Interventions That Increase Use of Adult Immunization and Cancer Screening Services: A Meta-Analysis

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Purpose: The relative effectiveness of the diverse approaches used to promote preventive care activities, such as cancer screening and adult immunization, is unknown. Despite many high-quality published studies, practices and policymakers attempting to improve preventive care have little definitive information on which to base decisions. Thus, we quantitatively assessed the relative effectiveness of previously studied approaches for improving adherence to adult immunization and cancer screening guidelines.

Data Sources: MEDLINE, the Cochrane Effective Practice and Organization of Care Review Group register, previous systematic reviews, and the Medicare Health Care Quality Improvement Project database.

Study Selection: Controlled clinical trials that assessed interventions to increase use of immunizations for influenza and pneumococcal pneumonia and screening for colon, breast, and cervical cancer in adults.

Data Extraction: Two reviewers independently extracted data on characteristics and outcomes from unmasked articles. Intervention components to increase use of services were classified as reminder, feedback, education, financial incentive, legislative action, organizational change, or mass media campaign.

Data Synthesis: Of 552 abstracts and articles, 108 met the inclusion criteria. To assess the effect of intervention components, meta-regression models were developed for immunizations and each cancer screening service by using 81 studies with a usual care or control group. The most potent intervention types involved organizational change (the adjusted odds ratios for increased use of services from organizational change ranged from 2.47 to 17.6). Organizational change interventions included the use of separate clinics devoted to prevention, use of a planned care visit for prevention, or designation of nonphysician staff to do specific prevention activities. The next most effective intervention components were patient financial incentives (adjusted odds ratios, 1.82 to 3.42) and patient reminders (adjusted odds ratios, 1.74 to 2.75); the adjusted odds ratios ranged from 1.29 to 1.53 for patient education and from 1.10 to 1.76 for feedback.

Conclusions: Rates of adult immunization and cancer screening are most likely to improve when a health care organization supports performance of these activities through organizational changes in staffing and clinical procedures. Involving patients in self-management through patient financial incentives and reminders is also likely to positively affect performance.


For author affiliations, see end of text.
See editorial comment on pp 701-703.

Despite the strong commitment to improved prevention reflected in reports from national task forces and performance measures of health care organizations, performance rates remain below national and international targets (1–5). Prevention literature (6–19) and expert panels (20, 21) identify influenza and pneumococcal pneumonia vaccinations and breast, cervical, and colon cancer screening as key health care services for reducing morbidity and mortality in adults. These five services are covered by most insurance plans, including Medicare. Although the extensive literature on methods for changing provider behavior in general and on improving prevention rates in particular provides many insights, we found no clear message about how best to improve indicated prevention activities in usual-practice settings. One difficulty in interpreting the literature is that evaluated interventions often comprise one or more empirically designed components that are evaluated as a unit, making it difficult to identify what caused the intervention as a whole to succeed or fail.

We used rigorous qualitative methods and a typology based on clinical literature and social science theory to characterize the key components and features of prevention improvement interventions identified from published and unpublished literature. We then used meta-analysis techniques to evaluate the effectiveness of each intervention component and feature across multiple studies. Finally, we qualitatively validated the meta-analysis results by comparing them with results from individual studies that directly compared intervention components. This approach allows us to judge the relative effectiveness of specific types of interventions; these
results can then guide policymakers, health care organizations, and researchers about how to improve the performance of critical preventive services.

**METHODS**

**Conceptual Model**

On the basis of a conceptual model developed from social science theory and clinical literature (22), we categorized interventions according to seven intervention components and four potential targets of the intervention. We also postulated seven key features of the intervention that have been thought to contribute to success (Figure).

We defined the seven types of intervention components as follows.

**Reminders:** Reminders prompt providers or patients to use a preventive service. Reminders can be generated manually or by computer and can be delivered to providers and patients verbally, on paper, or on a computer screen.

**Provider feedback:** Summaries of rates of performance of indicated prevention activities over a specified period are given to providers to stimulate improvement. Providers can be individual clinicians, groups of clinicians, or organizations. Summaries may include recommended clinical action.

**Education:** The dissemination of information about indicated prevention practices can target providers or patients. Means of dissemination include mass mailings, conferences, workshops, training sessions, lectures, and in-person detailing or individual educational sessions.

**Financial incentives:** Financial incentives are direct or indirect financial rewards tied to a specific action of a provider or patient. Incentives include reductions in patient payment or copayment and direct compensation to patients or providers.

**Regulatory and legislative actions:** Regulatory and legislative actions at the national or regional level operate outside the medical care organization to change the external environmental, legal, and organizational contexts in which providers practice.

**Organizational change:** Changes in the work processes in a medical care organization can facilitate improved performance of preventive services. Changes can include addition or redesign of jobs, changes in clinical procedures, or changes in facilities or infrastructure.

**Mass media campaigns:** Media campaigns target

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**Figure.** Conceptual framework for assessing interventions to improve receipt of preventive services.
large population segments through television, radio, newspapers, posters, leaflets, and booklets.

We defined a key intervention feature as being present when an intervention design intentionally incorporated it. Key features were the following.

Social influence: Use of social influence to enhance interventions is based on social science theory indicating that delivery of an intervention through valued members of a social group is more likely to change behavior.

Marketing and outreach: Marketing and psychological theories indicate that interventions can best be “sold” to providers and patients by targeting these groups’ own interests and motivations, using vivid language through channels that maximize customer convenience.

High visual appeal and clarity: Most interventions include visual materials of some kind. Some types of graphic design flaws, such as high contrast or small font size for geriatric populations, make intervention materials almost unusable. In this study, we lacked access to the materials themselves. We judged this feature to be present if the authors of the included study had indicated attention to graphic design or had used films or videotapes.

Collaboration and teamwork: Sociologic theory and the clinical quality improvement (23) literature identify the importance of collaboration and teamwork in fostering behavioral change. Interventions such as continuous quality improvement include this feature as a foundation.

Design based on needs, barriers, incentives, assessments, or theory: Both marketing and quality improvement theory indicate that tailoring an intervention on the basis of identification of a target population’s needs and current barriers to the desired behavior will enhance the chances of success.

Top management support: Sociologic theories of organizational change indicate that major changes are not generally possible without top management support.

Active learning strategies: Although almost all interventions incorporate learning of some kind, not all types of learning are equally effective in changing behavior. In general, educational and psychological theory supports participatory or active learning strategies, such as role playing instead of passive learning through lectures or written materials alone.

Each intervention component and key intervention feature was independently abstracted without regard to other intervention components or intervention features.

Databases for Literature Search
We used three databases to identify articles on our five preventive services: 1) the Cochrane Effective Practice and Organization of Care (EPOC) Special Register (developed through prospective and retrospective searches of MEDLINE [since 1966], EMBASE [since 1980], Healthstar [since 1975], and the Cochrane Controlled Trials Register [since 1996]); 2) previous systematic reviews (24–32); and 3) the Health Care Quality Improvement Projects (HCQIP) database, which contains narrative project documents (NPDs) and is maintained by the U.S. Centers for Medicare & Medicaid Services (formerly known as the Health Care Financing Administration [HCFA]). Each NPD describes an individual research project conducted by a Medicare Peer Review Organization (PRO), including its aims, background, quality indicators, collaborators, sampling methods, interventions, measurements, and results. Most projects in this database are not published elsewhere. Our search was current through February 1999. A complete description of our databases has been reported elsewhere (33) and is available at www.cms.hhs.gov/healthyaging.

Article Selection and Data Abstraction
Article selection, quality assessment, and data abstraction were done in standard fashion by using two trained physician reviewers working independently; disagreements were resolved by consensus or third-party adjudication. The Appendix (available at www.annals.org) provides details of this process.

Statistical Analysis
All analyses were conducted by using SAS software (SAS Institute, Inc., Chicago, Illinois) (34). We first retrieved all studies that assessed the effects of an intervention relative to a usual care or control group. We fit meta-regression models (35) to estimate adjusted odds ratios for evaluating the relative effectiveness of different intervention components (for example, provider education) on receiving different services. This multivariate modeling approach allowed us to include multiple components as a study’s covariates if the study’s intervention
contained more than one and to independently assess the effect of each individual component after adjustment for all other components. We used a similar approach for intervention features (for example, visual appeal) but limited ourselves to testing only a few key intervention components by feature interactions that we chose a priori.

We fit separate sets of models for each of the following preventive services: immunizations (this model combined studies for both influenza vaccination and pneumococcal vaccination), screening mammography, cervical cytology screening, and fecal occult blood testing (for colon cancer screening). We could not perform a meta-regression analysis on the use of colon visualization (that is, sigmoidoscopy, colonoscopy, or barium enema) because of an insufficient number of accepted studies on this topic. The Appendix (available at www.annals.org) describes technical details of our meta-regression modeling.

To test the robustness of our meta-regression, we compared our multivariate results with a standard stratified approach in which we constructed random-effects pooled estimates of the odds ratios for particular subgroups of studies, such as all studies that included a particular intervention component. We reached consistent conclusions using the two approaches.

Assessment of Publication Bias

We assessed the possibility of publication bias both graphically and via formal tests for each screening service and intervention component. (Details are available in the Appendix at www.annals.org.)

Role of the Funding Source

The sponsor of this study (the Centers for Medicare & Medicaid Services) provided assistance in our request to access the HCQIP database and provided feedback on a draft of the final report. The collection, analysis, and interpretation of the data, along with all decisions regarding submission of this paper for publication, were the responsibility of the authors.

RESULTS

Identification, Distribution, and Quality of Evidence

The EPOC literature searches identified 264 potentially relevant articles. Previous systematic reviews contained 243 references, and the database for the HCQIP yielded 148 potentially relevant NPDs. After elimination of 107 duplicate articles, 552 potentially relevant articles remained; after screening, 137 articles remained for detailed review. Of note, some articles contained more than one study or addressed more than one service or combined several intervention components into an intervention; therefore, there will be more studies than articles. We excluded 15 studies that did not include information on the number of patients studied and 6 studies whose unit of analysis was not the patient. Only 4 studies dealt with interventions to improve the use of colon visualization, and this was an insufficient number to include in our meta-analysis. Nine studies assessed the effect of mass mailings, and these studies had a sample size one or two orders of magnitude greater than that of the other studies. Thus, we did not include the mass mailing studies in our meta-analysis because they would have disproportionately affected the results. These mass mailing studies (which generally showed disappointing results) are reported elsewhere (37). Finally, 25 studies assessed different forms of the same intervention component (for example, two different ways of providing patient reminders) or were idiosyncratic comparisons of multiple intervention components, and these data could not be pooled. This left 108 studies that contributed data to our quantitative meta-regression analysis or qualitative analysis (Appendix Figure, available at www.annals.org).

Table 1 shows the included studies stratified by service and characterized by intervention component. The evidence table, described elsewhere (33) (and available at www.cms.hhs.gov/healthyaging), fully describes information for each study that met our acceptance criteria. Of the 108 studies in our analysis, 95 were randomized clinical trials and 13 were controlled clinical trials. Forty studies allocated at the provider, organization, or community level and did not account for potential clustering of patients in these larger units. As a result, such studies may have underestimated the variance in the estimate of the effect of the intervention, resulting in overly narrow confidence intervals or artificially low P values. Eighty-one studies contained a usual care or control group and were eligible for the meta-regression. Of these 81 studies, 25 allocated at the provider, organization, or community level and were adjusted for in the sensitivity analysis. Seventy of the 81 studies were ran-
Table 1. Intervention Components by Service

<table>
<thead>
<tr>
<th>Intervention Component</th>
<th>Studies according to Target</th>
<th>Studies*</th>
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<tbody>
<tr>
<td></td>
<td>Patients</td>
<td>Provider</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Influenza immunization</td>
<td>17</td>
<td>7</td>
</tr>
<tr>
<td>Pneumonia immunization</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Mammography</td>
<td>26</td>
<td>15</td>
</tr>
<tr>
<td>Cervical cytology</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>Colon cancer screening</td>
<td>19</td>
<td>11</td>
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<tr>
<td>Provider feedback</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Influenza immunization</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Mammography</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Cervical cytology</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Colon cancer screening</td>
<td>1</td>
<td>4</td>
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<tr>
<td>Financial incentive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Influenza immunization</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Pneumonia immunization</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Mammography</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Cervical cytology</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Colon cancer screening</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Reminders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Influenza immunization</td>
<td>19</td>
<td>12</td>
</tr>
<tr>
<td>Pneumonia immunization</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Mammography</td>
<td>29</td>
<td>21</td>
</tr>
<tr>
<td>Cervical cytology</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>Colon cancer screening</td>
<td>21</td>
<td>15</td>
</tr>
<tr>
<td>Organizational change</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Influenza immunization</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Pneumonia immunization</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Mammography</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Cervical cytology</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Colon cancer screening</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Mass media</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Influenza immunization</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

* The sum of the studies in this column will not equal the total number of articles because some articles contain more than one study, some studies address more than one service, and some studies report on more than one target.

domized trials, of which 22 allocated at the provider, organization, or community level.

Effectiveness of Each Intervention Component

Table 2 shows the results of the meta-regression analysis for immunizations, screening mammography, cervical cytology screening, and colon cancer screening. The adjusted odds ratio and 95% CIs for improving preventive care delivery for each intervention component are reported. The reference group is a usual care or control group. Within each service, intervention components are ordered from the most to the least effective. As an example, the adjusted odds ratio for improved adult immunization rates based on use of organizational change methods is 16.0 and reflects adjustment for provider reminder interventions, financial incentives, and all remaining intervention methods, as well as for study level differences, such as study setting and patient characteristics.

We identified some consistent patterns across all four regressions. First, organizational change was consistently one of the most effective intervention components at increasing use of the clinical and preventive services. Although it was one of the most effective intervention components, organizational change was also one of the most diverse components. The 20 organizational change studies in our meta-regression analysis can be classified into four general categories: 1) the establishment of a separate clinic devoted to screening and prevention activities (38–40); 2) use of a planned care visit for prevention (41, 42); 3) use of techniques similar to continuous quality improvement (43); and 4) designation of specific prevention responsibilities to nonphysician staff (44–57). Examples in the fourth category,
which contained the largest number of studies, included the use of nursing or clerical staff to identify patients needing prevention services and to arrange a physician visit (45, 47, 48, 55) or use of protocols for nurses to identify prevention services and deliver these services themselves (46).

The second consistent pattern was that patient financial incentives, such as reducing or eliminating copayments, were also highly effective across types of preventive care. Third, although patient reminders were less effective than organizational change or patient financial incentives, this intervention consistently improved care. Other studies showed that personalized reminders (or ones signed by the patient’s physician) are more effective than generic reminders (58–61). Fourth, although patient education was one of the least effective interventions in these studies, it was consistently moderately effective. Finally, provider feedback consistently appeared relatively ineffective. Provider reminders and provider education showed no consistent pattern. We could not assess provider financial incentives, regulatory or legislative actions, or media campaigns because of insufficient data.

Qualitative Analysis

We further assessed relative intervention effectiveness by evaluating whether direct comparison of multiple intervention components in a single study led to the same conclusions about relative intervention effectiveness as did our meta-regression. We identified nine studies that assessed a single intervention component relative to another single intervention component. Five studies reported statistically significant results consistent with the meta-regression (62–66), two had nonsignificant trends consistent with the meta-regression (67, 68), and two had statistically significant results inconsistent with the meta-regression.

Next, we reviewed studies that directly compared a single intervention component with that same component plus a second component. We identified 33 such comparisons. We classified the components as either “effective” (for example, organizational change, financial incentives, and patient reminders) or “less effective” (for example, provider reminders, provider feedback, patient education, and provider education) on the basis of the relative effectiveness according to our meta-regression (Table 2). We hypothesized that adding an effective intervention component to any other intervention would produce significant, positive effects; that adding a less effective component to an effective one would produce little effect; and that adding a less effective component to another less effective one would produce variable effects. Our analysis supported these hypotheses. All 7 comparisons of a single effective component with that component plus another effective component reported statistically significant benefits, as indicated by a comparison of the percentage changes in the patients receiving the preventive service (64, 69–74). Similarly, 10

Table 2. Effectiveness of Intervention Components To Improve the Use of Screening Services

<table>
<thead>
<tr>
<th>Intervention Component</th>
<th>Immunizations (29 Studies)</th>
<th>Mammmography (33 Studies)</th>
<th>Cervical Cytology (27 Studies)</th>
<th>Colon Cancer Screening (19 Studies)*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Immunizations (29 Studies)</strong></td>
<td><strong>Adjusted Odds Ratio (95% CI)†</strong></td>
<td><strong>Adjusted Odds Ratio (95% CI)†</strong></td>
<td><strong>Adjusted Odds Ratio (95% CI)†</strong></td>
<td><strong>Adjusted Odds Ratio (95% CI)†</strong></td>
</tr>
<tr>
<td>Organizational change</td>
<td>16.0 (11.2–22.8)</td>
<td>2.74 (1.78–4.24)</td>
<td>3.03 (2.56–3.58)</td>
<td>17.6 (12.3–25.2)</td>
</tr>
<tr>
<td>Provider reminder</td>
<td>3.80 (3.31–4.37)</td>
<td>2.47 (1.97–3.10)</td>
<td>2.82 (2.35–3.38)</td>
<td>3.01 (1.98–4.56)</td>
</tr>
<tr>
<td>Patient financial incentive</td>
<td>3.42 (2.89–4.06)</td>
<td>2.31 (1.97–2.70)</td>
<td>1.74 (1.58–1.92)</td>
<td>2.75 (1.90–3.97)</td>
</tr>
<tr>
<td>Provider education</td>
<td>3.21 (2.24–4.61)</td>
<td>1.99 (1.58–2.51)</td>
<td>1.72 (1.39–2.13)</td>
<td>1.82 (1.35–2.46)</td>
</tr>
<tr>
<td>Patient reminder</td>
<td>2.52 (2.24–2.82)</td>
<td>1.76 (1.44–2.15)</td>
<td>1.53 (1.30–1.81)</td>
<td>1.46 (1.15–1.85)</td>
</tr>
<tr>
<td>Patient education</td>
<td>1.29 (1.14–1.45)</td>
<td>1.63 (1.39–1.92)</td>
<td>1.37 (1.25–1.51)</td>
<td>1.38 (0.84–2.25)</td>
</tr>
<tr>
<td>Provider financial incentive</td>
<td>1.26 (0.83–1.90)</td>
<td>1.31 (1.12–1.52)</td>
<td>1.10 (0.93–1.31)</td>
<td>1.18 (0.98–1.43)</td>
</tr>
<tr>
<td>Feedback</td>
<td>1.23 (0.96–1.58)</td>
<td>1.29 (1.06–1.57)</td>
<td>1.29 (1.06–1.57)</td>
<td>1.29 (1.06–1.57)</td>
</tr>
</tbody>
</table>

* The screening method was fecal occult blood test.
† Adjusted odds ratios from meta-regression. These estimates and CIs were not adjusted for clustering of patients within providers. The Appendix (available at www.annals.org) discusses a sensitivity analysis that included this adjustment.
(52, 62, 75–82) of the 12 comparisons that added an effective component to a less effective one reported significant benefits. Nine (66, 67, 71, 72, 83–87) of the 12 comparisons that added a less-effective component to an effective one reported no additional benefit; meanwhile, 3 (58, 59, 88) reported some benefit. Finally, of the 2 comparisons in which a less effective component was added to another less effective component, 1 (89) reported a benefit and the other (77) did not. These results support the rank order of effectiveness of intervention components as determined by our meta-regression models. They also suggest that among these intervention types, two weak interventions together do not produce better results than does each intervention alone.

Exploratory Analysis of Features Instrumental to the Success of Each Intervention

From the social science literature, we identified seven key intervention features that can be incorporated into intervention components. Data sparseness—in terms of the number of studies with particular combinations of components and features and the total number of studies (and therefore degrees of freedom) available—prevented assessment of the effect of the interaction of these key intervention features with intervention components as applied to specific preventive services. As an exploratory analysis, we used meta-regression to model the instrumental features as predictors of improvement in preventive services. As shown in Table 3, explicitly designing an intervention that is based on needs or theory, fosters collaboration or teamwork, or provides materials with high visual appeal was associated with a statistically significantly increased effect on three or more preventive care services.

Publication Bias

We assessed publication bias along two dimensions: screening service and intervention component. Evidence of publication bias, as indicated graphically and via the adjusted rank correlation and regression asymmetry tests (90, 91), was apparent for mammography studies and for patient education and provider reminder interventions.

DISCUSSION

Clinical managers, payers, and policymakers are responsible for improving preventive care for the patient populations they serve. The numerous high-quality health services research studies on interventions to improve preventive care represent an extraordinary resource for prevention improvement and demonstrate that improvement is feasible through various methods. The diverse types of interventions these studies used, however, leaves us with a compelling question: Which intervention approaches work best?

In our analysis, we made use of intervention diversity to assess the relative contributions of different intervention components and features to help managers pick the most effective strategies. We have validated our re-

Table 3. Effects of the Presence of Key Intervention Features To Improve the Use of Screening Services

<table>
<thead>
<tr>
<th>Intervention Feature</th>
<th>Intervention Feature</th>
<th>Intervention Feature</th>
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<tbody>
<tr>
<td>Immunizations (29 Studies)</td>
<td>Mammography (33 Studies)</td>
<td>Cervical Cytology (27 Studies)</td>
</tr>
<tr>
<td><strong>Intervention Feature</strong></td>
<td><strong>Adjusted Odds Ratio (95% CI)</strong>†</td>
<td><strong>Intervention Feature</strong></td>
</tr>
<tr>
<td>Collaboration and teamwork</td>
<td>17.9 (10.4–30.9)</td>
<td>Design and theory</td>
</tr>
<tr>
<td>High visual appeal and clarity</td>
<td>3.25 (2.09–5.06)</td>
<td>Use of social influence</td>
</tr>
<tr>
<td>Design and theory</td>
<td>1.61 (1.52–1.71)</td>
<td>Marketing and outreach</td>
</tr>
<tr>
<td>Use of social influence</td>
<td>1.35 (0.78–2.34)</td>
<td>Learning strategies</td>
</tr>
<tr>
<td>Learning strategies</td>
<td>1.29 (0.68–2.42)</td>
<td>Collaboration and teamwork</td>
</tr>
<tr>
<td>High visual appeal and clarity</td>
<td>1.19 (0.89–1.59)</td>
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</table>

† Adjusted odds ratios from meta-regression. These estimates and CIs were not adjusted for clustering of patients within providers. The Appendix (available at www.annals.org) discusses a sensitivity analysis that included this adjustment.
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results by evaluating the extent to which our conclusions are confirmed by direct comparisons between intervention components in individual controlled studies.

A striking result of our analysis was the dramatic effect of organizational change. When combined with the finding that teamwork and collaboration are powerful intervention features, this result confirms key elements of team-based quality improvement approaches for introducing practice change. These methods search for system-based problems and solutions and depend on input from teams of involved health care providers to design or tailor interventions. This result also confirms that the current organization of many primary care practices is not optimal for prevention performance.

Another encouraging result from these analyses is that adding one or more effective intervention components to an already existing intervention component can enhance effectiveness. This result will encourage additional studies combining effective provider, patient, and organizational approaches to enhance performance. On the other hand, health care managers may be disappointed to learn of the relative ineffectiveness of provider feedback, because this is a burgeoning area of development. Although it is tempting to assume that providers fail to act because of lack of knowledge about correct practice or about their own performance, these knowledge limitations alone do not explain most cases of poor quality care.

Our results have implications for clinical practice. Organizations interested in increasing the use of these immunizations and cancer screening services should selectively choose interventions that are based on theory or a local assessment of needs and barriers; that involve collaboration and teamwork; and that involve organizational change, such as nurse standing orders, special prevention clinics, or other system changes designed to make the identification and delivery of this care routine. If such interventions are not feasible or are already in place and additional improvement is desired, then a system of patient reminders should be implemented. Our results indicate that adoption of these two strategies should substantially increase the use of these services. Patient or provider education and provider feedback were consistently less effective and should not be the first interventions chosen. Although patient financial incentives were effective, the Centers for Medicare & Medicaid Services has recently partially addressed this by providing full coverage for immunizations and partial coverage for other preventive services. Further decreases in financial barriers, under Medicare and other insurance plans, can be expected to increase the use of these services.

Our study has several limitations. The Appendix (available at www.annals.org) details these limitations and our methods to mitigate them. The most important limitation on the study’s ability to inform decision makers is its lack of information on intervention cost-effectiveness. One can imagine a future time when intervention evaluation standards will be such that meta-analysis, especially if preplanned, will routinely measure cost-effectiveness. In the current literature, however, intervention costs and benefits are not reported sufficiently to allow researchers to conduct such an analysis.

Despite these limitations, we believe our study has many strengths. First, to the best of our knowledge, our search methods for identifying primary literature yielded more studies that tested more comparisons than any previous review. Second, our study is strengthened by the a priori use of a conceptual model for changing behavior. Third, the consistency of our finding in the sensitivity analysis makes our results more robust. Fourth, our study is strengthened by the convergent validity that we found across meta-regression analyses for different services and between meta-regression analyses and studies that directly compared different interventions. Finally, meta-analysis is probably the only practical way to conduct such comparisons. Direct comparisons in randomized clinical trials of the relative effectiveness of intervention components in all their combinations for each of the four preventive services would require prohibitively large sample sizes. Thus, for this clinical question, meta-analysis probably represents the strongest level of evidence available on which to base decisions.

In conclusion, our study indicates that the best strategy to increase the use of immunizations and cancer screening services is implementation of specific organizational change that makes identification and delivery of these services a routine part of patient care. Collaboration and teamwork and a design based on knowledge of needs, barriers, and theory will enhance intervention effectiveness. Patient reminders can be used in addition to, in place of, or as a supplement to organization change as a means of increasing the use of services. Patient financial incentives, if not already implemented,
should also be considered. Education and provider feedback are consistently less effective and should not be the first choices for interventions.

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