Impact of the 2004 Influenza Vaccine Shortage on Patients from Inner City Health Centers

Richard K. Zimmerman, Melissa Tabbarah, Mary Patricia Nowalk,
Mahlon Raymund, Stephen A. Wilson, Ann McGaffey,
J. Todd Wahrenberger, Bruce Block, and Edmund M. Ricci

ABSTRACT *In the fall of 2004, the FDA and British authorities suspended the license of one of only two manufacturers that provided the US supply of inactivated influenza vaccine. With a 50% reduction in supply, a severe vaccine shortage resulted. This situation necessitated the development of priority groups for vaccination including those ≥ 65 years, when ordinarily, influenza vaccine is recommended for those ≥ 50 years old. A sample of patients ≥ 50 years old ($n=336$), who had been seen at one of four inner-city health centers, was interviewed in summer 2005 using computer-assisted telephone interviewing. Associations of survey responses were examined for three groups: those vaccinated in the 2003–2004 and 2004–2005 influenza seasons ($n=142$), those vaccinated in 2003–2004 but not vaccinated in 2004–2005 because of the shortage ($n=63$), and those unvaccinated in both seasons ($n=83$). Bivariate and multivariate logistic regression analyses were used to determine factors significantly influencing the likelihood of vaccination status. A significantly larger proportion of patients 50–64 years of age were unvaccinated due to the shortage (73%) compared to those who were vaccinated during both seasons (36%, $P<0.001$), but there were no racial disparities in vaccination rates. Compared with patients who were vaccinated during both seasons, those who were unvaccinated due to the shortage were more frequently employed, self-reported their health positively, saw their physician less frequently, rated the US government's response to the shortage as "terrible," and blamed the US government for the shortage. Vaccination during the influenza vaccine shortage appears to have followed preferential vaccination of the CDC-established priority group (≥ 65 years) and did not result in racial disparities in inner-city health centers.*

KEYWORDS *Influenza vaccine, Vaccine shortage, Immunization trends, Immunization utilization*

Zimmerman, Tabbarah, Nowalk, and Raymund are with the Department of Family Medicine and Clinical Epidemiology, University of Pittsburgh School of Medicine, Pittsburgh, PA, USA; Zimmerman and are with the Department of Behavioral and Community Health Sciences, University of Pittsburgh Graduate School of Public Health, Pittsburgh, PA, USA; Wilson and McGaffey are with the UPMC St Margaret Family Health Center, Pittsburgh, PA, USA; Wahrenberger is with the Northside Christian Health Center, Pittsburgh, PA, USA; Block is with the UPMC Shadyside Family Health Center, Pittsburgh, PA, USA.

Correspondence: Mary Patricia Nowalk, PhD, RD, Department of Family Medicine and Clinical Epidemiology, University of Pittsburgh School of Medicine, Pittsburgh, PA, USA. (E-mail: tnowalk@pitt.edu)

This paper was presented at the American Academy of Family Physicians Annual Meeting held in Washington DC, September, 2006. It received a runner-up award for Family Medicine Research.

INTRODUCTION

In an effort to reduce the 36,000 annual deaths and 114,000 annual hospitalizations attributable to influenza,¹ Healthy People 2010 has set an influenza immunization goal of 90% for those most vulnerable, i.e., individuals aged 65 years and older.² Yet, influenza vaccination rates among adults ≥ 65 in the 2003 National Health Interview Survey were only 69% for non-Hispanic whites, 48% for non-Hispanic blacks, and 45% for Hispanics, with an overall rate of 65.5%.³ A variety of barriers to annual influenza vaccination exist, including access, fear of side effects or getting influenza from the vaccine, and not realizing one's need for the vaccine, among others.⁴⁻⁸ However, in recent years, a major barrier to increasing immunization rates has been vaccine production delays and shortages. In 2000, inequitable distribution of limited vaccine supplies left many of those most vulnerable unvaccinated,⁹ and in 2004, when nearly one-half of the US influenza vaccine supply was unavailable, many of those for whom vaccine is recommended were unable to be vaccinated. Interruptions in supply are a serious issue in light of recent evidence that an interruption of the annual vaccination pattern led to increased mortality among the elderly, whereas repeat vaccinations reduced all-cause mortality compared with initial vaccination.¹⁰

In response to prior distribution inequities and vaccine shortages, nationwide changes were instituted by one manufacturer in 2002 so that the majority of providers received at least a portion of their requested vaccine orders and could administer vaccine first to those at highest risk. Due to the magnitude of the shortage, however, the Centers for Disease Control and Prevention established guidelines for the administration of influenza vaccine, with the elderly ≥ 65 years and those 2–64 years with “underlying chronic medical conditions” among the groups given priority status.¹¹ This differs from the recommendation to vaccinate all adults ≥ 50 years old, which was established in 1999 by the American Academy of Family Physicians and the following year by the Centers for Disease Control and Prevention.^{12,13}

This study assessed the impact of the shortage in inner-city health centers serving patient populations who are largely among the groups least likely to be vaccinated (low education, low income, minority racial groups).³ Specifically, patients ≥ 50 years old were surveyed to determine (1) their vaccination status and response to the shortage, (2) whether vaccination rates varied by age, and (3) if the shortage reintroduced racial disparities in health centers where they had been eliminated.¹⁴

METHODS

Health Centers

Since 2001, we have worked with several inner-city health centers to improve adult immunization rates and eliminate racial disparities. Following each influenza season, patients were surveyed regarding immunization status, knowledge, attitudes, and beliefs about immunizations and other health issues. Two of the centers were faith-based federally qualified health centers (FQHC) or FQHC look-alike and two were family practice residency sites affiliated with the University of Pittsburgh School of Medicine. All served populations that are largely minority and economically disadvantaged. Results from previous studies have been published.¹⁴⁻¹⁷

Sample and Recruitment

Patients who were ≥ 50 years old and had been seen at one of the health centers in the last year were either recruited from an existing panel who had participated in previous surveys or were new recruits. The existing panel of 330 persons was initially selected from a random sample of billing records from which 249 participated, 14 refused, and 67 were ineligible, for a response rate of 95% [249/(330–67)]. This panel was augmented by a sample that was recruited by the sites using a mailed introductory letter or a recruitment sheet that was distributed by office staff during visits. This method was chosen because the Health Insurance Portability and Accountability Act guidelines do not allow direct contact between investigators and potential participants via patient lists. Therefore, we were dependent upon the sites to recruit on our behalf. Among the new recruits, the response rate was 18% (87/480), bringing the total sample to 336 patients. A personalized introductory letter and a letter from the health centers endorsing the project and encouraging participation were sent to each of the sampled patients. A \$10 honorarium was offered for completing the survey.

Survey

The survey was designed by a multidisciplinary team using an iterative process. Items on the questionnaire assessed self-reported demographic characteristics including race; health behaviors; and attitudes and beliefs regarding influenza vaccine based on the theory of reasoned action,^{18,19} which accounts for facilitating conditions, habit, social support and perceived consequences of a behavior on outcomes, and experience with the vaccine shortage. For example, respondents were asked if they had received the influenza vaccine during the 2003–2004 and 2004–2005 influenza seasons and, if they had not received it during the 2004–2005 season, the reason why not. They were also asked to whom they would assign blame for the shortage and other precautions they may have taken to prevent influenza infection, among others.

Depending upon skip pattern, the final questionnaire included approximately 83 multiple choice and three-point Likert scale questions, of which 47 related to the present study and took 30–45 min to complete. The survey was conducted by trained interviewers using computer-assisted telephone interviewing (CATI) during August through October 2005 when new vaccine supplies had been delivered to the health centers and were being administered. CATI permitted direct data entry during the interview,²⁰ as well as managed the sample of persons to be contacted by randomly assigning participants to be contacted to each interviewer and recording the outcome of attempts to reach them. The CATI system also directed question sequence, reduced unintentionally skipped questions, and provided automatic range checks.

Statistical Analysis

Chi-square tests (or Fisher's exact tests for small cell counts) were used to examine associations of survey responses for three groups: those vaccinated in the 2003–2004 and 2004–2005 influenza seasons (vaccinated both seasons; $n = 142$); those vaccinated in 2003–2004 but *not* vaccinated in 2004–2005, specifically because of the vaccine shortage (unvaccinated—shortage; $n = 63$); and those unvaccinated in

2003–2004 and also unvaccinated in 2004–2005 for nonshortage reasons (unvaccinated both seasons; $n = 83$). Due to both size and our intention to focus on the shortage, the groups who did not fit into these scenarios (e.g., not vaccinated in 2004–2005 for reasons other than the shortage or missing data) were not included in these analyses, leaving a final sample size of 288. Logistic regression analysis was performed to determine variables significantly associated with receiving/not receiving influenza vaccine due to the 2004–2005 influenza shortage, compared with receiving vaccine both seasons or not receiving vaccine both seasons. All independent variables associated in bivariate analyses with the dependent variable at the $P < 0.10$ level or specified a priori (i.e., gender, race) were included in the multivariate models. Because annual household income was highly correlated with frequency of physician visits ($r = 0.3$, $P < 0.001$), annual household income was excluded from the multivariate model. All statistical analyses were performed using SAS 8.2 statistical software (SAS, Cary, NC, USA). Statistical significance was set at $P < 0.05$ and data were unweighted.

This project was approved by the Institutional Review Board of the University of Pittsburgh.

RESULTS

Demographics and other characteristics of the three groups (vaccinated both seasons, unvaccinated both seasons, and unvaccinated—shortage season) are shown in Table 1. Almost one fourth (22%) of the sample who had been vaccinated against influenza in 2003–2004 was not vaccinated in the 2004–2005 season and attributed it to the influenza vaccine shortage.

The three groups differed significantly with regard to age, sex, marital status, household income, employment status, frequency of physician visits, and self-rated health. In general, compared with those who received the vaccine both seasons, those who were unvaccinated due to the shortage were younger, healthier, and from a higher socioeconomic status. These groups were similar in their beliefs about influenza vaccine except regarding susceptibility to influenza without vaccination and awareness of avian flu. Compared with those unvaccinated both seasons, those who were unvaccinated due to the shortage were more likely to be male, be of higher income, be healthier, and have a more positive attitude about the efficacy of the influenza vaccine. In logistic regression analyses, those who were unvaccinated because of the shortage were compared separately with those vaccinated both seasons and those unvaccinated both seasons. Table 2 indicates that younger individuals, those who self-rated their health as good, and those with fewer physician visits were more likely to have been unvaccinated due to the shortage compared with those vaccinated both seasons. Those who were unvaccinated because of the shortage also self-rated their health as good and believed in the protection from influenza offered by vaccination.

We were especially interested in the views of those who were unvaccinated in 2004 because of the vaccine shortage. In the past 5 years, over half (57%, $n = 36$) had been vaccinated every year except the most recent, 27% ($n = 17$) had been vaccinated three times, 10% ($n = 6$) were vaccinated twice, and 6% ($n = 4$) were vaccinated only once. Normally, these patients reported receiving the vaccine at their primary care physician's office (86%, $n = 54$), as opposed to "other" locales (14%, $n = 9$) including Veterans Affairs' and Allegheny County Health Department clinics.

TABLE 1 Characteristics and views of respondents by influenza vaccination status during the 2003–2004 and 2004–2005 seasons

Variable	Overall (<i>n</i> = 288) <i>n</i> (%)	Vaccinated both seasons (<i>n</i> = 142) <i>n</i> (%)	Unvaccinated— shortage (<i>n</i> = 63) <i>n</i> (%)	Unvaccinated both seasons (<i>n</i> = 83) <i>n</i> (%)	<i>P</i> value
Age (years)					<0.001
50–64	158 (69)	51 (36)	46 (73)	61 (73)	
65+	130 (31)	91 (64)	17 (27)	22 (27)	
Gender					0.002
Male	81 (28)	47 (33)	23 (37)	11 (13)	
Female	207 (72)	95 (67)	40 (63)	72 (87)	
Race					0.127
African American	129 (47)	64 (48)	22 (37)	43 (54)	
Caucasian	143 (53)	68 (52)	38 (63)	37 (46)	
Marital status					0.034
Not married	194 (67)	96 (68)	35 (56)	63 (76)	
Married/in long-term relationship	94 (33)	46 (32)	28 (44)	20 (24)	
Household income					<0.001
<\$20,000	130 (49)	72 (57)	15 (26)	43 (54)	
≥\$20,000	133 (51)	54 (43)	43 (74)	36 (46)	
Education					0.165
<College degree	161 (56)	81 (57)	29 (46)	51 (61)	
College degree +	127 (44)	61 (43)	34 (54)	32 (38)	
Employed part- or full-time	114 (40)	40 (28)	36 (57)	38 (46)	<0.001
Frequency of seeing a physician					0.018
Every 1–2 months	54 (20)	37 (27)	5 (8)	12 (16)	
3–4 times per year	113 (41)	56 (41)	26 (43)	31 (41)	
1–2 times a year	106 (39)	44 (32)	30 (49)	32 (43)	
Self-rated health					0.004
Excellent/very good	113 (40)	52 (37)	22 (35)	39 (48)	
Good	99 (35)	45 (32)	33 (52)	21 (26)	
Fair/poor	74 (26)	44 (31)	8 (13)	22 (27)	
Rates the government’s response to the flu vaccine shortage in getting vaccine to those who need it most as					0.073
Terrible (1, 2)	128 (46)	56 (40)	38 (60)	34 (44)	
Neutral (3)	70 (25)	35 (25)	14 (22)	21 (27)	
Excellent (4, 5)	81 (29)	48 (35)	11 (17)	22 (29)	
Blames US government for shortage	138 (48)	59 (42)	37 (59)	42 (51)	0.064
Agrees that a person who does not get a flu shot will probably get the flu ^a	109 (38)	72 (52)	21 (33)	16 (19)	<0.001

TABLE 1 Continued

Variable	Overall (<i>n</i> = 288) <i>n</i> (%)	Vaccinated both seasons (<i>n</i> = 142) <i>n</i> (%)	Unvaccinated— shortage (<i>n</i> = 63) <i>n</i> (%)	Unvaccinated both seasons (<i>n</i> = 83) <i>n</i> (%)	<i>P</i> value
Agrees that the flu shot keeps a person from getting the flu ^a	126 (45)	71 (51)	36 (59)	19 (24)	<0.001
Agrees with the statement “If a person in the house gets the flu, other unvaccinated members of the household are also likely to get the flu” ^a	205 (75)	109 (80)	50 (82)	46 (61)	0.003
Had heard of the avian or bird flu before the survey	201 (71)	96 (68)	51 (84)	54 (66)	0.040

^a“Agree,” “maybe/sometimes” compared with “disagree”

The respondents who were unvaccinated due to the vaccine shortage heard about it from multiple sources including their physicians (31%, *n* = 19), newspapers (31%, *n* = 19), television (27%, *n* = 17), and “other” resources (11%, *n* = 7). The vaccine shortage did not influence their desire to get vaccinated, as most (74%, *n* = 46) reported no change in wanting to get vaccinated, whereas 14% (*n* = 9) wanted the vaccine more and 11% (*n* = 7) wanted the vaccine less. In addition, the shortage did not cause patients to worry more or less about the side effects from the vaccine, compared to previous years (87%, *n* = 53). Looking ahead, all of these patients planned to get vaccinated in the fall of 2005 (100%, *n* = 63).

As a majority of the respondents who were unvaccinated due to the shortage regularly received the influenza vaccine, we were interested in what precautions they took to reduce their risk of contracting influenza. Many washed their hands or used a hand sanitizer more frequently (79%, *n* = 30), stayed home or out of crowded places (55%, *n* = 38), tried not to touch places where people put their hands (24%, *n* = 9), took more vitamins or ate more healthful foods (24%, *n* = 9), and got more rest (5%, *n* = 2; more than one source could be cited).

When asked who they blamed for the influenza vaccine shortage, a majority of those who were unvaccinated because of the shortage said the US government (59%, *n* = 37); half blamed the vaccine manufacturers (51%, *n* = 32); and the remainder chose the CDC (13%, *n* = 8), health insurance companies or others (17%, *n* = 11), the medical profession, and their physician or physician’s office (6%, *n* = 4; more than one source could be cited). In addition, patients who were unvaccinated due to the shortage often negatively rated the US government’s response to the vaccine shortage in getting the vaccine to those who needed it (60%, *n* = 38 rated the response as “1” or “2” on a five-point scale from “terrible” to “excellent”).

TABLE 2 Variables associated with being unvaccinated due to the shortage compared with being vaccinated in both seasons in logistic regression analyses

Variable	Shortage vs vaccinated both seasons OR ^a (95% CI)	Shortage vs unvaccinated both seasons OR ^a (95% CI)
Demographics		
Age 50–64 (ref., ≥65)	4.56 (1.82–11.4)*	0.50 (0.15–1.6)
Female (ref., male)	0.91 (0.39–2.13)	0.51 (0.17–1.54)
African American (ref., Caucasian)	0.80 (0.35–1.84)	0.94 (0.35–2.50)
Employed either part-time or full-time (ref., unemployed)	1.30 (0.54–3.14)	1.78 (0.62–5.09)
Marital status		
(ref., not married) Married or in long-term relationship	1.08 (0.46–2.50)	2.00 (0.77–5.19)
Beliefs		
Self-rated health		
(ref., excellent/very good) Good	3.31 (1.29–8.50)*	3.1 (1.10–8.71)*
Fair/poor	0.83 (0.27–2.60)	1.37 (0.35–5.38)
Frequency of seeing a physician		
(ref., 1–2 times per year) 1–2 times per month	0.14 (0.04–0.62)*	0.90 (0.18–4.44)
3–4 times per year	0.61 (0.25–1.48)	1.17 (.43–3.17)
A person who does not get a flu shot will probably get the flu	0.57 (0.24–1.35)	1.36 (0.46–3.98)
The flu shot keeps a person from getting the flu	1.59 (0.71–3.56)	3.27 (1.27–8.40)*
If a person in the house gets the flu, other unvaccinated members of the household are also likely to get the flu	0.81 (0.29–2.26)	2.28 (0.81–6.40)
Had heard of the avian or bird flu before survey	1.68 (0.62–4.54)	1.71 (5.6–5.26)

ref. = referent
^aAdjusted odds ratio
**P* ≤ 0.05

DISCUSSION

The influenza vaccination season of 2004–2005 was seriously circumscribed by a 50% reduction in vaccine supplies, leading to priority grouping for vaccination. We examined influenza vaccination rates among adults seen at inner-city health centers that serve largely minority and disadvantaged populations in which racial disparities had been eliminated.¹⁴ This equivalence in vaccination rates across races was sustained even in a season of severe vaccine shortage. Moreover, those who received the influenza vaccine during both the previous and current seasons,

were more frequently older and presumably less healthy (saw their physicians more frequently) than those who were unvaccinated because of the shortage. These findings are consistent with guidelines from the CDC for the tiered rationing during the shortage,¹¹ that is, the elderly and high-risk groups were to be given priority. However, they differ from those of the Behavioral Risk Factor Surveillance System (BRFSS) survey following the 2004–2005 influenza vaccine shortage. It found that vaccination rates among those ≥ 65 years old declined for white, black, and Hispanic groups and racial disparities in rates persisted. Among younger adults, there were no racial disparities in influenza vaccination rates.²¹

Rationing of scarce medical resources is a difficult task and the differing views of what is in the best interest of the public must be considered. CDC officials worked rapidly to coordinate data, develop a tiered structure for priority groupings, and encourage appropriate use of limited vaccine supplies. But it was unknown what the response to these rationing guidelines would be.

Many respondents who were unvaccinated due to the shortage rated the government's response to the vaccine shortage as "terrible" and were more likely to blame the US government for the shortage than other entities, such as vaccine manufacturers. Another study found that manufacturers were the most likely to be blamed (39%), with fewer blaming the federal government (29%).²² However, nearly half (45%) thought that the federal government should be responsible for ensuring the adequacy of the vaccine supply.²²

Concern about side effects is a prominent barrier to vaccination,²³ and fears about the safety of vaccine may increase when shortages occur due to substandard manufacturing processes. The BRFSS analyses showed that during the shortage, blacks were more likely to have concerns about the vaccine (14 vs 8%).²¹ Studies of the 2000 influenza vaccine delay found that a small number of individuals reported changes in their beliefs about influenza vaccine or its safety.^{24,25} Fortunately, among our study population, the 2004–2005 shortage did not influence their vaccination desires or fear about side effects and 100% planned to be vaccinated in the subsequent year.

Strengths and Limitations

As this study included two racial groups (African Americans and Caucasians), it is limited by our inability to generalize the findings to other racial or ethnic groups. Furthermore, this sample was predominantly female, unemployed, and low-income, as might be expected from a study of patients seeking care at inner-city health centers.

Secondly, vaccination status was determined from self report, which has been shown to have a sensitivity of 92%–100%, and a specificity of 38%–98%, compared with medical record review.^{26–29} Although recall bias may have occurred, self-reported vaccination status is widely used in national surveys including the BRFSS. We intentionally sampled patients over 50 years old as that is the age recommended for universal influenza vaccination. Our findings might not be applicable to younger, high-risk populations, children, or to cities with different ethnic groups.

Strengths of this study include the use of CATI and its focus on a primarily minority population, which is frequently more difficult to reach than socioeconomically advantaged groups. Further, we directed our analyses to address characteristics of those who presumably would have been vaccinated in 2004–2005, but for the vaccine shortage.

CONCLUSIONS

While disruptions in vaccine supply cannot always be anticipated or prevented, quick response to shortages in the form of equitable distribution and priority administration guidelines may attenuate their effects. This study suggested some success in implementing the guidelines in Pittsburgh. That is, older individuals were less likely to remain unvaccinated because of the shortage and no racial disparities in vaccination rates emerged. This process and its effect on the population is a model for establishing priority groups for vaccination in anticipation of a possible influenza pandemic with insufficient vaccine supplies.

ACKNOWLEDGEMENTS

This project was funded by P01 HS10864 from the Agency for Healthcare Research and Quality and 1 P60 MD000207-01 from the National Institutes of Health and the EXPORT Health Project at the Center for Minority Health, University of Pittsburgh Graduate School of Public Health, NIH/National Center on Minority Health and Health Disparities Grant No. P60 MD-000-207. Its contents are the responsibility of the authors and do not necessarily reflect the official views of the CDC, the Association of Teachers of Preventive Medicine, or the NIH.

APPENDIX

Selection of Sample for Analysis

Among our 336 patients, 142 were vaccinated for influenza during both seasons (2003–2004 and 2004–2005), 85 were vaccinated in the first season (2003–2004) alone (63 blamed the shortage and 22 cited other reasons for their unvaccinated status in 2004–2005), 90 were unvaccinated across both seasons (7 blamed the shortage and 83 cited other reasons for their unvaccinated status in 2004–2005), 14 were unvaccinated in the first season and vaccinated in the second season, and 5 had incomplete information on their vaccination status over time.

REFERENCES

1. Thompson WW, Shay DK, Weintraub E, Brammer L, Anderson LJ, Fukuda K. Mortality associated with influenza and respiratory syncytial virus in the United States. *J Am Med Assoc.* 2003;289:179–186.
2. U.S. Department of Health and Human Services. *Healthy People 2010. With Understanding and Improving Health and Objectives for Improving Health.* Washington, DC: U.S. Government Printing Office; 2000.
3. Centers for Disease Control and Prevention. Influenza vaccination levels among persons aged ≥ 65 years and among persons aged 18–64 years with high-risk conditions—United States, 2003. *MMWR Morb Mortal Wkly Rep.* 2005;54:1045–1049.
4. Nichol KL, Lofgren RP, Gapinski J. Influenza vaccination. Knowledge, attitudes, and behavior among high-risk outpatients. *Arch Intern Med.* 1992;152:106–110.
5. Fiebach NH, Viscoli CM. Patient acceptance of influenza vaccination. *Am J Med.* 1991;91:393–400.
6. Centers for Disease Control and Prevention. Adult immunization: knowledge, attitudes, and practices—DeKalb and Fulton Counties, Georgia, 1988. *MMWR Morb Mortal Wkly Rep.* 1988;37:657–661.

7. Fedson DS. Influenza and pneumococcal immunization strategies for physicians. *Chest*. 1987;91:436–443.
8. Centers for Disease Control and Prevention. Reasons reported by Medicare beneficiaries for not receiving influenza and pneumococcal vaccinations—United States, 1996. *MMWR Morb Mortal Wkly Rep*. 1999;48:886–889.
9. Nowalk MP, Zimmerman RK, Cleary SM, Bruehlman RD. Missed opportunities to vaccinate older adults in primary care. *J Am Board Fam Pract*. 2005;18:20–27.
10. Voordouw AC, Sturkenboom MC, Dieleman JP, et al. Annual revaccination against influenza and mortality risk in community-dwelling elderly persons. *JAMA*. 2004;292:2089–2095.
11. Centers for Disease Control and Prevention. Interim influenza vaccination recommendations, 2004–05 influenza season. *MMWR Morb Mortal Wkly Rep*. 2004;53:923–924 (Dispatch).
12. Zimmerman RK. Lowering the age for routine influenza vaccination to 50 years: AAFP leads the nation in influenza vaccine policy. *Am Fam Physician*. 1999;60:2061–2066.
13. Centers for Disease Control and Prevention. Prevention and control of influenza: recommendations of the advisory committee on immunization practices (ACIP). *MMWR Morb Mortal Wkly Rep*. 2000;49:1–38.
14. Zimmerman RK, Nowalk MP, Raymund M, et al. Tailored interventions to increase influenza vaccination in neighborhood health centers serving the disadvantaged. *Am J Public Health*. 2003;93:1699–1705.
15. Zimmerman RK, Tabbarah M, Nowalk MP, et al. Predictors of pneumococcal polysaccharide vaccination among patients at three inner-city neighborhood health centers. *Am J Geriatr Pharmacother*. 2005;3:149–159.
16. Tabbarah M, Zimmerman RK, Nowalk MP, et al. What predicts influenza vaccination status in older Americans over several years? *J Am Geriatr Soc*. 2005;53:1354–1359.
17. Nowalk MP, Zimmerman RK, Tabbarah M, Raymund M, Jewell IK. Determinants of adult vaccination at inner-city health centers: a descriptive study. *BMC Fam Pract*. 2006;7:2.
18. Montano DE. Predicting and understanding influenza vaccination behavior. Alternatives to the Health Belief Model. *Med Care*. 1986;24:438–453.
19. Montano DE, Kasprzyk D. The theory of reasoned action and the theory of planned behavior. In: Glanz K, Rimer BK, Lewis FM, eds. *Health Behavior and Health Education: Theory, Research, and Practice*. San Francisco: Jossey-Bass; 2002:67–98.
20. Aday LA. *Designing and Conducting Health Surveys*. San Francisco: Jossey-Bass; 1989.
21. Link MW, Ahluwalia IB, Euler GL, Bridges CB, Chu SY, Wortley PM. Racial and ethnic disparities in influenza vaccination coverage among adults during the 2004–2005 season. *Am J Epidemiol*. 2006;163:571–578.
22. DesRoches CM, Blendon RJ, Benson JM. Americans' responses to the 2004 influenza vaccine shortage: how did the public respond to the flu vaccine shortage in 2004, and what are the implications for such potential events in the future? *Health Aff*. 2005;24:822–831.
23. Singleton JA, Santibanez TA, Wortley PM. Influenza and pneumococcal vaccination of adults aged ≥ 65 : racial/ethnic differences. *Am J Prev Med*. 2005;29:412–420.
24. Santibanez TA, Nowalk MP, Zimmerman RK, Bruehlman RD. Effects of the year 2000 influenza vaccine delay on elderly patients' attitudes and behaviors. *Prev Med*. 2003;37:417–423.
25. Zimmerman RK, Nowalk MP, Santibanez TA, Jewell IK, Raymund M. Shortage of influenza vaccine in 2000–2001. Did it change patient beliefs? *Am J Prev Med*. 2003;24:349–353.
26. Zimmerman RK, Raymund M, Janosky JE, Nowalk MP, Fine MJ. Sensitivity and specificity of patient self-report of influenza and pneumococcal polysaccharide vaccinations among elderly outpatients in diverse patient care strata. *Vaccine*. 2003;21:1486–1491.

27. Mac Donald R, Baken L, Nelson A, Nichol KL. Validation of self-report of influenza and pneumococcal vaccination status in elderly outpatients. *Am J Prev Med.* 1999;16:173–177.
28. Nichol KL, Korn JE, Baum P. Estimation of outpatient risk characteristics and influenza vaccination status: validation of a self-administered questionnaire. *Am J Prev Med.* 1991;7:199–203.
29. Hutchison BG. Measurement of influenza vaccination status of the elderly by mailed questionnaire: response rate, validity, and cost. *Can J Public Health.* 1989;80:271–275.