Meeting the Challenges of Immunizing Adults

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The overall burden of illness from diseases for which vaccines are available disproportionately falls on adults. Adults are recommended to receive vaccinations based on their age, underlying medical conditions, lifestyle, prior vaccinations, and other considerations. Updated vaccine recommendations from CDC are published annually in the U.S. Adult Immunization Schedule. Vaccine use among U.S. adults is low. Although receipt of a provider (physician or other vaccinating healthcare provider) recommendation is a key predictor of vaccination, more often consumers report not receiving vaccine recommendations at healthcare provider visits. Although providers support the benefits of vaccination, they also report several barriers to vaccinating adults, including the cost of providing vaccination services, inadequate or inconsistent payment for vaccines and vaccine administration, and acute medical care taking precedence over preventive services. Despite these challenges, a number of strategies have been demonstrated to substantially improve adult vaccine coverage, including patient and provider reminders and standing orders for vaccination. Providers are encouraged to incorporate routine assessment of their adult patients' vaccination needs during all clinical encounters to ensure patients receive recommendations for needed vaccines and are either offered needed vaccines or referred for vaccination.

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Introduction

Vaccinations are recommended from birth through adulthood. The pediatric vaccination program in the U.S. is without question one of the most successful public health programs on record, resulting in millions of lives saved and illnesses prevented.[1] Pediatric vaccination not only prevents disease, disability, and death among those vaccinated but also contributes to lowering the risk of these same outcomes among those who are not vaccinated through increasing population immunity and reducing transmission. Vaccination rates in the U.S. for most routinely recommended pediatric vaccinations reach 90% or more for most vaccines within a few years after a new recommendation is published due in part to school entry requirements and the Vaccines for Children entitlement program, which ensures access to vaccines for uninsured children. Notable exceptions to generally high pediatric vaccination rates are human papillomavirus (HPV) vaccine, and annual influenza vaccination, neither of which are routinely required for school entry.[2,3]

In contrast to most routinely recommended pediatric vaccines, adult vaccination levels in the U.S. are low (Table 1).[4] Many factors contribute to these low rates, including complexities in how adult vaccinations are paid for by private and public insurers, limited funding for vaccination of uninsured adults, costs of and requirements for stocking vaccines, concerns among providers about adequate reimbursement for vaccination, lack of vaccine requirements for adults except for healthcare workers and college entry, gaps in incorporation of routine vaccine needs assessment and recommendations for adults during healthcare visits, limited use of tools to assist providers with implementation of the complex adult vaccine schedule, such as use of immunization information systems, and limited awareness among the public about adult vaccinations.[7–9] Even for vaccines that have been recommended for more than 20 years,

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Table 1. Immunization Rates for Selected Vaccines and Adult Populations in the U.S.

Vaccine	Age group or risk group	Vaccination coverage (%)	Year	Data source
Pneumococcal vaccine[a]	18–64-year-old high risk	21	2013	NHIS[b,c]
	≥65 years	60	2013	NHIS[b]
Herpes zoster	≥60	24	2013	NHIS[b]
Influenza vaccine	18–49 years	32	2013–2014 influenza season	BRFSS[d]
	50–64 years	45	2013–2014 influenza season	BRFSS
	≥65 years	65	2013–2014 influenza seasons	BRFSS
	Healthcare personnel	75	2013–2014 influenza seasons	Internet panel survey[e]
	Pregnant women	52	2013–2014 influenza seasons	Internet panel survey[f]
Tdap[b,g]	≥19 years	17	2013	NHIS[b]
	Healthcare personnel	37	2013	NHIS[b]
Td in past 10 years[b,g]	19–49 years	63	2013	NHIS[b]
	50–65 years	64	2013	NHIS[b]
	≥65 years	56	2013	NHIS[b]
Hepatitis A	≥19 years	9	2013	NHIS[b]
	≥19 years with chronic liver disease	13	2013	NHIS[b]
	≥19 years with travel to area where Hepatitis A endemic	16	2013	NHIS[b]
Hepatitis B	≥19 years	25	2013	NHIS[b]
	≥19 years with chronic liver disease	34	2013	NHIS[b]
	≥19 years with travel to area where Hepatitis B endemic	33	2013	NHIS[b]
	19–59 years with diabetes	26	2013	NHIS[b]
	Healthcare personnel	62	2013	NHIS[b]
HPV	Females 19–26 years	37	2013	NHIS[b]
	Males 19–21 years	8	2013	NHIS[b]

[a]Estimates reflect overall pneumococcal vaccine coverage for both PPSV23 and PCV13. Estimates of vaccination coverage for each individual vaccine are not currently available. Adults were considered at high risk for pneumococcal disease or its complications if they had ever been told by a doctor or other health professional that they had diabetes, emphysema, chronic obstructive pulmonary disease, coronary heart disease, angina, heart attack, or other heart condition; had a diagnosis of cancer during the previous 12 months (excluding nonmelanoma skin cancer); had ever been told by a doctor or other health professional that they had lymphoma, leukemia, or blood cancer; had been told by a doctor or other health professional that they had chronic bronchitis or weak or failing kidneys during the preceding 12 months; had an asthma episode or attack during the preceding 12 months; or were current smokers.
[b]Williams et al. (2015).[4]
[c]Details regarding methods used for the NHIS can be found at www.cdc.gov/nchs/nhis/methods.htm.
[d]Estimates of the percentage of people vaccinated are based on interviews conducted beginning September (BRFSS) or October (NIS) 2013 through June 2014 and reported vaccinations from July 2013 through May 2014. For California, BRFSS interview data were only available for September–December 2013, and thus estimates for persons aged ≥18 years only reflect vaccinations during July–November 2013. For Mississippi, sample size was insufficient from interviews conducted April–June 2014 to estimate vaccinations past the end of February 2014 for persons aged ≥18 years. Additional details can be found at www.cdc.gov/flu/fluvaxview/index.htm.
[e]Black et al. (2014).[5]
[f]Ding et al. (2014).[6]
[g]Those without a "yes" or "no" classification for tetanus vaccination status during the previous 10 years or for tetanus vaccination during 2005–2013, or those who reported tetanus vaccination during 2005–2013 but were not told vaccine type by the provider or did not know vaccine type were excluded from estimations of Tdap coverage. Hence, the Tdap estimate is subject to considerable uncertainty. Further details regarding limitations of the NHIS estimates are included in the publication by Williams 2015.
BRFSS, Behavioral Risk Factor Surveillance System; HPV, human papillomavirus; NHIS, National Health Interview Survey; Td, tetanus diphtheria; Tdap, tetanus, diphtheria, acellular pertussis.

such as pneumococcal polysaccharide 23-valent vaccine (PPSV23) and seasonal influenza vaccine for adults aged ≥65 years, which are 100% covered by Medicare Part B, more than a third of adults are unvaccinated.[4] This article provides an overview of the burden of illness among adults for selected vaccine-preventable diseases, effectiveness of selected vaccines, barriers for vaccinating adults in the U.S., and examples of successful strategies to improve vaccine uptake among adults. Further details regarding all vaccines recommended for adults can be found at www.cdc.gov/vaccines/hcp/acip-recs/index.html.

Vaccine Recommendations

The Advisory Committee on Immunization Practices (ACIP) advises CDC regarding the use of vaccines in the U.S.[4] ACIP includes 14 voting members with expertise in the areas of vaccines, immunology, clinical care, public health, and infectious diseases, and one voting member who represents consumers, providing perspective on the social and community aspects of vaccination. ACIP reviews data on the effectiveness and safety of U.S. Food and Drug Administration–approved vaccines, and the epidemiology of vaccine-preventable diseases, including the cost effectiveness of different vaccination strategies. Recommendations may be updated as new information becomes available regarding vaccine effectiveness, safety, and changes in the epidemiology of vaccine-preventable diseases.

ACIP recommendations are reviewed by the Director of CDC and, if approved, are published in the *Morbidity and Mortality Weekly Report* and on the CDC website at www.cdc.gov/vaccines/acip. Recommendations for individual vaccines are incorporated annually into the Recommended Immunization Schedule for Persons Aged 0 Through 18 Years and the Recommended Adult Immunization Schedule (www.cdc.gov/vaccines/schedules/hcp/adult.html). The adult immunization schedule is also reviewed and approved by the American College of Physicians, American Academy of Family Physicians, American College of Obstetricians and Gynecologists, and the American College of Nurse–Midwives.[10] Recommendations for the use of vaccines in the U.S. are not reviewed by the U.S. Preventive Services Task Force, which has deferred this responsibility to ACIP.[11]

In addition to ACIP, other professional medical organizations recommend use of vaccinations after their own reviews. For example, the American College of Cardiology recommends influenza vaccination for secondary prevention of acute cardiovascular events among people with atherosclerotic disease based on results of clinical studies indicating a reduced risk of acute cardiac events among patients vaccinated against influenza.[12] In addition, the Infectious Diseases Society of America has published guidance for the use of vaccines among immunocompromised people, and the American Society for Blood and Marrow Transplantation has published guidance of vaccination of people who have had hematopoietic cell transplantation.[13,14] Evidence-based reviews and graded recommendations of vaccine program implementation strategies are conducted by the Community Preventive Services Task Force (www.thecommunityguide.org/vaccines/index.html).[15]

Burden of Disease in Adults and Vaccine Effectiveness

Among most diseases for which vaccines are routinely recommended, the burden of severe disease and deaths falls largely among adults.[16] Reasons for the higher burden in adults include greater susceptibility to vaccine-preventable diseases and generally lower effectiveness of vaccines due in part to increased prevalence of chronic medical conditions, and immunosenescence and frailty, particularly among older adults.[17] Despite these challenges, including for older adults, vaccination can have substantial health impact given the large burden of disease. Newer vaccines may provide greater benefit even among older adults as shown in a recent clinical trial of an as-yet unlicensed adjuvanted inactivated vaccine with reported 97% effectiveness against shingles.[18] Vaccination of healthcare personnel is also critical to reduce the risk of infection among healthcare personnel and thereby reduce transmission of pathogens to vulnerable patients and other healthcare workers.[7]

Approximately half of the average 226,000 annual influenza-related hospitalizations and 90% of the 3,000–49,000 influenza-related deaths in the U.S. occur among adults aged ≥65 years.[19,20] Influenza vaccine effectiveness can vary substantially by year, with lower effectiveness among older adults and in years where vaccine and circulating strains are not well matched. However, influenza vaccination overall is a cost-effective strategy to reduce the substantial burden of influenza, including reducing influenza-related medical visits and hospitalizations in all ages and lost work among working adults.[21–23]

Children aged <6 months are the pediatric age group at highest risk of influenza-related hospitalizations and deaths.[24,25] Influenza-related illness in pregnant women is also associated with increased risk of hospitalization, preterm labor, small for gestational weight infants, and an increased risk of congenital birth defects.[26] Vaccination of pregnant women has been shown to reduce the risk of influenza-related illness in pregnant women and to reduce the risks of preterm labor and infants born small for gestational age. In addition, vaccination during

pregnancy provides transplacental antibody transfer and passive protection of the neonate, reducing the risk of influenza and influenza-related hospitalization in infants during their first 6 months of life.[23,27–29]

For herpes zoster (HZ), the lifetime risk is approximately 30% with 1 million cases in the U.S. annually.[30] Although many cases of HZ occur among those aged 50–59 years, the risk of HZ and the post-herpetic neuralgia (PHN), a complication of HZ, increases with age; the risk of both HZ and PHN is approximately three times higher among adults aged ≥65 years compared with those aged <65 years.[30] A large randomized controlled trial of Zostavax® zoster vaccine, which followed participants for a median of 3 years, reported vaccine efficacy of 51% (95% CI=44%, 58%) against HZ and 66.5% (95% CI=47.5%, 79%) against PHN.[31] Although the vaccine is approved by the U.S. Food and Drug Administration for people aged ≥50 years, CDC recommends HZ vaccination at age 60 years because of the higher risk of HZ and PHN with increasing age and available information regarding somewhat limited duration of effectiveness after vaccination.[32]

Both hepatitis A and hepatitis B vaccines are recommended for certain risk groups, such as travelers to countries where these viruses are endemic, people with chronic liver disease, men who have sex with men, and adults who wish to decrease their risk of viral hepatitis.[33,34] In 2012, an estimated 3,050 cases of acute hepatitis A occurred in the U.S., with the highest incidence among people aged 20–29 years (www.cdc.gov/hepatitis/Statistics/2012Surveillance/Commentary.htm#hepA). The number of hepatitis A cases has decreased 88% from 2000 to 2012.

For hepatitis B, the recommendation for routine pediatric vaccination, which began in 1991, and recommendations to vaccinate adults at increased risk of hepatitis B has led to a substantial reduction in hepatitis B in all age groups. However, cases continue to occur, mainly among adults, with significant numbers of cases imported from outside of the U.S.[34,35] Based on CDC surveillance data (www.cdc.gov/hepatitis/Statistics/2012Surveillance/Commentary.htm), an estimated 18,760 new cases of hepatitis B occurred in 2012, with the highest number among adults aged 20–59 years.

Adults with diabetes have approximately twice the risk of hepatitis B compared with those without diabetes and are recommended for hepatitis B vaccination.[36] Vaccine effectiveness among people with diabetes is estimated to be more than 90% among adults aged ≤40 years, with incremental decreases in effectiveness with increasing age (80% among those aged 41–59 years, 70% for those aged 60–69 years, and less than 40% for those aged >69 years),[36] illustrating the need for hepatitis B vaccination ideally as soon as possible after a diagnosis of diabetes is made. For vaccination of diabetic patients aged ≥60 years, ACIP advises providers to consider a patient's likelihood of acquiring hepatitis B virus infection, the declining immunologic responses to vaccines that are associated with frailty, and other considerations that may impact an adult's risk of exposure to hepatitis B virus, hepatitis B–related complications, and likelihood of benefiting from vaccination.[36]

The burden of disease associated with infection with *Streptococcus pneumoniae* is also high in adults. The 13-valent pneumococcal conjugate vaccine (PCV13) and PPSV23 both are recommended for certain high-risk adults before age 65 years.[37] PCV13 is recommended at age 65 years for adults not previously vaccinated with PCV13 whereas PPSV23 is recommended at age 65 years even for adults vaccinated with PPSV23 at a younger age.[10,38] When both vaccines are indicated, PCV13 should be given first, followed by PPSV23. For adults aged ≥19 years who are immunocompromised, or who have functional or anatomic asplenia, a cerebrospinal fluid leak, or cochlear implant, PPSV23 can be administered at least 8 weeks after PCV13, whereas the interval between PCV13 and PPSV23 is 12 months for adults aged >65 years without these conditions.[a] If PPSV23 has already been given, then PCV13 should be administered 12 months or more after PPSV23 for all adults. Although the pediatric pneumococcal conjugate vaccination program has substantially reduced the incidence of disease caused by vaccine-specific *S. pneumoniae* serotypes among children and indirectly reduced the burden among adults through herd immunity, invasive pneumococcal disease (IPD) remains common, with an estimated 13,500 cases of IPD among adults aged ≥65 years in 2013.[39] PPSV23 contains 12 of the serotypes included in PCV13, plus 11 additional serotypes. Among IPD cases in people aged ≥65 years identified through surveillance in 2013, 38% were due to serotypes unique to the PPSV23 vaccine, and 20%–25% were due to PCV13 serotypes.[38] For PCV13, a recent clinical trial[40] reported efficacy of 46% (95% CI=22%, 62.5%) against PCV13 vaccine–type pneumococcal pneumonia; 45% (95% CI=14%, 65%) against vaccine-type nonbacteremic pneumonia; and 75% (95% CI=41%, 91%) against vaccine-type IPD among adults aged ≥65 years. The effectiveness of PPSV23 vaccine against IPD has been estimated at 74% (95% CI=55%, 86%) in a recent meta-analysis[41] of studies among a range of adult populations; however,

[a]The Advisory Committee on Immunizations Practices voted at their June 24–25, 2015, meeting to change the interval from 6–12 months to 12 months. This recommendation was approved by the CDC Director on July 20, 2015, but has not yet been published in the *Morbidity and Mortality Weekly Report*.

the benefit of PPSV23 in preventing community-acquired pneumococcal pneumonia is less certain.

The effectiveness of the HPV vaccine against cervical cancer and genital warts–associated HPV serotypes included in the vaccine is estimated at more than 90%.[42–44] Vaccination against HPV during adolescence before exposure to HPV through sexual intercourse is the most effective and cost-effective strategy to reduce the consequences of HPV infection, including cervical and anal cancers and genital warts. However, many adolescents do not receive one or more doses[2] and catch-up vaccination for young women (through age 26 years) and men (through 21 years of age for all men and 26 years for high-risk men) is recommended.[44] Although vaccination during adolescence is the most effective strategy to reduce the impact of HPV, vaccination during young adulthood can also be cost effective, especially when vaccination rates among adolescents are suboptimal.[42,44]

Though tetanus and diphtheria are rarely seen in the U.S., thousands of pertussis cases have occurred annually in recent years (National Notifiable Disease Surveillance System, wwwn.cdc.gov/nndss/). Infants are at greatest risk of severe disease and death from pertussis infection, although adults may have severe cough lasting weeks and are an important source of pertussis transmission to infants.[45] Tetanus, diphtheria, acellular pertussis (Tdap) vaccine is recommended at age 11 or 12 years followed by tetanus diphtheria (Td) vaccine every 10 years. All adults, including adults aged ≥65 years, are recommended to receive one dose of Tdap if not vaccinated earlier regardless of the interval since the last Td vaccination and to continue Td vaccination every 10 years. Tdap vaccination is also recommended during each pregnancy and has been estimated to be approximately 90% effective in preventing pertussis in infants.[46]

Other vaccines routinely recommended during childhood or adolescence also may be indicated for some adults and should be considered when assessing adult vaccine needs. These include meningococcal; measles, mumps, rubella; varicella; and hepatitis A and B vaccines. Recent outbreaks of both measles and mumps are reminders that these diseases, though less common, can still occur in the U.S.[47,48]

Current Vaccination Rates

Despite the burden of illness and current recommendations, vaccination rates among adults are low (Table 1).[4] Rates among adults are lowest for vaccines recommended primarily during adolescence, including Tdap and HPV vaccines; vaccines recommended for adults based on high-risk conditions (e.g., pneumococcal vaccination of high-risk adults aged 18–64 years and hepatitis B vaccine for patients with diabetes); and zoster vaccination of adults aged ≥60 years.[4] In addition, racial and ethnic disparities in vaccine coverage persist for routinely recommended vaccines for adults. Disparities have widened for zoster and Tdap vaccines, with the highest rates in white non-Hispanic adults and the lowest rates among Hispanic and black non-Hispanic adults.[4]

Challenges for Vaccination of Adults

Leading factors impacting vaccination of adults include absence of recommendations from healthcare providers, and limited awareness about vaccines needed for adults. For example, a 2012 survey[49] of adults aged ≥60 years—a group recommended to receive zoster vaccine—found that 16% of black and 42% of white adults were aware that zoster vaccine was recommended and 2% and 14%, respectively, reported vaccination. Among all racial and ethnic groups combined, only 14% reported that a medical provider discussed the vaccine with them, but 59% of the unvaccinated were interested in receiving the vaccine after they were provided vaccine information as part of the survey.[49] A consumer survey conducted in 2006 regarding influenza, tetanus, and pneumococcal vaccines found that 82% of consumers believed it was important to keep up with immunizations.[9] The main reasons cited for not getting vaccinations included the belief that the vaccine was not needed because they were healthy, their doctor did not tell them to get the vaccine, and concerns regarding potential side effects. Other studies also identified provider recommendation as a strong predictor of vaccinations across all racial and ethnic groups.[6,50,51]

A 2010 survey of consumers and providers conducted by the National Foundation for Infectious Diseases found a similar result, highlighting the high value that patients place on physician recommendations for vaccination. Factors reported by consumers that would increase the likelihood of vaccination included a strong recommendation from their physician (88%) and more knowledge about vaccine effectiveness (83%). The provider survey[52] found that 87% of physicians reported discussing vaccines with all of their patients, but only 47% of consumers recalled discussing vaccines other than seasonal influenza vaccine with their provider.

Although vaccine-related costs and lack of insurance coverage for vaccines and vaccination services are not the leading barriers reported by consumers, vaccination rates are lower among uninsured adults.[9,53] And, for adult patients with Medicaid, coverage for vaccines and patient copayments varies by state, with only 17 states covering all ACIP-recommended vaccines without copayments as of 2012.[54]

Cost-related issues are the leading barriers to adult vaccination reported by physicians. In a 2012 survey of internists and family physicians, the top five barriers to

vaccination were related to financial issues, including lack of adequate reimbursement, difficulty determining if a patient's insurance will reimburse for the vaccine, patients not having insurance coverage for a vaccine, and upfront costs of buying vaccines.[55]

Concerns about the costs of stocking vaccines likely contribute to the substantial proportion of providers who reported not stocking one or more ACIP-recommended vaccines.[55] The vaccines least likely to be stocked by internists included vaccines more often given to adolescents and children (hepatitis A and B; measles, mumps, rubella; varicella; meningococcal; and HPV vaccines) and zoster vaccine.

Challenges regarding vaccine and vaccine administration cost reimbursement reflect, in part, the complexities in insurance coverage for vaccines. The Affordable Care Act requires zero-dollar insurance coverage for ACIP-recommended vaccines when administered by an in-network provider among private health insurance plans. Although insurance coverage for vaccinations should improve for younger adults, the in-network provider clause may in some cases limit patient's access to vaccinations or increase some patients' out-of-pocket costs for vaccination when vaccines are provided by an out-of-network provider.

No vaccine insurance coverage changes were made to Medicare as part of the Affordable Care Act. Influenza, pneumococcal vaccines, hepatitis B vaccine for high-risk people, and Td vaccine for wound management are covered under Medicare Part B and all other vaccines (e.g., Td vaccine for prophylaxis, Tdap, and zoster vaccines) are included under Medicare Part D (approximately 69% of Medicare enrollees are enrolled in a Medicare Part D plan).[56] Having vaccines covered under Medicare Part D (insurance for medications for Medicare enrollees) eases billing for vaccines by pharmacists, but results in barriers for billing by medical providers.[57] Having a higher proportion of patients with Medicare Part D has been associated with reporting greater financial barriers for providing vaccine services among internists, but not among family physicians.[55]

Other barriers reported by providers include attention to acute care patient issues and other preventive services taking precedence over vaccination services. Less often–reported major barriers include patients' refusing vaccines because they do not believe they need vaccines and patient concerns about vaccine safety.[9,55]

Interventions That Work to Improve Vaccination

Multiple studies have documented successful strategies to improve adult vaccination rates. A meta-analysis conducted by Stone et al.[58] found that organizational change was by far the strongest predictor of increases in vaccination rates (Table 2). Similarly, an evaluation by the Community Preventive Services Task Force recommends systems interventions, such as the use of standing orders or protocols for vaccinations, provider reminders, and reminders for patients for vaccines that are due, as effective evidence-based strategies to improve adult vaccine use.[59] Though the analyses by Stone and colleagues did not find a benefit of provider assessment and feedback, this intervention was found to have strong evidence for improving adult vaccination in the more recent review by the Guide to Community Preventive Services.[57,58] The Guide noted insufficient evidence that community education alone improved uptake of vaccines, although efforts to increase community awareness in combination with other interventions were found to have evidence of benefit. This result is consistent with patient surveys indicating the importance of a provider's recommendation, not just patient awareness of vaccines. However, educational efforts may lead to increases in patient queries about available vaccines. Effective provider reminders to patients can take the form of phone calls, letters, and other communications to individual patients about specific vaccines.[59]

A vaccine recommendation from a provider is a strong predictor of vaccination, with higher uptake of vaccination reported when the recommendation is accompanied by an offer of vaccination.[6,60] For example, influenza vaccination coverage among pregnant women was 70.5% when the vaccine was both recommended and offered by the provider, but decreased to 32% when recommended but not offered; only 10% were vaccinated among patients who reported that no recommendation was made by the provider.[6]

Pharmacies and other retail settings and workplaces are increasingly important venues for the vaccination of adults, increasing vaccine access and convenience for patients.[61,62] In

Table 2. Interventions Associated With Improved Uptake of Immunizations Among Adults[a]

Intervention	OR[b]
Organizational change (e.g., standing orders, separate clinics devoted to prevention)	16.0
Provider reminder	3.8
Patient financial incentive	3.4
Provider education	3.2
Patient reminder	2.5
Patient education	1.3

[a]Adapted from Stone et al. (2002).[58]
[b]Compared to usual care or control group, adjusted for all remaining interventions.

one study,[62] 30% of adults vaccinated in a pharmacy setting did so during times when medical offices were typically closed (weekends and evenings). Access to vaccination in pharmacies or other venues provides options for referral of patients by primary care physicians whose offices do not stock all ACIP-recommended vaccines or who are not able to offer or bill for certain vaccines such as vaccines covered under Medicare Part D.[55,57]

Although medical providers are generally supportive of expanded access to vaccination services in pharmacies for their adult patients, primary care providers believe that it is their responsibility to ensure their patients receive recommended vaccines.[55] Determining which vaccines patients have had at work, during hospital stays, at pharmacies, or at other retail settings or medical care sites can be difficult for patients and providers. Ensuring that all of a patient's providers have access to documentation of a patient's vaccination history is critical to patients receiving the correct vaccines at the appropriate time. State-based immunization information systems (IISs) (also known as vaccine registries) are available for entry of adult vaccinations in 47 states and can serve as a central point of access for all providers to report which vaccines a patient has been given and to check for vaccinations already received.[63] Use of these systems, however, is limited among adult providers, and state IISs may have limited capacity for enrolling adult patient providers (American Immunization Registry Association, unpublished survey data, 2015).[55,63] Although initially developed for tracking pediatric vaccinations, given the number of venues in which adults may be vaccinated and the increasing complexity of the adult immunization schedule, efforts are needed to increase capacity of IISs to enroll and support adult providers' use of IISs, including pharmacists, occupational health specialists, hospitals, and primary care providers.[63,64]

A systematic review of studies of childhood IISs provided evidence that "IISs are effective in improving vaccination-related activities linked to increased vaccination rates and reduced risk for vaccine-preventable disease."[65] It is logical that use of IISs could also contribute to improving adult vaccination-related activities. In a survey of the American Immunization Registry Association Membership in March 2015, a total of 33 of 39 jurisdictions responding to the survey said that they were interested in working with medical associations and other partners to expand the number of providers that report adult immunizations to the IIS, and health departments in 28 jurisdictions had already taken actions to encourage adult providers to access the IIS to view patients' immunization histories (American Immunization Registry Association, unpublished survey data, 2015).

Use of electronic medical records systems that include clinical decision support systems and provider reminders can also improve vaccination rates. The Indian Health Service uses their electronic medical records for assessing patient vaccination status, generating reminders for providers and patients, and monitoring vaccination coverage levels. Use of electronic medical records, in conjunction with standing orders and broad involvement of medical and pharmacy staff in the delivery of vaccines, resulted in adult vaccination coverage levels in the Indian Health Service that are substantially higher than national estimates. In 2013, 74% of Indian Health Service patients aged $\geq$19 years had received a Tdap vaccine compared with 17% nationally, 39% of adults aged $\geq$60 years received zoster vaccine compared with 24% nationally, and 87% of adults aged $\geq$65 years received a dose of pneumococcal vaccine PPSV23 compared with 60% nationally who reported pneumococcal vaccination.[4,66] Sustained improvements in vaccination coverage for targeted vaccines were also demonstrated in a large urban integrated health system when a clinical decision support system was combined with a standing orders program. This clinical decision support system helped nurses and nursing assistants identify patients with indications for specific vaccines and initiate a standing orders protocol, reducing the number of missed opportunities to vaccinate adult patients.[67]

Standards for Adult Immunization Practice

Based on available evidence of the barriers for adult vaccination and evidence supporting strategies for increasing use of vaccines among adults, the National Vaccine Advisory Committee published an update to the Standards for Adult Immunization Practice.[64] The overarching goal of the standards is to reduce missed opportunities for vaccination through routine assessment of patients' vaccination needs. The standards acknowledge that adult patients see many different providers in a variety of settings, but may not or only infrequently be seen for preventive care visits; that the provider recommendation and offer are key predictors of vaccination, but not all providers stock all vaccines; and that documentation is critical to ensure appropriate vaccination and communication among a patient's providers. Thus, the standards call on all healthcare providers to

1. assess the vaccination status of patients at every clinical encounter;
2. strongly recommend needed vaccines;
3. offer vaccinations at the same visit or, if the vaccine is not stocked by the provider, refer the patient to another vaccine provider; and
4. document vaccinations, including in the IIS where available.

Strategies to implement the standards include organizational changes such as use of standing orders, patient and provider reminders, and other organizational changes to routinely integrate vaccine needs assessment into patient encounters in healthcare settings. Though implementation of all recommended preventive care services into clinical care is challenging,[68] utilization of non-physician staff such as pharmacists and nursing staff to conduct assessments and vaccinate using protocols or standing orders can help to reduce the impact on physicians' time in instances where addressing acute care issues or chronic care management leaves less time for preventive services such as immunizations.

Conclusions

Adults shoulder the largest burden of vaccine-preventable disease in the U.S. Low vaccination rates leave adults vulnerable to illnesses, hospitalizations, and deaths that could be prevented through use of vaccines. A strong provider recommendation for vaccination is the single best predictor of patient vaccination. Interventions to improve routine vaccine needs assessment at every clinic encounter and vaccination when indicated, such as implementation of standing orders or protocols for vaccination, can substantially improve vaccination among adults. Healthcare providers are encouraged to incorporate vaccine needs assessments, recommendation and offer of vaccination, or referral if needed vaccines are not available, into the routine care of adult patients in their practices and healthcare systems to reduce the burden of vaccine-preventable diseases.

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