Adherence to National Guidelines on Cervical Screening: A Population-Based Evaluation from a Statewide Registry

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Abstract

In 2012, national recommendations for cervical-cancer screening of women aged 30-64 years were quinquennial human papillomavirus and cytology co-testing or triennial cytology. Data from a state-wide surveillance program in New Mexico demonstrated 65.2% (95% confidence interval [95%CI]= 64.6% to 65.7%) of women screened in 2019 had negative co-test within the last 3 years. Percentages of women screened in 2013, 2016, and 2019 with a prior negative co-test more than 5 and up to 7 years ago were 2.6% (95% CI=2.2% to 2.9%), 2.1% (95% CI=1.9% to 2.2%), and 6.5% (95% CI=6.2% to 6.8%), respectively (2-sided $P_{\text{trend}}$<.001). Percentages of women screened in 2013, 2016, and 2019 with a prior negative cytology more than 5 and up to 7 years ago were 3.8% (95% CI=3.7% to 3.9%), 9.0% (95% CI=8.7% to 9.3%), and 14.9% (95% CI=14.4% to 15.4%), respectively (2-sided $P_{\text{trend}}$<.001). Thus, in 2019, only 12.7% (95% CI=12.4% to 13.1%) of the 30,215 women aged 30-64 years underwent co-testing and 27.7% (95% CI=27.1% to 28.3%) of the 18,733 underwent cytology at the recommended interval. The observed under- and over-screening could result in increases in cervical-cancer incidence and harms and costs, respectively.
Human papillomavirus (HPV) testing for cervical screening has been introduced stepwise into routine practice in the U.S. in women aged 30-64 years (1-3). Triennial concurrent HPV testing and cytology (“co-testing”) for women was first recommended in 2004 (1). In 2012, co-testing every 5 years was recommended (3, 4), and more recently HPV testing alone (“primary HPV testing”) was recommended every 5 years (2). Triennial cytology-only screening has remained an option because HPV testing has not been available or reimbursed in some clinics.

There is documentation of an increase in and determinants of co-testing uptake nationally (5, 6). However, there are no data documenting population-based adherence to 5-year intervals for co-testing or 3-year intervals for cytology-only cervical screening following those 2012 recommendations.

We examined time trends for cervical screening across the state of New Mexico using data from the New Mexico HPV Pap Registry (NMHPVPR), which was established in 2006 to evaluate cervical-cancer screening delivery across the continuum of care for New Mexico residents (http://164.64.110.134/parts/title07/07.004.0003.html; https://hpvprevention.unm.edu/nmhpvpr/) (7). The University of New Mexico Human Research Review Committee determined that public health surveillance activities of NMHPVPR were exempt.

We conducted a retrospective examination of cervical screening usage through 2019 for women aged 25-64 years. Percent screened within a given interval and the binomial 95% confidence interval (95% CIs) were calculated by age group and screening year. Percent screened within a given interval were compared across screening years using Cochran-Armitage Trend tests. Linear regression with one-sample t-tests were used to test if there was a trend in percent screened as interval lengthened. All statistical tests were 2-sided and a P value of less
than 0.05 as considered statistically significant. Percentages of under-screened and over-screened by age group and screening year (co-test or cytology) shown in Table 1 were based on guideline recommendations since the screening interval is determined by the antecedent test result (i.e., negative co-test or cytology). Exclusions and inclusions and additional details are found in Supplementary Methods.

From 2008 to 2019, the percentage of women screened decreased two-fold for all age groups, with younger women more likely to be screened than older women (Figure 1A). There was a concomitant increase in the median screening interval from approximately 1.5 years in 2008 to approximately 3.4 years in 2019 (Figure 1B).

We identified 91,651, 71,300 and 57,532 index (T₀) screens in 2013, 2016, and 2019, respectively (total represents Table 1 and Supplementary Table 1). Screening intervals significantly lengthened over time for women with an antecedent (T₁) co-test or a cytology-alone, overall and in each age group (Pₜₐₚₜ<.01), with exception only among women age 25-29 with intervals of 5-7 years. Notably, some women aged 25-29 years were being screened by co-testing, for whom only cytology screening is recommended (Table 1), with one-quarter of those women undergoing annual co-testing. In 2019, 65.2% (95% CI=64.6% to 65.7%) of women screened in 2019 had negative co-tests within the last 3 years, 17.9% (95% CI=17.5% to 18.3%) in a year, 20.3% (95% CI=19.9% to 20.8%) in two years, and 27.0% (95% CI=26.5% to 27.5%) in three years.

There was an increasing trend across time for women to be screened at intervals longer than those recommended (Table 1). For women aged 30-64 years with an antecedent negative co-test (Figure 1C, Table 1), the percentage screened at an interval of more than 5 years and up to 7 years (i.e., 67-84 months) was 2.6% (95% CI=2.2% to 2.9%), 2.1% (95% CI=1.9% to
2.2%), and 6.5% (95% CI=6.2% to 6.8%) for women with an index screen in 2013, 2016, and 2019, respectively ($P_{\text{trend}}<.001$). Only 12.7% (95% CI=12.4% to 13.1%) of women with an antecedent negative co-test received cervical screening at the recommended 5-year interval in any year.

Among women aged 30-64 years with an antecedent negative cytology test (Figure 1D, Supplementary Table 1), for whom screening in 3 years was recommended, the percentage screened at an interval of more than 5 years and up to 7 years was 3.8% (95% CI=3.7% to 3.9%), 9.0% (95% CI=8.7% to 9.3%), and 14.9% (95% CI=14.4% to 15.4%) for women with an index screen in 2013, 2016, and 2019, respectively ($P_{\text{trend}}<.001$). Only 27.7% (95% CI=27.1% to 28.3%) of women with an antecedent negative cytology received cervical screening at the recommended 3-year interval in any year.

Of the screen-eligible population served across New Mexico by a diversity of clinical practices, insurers and health service delivery settings, few women received cervical screening at recommended intervals. Many were screened too frequently, especially by co-testing, although the percentage of over-screening did decrease for co-testing (94.4% [95% CI=93.9% to 94.9%] in 2013 to 80.8% [95% CI=80.3% to 81.2%] in 2019) (Table 1) and cytology (65.1% [95% CI=64.7% to 65.4%] in 2013 to 26.2% [95% CI=25.5% to 26.8%] in 2019) (Supplementary Table 1).

A new and alarming observation was the increasing percentage of women being screened at too long an interval. Most notable was the greater than 4-fold increase in women being screened at an interval of more than 5 years and up to 7 years following a negative cytology-alone, which does not provide the same re-assurance against cancer as a negative HPV test or co-test (8, 9). There was also an increasing trend in women being screened an interval of more than
5 years and up to 7 years following a negative HPV co-test, which may increase the risk of cancer (10).

Thus, in 2019, only approximately 13% of women aged 30-64 years underwent co-testing at the recommended 5-year interval (Table 1). In addition, only approximately 28% of women aged 30-64 years underwent cytology screening at the recommended 3-year interval (Supplementary Table 1).

Because of limitations of NMHPVPR data, we were not able to examine the determinants of adherence. One of the main factors related to poor acceptance of longer screening intervals may be a lack of patient and providers knowledge (6, 11-14).

Of note, only women with two screens are included in Table 1 and we did not account for women with very long screening intervals, only one screen, or none at all. Thus, we have underestimated the proportion of women being under-screened. The NMHPVPR was established in 2006, allowing a maximum 7-year look-back comparison of screening intervals for index screens in 2013, 2016, and 2019. Supplementary Tables 2 and 3 detail women with screening intervals of more than 5 years (>66 months) following a negative co-test and cytology-alone screen, respectively. Finally, our findings were limited to screening in New Mexico, which may not be generalizable to other settings. Strengths of this analysis include the use of electronic health records from a population-based, state-wide registry.

In conclusion, while over-screening is declining, many women are still undergoing cervical-cancer screening too frequently, especially by co-testing, thereby increasing its harms and costs. Meanwhile, an increasing number of women are undergoing cervical-cancer screening too infrequently and as consequence, may reduce its health benefits (3, 10).
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Data Availability

Data supporting the investigation reported in this article can be made available in de-identified form subject to establishing a data use agreement with the University of New Mexico Health Sciences Center.
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Tables

Table 1. Screening intervals among women aged 25-64 years with prior (antecedent) negative co-test (T₁); cytology and human papillomavirus (HPV) negative who underwent a second (index) screening (HPV and cytology co-testing or cytology-alone) (T₀) in 2013, 2016, or 2019.

| Age group, years | Screening interval[^a], years |  |  |  |  |  |  |  |
|------------------|--------------------------------|---|---|---|---|---|---|
|                  |                                | 2013 (n<sub>total</sub>=8,537) | 2016 (n<sub>total</sub>=23,053) | 2019 (n<sub>total</sub>=31,178) | P<sub>trend</sub>^b |
|                  | No. | % (95% CI) | No. | % (95% CI) | No. | % (95% CI) |    |
| 25-29            | 1   | 184 44.4 (39.7, 49.2) | 320 36.5 (33.3, 39.7) | 222 23.1 (20.4, 25.7) | <.001 |
|                  | 2   | 114 27.5 (23.2, 31.8) | 279 31.8 (28.8, 34.9) | 222 23.1 (20.4, 25.7) | .008 |
|                  | 3   | 64 15.5 (12.0, 18.9) | 180 20.5 (17.9, 23.2) | 268 27.8 (25.0, 30.7) | <.001 |
|                  | 4   | 26 6.3 (3.9, 8.6) | 67 7.6 (5.9, 9.4) | 146 15.2 (12.9, 17.4) | <.001 |
|                  | 5   | 16 3.9 (2.0, 5.7) | 16 1.8 (0.9, 2.7) | 75 7.8 (6.1, 9.5) | <.001 |
|                  | >5-7 | 10 2.4 (0.9, 3.9) | 14 1.6 (0.8, 2.4) | 30 3.1 (2.0, 4.2) | .21 |
| All              |     | 414 | —   | 876 | —   | 963 | — |
| P<sup>c</sup>    |     | .004 | <.001 |  | .03 |

[^a]: Slightly different from the prior definition.
[^b]: Chi-squared tests for linear trend.
[^c]: Overall trend across age groups.
| Age Group | 5 (recommended) | >5-7 | All | \( P^c \) |
|-----------|-----------------|------|-----|---------|
| 40-49     |                 |      |     |         |
| 1         | 60              | 177  | 796 | <.001   |
| 2         | 32              | 91   | 375 | <.001   |
| 3         |                  |      |     |         |
| 4         | 75              | 263  | 1,285 | .006 |
| 5 (recommended) | d | 108 | 409 | <.001 |
| All       | 2,734           | 6,778| 8,592| .003 |
| \( P^c \) | .08             |      |     |         |
| 50-64     |                 |      |     |         |
| 1         | 1,128           | 1,920| 1,618| <.001   |
| 2         | 636             | 1,927| 1,891| <.001   |
| 3         | 395             | 1,942| 2,541| <.001   |
| 4         | 155             | 621  | 1,464| <.001   |
| 5 (recommended) | d | 75  | 263  | <.001 |
| >5-7      | 79              | 142  | 666  | <.001   |
| All       | 2,468           | 6,815| 9,465| .006 |
| \( P^c \) | .18             |      |     |         |
|       | 1983-84 | 1985-87 | 1989-92 | 1992-97 | >5-7     |  All  | <.001 |
|-------|---------|---------|---------|---------|----------|-------|-------|
|       | 98      | 3.4 (2.7, 4.0) | 222   | 2.6 (2.3, 2.9) | 922   | 7.6 (7.1, 8.1) |  <.001 |
|       | 2,921   | —       | 8,584  | —       | 12,158  |       |       |
|       | .002    | .03     | .19    |         |         |       |       |
|       | 30-64   |         |        |         |         |       |       |
|       | 1       | 3,663   | 45.1 (44.0, 46.2) | 6,270 | 28.3 (27.7, 28.9) | 5,407 | 17.9 (17.5, 18.3) | <.001 |
|       | 2       | 2,228   | 27.4 (26.5, 28.4) | 6,487 | 29.3 (28.7, 29.8) | 6,142 | 20.3 (19.9, 20.8) | <.001 |
|       | 3       | 1,302   | 16.0 (15.2, 16.8) | 6,236 | 28.1 (27.5, 28.7) | 8,145 | 27.0 (26.5, 27.5) | <.001 |
|       | 4       | 478     | 5.9 (5.4, 6.4) | 1,880 | 8.5 (8.1, 8.8) | 4,709 | 15.6 (15.2, 16.0) | <.001 |
|       | 5 (recommended) | 243 | 3.0 (2.6, 3.4) | 849 | 3.8 (3.6, 4.1) | 3,849 | 12.7 (12.4, 13.1) | <.001 |
|       | >5-7    | 209     | 2.6 (2.2, 2.9) | 455 | 2.1 (1.9, 2.2) | 1,963 | 6.5 (6.2, 6.8) | <.001 |
|       | All     | 8,123   | —       | 22,177 | —       | 30,215 | —     |       |
|       | .004    | .01     | .14    |         |         |         |       |       |
|       | Over-Screened (1 year) | 3,663 | 45.1 (44.0, 46.2) | 6,270 | 28.3 (27.7, 28.9) | 5,407 | 17.9 (17.5, 18.3) | <.001 |
|       | Over-Screened (1 & 2 years combined) | 5,891 | 72.5 (71.6, 73.5) | 12,757 | 57.5 (56.9, 58.2) | 11,549 | 38.2 (37.7, 38.8) | <.001 |
|       | Over-Screened (1, 2 & 3, years combined) | 7,193 | 88.6 (87.9, 89.2) | 18,993 | 85.6 (85.2, 86.1) | 19,694 | 65.2 (64.6, 65.7) | <.001 |
|       | Over-Screened (1, 2, 3, & 4 years combined) | 7,671 | 94.4 (93.9, 94.9) | 20,873 | 94.1 (93.8, 94.4) | 24,403 | 80.8 (80.3, 81.2) | <.001 |

aScreening intervals were defined by T0-T1 and were categorized as 11-<18 months (1 year) and in 12-month periods thereafter corresponding to the integer number of years in the interval ±6 months: 1 year = 11-18 months, 2 years = 19-30 months, 3 years = 31-42 months, etc. CI = confidence interval.

bTwo-sided Cochran-Armitage Trend tests were used.
Linear regression with two-sided one-sample t-tests were used.

A 5-year screening interval following a negative co-test was the national recommendation in 2013, 2016 and 2019 for women aged 30-64 years.
**Figure Legend**

**Figure 1.** Cervical cancer screening utilization and median screening intervals for women living in New Mexico.

Shown are the (A) Percentage of women screened and (B) median screening intervals for women aged 25-64 years living in New Mexico undergoing cervical screening by age group and year (irrespective of screening modality). Panels A and B include 600,987 individual women with screening cytology across the period of 2008-2019. Percentages of women included in Panel A use age-specific denominators from the U.S. Census (https://www.census.gov/data/tables/time-series/demo/popest/2010s-state-detail.html). Panel (C) is the percentage of women aged 30-64 years who had an index \((T_0)\) screen (irrespective of screening modality or result; cytology-alone or co-testing) in 2013, 2016, or 2019 following an antecedent \((T_{-1})\) negative co-test (negative HPV and negative cytology) 1, 2, 3, 4, and >5-7 years prior to the index screen. Panel (D) is the percentage of women aged 30-64 years who had an index \((T_0)\) screen (irrespective of screening modality or result; cytology-alone or co-testing) in 2013, 2016, or 2019 following an antecedent \((T_{-1})\) negative cytology 1, 2, 3, 4, and >5-7 years prior to the index screen. The denominators for Panel C (antecedent negative co-test) and Panel D (antecedent negative cytology) are shown in **Table 1** and **Supplementary Table 1** respectively. Screening intervals are defined by the time between the index screen and the antecedent screen i.e., \(T_0\) to \(T_{-1}\). Exclusions defining screening tests are detailed in the **Supplementary Methods**.
Figure 1.