

PEDIATRICS®

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Effectiveness and Net Cost of Reminder/Recall for Adolescent Immunizations

Christina A. Suh, Alison Saville, Matthew F. Daley, Judith E. Glazner, Jennifer Barrow, Shannon Stokley, Fran Dong, Brenda Beaty, L. Miriam Dickinson and Allison Kempe

Pediatrics 2012;129:e1437; originally published online May 7, 2012;
DOI: 10.1542/peds.2011-1714

The online version of this article, along with updated information and services, is located on the World Wide Web at:

<http://pediatrics.aappublications.org/content/129/6/e1437.full.html>

PEDIATRICS is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1948. PEDIATRICS is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2012 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 0031-4005. Online ISSN: 1098-4275.

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™



Effectiveness and Net Cost of Reminder/Recall for Adolescent Immunizations

AUTHORS: Christina A. Suh, MD,^{a,b} Alison Saville, MSPH, MSW,^a Matthew F. Daley, MD,^{a,b,c} Judith E. Glazner, MS,^d Jennifer Barrow, MSPH,^a Shannon Stokley, MPH,^e Fran Dong, MS,^a Brenda Beaty, MSPH,^{a,c} L. Miriam Dickinson, PhD,^{c,f} and Allison Kempe, MD, MPH^{a,b,c}

^aChildren's Outcomes Research Program, Children's Hospital Colorado, Aurora, Colorado; Departments of ^bPediatrics and ^cFamily Medicine, ^dColorado Health Outcomes Program, and ^eColorado School of Public Health, University of Colorado School of Medicine, Denver, Colorado; and ^fImmunization Services Division, the Centers for Disease Control and Prevention, Atlanta, Georgia

KEY WORDS

reminder, recall, adolescents, immunizations

ABBREVIATIONS

CIIS—Colorado Immunization Information System
HPV—human papillomavirus vaccine
HPV1—first dose of human papillomavirus vaccine
MCV4—meningococcal conjugate vaccine
R/R—reminder/recall
Tdap—tetanus-diphtheria-acellular pertussis
WCV—well-child care visit

Portions of this work were presented at the 43rd National Immunization Conference; April 2009; Dallas, TX, and the annual meeting of the Pediatric Academic Societies; May 2009; Baltimore, MD.

The findings and conclusions in this report are those of the authors, and do not necessarily represent the views of the Centers for Disease Control and Prevention, US Department of Health and Human Services.

This project has been registered at www.clinicaltrials.gov (identifier NCT00715234).

www.pediatrics.org/cgi/doi/10.1542/peds.2011-1714

doi:10.1542/peds.2011-1714

Accepted for publication Mar 5, 2012

Address correspondence to Christina Suh, MD, 13199 Montview Blvd, Suite 300, Aurora, CO 80045. E-mail: christina.suh@ucdenver.edu

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

Copyright © 2012 by the American Academy of Pediatrics

FINANCIAL DISCLOSURE: *The authors have indicated they have no financial relationships relevant to this article to disclose.*

FUNDING: Funded by a grant from the Centers for Disease Control and Prevention (3U01P000129-02W1) to the University of Colorado Denver Anschutz Medical Campus.

COMPANION PAPER: A companion to this article can be found on page e1446, online at www.pediatrics.org/cgi/doi/10.1542/peds.2011-2921.



WHAT'S KNOWN ON THIS SUBJECT: Rates of coverage for recommended vaccinations in adolescents are substantially lower than Healthy People 2010 goals. Reminder/recall is an evidence-based strategy that is proven to increase immunization rates in both adults and young children.



WHAT THIS STUDY ADDS: This study shows that reminder/recall is effective in increasing adolescent immunization rates. Practices may also benefit financially from conducting reminder/recall in this age group if they are able to generate additional well visits and keep supply costs low.

abstract

OBJECTIVE: To assess the effectiveness of reminder/recall (R/R) for immunizing adolescents in private pediatric practices and to describe the associated costs and revenues.

METHODS: We conducted a randomized controlled trial in 4 private pediatric practices in metropolitan Denver. In each practice, 400 adolescents aged 11 to 18 years who had not received 1 or more targeted vaccinations (tetanus-diphtheria-acellular pertussis, meningococcal conjugate, or first dose of human papillomavirus vaccine for female patients) were randomly selected and randomized to intervention (2 letters and 2 telephone calls) or control (usual care) groups. Primary outcomes were receipt of >1 targeted vaccines and receipt of all targeted vaccines 6 months postintervention. We calculated net additional revenue for each additional adolescent who received at least 1 targeted vaccine and for those who received all targeted vaccines.

RESULTS: Eight hundred adolescents were randomized to the intervention and 800 to the control group. Baseline rates of having already received tetanus-diphtheria-acellular pertussis, meningococcal conjugate, and first dose of human papillomavirus vaccine before R/R ranged from 33% to 54%. Postintervention, the intervention group had significantly higher proportions of receipt of at least 1 targeted vaccine (47.1% vs 34.6%, $P < .0001$) and receipt of all targeted vaccines (36.2% vs 25.2%, $P < .0001$) compared with the control group. Three practices had positive net revenues from R/R; 1 showed net losses.

CONCLUSIONS: R/R was successful at increasing immunization rates in adolescents and effect sizes were comparable to those in younger children. Practices conducting R/R may benefit financially if they can generate additional well-child care visits and keep supply costs low. *Pediatrics* 2012;129:e1437–e1445

Since 2005, several new vaccines have been recommended for adolescents: tetanus-diphtheria-acellular pertussis (Tdap) vaccine,¹ meningococcal conjugate vaccine (MCV4),² and human papillomavirus vaccine (HPV).³ Because these immunizations are recommended for adolescents, there has been a renewed focus on improving immunization delivery⁴ by concentrating on the 11- to 12-year-old primary care visit and creating an adolescent vaccination platform.⁵ Barriers to adolescent immunization include lack of regular preventive care visits at this age,⁶ record scatter,^{7,8} difficulty obtaining parental consent,⁹ and lack of insurance.¹⁰

Reminder/recall (R/R) has been proposed as an evidence-based solution to immunizing adolescents. In R/R, patients receive a reminder notification for upcoming immunizations or a recall notice for overdue immunization(s). R/R is generally effective in increasing immunization rates in young children and adults,^{11,12} but there have been few studies of R/R systems for adolescents.^{13,14} The objectives of this study were to (1) determine the effectiveness of letter and autodialer R/R in increasing immunization rates for Tdap, MCV4, and first dose of HPV (HPV1; female patients only) among adolescents in 4 private urban/suburban pediatric practices, and (2) measure the costs and revenues associated with R/R. As secondary outcomes, we assessed the effect of the R/R on immunization rates for other childhood vaccines, completion of the 3-dose HPV series among female patients, and well-child care visit (WCV) rates.

METHODS

Study Setting and Population

The study protocol was reviewed and approved by the Colorado Multiple Institutional Review Board as an expedited protocol, not requiring consent from individual families. We conducted

the study in 4 suburban private pediatric practices in metropolitan Denver from February 2008 to August 2009. The practices participate in the Colorado Immunization Information System (CIIS), a statewide immunization registry, and share a common computerized billing system.

The study population was a sample of adolescents aged 11 to 18 years who had been seen at their practice at least once in the preceding 2 years. Adolescents were eligible for study enrollment if they needed 1 or more of the targeted adolescent vaccines (Tdap, MCV4, and HPV1 for female patients only). In the case in which an adolescent had a sibling who also met inclusion criteria, 1 adolescent from the household was randomly chosen to be in the study. Eligible siblings received the same intervention type as the enrolled adolescent, but their data were not analyzed.

Data Sources

To ensure that all immunizations previously given at the practice were represented in CIIS, administrative data from the practices' electronic billing systems were merged with CIIS data, and these combined data were used to determine which adolescents were eligible for our study. Patient contact information (home phone number and address) was determined from administrative data.

Randomization

We randomized at the patient-level within each practice by using random number generation (SAS 9.1, SAS Institute, Cary, NC). Providers were blinded to group allocation.

R/R Intervention

The R/R intervention consisted of up to 2 letters separated by 2 autodialer telephone calls because previous literature has demonstrated that a letter followed by a telephone message is better than

either method alone.¹⁵ All families were sent a first letter and autodialer telephone call. Adolescents still in need of targeted immunizations 1 month later received a second autodialer telephone call. A final letter was sent to adolescents still needing immunizations 2 months after the initial R/R. The letters and autodialer calls were scripted with the input of the practices and letters were sent on each practice's letterhead. The letter and phone calls informed parents that their adolescent was due to receive at least 1 immunization (Tdap, MCV4, or HPV1 for female patients), and provided brief information on each immunization. Adolescents in the control group received usual care, which did not include R/R.

The first reminder was sent with a form allowing a family to defer or decline additional R/R for the following reasons: they did not want the patient to receive the vaccine(s), the patient had already received the vaccine(s), the patient already had an appointment scheduled to receive the vaccine(s), or the parent did not wish to receive additional reminders. The individual participating practices decided whether to schedule a WCV or a shot-only visit for a particular child, but all practices had a policy of recommending yearly WCV for adolescent patients.

Outcome Measures

The primary outcome measures were receipt of at least 1 targeted adolescent vaccine and receipt of all targeted adolescent vaccines at 6 months post-intervention. Secondary outcomes included completion of the following vaccine series at 12 months post-intervention: hepatitis A, hepatitis B, varicella, and HPV (females only). We also examined WCV rates at 6 months and 12 months postintervention. We used immunization data from CIIS supplemented by billing data to determine all immunization-related outcome

measures, and billing data to determine WCV rates. The reach of the intervention was estimated by assuming letters had been received if they were not returned or forwarded and telephone calls received if either a person or voicemail was reached.

Analytic Methods

This study was powered at 80% to detect an absolute difference of 7 percentage points in postimmunization rates between control and intervention groups. The target for each practice was to enroll and randomize 200 adolescents to each study group. We used intention to treat for all analyses. We calculated descriptive statistics for patient gender and age and compared intervention and control groups for all outcomes by using χ^2 tests. We computed unadjusted relative risks and 95% confidence intervals for the primary outcome by using a log binomial regression model by using SAS PROC GENMOD with the binomial distribution and the log link function. We derived adjusted relative risks and 95% confidence intervals for the primary outcome from logistic regression models by using regression risk analysis.¹⁶ We included gender, age, and practice site as covariates. We performed all statistical analyses by using SAS software.

Cost Analysis Methods

The net cost analysis in this study took the point of view of the pediatric practices, based on the fact that these practices function as small businesses and that costs and revenues must be considered in their decision-making. We calculated cost and revenue per additional adolescent who received all targeted vaccines and at least 1 targeted vaccine. We calculated total costs for each practice, divided into initial startup costs and operating costs. To calculate net additional revenue, we only used operating costs (personnel

and supply costs). Initial startup costs are 1-time costs that would be incurred in developing an R/R system; for this study, they included those related to creating and translating the autodialer script. We excluded startup costs in our net revenue calculations because of uncertainty regarding the period over which these costs would be amortized by different practices. However, startup costs would need to be considered if a practice were to begin an R/R program de novo.

To determine personnel costs, study staff members documented the amount of time they spent on R/R activities, including defining the eligible population, checking immunization records, and generating patient lists for recall. For each activity, we collected the job titles of office staff who would typically perform it. Office staff members recorded their time (1) keeping track of patients who called to make appointments or ask questions after receiving a notice and (2) processing returned mail. We applied national average salaries published by the Bureau of Labor Statistics for each job title to the times recorded by both project and practice staff.¹⁷ We determined supply costs by examining invoices for mailing supplies, postage, and autodialer supplies.

We estimated reimbursement for each adolescent within the intervention and control groups for each practice by using patient age, number of visits, and number of shots received. We reviewed Current Procedural Terminology codes to identify WCV and immunizations. Other non-WCV immunization visits were defined as an office visit in which vaccinations were given but no WCV code was observed and included both immunization-only visits and visits for sick or follow-up care. The revenues for all non-WCV only include administration and vaccination costs. Reimbursement data for WCV and immunizations were taken from the American Academy of

Pediatrics Analysis of 2005 Medstat MarketScan¹⁸ and Colorado Medicaid reimbursement rates.¹⁹ We calculated total additional revenue for each practice by subtracting the revenues for the control group from those of the intervention group. We calculated net additional revenue for each practice by subtracting total operating costs from total additional revenues. To make this study useful for pediatric practices, we included revenues resulting from all shots given during the visit prompted by the recall, not only those for the target vaccines. Our analyses did not include either cost or revenue realized from the purchase of vaccines.

RESULTS

Figure 1 is a Consolidated Standards of Reporting Trials diagram detailing selection of the study population. Of the 6775 adolescents who needed ≥ 1 target vaccines, 1600 were randomly selected, with 800 randomized to the intervention and 800 to the control group. Seven hundred fifty-one (94%) adolescents in the intervention group received at least 1 recall phone call and 1 recall letter, 34 (4%) received recall letters only, 13 (2%) received at least 1 recall phone call only, and 2 (<1%) received neither recall letters nor phone calls. Recalls were stopped for 91 patients (11%) whose parents returned the defer or decline immunization form; these patients were included in the final analysis. Table 1 presents characteristics of enrolled patients including baseline up-to-date rates for the target vaccines for practices. Overall, the intervention and control groups did not differ with respect to gender, age, or insurance status. Baseline up-to-date rates for all targeted vaccines ranged from 32.6% to 53.9% across practices and was 40.3% overall for the study population. Three of the practices were located in suburban areas and the fourth was in an urban, but not inner-city, setting. The

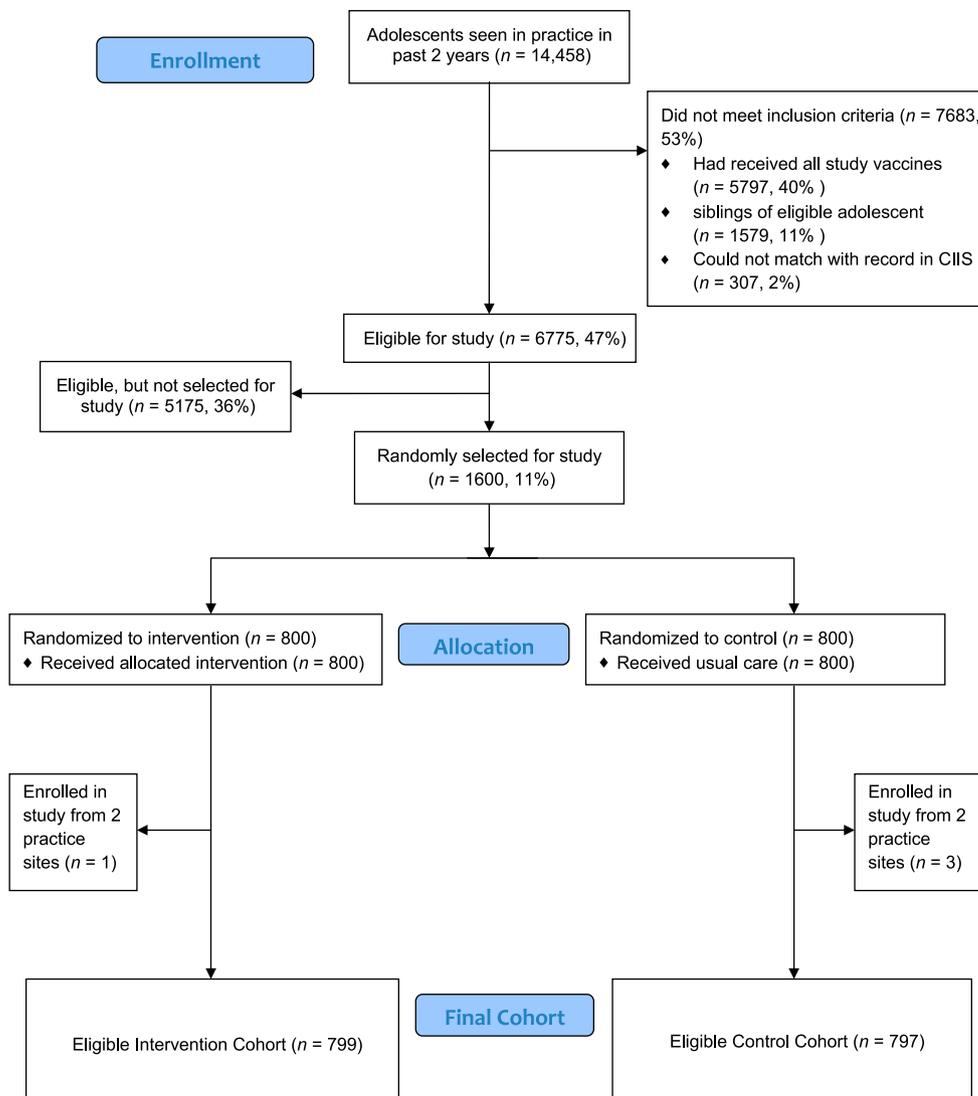


FIGURE 1
Flow diagram of study participants.

number of midlevel or physician providers varied from 8 to 21 providers per practice, and the total number of adolescent patients who had been seen within the past 2 years ranged from 1138 to 3200 per practice.

Effectiveness of R/R in Pediatric Practices

When results for all practices were pooled, a significantly higher percentage of adolescents in the intervention group versus the control group received at least 1 targeted vaccine ($P < .001$; Fig 2). In 3 individual practices, the intervention group had a significantly

higher proportion of adolescents who received at least 1 targeted vaccine compared with the control group ($P < .05$), with effect sizes ranging from 15.2 to 20.5 percentage points. In 1 practice (Practice 2), no effect was observed. Among the entire study population, the adjusted risk ratio for probability of an adolescent in the intervention versus control group to receive at least 1 targeted vaccine was 1.36 (95% confidence interval 1.21–1.54), adjusting for age, gender, and practice site.

In addition, among all the practices a significantly higher percentage of adolescents in the intervention group

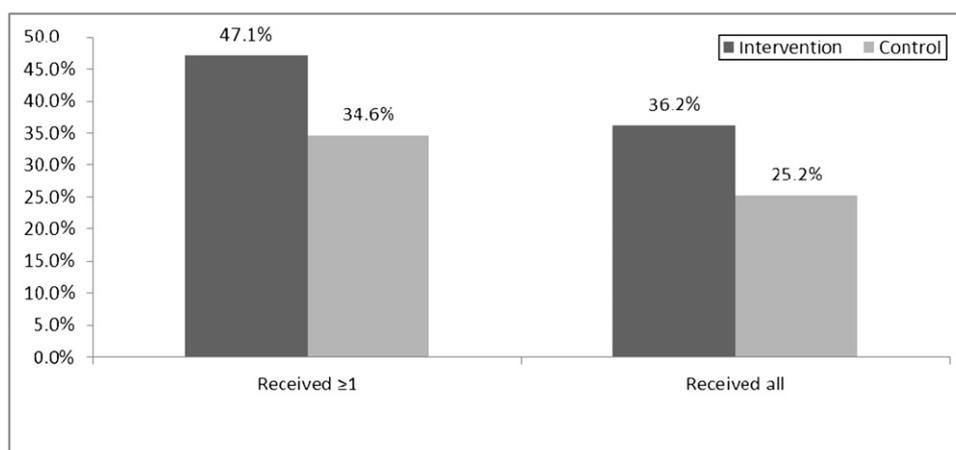
versus the control group received all targeted vaccines ($P < .001$; Fig 2). In 3 of the individual practices, significantly higher proportions of adolescents in the intervention group received all targeted vaccines compared with the control group ($P < .05$), with effect size ranging from 10.1 to 19.5 percentage points. Again, in Practice 2, no effect was observed. The adjusted risk ratio for probability of an adolescent in the intervention versus control group to receive all targeted vaccines was 1.44 (95% confidence interval 1.25–1.67), adjusting for age, gender, and practice site. Figure 3 shows the percentages of

TABLE 1 Study Population ($n = 1600$)

	Practice 1		Practice 2		Practice 3		Practice 4		Total		P Value
	C ($n = 200$)	I ($n = 200$)	C ($n = 198$)	I ($n = 200$)	C ($n = 199$)	I ($n = 199$)	C ($n = 200$)	I ($n = 200$)	CI ($n = 797$)	I ($n = 799$)	
Population characteristics											
Male gender	45.5 (91)	31.5 (63)	34.9 (69)	44.0 (88)	45.2 (90)	31.7 (63)	39.0 (78)	41.0 (82)	41.2 (328)	37.1 (296)	.09
Median age, y	14.1	14.1	14.2	14.3	14.1	13.8	14.1	13.9	14.1	13.9	.35 ^a
Insurance status											
Private	82.5 (165)	82.5 (165)	91.0 (182)	92.5 (185)	90.0 (180)	92.5 (185)	93.5 (187)	91.0 (182)	89.3 (714)	89.6 (717)	.30
Public	16.0 (32)	15.0 (30)	8.0 (16)	6.5 (13)	9.0 (18)	4.5 (9)	4.5 (9)	6.5 (13)	9.4 (75)	8.1 (65)	
Missing	1.5 (3)	2.5 (5)	1.0 (2)	1.0 (2)	1.0 (2)	3.0 (6)	2.0 (4)	2.5 (5)	1.4 (11)	2.3 (18)	
Baseline Vaccination Rates											
Before Intervention											
UTD rate for HPV (first dose only), %		39.0		42.7		50.1		33.3		40.7	<.0001
UTD rate for Tdap, %		64.4		62.0		76.3		66.0		66.8	<.0001
UTD rate for MCV4, %		55.2		57.2		69.5		49.6		57.4	<.0001
Baseline UTD rate for all targeted vaccines, %		39.3		32.6		53.9		34.3		40.3	<.0001

Data are % (n) unless otherwise indicated. C, control group; I, intervention.

^a Wilcoxon test.

**FIGURE 2**

Percent of adolescents who received at least 1 targeted immunization and who received all needed immunizations 6 months postintervention. For both comparisons, $P < .001$.

adolescents who received each individual study vaccine, among those who needed that vaccine, in the intervention and control groups. Overall, there was a significant increase in the intervention group compared with the control group for each of the individual vaccines ($P < .05$). Immunization rates were lower for HPV1 than for the other 2 vaccines.

Cost Analysis

Table 2 shows revenue generated by WCV and other non-WCV immunization visits, total operating costs, total additional revenues, and net additional revenues associated with the R/R

program. The startup costs (auto-dialer script preparation and transcription) for the 4 practices, which ranged from \$327 to \$485, are excluded. After subtracting total operating costs from total additional revenues, 3 practices experienced positive net additional revenues and 1 (Practice 2) showed a loss. Three of the practices also experienced positive net revenues per each additional adolescent who received all targeted vaccines (range: \$2483–\$753) and for each additional adolescent who received at least 1 targeted vaccine (range: \$75.24–\$21.32). Because in Practice 2 more

adolescents in the control group than the intervention group received at least 1 vaccine, it was not possible to calculate net revenue, but it is likely that there was a net loss for this practice.

Secondary Outcomes

Table 3 demonstrates the percentages of the intervention and control groups that had not received 2 hepatitis A vaccines, 3 hepatitis B vaccines, and 2 varicella vaccines. The percentage brought up-to-date for each of these series by 12 months postintervention are also shown. The R/R intervention was

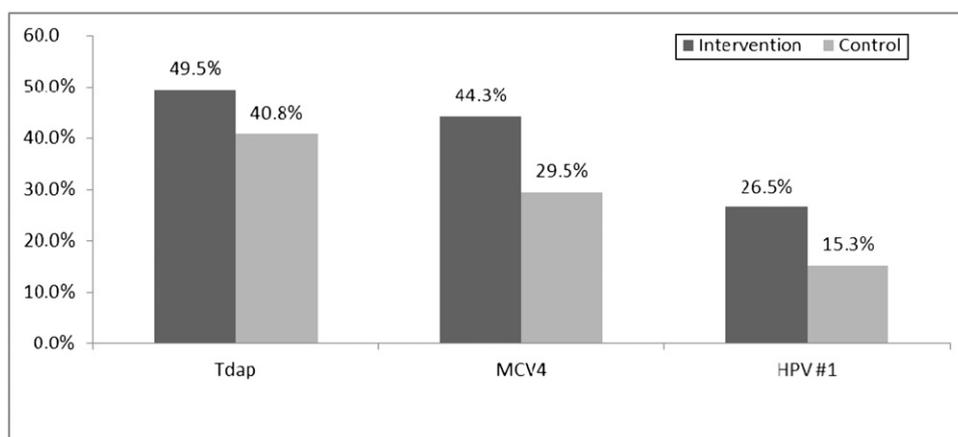


FIGURE 3

Vaccination rates among eligible adolescents by individual vaccine type: Tdap, MCV4, and HPV1 (females only). For all comparisons, $P < .05$.

TABLE 2 Costs and Revenues Associated With an R/R Program for Adolescents

	Practice 1	Practice 2	Practice 3	Practice 4
No. of additional WCV	27	(13)	13	7
Additional WCV revenue	\$2691	(\$1450)	\$1340	\$811
Additional WCV vaccination revenue	\$641	(\$182)	\$247	\$204
No. of additional non-WCV with immunizations given ^a	10	4	24	44
Additional immunization-only visits	3	5	19	30
Additional ill or follow-up visits	7	(1)	5	14
Additional non-WCV vaccination revenue	\$270	\$99	\$423	\$825
Total additional revenues ^b	\$3602	(\$1533)	\$2010	\$1840
Total operating costs	\$1119	\$1245	\$1349	\$1087
Personnel costs	\$589	\$420	\$622	\$458
Supply costs	\$530	\$825	\$727	\$629
Net additional revenue	\$2483	(\$2778)	\$661	\$753
No. of additional teenagers ^c who received all targeted vaccines	24	5	20	39
Net additional revenue/additional teenagers who received all targeted vaccines	\$103.46	(\$555.60)	\$33.05	\$19.31
No. of additional teenagers who received at least 1 targeted vaccine	33	(5)	31	41
Net additional revenue/additional teenager who received at least 1 targeted vaccine	\$75.24	Not applicable	\$21.32	\$18.37

^a Additional non-WCV are defined as an office visit at which vaccinations were given but no WCV was observed. These visits include visits when immunizations were only given and ill or follow-up visits when 0 immunizations were given. The revenues that were for these included only the administration and vaccination costs.

^b This figure is the result of subtracting the revenues for the comparison group from those of the intervention group for each practice. Amounts in parentheses are negative.

^c The number of additional teens is, for each practice, the difference between the number of teens in the intervention group who had a well-child or immunization-only visit, and the number in the control group who had such visits. Includes teens who had historical immunization data entered during visit.

associated with significant increases in series completion for hepatitis A and varicella but not for hepatitis B. Shown in Table 4 is the percentage of female patients who had not initiated the HPV series at baseline who completed the series among both the intervention and control groups. The percentage of

adolescents who attended a WCV was significantly higher in the intervention group compared with the control group (35.3% vs 30.1%, $P < .05$) at 6 months postintervention. However, differences were no longer significant 12 months postintervention (46.4% vs 44.9%, $P =$ not significant).

DISCUSSION

The results of this study demonstrate that R/R increased immunization rates among adolescents in 3 of the 4 private pediatric practices, with effect sizes similar to or larger than those seen in previous studies of R/R for infants and adults¹¹ and adolescents.²⁰ The intervention in these private practices also resulted in higher up-to-date rates for other vaccines such as hepatitis A and varicella as well as a higher rate of completion of the HPV series, demonstrating ancillary benefits of conducting R/R in this population. Furthermore, the 3 practices that were successful in their R/R efforts showed positive net revenues associated with the R/R effort when we included revenues associated with visits generated. We also found that the intervention resulted in more timely receipt of WCV at 6 months post-intervention, although this effect was no longer seen at 12 months.

Our results show a level of effectiveness of R/R that is at least equivalent to the effectiveness demonstrated in previous trials conducted primarily in practices serving children or adults. A 2009 Cochrane review noted immunization increases in the range of 5% to 20% for all settings,²¹ and a systematic review in 2000 showed a median absolute change of ~8.2% in previous trials of recall

TABLE 3 Percent of Adolescents in Intervention Versus Control Groups Who Became Up-to-Date (UTD) for Hepatitis A, Hepatitis B, and Varicella Series During the 12 Months Postintervention

Type of Vaccine	Intervention, <i>n</i> = 799		Control, <i>n</i> = 797	
	Not UTD at Baseline, % (<i>n</i>)	Brought UTD at 12 Mo, % (<i>n</i>)	Not UTD at Baseline, % (<i>n</i>)	Brought UTD at 12 Mo, % (<i>n</i>)
Hepatitis A series (2 doses)	53.6 (428)	27.3 (117) ^a	52.5 (418)	19.1 (80)
Hepatitis B series (3 doses)	10.9 (87)	3.5 (3)	13.9 (111)	1.8 (2)
Varicella series (2 doses)	40.4 (323)	33.1 (107) ^a	40.8 (325)	25.5 (83)

^a *P* < .05.**TABLE 4** Percent of Female Adolescents in Intervention Versus Control Groups Who Became Up-to-Date (UTD) for HPV Series During the 12-Months Postintervention

Baseline	Intervention, <i>n</i> = 503		Control, <i>n</i> = 469	
	Not UTD at Baseline, <i>n</i>	Brought UTD for 3 Doses HPV at 12 Mo, % (<i>n</i>)	Not UTD at Baseline, <i>n</i>	Brought UTD for 3 Doses HPV at 12 Mo, % (<i>n</i>)
0 HPV	402	11.4 (46) ^a	387	4.4 (17)
≥1 HPV	87	74.7 (65)	65	73.9 (48)

^a *P* < .05.

conducted specifically within private practice settings.²² In a study of a tiered immunization intervention aimed at adolescents that consisted of patient immunization tracking, R/R, and home visits by patient immunization navigators, researchers found an absolute increase in immunization rates in the range of 12% to 16% over control.²⁰ In 3 of our practices, the absolute change ranged from 15% to 20% and, even taking into account the practice in which the recall was ineffective, the overall change was ~13%. Taken together with these previous studies, our findings that R/R can be effective for increasing rates in adolescents in some settings are encouraging. The results of our study differ substantially from a previous investigation of R/R in adolescents conducted in 4 urban primary care sites with 35% to 40% of the study population insured by Medicaid.¹³ In that study, weekly audiotaped reminders were minimally effective at increasing immunization rates in 11- to 14-year-old adolescents. Families with only 1 telephone contact number had a greater response to the recalls than families with multiple telephone contact numbers, suggesting that problems with contacting families contributed to the lack of effect seen. In another trial in which immunization recall for young children

conducted in an urban teaching hospital serving a low-income population was not effective at increasing immunization rates, the investigators found they were unable to reach ~30% of families either by phone or mail.²³ The comparison of our findings with these studies underscores the importance of the practice settings and study populations in the success of R/R efforts. Maintaining accurate contact information may be more difficult in patient care settings that serve predominately low-income, urban populations that may more frequently move or lose telephone service. The private practices that participated in our study are located in suburban settings with patient populations that are generally of higher socioeconomic status, with approximately <10% of patient populations being publically insured. In addition, we enrolled adolescents who had been seen in their respective practice in the prior 2 years to ensure the most accurate contact information and that we were excluding those adolescents who were no longer active patients. As a result, only 2 adolescents out of the intervention did not receive either a recall phone call or recall letter in our study.

It is important to note that receipt of HPV1 among those female patients who

were unimmunized was just over half as common as receipt of Tdap among those needing these vaccines. This is consistent with recent national data from the National Immunization Survey-Teen, demonstrating significantly lower rates of initiation of the HPV series compared with receipt of Tdap and MCV4 vaccines.²⁴ We did demonstrate a statistically significant increase in completion of the 3-dose HPV series 1 year after the intervention, although the rate of completion in the intervention group was low. In addition, there were ancillary benefits of the targeted R/R on increasing rates of other childhood immunization series that adolescents were missing.

The 3 private practices that successfully raised immunization rates through R/R all generated extra revenue from extra visits and payment for vaccine administration. It is difficult to compare our cost and revenue data with other studies because of the variability in methods of assessing costs, variation in the items included in the cost analyses, and the lack of measurement of both costs and revenues in previous studies.²¹ Although a recent Cochrane review included 8 cost-effectiveness studies of R/R,^{15,25–30} to our knowledge, this is the first trial concerning costs and/or effectiveness of R/R that takes

the point of view of practicing pediatricians and examines both costs and revenues. This approach allows us to more directly address the likely economic consequences to practices of adopting an R/R system such as that used in the study. In our study, the practices that generated the most additional WCV (Practices 1 and 3) had the highest net additional revenues. However, Practice 4, which scheduled fewer WCV and delivered more vaccinations at immunization-only visits, also experienced a profit. Although scheduling WCV generated the most revenue, the ability of practices to schedule such visits is limited by the fact that some insurance plans do not cover these annual visits³¹ or that a WCV may not be indicated for an adolescent for that year.³² The operating costs for R/R at the 4 practices ranged from \$1087 to \$1349. With 1 exception, the greatest single cost for the practices was supplies, including the printing of letterheads and envelopes. The range of supply costs for these practices was wide; the highest practice supply cost 50% more than that for the lowest practice. If this particular cost could be lowered, net additional revenues would increase. Surprisingly, our R/R intervention had no effect on increasing immunization rates in 1 practice. This practice also had the largest net revenue loss associated with the intervention, mainly because the intervention did not generate additional

WCV or vaccinations and the practice had relatively high operating costs. Researchers met with key providers in this practice after the results were analyzed to discuss potential explanations for the negative results. We identified problems with staff turnover and miscommunication about the R/R project among front office staff and providers that may have resulted in cross-contamination between the intervention and control groups. This information provides only limited insight into the lack of effectiveness of the intervention in this practice, although it is interesting to note that this practice had the lowest baseline immunization rates overall, which might suggest more systematic limitations in implementation within this practice.

There are some strengths and limitations to our study. It was a randomized controlled trial with randomization at the patient level. All study participants received their allocated intervention and we were able to obtain post-intervention immunization data on close to 100% of participants. Also, although some startup recall activities were performed by the study team, we attempted to simulate practice-based R/R by suggesting that reminder letters be printed on practice letterhead, having staff from practices record autodialer messages, and allowing practice staff to handle all questions and visit-related activities.

The primary limitations of our study have to do with the external generalizability of our results. The 4 private pediatric practices in which this study was conducted participate in the statewide, computerized immunization registry and have participated in previous R/R efforts^{33,34} and therefore may be more motivated to perform R/R than other practices. In addition, their patient populations are generally insured and of higher socioeconomic level. Finally, it is important to note that if R/R were implemented in practices without a functioning immunization information system and easily accessible administrative records, identifying patients to target for R/R would be more difficult and likely associated with increased costs; in such cases, R/R may not be economically advantageous.

CONCLUSIONS

Our study shows that R/R is as effective in increasing immunization rates among adolescents as it has been among younger children in practices serving suburban populations. All practices that were successful in increasing rates by using R/R showed net profits and the cost analysis conducted identified modifiable factors that can result in lower costs and higher revenues, such as reducing supply costs and maximizing WCV when administering vaccinations.

REFERENCES

1. Broder KR, Cortese MM, Iskander JK, et al; Advisory Committee on Immunization Practices (ACIP). Preventing tetanus, diphtheria, and pertussis among adolescents: use of tetanus toxoid, reduced diphtheria toxoid and acellular pertussis vaccines recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Rep.* 2006;55(RR-3):1–34
2. Bilukha OO, Rosenstein N; National Center for Infectious Diseases, Centers for Disease Control and Prevention (CDC). Prevention and control of meningococcal disease. Recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Rep.* 2005;54(RR-7):1–21
3. Markowitz LE, Dunne EF, Saraiya M, Lawson HW, Chesson H, Unger ER; Centers for Disease Control and Prevention (CDC); Advisory Committee on Immunization Practices (ACIP). Quadrivalent human papillomavirus vaccine: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Rep.* 2007;56(RR-2):1–24
4. National Vaccine Advisory Committee. The promise and challenge of adolescent immunization. *Am J Prev Med.* 2008;35(2):152–157
5. McCauley MM, Fishbein DB, Santoli JM. Introduction: strengthening the delivery of new vaccines for adolescents. *Pediatrics.* 2008;121(suppl 1):S1–S4

6. Rand CM, Shone LP, Albertin C, Auinger P, Klein JD, Szilagyi PG. National health care visit patterns of adolescents: implications for delivery of new adolescent vaccines. *Arch Pediatr Adolesc Med.* 2007;161(3):252–259
7. Schaffer SJ, Humiston SG, Shone LP, Averhoff FM, Szilagyi PG. Adolescent immunization practices: a national survey of US physicians. *Arch Pediatr Adolesc Med.* 2001;155(5):566–571
8. Oster NV, McPhillips-Tangum CA, Averhoff F, Howell K. Barriers to adolescent immunization: a survey of family physicians and pediatricians. *J Am Board Fam Pract.* 2005;18(1):13–19
9. Szilagyi PG, Rand CM, McLaurin J, et al; Working Group on Adolescent Vaccination in the Medical Home. Delivering adolescent vaccinations in the medical home: a new era? *Pediatrics.* 2008;121(suppl 1):S15–S24
10. Newacheck PW, Park MJ, Brindis CD, Biehl M, Irwin CE Jr. Trends in private and public health insurance for adolescents. *JAMA.* 2004;291(10):1231–1237
11. Jacobson VJ, Szilagyi P. Patient reminder and patient recall systems to improve immunization rates. *Cochrane Database Syst Rev.* 2009;CD003941
12. Guide to community preventive services. Universally recommended vaccinations: client reminder & recall systems. 2008 February. Available at: www.thecommunityguide.org/vaccines/universally/clientreminder.html. Accessed November 2, 2011
13. Szilagyi PG, Schaffer S, Barth R, et al. Effect of telephone reminder/recall on adolescent immunization and preventive visits: results from a randomized clinical trial. *Arch Pediatr Adolesc Med.* 2006;160(2):157–163
14. Harper P, Madlon-Kay DJ. Adolescent measles vaccination. Response rates to mailings addressed to patients vs parents. *Arch Fam Med.* 1994;3(7):619–622
15. Lieu TA, Capra AM, Makol J, Black SB, Shinefield HR. Effectiveness and cost-effectiveness of letters, automated telephone messages, or both for underimmunized children in a health maintenance organization. *Pediatrics.* 1998;101(4). Available at: www.pediatrics.org/cgi/content/full/101/4/e3
16. Kleinman LC, Norton EC. What's the risk? A simple approach for estimating adjusted risk measures from nonlinear models including logistic regression. *Health Serv Res.* 2009;44(1):288–302
17. Bureau of Labor Statistics. May 2009 national occupational employment and wage estimates, United States. 2010
18. Medicaid, Medicare and commercial payments for commonly reported pediatric services, 2004/05: Colorado. 2006
19. Medicaid reimbursement survey, 2004/05: Colorado
20. Szilagyi PG, Humiston SG, Gallivan S, Albertin C, Sandler M, Blumkin A. Effectiveness of a citywide patient immunization navigator program on improving adolescent immunizations and preventive care visit rates. *Arch Pediatr Adolesc Med.* 2011;165(6):547–553
21. Jacobson Vann JC, Szilagyi P. Patient reminder and patient recall systems to improve immunization rates. *Cochrane Database Syst Rev.* 2009;CD003941
22. Szilagyi PG, Bordley C, Vann JC, et al. Effect of patient reminder/recall interventions on immunization rates: a review. *JAMA.* 2000;284(14):1820–1827
23. Kempe A, Lowery NE, Pearson KA, et al. Immunization recall: effectiveness and barriers to success in an urban teaching clinic. *J Pediatr.* 2001;139(5):630–635
24. Centers for Disease Control and Prevention (CDC). National and state vaccination coverage among adolescents aged 13 through 17 years—United States, 2010. *MMWR Morb Mortal Wkly Rep.* 2011;60(33):1117–1123
25. LeBaron CW, Starnes DM, Rask KJ. The impact of reminder-recall interventions on low vaccination coverage in an inner-city population. *Arch Pediatr Adolesc Med.* 2004;158(3):255–261
26. Rodewald LE, Szilagyi PG, Humiston SG, Barth R, Kraus R, Raubertas RF. A randomized study of tracking with outreach and provider prompting to improve immunization coverage and primary care. *Pediatrics.* 1999;103(1):31–38
27. Young SA, Halpin TJ, Johnson DA, Irvin JJ, Marks JS. Effectiveness of a mailed reminder on the immunization levels of infants at high risk of failure to complete immunizations. *Am J Public Health.* 1980;70(4):422–424
28. Lieu TA, Black SB, Ray P, et al. Computer-generated recall letters for underimmunized children: how cost-effective? *Pediatr Infect Dis J.* 1997;16(1):28–33
29. Rosser WW, Hutchison BG, McDowell I, Newell C. Use of reminders to increase compliance with tetanus booster vaccination. *CMAJ.* 1992;146(6):911–917
30. McDowell I, Newell C, Rosser W. Comparison of three methods of recalling patients for influenza vaccination. *CMAJ.* 1986;135(9):991–997
31. Fox HB, McManus MA, Reichman MB. Private health insurance for adolescents: is it adequate? *J Adolesc Health.* 2003;32(suppl 6):12–24
32. US Preventive Services Task Force. Guide to clinical preventive services 2010–2011: recommendations of the U.S. Preventive Services Task Force. 2010
33. Daley MF, Barrow J, Pearson K, et al. Identification and recall of children with chronic medical conditions for influenza vaccination. *Pediatrics.* 2004;113(1 pt 1). Available at: www.pediatrics.org/cgi/content/full/113/1/e26
34. Kempe A, Daley MF, Barrow J, et al. Implementation of universal influenza immunization recommendations for healthy young children: results of a randomized, controlled trial with registry-based recall. *Pediatrics.* 2005;115(1):146–154

Effectiveness and Net Cost of Reminder/Recall for Adolescent Immunizations

Christina A. Suh, Alison Saville, Matthew F. Daley, Judith E. Glazner, Jennifer Barrow, Shannon Stokley, Fran Dong, Brenda Beaty, L. Miriam Dickinson and Allison Kempe

Pediatrics 2012;129:e1437; originally published online May 7, 2012;

DOI: 10.1542/peds.2011-1714

Updated Information & Services	including high resolution figures, can be found at: http://pediatrics.aappublications.org/content/129/6/e1437.full.html
References	This article cites 27 articles, 8 of which can be accessed free at: http://pediatrics.aappublications.org/content/129/6/e1437.full.html#ref-list-1
Citations	This article has been cited by 5 HighWire-hosted articles: http://pediatrics.aappublications.org/content/129/6/e1437.full.html#related-urls
Subspecialty Collections	This article, along with others on similar topics, appears in the following collection(s): Adolescent Health/Medicine http://pediatrics.aappublications.org/cgi/collection/adolescent_health:medicine_sub
Permissions & Licensing	Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at: http://pediatrics.aappublications.org/site/misc/Permissions.xhtml
Reprints	Information about ordering reprints can be found online: http://pediatrics.aappublications.org/site/misc/reprints.xhtml

PEDIATRICS is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1948. PEDIATRICS is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2012 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 0031-4005. Online ISSN: 1098-4275.

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™

