more appropriate allocation of resources according to guidelines, all women could be screened and the total number of Pap tests reduced, despite projected increases in the population. (CA Cancer J Clin 2007;57:105–111.) © American Cancer Society, Inc., 2007.

INTRODUCTION

Cervical screening has proved to be a model for successful cancer prevention and is largely responsible for the 70% decrease in cervical cancer mortality in the United States over the last 50 years. Cervical cytology screening, also known as the Papanicolaou (Pap) test, is based on examining cells scraped from direct examination of the cervix and is considered an integral part of women’s preventive health care.

Screening guidelines and adherence to the recommendations are key factors affecting the numbers of Pap tests performed. From 1988 to 2002, cervical screening recommendations promulgated by various US organizations generally recommended that screening should begin at the onset of sexual activity and continue throughout life; some organizations recommended annual screening, while others recommended longer intervals for women with several prior negative Pap tests.

From 2002 to 2003, revised screening guidelines were published by the American Cancer Society (ACS), the American College of Obstetricians and Gynecologists (ACOG), and the United States Preventive Services Task Force (USPSTF). The revisions address when to start, when to stop, and how often to screen. To summarize:

1. All three organizations emphasize that screening should not begin coincident with the onset of sexual activity, when the risk of transient human papillomavirus (HPV) infection is highest and the risk of cervical cancer virtually nil.

2. Screening should begin approximately 3 years after sexual debut or by age 21, whichever comes first.

3. Two groups provide guidance on when to stop screening: at age 65 or 70, provided there is documentation of 3 consecutive negative Pap tests during the preceding 10 years.
3. In terms of screening intervals, there is variation among the guidelines, with the USPSTF recommending screening at least every 3 years, while ACS and ACOG tailor recommendations based on cytology testing method and/or use of ancillary HPV testing in women aged 30 and older. For women aged 30 and older, dual screening by cytology and testing for HPV is an option; if both test results are negative, screening should not be repeated for 3 years.²,³

4. Previous recommendations did not specifically address screening for women who have had a total hysterectomy with removal of the cervix. All three guidelines now recommend against routine cervical screening for hysterectomized women without a cervix, unless the procedure was performed for cervical precancer or cancer.

The future impact of these guidelines on the numbers of Pap tests performed has not been formally assessed. In these analyses, we use the National Health Interview Survey (NHIS) data from 1987, 1991, 1992, 1998, 2000, and 2003 to estimate the percentage of women who received Pap tests. We then extrapolate these rates to the US population in those years to estimate the total number of Pap tests performed. Finally, we use US Census Bureau population projections to extrapolate the number of Pap tests that would be performed through 2010 under 5 different scenarios of screening guideline implementation, spanning the spectrum from screening all women according to guidelines to no change from current behavior patterns of screening.

METHODS

The NHIS is a primary source of health information on the civilian, noninstitutionalized population in the United States. It is conducted annually using a clustered, randomized sample of US households. In-person interviews yield a basic set of demographic and health items for each participating household. The NHIS has a complex, stratified, multistage sample design. Oversampling of African Americans and Hispanics began in 1985 and 1995, respectively.⁵,⁶ Approximate oversampling rates are 1.5:1 for African Americans and 2:1 for Hispanics. Periodic questions on cancer screening are administered to adult respondents randomly sampled from each household. Response rates for the cancer questions are in the range of 80%.

Questions on Pap testing have been fielded to women aged 18 and older periodically since 1975 (see Online Supplement). In 1987, 1992, 1998, 2000, and 2003, women were asked whether they had ever received a Pap test and, if they responded yes, were asked how long ago they had their most recent one. In 1991, a variation of the question asked women if they had received a Pap test in the previous year. In 1993 and 1994, the question regarding past screening used overlapping categories that did not allow discrimination of women who had received a Pap test in the previous year; therefore, for these years, we analyzed only whether the woman had a Pap test within the previous 3 years. In 1991, 1993, 1994, 1998, and 2000, women were also asked whether they had had a hysterectomy. Women who refused to answer the question, reported “don’t know,” or for whom a response was not ascertained were excluded.

Using the screening rates from the NHIS and weighted US Census Bureau population estimates for the survey year, we extrapolated the number of women who had a Pap test. Women were initially stratified into 10-year birth cohorts. On examination, similarities in the percentage of women who reported having a Pap test in the previous year among some of the 10-year cohorts led us to combine some cohorts. This resulted in 4 separate cohorts: women born before 1930, women born between 1930 to 1949, women born between 1950 to 1969, and women born 1970 and later.

Of the total number of Pap tests performed, we determined the proportion contributed by each of the four birth cohorts and then stratified by hysterectomy status. Finally, we projected the number of women who would be expected to receive a Pap test under different scenarios using US Census Bureau Interim Projections. All analyses are weighted by the sample weights to account for the unequal probabilities of sample selection, for nonresponse, and for adjustments to the 2000 US Census age, race, and sex distribution. The data were analyzed using SAS® Software Version 8.2.
RESULTS

Population estimates for the number of women aged 18 and older who had a Pap test in the preceding year are shown in Table 1 for survey years 1987, 1991, 1992, 1998, 2000, and 2003. Of the total of 110.7 million women aged 18 and older in the United States in 2003, an estimated 65.6 million (59.3%) had a Pap test. Stratifying by hysterectomy status, the rate of screening for women with cervices and for hysterectomized women was 65% and 50%, respectively, in 2000 (the latest year with available hysterectomy data). Pap tests on hysterectomized women represented approximately 15% of all Pap tests in 1991, 1998, and 2000.

The population estimates for non-hysterectomized women who had a Pap test in the preceding year are presented in Table 2, stratified by age cohort. Women born 1930 and later showed similar screening behavior, with 60% to 65% and 67% to 68% having been screened in 1998 and in 2000, respectively. Women born before 1930, however, reported significantly less screening (38% to 44%) at each time point.

Table 3 shows the corresponding estimates, by birth cohort, for non-hysterectomized women who had a Pap test in the previous 3 years. Not surprisingly, higher percentages of women report screening at some point over the longer interval, ranging from 80% to 88% for women born 1930 and after, and from 60% to 65% for women born before 1930, according to the 1998 and 2000 surveys. Overall, in 2000, 83.3% of women with an intact cervix had been screened in the preceding 3 years.

The contribution of each age cohort to the total number of Pap tests performed in 1991, 1998, and 2000 is shown in Figure 1. Hysterectomized women are substratified within each age cohort. As would be expected, women born before 1930 constitute a shrinking proportion of all Pap tests over time.

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### Table 1: Estimated Proportion of Women (in Millions) Who Had a Pap Test in the Preceding Year, by Hysterectomy Status and Survey Year

| Year | 1987 | 1991 | 1992 | 1998 | 2000 | 2003 |
|------|------|------|------|------|------|------|
| Non-hysterectomized women | NA   | 45.3/76.6 (59.2%) | NA   | 48.3/80.1 (60.3%) | 52.3/80.1 (65.2%) | NA   |
| Hysterectomized women | NA   | 8.6/17.8 (48.4%) | NA   | 9.1/18.9 (47.9%) | 9.5/19.1 (50.0%) | NA   |
| Women with unknown hysterectomy status | NA   | 0.9/1.7 (51.7%) | NA   | 1.4/3.6 (39.8%) | 3.0/5.9 (50.7%) | NA   |
| Total Pap/all women | 51.7/92.2 (56.1%) | 54.8/96.0 (57.1%) | 57.1/96.8 (59.0%) | 59.4/102.6 (57.9%) | 65.4/105.1 (62.3%) | 65.6/110.7 (59.3%) |

NA = data not available

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### Table 2: Estimated Proportion of Non-hysterectomized Women (in Millions) Who Had a Pap Test in the Preceding Year, by Birth Cohort and Survey Year

| Year | 1991 | 1998 | 2000 |
|------|------|------|------|
| Born before 1930 | 5.3/13.6 (38.7%) | 3.3/8.7 (37.7%) | 3.2/7.2 (43.8%) |
| Born 1930 to 1949 | 10.7/18.6 (57.5%) | 9.5/15.9 (59.7%) | 9.9/14.9 (66.6%) |
| Born 1950 to 1969 | 25.9/38.4 (67.5%) | 23.5/37.1 (63.4%) | 24.3/35.8 (67.9%) |
| Born 1970 or later | 3.4/6.0 (57.4%) | 11.9/18.4 (64.7%) | 14.9/22.3 (66.8%) |
| Total Pap/total population | 45.3/76.6 (59.2%) | 48.3/80.1 (60.3%) | 52.3/80.1 (65.2%) |

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### Table 3: Estimated Proportion of Non-hysterectomized Women (in Millions) Who Had a Pap Test in the Preceding 3 Years, by Birth Cohort and Survey Year

| Year | 1993 | 1994 | 1998 | 2000 |
|------|------|------|------|------|
| Born before 1930 | 7.1/11.8 (60.4%) | 6.7/11.3 (59.5%) | 5.2/8.7 (60.4%) | 4.7/7.2 (65.3%) |
| Born 1930 to 1949 | 14.2/17.9 (79.4%) | 13.5/16.8 (80.2%) | 12.8/15.9 (80.6%) | 12.5/14.9 (84.1%) |
| Born 1950 to 1969 | 33.0/38.0 (86.9%) | 32.4/38.0 (85.4%) | 32.3/37.1 (87.0%) | 31.8/35.8 (88.3%) |
| Born 1970 or later | 7.3/9.5 (76.8%) | 8.5/11.3 (75.6%) | 14.7/18.4 (79.7%) | 17.9/22.3 (80.5%) |
| Total Pap/total population | 61.8/77.3 (80.0%) | 61.2/77.3 (79.1%) | 65.1/80.1 (81.3%) | 66.7/80.1 (83.3%) |

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of the total, while the cohort born 1970 or later has been expanding. Women born between 1950 and 1969 represent the largest proportion of Pap tests performed, with 26.8 million (44% of the total) in 2000.

Figure 2 presents estimates of the numbers of annual Pap tests that would be performed under various screening scenarios for 2005, 2008, and 2010 using US Census Bureau Interim Population Projections. For all scenarios, we assumed initiation of screening at age 18, approximately 3 years after the median age of onset of sexual activity. We stratified by 2 age cohorts: women aged 18 to 29 and women aged 30 and older. The first 4 scenarios (1, 1A, 2, and 2A) considered only non-hysterectomized women up to the age of 70, and varied by (i) whether all women participate in screening (scenarios 1 and 1A) or whether a continued 15% of women (based on the 2000 NHIS) are not screened (scenarios 2 and 2A); and (ii) whether there is full implementation of the 2002 ACS screening guidelines, assuming integration of liquid-based cytology and combined cytology and HPV testing for women aged 30 and older (scenarios 1 and 2), or partial compliance (scenarios 1A and 2A). The final scenario (3) is based on continuation of the same screening behavior from the 2000 NHIS for non-hysterectomized and hysterectomized women with no upper age limit to screening.

The fewest annual Pap tests, 27 to 34 million, would be performed under scenarios 1 and 2, if incorporation of liquid-based cytology and HPV testing technologies resulted in extended screening intervals. The percentage of compliance with lengthened screening intervals (scenario 1 versus 1A and 2 versus 2A) has a greater impact on numbers of Pap tests performed than the impact of reaching all women for screening (scenario 1 versus 2). The most annual Pap tests, 71 to 75 million, would be performed under scenario 3, if screening behavior remains unchanged from the 2000 NHIS and taking into account the increases in the target population.

**DISCUSSION**

From 1993 to 2003, there was a steady increase in the number of Pap tests performed in the target population of women aged 18 and older, with 65.6 million Pap tests estimated in 2003. Utilization of cervical screening among women born after 1930 is much higher compared with women born before 1930. In the most recent surveys from 1998 and 2000, approximately two thirds of women born after 1930 report having been screening in the last year, and approximately 85% within the previous 3 years. Over the time points with available data by hysterectomy status (1991 to 2000), there was little change in the proportion of hysterectomized women (48% to 50%) who were screened.

In 2002 to 2003, screening guidelines for the age to start screening, the interval between screens, and when to stop screening were revised by several groups. How these recommendations will impact utilization of cervical screening and the numbers of Pap tests performed will depend on the extent of the adherence to the guidelines. All three groups advise against routine screening of women who have undergone total hysterectomy with removal of the cervix for reasons other than cervical neoplasia. If routine
screening were eliminated in this population, we estimate it would affect the 15% of Pap tests (approximately 9 to 10 million) that are performed on hysterectomized women. This estimate is consistent with Sirovich et al.8 and suggests that eliminating routine screening in this population alone would have significant impact on the numbers of Pap tests performed.

Our extrapolations show that, if screening behavior remained unchanged, there would be a total of 75 million Pap tests performed annually by 2010. By contrast, 100% compliance with a program of biennial screening from ages 18 to 29 and triennial screening from ages 30 to 70, with combined HPV and cytology, would more than halve the total number of Pap tests to 34 million annually. Cost-effectiveness analysis suggests such a strategy—using more sensitive screening at less frequent intervals—would reduce cancer risk and reduce costs, compared with a program of annual cytology screening.9 Excessive screening increases not only monetary costs and inconvenience for women, but also unintended consequences of overtreatment.10

The rapidity with which guidelines are incorporated by practicing clinicians varies depending on many factors, including (1) the perceived need for guidelines; (2) the strength of the evidence basis for the recommendations; (3) the extent of promulgation by professional societies; (4) the cost of implementation and who bears the costs; (5) the impact on medicolegal risk; and (6) the consequences of noncompliance. A full examination of such issues is beyond the scope of this article. However, comparing the rate of implementation of HPV testing in two separate contexts—triage of equivocal cytology and primary screening—is informative.

Before 2001, most women with equivocal atypical squamous cells of undetermined significance (ASCUS) Pap test results were referred for colposcopy or followed with repeat Pap tests. The multicenter randomized ASCUS/low-grade squamous intraepithelial lesion Triage Study (ALTS)11 provided evidence of the utility of HPV testing for triage of ASCUS, which formed the basis for the development of consensus guidelines by professional societies that incorporated HPV triage as an option for ASCUS management.12 Four years later, estimates based on sales of the US Food and

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**FIGURE 2**  Modeling Projections of Women Aged 18 and Older Receiving Pap Tests in the Previous Year, for 2005, 2008, 2010. In all except Scenario 3, 0.53% of women aged 18 to 29 and 21.36% of women aged 30 to 70 were excluded because of hysterectomy. Source: 2000 National Health Interview Survey Base population projections are from US Census Bureau Interim Projections, released May 11, 2004.7
Drug Administration-approved HPV test suggest that 85% of ASCUS is now triaged using HPV testing (J. Schmalz, Digene Corporation, written communication, November 2006), and cytology laboratories report receiving fewer requests for repeat Pap tests following an ASCUS result. However, whether triennial screening with the combination of HPV testing and cytology for women aged 30 and older will be accepted by physicians and women is unclear. While a prospective cohort study and a cost-effectiveness model provide evidence for increased efficacy of this approach, clinicians and women may be reluctant to shift from annual to triennial screening. Many clinicians consider Pap testing to be the catalyst that brings women in for regular gynecologic examinations, and women, taught to believe in annual testing, may worry that less frequent screening will not be adequate. Cost-effectiveness studies demonstrate that HPV testing with triennial screening would increase both efficacy and cost-effectiveness of screening for cervical cancer. Adding HPV testing to annual screening, in combination with cytology, would dramatically increase screening and follow-up costs and overtreatment of women, with negligible gain in life expectancy.

The advent of prophylactic HPV vaccines that prevent infection in naïve (unexposed) girls and women is likely to dramatically impact the future of cervical cancer screening. At this writing, Gardasil—a quadrivalent vaccine that targets HPV types 6, 11, 16, and 18—has received approval from the US Food and Drug Administration and a recommendation by the Advisory Committee on Immunization Practice for use in girls aged 9 to 26. Another vaccine in late stage clinical trials, Cervarix, targets the same oncogenic HPV types 16 and 18 that are responsible for 70% of cervical cancers. Vaccines with even broader valency against additional oncogenic HPV types are under development. Such vaccines herald the era of primary prevention of cervical cancer and presage a minor role for cervical cytology screening in the decades to come. Until then, however, cervical screening for unvaccinated women, as well as vaccinated women and adolescents, remains important for three reasons. First, while the type-specific efficacy of the vaccine in naïve women approaches 100%, the vaccines are not likely to be effective in treating already established infections. Second, the duration of protection is not known. Third, oncogenic HPV types not included in the current vaccines are responsible for approximately 30% of cervical cancers. Therefore, women should continue to be screened according to guidelines, regardless of vaccination status.

In the longer term though, effective prophylactic vaccines against the major oncogenic HPV types are expected to greatly reduce risk for cervical precancer and cancer and should lead to less frequent screening. Later initiation and a longer interval between screenings should reduce the emotional and financial costs of overscreening and overtreatment. Reduced prevalence of cervical abnormalities in the era of vaccination is likely to decrease the positive predictive value of abnormal cytology results. Clinical studies to determine optimal strategies for screening in the era of prophylactic vaccines are needed now and ideally should include linking of abnormal cytology and histopathology results to vaccination status.

The NHIS is the only US population-based survey database designed for estimating the rate of cervical cancer screening in the United States and the number of Pap tests performed. However, a number of limitations to this analysis should be noted. First, although NHIS is weighted to the US Census and representative of the total US population, interviews are conducted only among a sample of the civilian, noninstitutionalized population; patients in long-term care facilities, persons on active duty with the US Armed Forces (although their dependents are included), and US nationals living in foreign countries are not included and may have different rates of screening. Second, a limitation shown in previous studies is that self-reported “recall” of cancer screening testing may overestimate rates of use. Third, the NHIS consistently captures only information regarding whether or not the woman received a Pap test. Most survey years did not ask whether the Pap test was performed for screening or was a repeat Pap test for follow-up of an initial abnormal screen, or whether she had multiple Pap tests. However, from years where this information was obtained in the NHIS, we know that the vast majority of Pap tests are performed for screening. Because the
question is whether a woman had a test within the time period, and not how many tests, the survey captures a maximum of one event per woman per time period. However, we believe underestimation of the number of Pap tests is minimal because (1) most clinicians now use HPV testing for triage of equivocal ASCUS results, rather than following women with repeat cytology; and (2) other circumstances where cytology follow up within a 1 year interval is recommended are very limited.12

Finally, our data on hysterectomy are limited. Women who report a hysterectomy were not asked when the surgery occurred in relation to the Pap test, the reason for the hysterectomy, or if the hysterectomy was supracervical (cervix sparing). Therefore, we cannot distinguish the proportion of women whose hysterectomy was for cervical neoplasia or who have an intact cervix; for such women, continued Pap testing would be appropriate, according to guidelines.2–4 However, with the increased utilization of loop electrosurgical excision procedure, an estimated 7% of hysterectomies are performed for cervical neoplasia,20 and only 2% of hysterectomies are supracervical.21 Therefore, less than 10% of hysterectomized women should continue to be screened.

Screening all women in accordance with revised guidelines would more appropriately allocate screening resources, while reducing the total number of Pap tests performed. Approximately 16% of women do not receive regular Pap tests, while 15% of Pap tests (9.5 million) are performed in hysterectomized women. Since an estimated 90% of hysterectomized women should not be screened, these resources would be more effectively used if they were to cover women currently not receiving regular Pap tests. Finally, the development of effective prophylactic HPV vaccines will not immediately impact the numbers of Pap tests performed, but will transform cervical cancer screening in the next decade. Physicians will need to develop alternatives to Pap testing to encourage regular check ups.

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