

# Use of High-Dose Influenza and Live Attenuated Influenza Vaccines by US Primary Care Physicians



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**BACKGROUND:** Several different types of influenza vaccine are licensed for use in adults in the USA including high-dose inactivated influenza vaccine (HD-IIV) and live attenuated influenza vaccine (LAIV). HD-IIV is licensed for use in adults  $\geq 65$  years, and recommendations for use of LAIV have changed several times in recent years.

**OBJECTIVE:** We sought to examine family physicians' (FPs) and general internal medicine physicians' (GIMs) perceptions, knowledge, and practices for use of HD-IIV and LAIV during the 2016–2017 and 2018–2019 influenza seasons.

**DESIGN:** E-mail and mail surveys conducted February–March 2017, January–February 2019.

**PARTICIPANTS:** Nationally representative samples of FPs and GIMs.

**MAIN MEASURES:** Surveys assessed HD-IIV practices (2017), knowledge and perceptions (2019), and LAIV knowledge and practices (2017, 2019).

**KEY RESULTS:** Response rates were 67% (620/930) in 2017 and 69% (642/926) in 2019. Many physicians believed HD-IIV is more effective than standard dose IIV in patients  $\geq 65$  years (76%) and reported their patients  $\geq 65$  years believe they need HD-IIV (67%). Most respondents incorrectly thought ACIP preferentially recommends HD-IIV for adults  $\geq 65$  years (88%); 65% “almost always/always” recommended HD-IIV for adults  $\geq 65$  years. Some physicians incorrectly thought ACIP preferentially recommends HD-IIV for adults  $< 65$  years with cardiopulmonary disease (38%) or immunosuppression (48%); some respondents recommended HD-IIV for these groups (25% and 28% respectively). In 2017, 88% of respondents knew that ACIP recommended against using LAIV during the 2016–2017 influenza season, and 4% recommended LAIV to patients. In 2019, 63% knew that ACIP recommended that LAIV could be used during the 2018–2019 influenza season, and 8% recommended LAIV.

**CONCLUSIONS:** Many physicians incorrectly thought ACIP had preferential recommendations for HD-IIV. Physicians should be encouraged to use any available age-appropriate influenza vaccine to optimize influenza vaccination particularly among older adults and patients with chronic conditions who are more vulnerable to severe influenza disease.

**KEY WORDS:** influenza vaccine; immunization; vaccination; influenza.

## Abbreviations

AAFP	American Academy of Family Physicians
ACIP	(Advisory Committee on Immunization Practices)
ACP	American College of Physicians
CDC	Centers for Disease Control and Prevention
FP	Family physician
FDA	Food and Drug Administration
GIM	General internal medicine physician
HD-IIV	High-dose inactivated influenza vaccine
HMO	Health maintenance organization
IIV	Inactivated influenza vaccine
LAIV	Live attenuated influenza vaccine
US	United States

J Gen Intern Med 36(7):2030–8  
DOI: 10.1007/s11606-020-06397-7  
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## BACKGROUND

In the United States (US), annual vaccination for seasonal influenza is recommended for all people over 6 months of age without a contraindication to receiving it.<sup>1</sup> The Advisory Committee on Immunization Practices (ACIP) issues updated recommendations for the Centers for Disease Control and Prevention (CDC) for influenza prevention and control annually including recommendations regarding use of specific types of vaccines in different patient populations. Ten types of influenza vaccine were licensed in 2018–2019 for use in adults including among others inactivated influenza vaccine (IIV, including trivalent and quadrivalent vaccines from

Received June 24, 2020

Accepted December 3, 2020

Published online January 22, 2021

several different manufacturers), live attenuated influenza vaccine (LAIV, quadrivalent vaccine from one manufacturer), and high-dose inactivated influenza vaccine (HD-IIV, trivalent vaccine from one manufacturer).<sup>1</sup>

HD-IIV was developed as an attempt to improve the immune response and protection provided by influenza vaccination among people  $\geq 65$  years and was licensed in the US in 2009 for use among adults 65 years and older.<sup>2</sup> Studies comparing standard dose trivalent IIV to high-dose trivalent IIV showed HD-IIV had modestly superior efficacy against laboratory-confirmed influenza among adults  $\geq 65$  years and also provided slightly better protection against influenza-like illness and hospitalization.<sup>3–8</sup> HD-IIV has demonstrated superior immunogenicity among different subpopulations of immunosuppressed patients and a double dose of IIV (single injection of 30  $\mu\text{G}/\text{strain}$  vs 15  $\mu\text{G}/\text{strain}$ ) showed increased immunogenicity over standard dose IIV among adults with heart failure; however, trials demonstrating differences in influenza infection or hospitalization among these groups are lacking.<sup>9–14</sup> Like adults  $\geq 65$  years, patients with cardiopulmonary disease or immunosuppression are at greater risk for complications from influenza infection, and vaccine effectiveness may be lower for immunosuppressed patients. However, HD-IIV is not licensed by the Food and Drug Administration (FDA) or recommended by ACIP for use in patients  $< 65$  years with such medical conditions. Among patient populations of all ages for which there is more than one licensed influenza vaccine available, ACIP recommends administration of any influenza vaccine without preference for a specific vaccine product type.<sup>1,15</sup>

LAIV was licensed in the US in 2003, initially for use among healthy, non-pregnant individuals 5–49 years of age; the age recommendation was expanded to 2–49 years of age in 2007.<sup>16</sup> There have been several changes in recommendations regarding the use of LAIV in recent years. During 2003–2013, ACIP recommended use of LAIV or IIV without preference among patient populations for which multiple influenza vaccine types were available and licensed.<sup>17</sup> In 2014, the ACIP issued a preferential recommendation for administration of LAIV over IIV among children 2–8 years of age based on studies showing superior efficacy of LAIV for young vaccine-naïve children.<sup>18–20</sup> No preference was stated for LAIV use in other patient populations.<sup>17</sup> In 2015, ACIP removed this preferential recommendation after recent observational studies of LAIV among young children showed inferior vaccine effectiveness.<sup>21</sup> Low effectiveness of LAIV against influenza A(H1N1)pdm09 during both the 2013–2014 and 2015–2016 seasons led the ACIP to recommend in 2016 that LAIV should not be used.<sup>22</sup> In 2018–2019, LAIV was again recommended after inclusion of a new influenza A(H1N1)pdm09-like vaccine virus in LAIV showed acceptable immunogenicity in children 24 to 47 months of age.<sup>1</sup> Although changing ACIP recommendations for LAIV have been based upon vaccine

effectiveness in children, these changes may have affected physicians' vaccine recommendations for adult patients as well.

Published descriptions of physician knowledge about recent ACIP recommendations for different types of influenza vaccine are lacking. Given multiple changes in recommendations for LAIV use, the availability of several different types of influenza vaccine, and the potential for different interpretations of when to use HD-IIV, we conducted a survey to assess the interpretation of recommendations and current practices for these two vaccines. Our objectives were to examine among family physicians (FPs) and general internists (GIMs): (1) knowledge, practices, and perception related to HD-IIV use, and (2) knowledge and practices related to LAIV use during the 2016–2017 and the 2018–2019 influenza seasons.

## METHODS

### Study Setting

During February–March 2017 and January–February 2019, we administered surveys to national networks of physicians who reported spending at least half of their time practicing primary care. The human subjects review board of the University of Colorado Denver approved this study as exempt research not requiring written informed consent.

### Study Population

These surveys were conducted as part of the Vaccine Policy Collaborative Initiative, a collaboration with the CDC to conduct survey research assessing physician knowledge, attitudes, and practices related to vaccination topics. We recruited FPs and GIMs from the American Academy of Family Physicians (AAFP) and the American College of Physicians (ACP) to develop networks of primary care physicians. We used quota sampling<sup>23</sup> to ensure these networks of physicians were similar to AAFP and ACP memberships by region, urban versus rural location, and practice setting. New sentinel networks are recruited using quota sampling from updated professional society databases every 3 years to ensure network physicians remain representative of current professional society members. We previously demonstrated responses from network physicians were similar to those of physicians sampled randomly from American Medical Association (AMA) physician databases by practice characteristics, demographics, and attitudes about vaccination.<sup>23</sup>

### Survey Design

We developed the surveys in collaboration with CDC. Surveys were pretested by a national advisory panel of FPs and GIMs and then piloted among a small national sample of FPs ( $n = 13$  in 2017 and 2019) and GIMs ( $n = 23$  in 2017,  $n = 71$  in

2019). Piloting samples were composed of providers who responded to sentinel network recruitment surveys and were not included in the networks due to late response or to avoid over-representation in quota sampling. In 2017, we used a 4-point Likert scale to assess how often a physician actively recommended HD-IIV to different groups of patients during the 2016–2017 influenza season (“Rarely/Never” to “Almost always/always”). In 2019, we assessed physician knowledge about ACIP recommendations for HD-IIV using true/false questions and assessed physician perceptions about the effectiveness of HD-IIV using a 4-point Likert scale (“strongly disagree” to “strongly agree”). In 2017, we asked physicians if they were aware of the ACIP recommendation that LAIV should not be used during the 2016–2017 season and if they recommended LAIV during that season. In 2019, we asked physicians if they were aware of the ACIP recommendation that LAIV could be used again in the 2018–2019 season and if they recommended LAIV during that season (all yes/no questions).

### Survey Administration

Depending on physician preference noted on recruitment, the survey was sent via Internet (Verint, Melville, NY, <http://www.verint.com>) or mail. Using methods from prior surveys, we sent the Internet group an initial e-mail message with up to eight e-mail reminders, and we sent the mail group an initial mailing plus up to two additional reminders.<sup>24</sup> Non-respondents from the Internet group were also sent up to two mail surveys in case of problems with e-mail correspondence. We patterned the mail protocol using Dillman’s tailored design method.<sup>25</sup>

### Statistical Analysis

We combined Internet and mail survey responses for analyses because prior studies have found physician attitudes are similar when obtained by either method.<sup>25–27</sup> We compared respondents to non-respondents using *t* tests, Wilcoxon tests, and chi-squared tests, as appropriate. Non-respondent characteristics were obtained from the recruitment survey for the sentinel physician networks. We compared FP and GIM responses using chi-squared tests. Results were mostly similar between FP and GIM and are therefore presented together. Where differences between specialties exist, results are presented by specialty with these differences noted. To examine characteristics associated with “almost always/always” recommending HD-IIV to patients 65–79 years of age, we conducted bivariate analyses with independent variables including physician specialty, provider age, practice location and setting, region, and number of providers in practice. All analyses were performed in SAS 9.4 (SAS, Inc., Cary, NC) from January–December 2019.

## RESULTS

### Survey Response and Respondent Characteristics

The overall 2017 response rate was 67% (620/930); 73% for FPs (337/464) and 61% for GIMs (283/466). The overall 2019 response rate was 69% (642/926); 64% for FPs (278/432) and 74% for GIMs (364/494). In 2017, respondents and non-respondents did not differ significantly by census location (urban, suburban, rural). Respondents were more likely to be from the West and less likely to be from the South, were more likely to be female, younger, or work in a practice with a higher median number of providers, and they were less likely to be in private practice. In 2019, respondents and non-respondents did not differ significantly by gender, practice setting, or region of the country; respondents were younger, more likely to work in a suburban location, and more likely to work in a practice with a higher median number of providers (Table 1).

### Practices Related to High-Dose Influenza Vaccine (2017 Survey)

A majority of respondents (65%) “almost always/always” recommended HD-IIV to patients  $\geq 65$  years. Fewer physicians “almost always/always” recommended HD-IIV to adult patients  $< 65$  years with cardiopulmonary disease (25%) or immunosuppression (28%); this vaccine is not FDA licensed for use in persons aged  $< 65$  years (Table 2). In bivariate analyses, neither physician specialty; nor provider age, location or setting; practice region, nor number of providers in the practice were associated with “almost always/always” recommending HD-IIV to patients 65–79 years of age ( $p > 0.05$  each).

### Knowledge, and Perceptions Related to High-Dose Influenza Vaccine (2019 Survey)

Eighty-eight percent of physicians incorrectly thought ACIP preferentially recommended HD-IIV for adults  $\geq 65$  years (Fig. 1). Seventy-six percent of physicians agreed (33% strongly; 43% somewhat) with the statement “High dose seasonal influenza vaccine is much more effective than standard dose influenza vaccine at preventing influenza in adults  $\geq 65$  years of age” (Table 2). The majority of respondents also agreed (27% strongly; 40% somewhat) with the statement “My adult patients  $\geq 65$  years of age believe they need high dose rather than standard dose influenza vaccine.” More GIMs than FPs strongly or somewhat agreed that HD-IIV is more effective than standard dose influenza vaccine for adults  $\geq 65$  years of age (81% vs 68%,  $p = 0.001$ ) and agreed their patients believed they needed HD-IIV rather than standard dose IIV (74% vs 58%,  $p < 0.001$ ).

Table 1 Comparison of Respondents and Non-respondents and Family Physician (FP) and General Internal Medicine (GIM) Respondent Characteristics

	2017					2019				
	FP respondents, n = 337, % (n)	GIM respondents, n = 283, % (n)	Total respondents, n = 620, % (n)	Total non-respondents, n = 310, % (n)	P value*	FP respondents, n = 278, % (n)	GIM respondents, n = 364, % (n)	Total respondents, n = 642, % (n)	Total non-respondents, n = 284, % (n)	P value*
Male, %	57 (191)	56 (155)	56 (346)	66 (200)	<0.01	60 (167)	50 (181)	54 (348)	59 (167)	0.18
Setting, %					<0.01					0.37
Private practice	69 (233)	76 (215)	72 (448)	82 (253)		71 (198)	77 (279)	74 (477)	79 (223)	
Hospital or clinic	23 (77)	20 (57)	22 (134)	15 (46)		22 (60)	19 (70)	20 (130)	17 (47)	
HMO	8 (27)	4 (11)	6 (38)	3 (10)		7 (20)	4 (15)	6 (35)	5 (14)	
Location, %					0.12					0.05
Urban	35 (117)	56 (157)	44 (274)	49 (151)		35 (98)	13 (48)	23 (146)	30 (85)	
Suburban	57 (191)	44 (123)	51 (314)	49 (151)		58 (160)	75 (269)	67 (429)	59 (167)	
Rural	9 (29)	1 (3)	5 (32)	3 (8)		7 (20)	12 (42)	10 (62)	10 (29)	
Region, %					0.04					0.98
Midwest	29 (96)	22 (63)	26 (159)	25 (77)		29 (80)	23 (84)	26 (164)	26 (74)	
Northeast	17 (58)	24 (69)	20 (127)	18 (57)		18 (49)	23 (82)	20 (131)	21 (60)	
South	30 (102)	29 (83)	30 (185)	38 (119)		31 (86)	33(119)	32 (205)	32 (90)	
West	24 (81)	24 (68)	24 (149)	18 (57)		23 (63)	22 (79)	22 (142)	21 (60)	
Decision-making \$, %					0.07					0.86
Independent	54 (181)	55 (154)	54 (335)	61 (188)		53 (146)	61 (220)	57 (366)	58 (163)	
Larger system level	46 (154)	45 (126)	46 (280)	39 (121)		47 (132)	39 (140)	43 (272)	42 (118)	
Mean age in years (SD)	54.0 (8.1)	53.9 (9.0)	54.0 (8.5)	56.0 (8.3)	<	55.6 (7.7)	52.5 (10.4)	53.9 (9.5)	56.5 (9.0)	<
Median (IQR) number of providers	5 (3–10)	6 (3–15)	6 (3–12)	5 (2–10)	0.01†	6 (3–10)	6 (2–12)	6 (3–10)	5 (2–10)	0.01†
Patient insurance, %					0.01‡					0.03‡
≥ 50% privately insured	41 (135)	41 (113)	41 (248)	–	–	40 (106)	39 (133)	40 (239)	–	–
≥ 50% Medicaid	7 (22)	3 (9)	5 (31)	–	–	7 (19)	4 (13)	5 (32)	–	–
≥ 50% Medicare part B	10 (33)	30 (84)	19 (117)	–	–	15 (39)	32 (106)	24 (145)	–	–

\*Chi-square test

†t test

‡Wilcoxon test

\$Decision-making refers to the level at which a respondent's practice/site makes decisions about purchasing and handling of vaccines; percentages may not add up to 100% due to rounding. All comparisons made for respondents vs. non-respondents within the same survey year. HMO, health maintenance organization

**Table 2 Physician Knowledge, Practices, and Perception Related to High-Dose Inactivated and Live Attenuated Influenza Vaccines During the 2016–2017 and 2018–2019 Influenza Se**

		All respondents, %	FP, %	GIM, %	<i>p</i> value (chi-squared test, FP vs GIM)
Recommended HD-IIV to adult patients 65–79 years of age (2017)	Rarely	16	17	15	0.45
	Sometimes	9	9	10	
	Often	9	10	7	
	Almost always/always	66	64	69	
Recommended HD-IIV to adult patients ≥ 80 years of age (2017)	Rarely	14	15	13	0.06
	Sometimes	8	7	10	
	Often	10	13	7	
	Almost always/always	67	65	69	
Recommended HD-IIV to adult patients < 65 years with cardiopulmonary disease (2017)	Rarely	50	49	52	0.69
	Sometimes	13	13	13	
	Often	12	13	10	
	Almost always/always	25	25	26	
Recommended HD-IIV to adult patients < 65 years with immunosuppression (2017)	Rarely	46	44	48	0.57
	Sometimes	14	15	13	
	Often	12	13	11	
	Almost always/always	28	28	29	
High dose seasonal influenza vaccine is much more effective than standard dose influenza vaccine at preventing influenza in adults ≥ 65 years of age (2019)	Strongly agree	33	30	35	0.007
	Somewhat agree	43	39	46	
	Somewhat disagree	13	17	10	
	Strongly disagree	5	7	3	
	Do not know	7	8	6	
My adult patients ≥ 65 years of age believe they need high dose rather than standard dose influenza vaccine (2019)	Strongly agree	27	19	33	< 0.0001
	Somewhat agree	40	39	41	
	Somewhat disagree	17	22	13	
	Strongly disagree	6	9	3	
	Do not know	11	12	9	
Were aware of ACIP's recommendation that LAIV should not be used during the 2016–2017 influenza season (2017)	Yes	88	90	84	0.02
Recommended LAIV during the 2016–2017 influenza season (2017)	Yes	4	5	3	0.32
Were aware of ACIP's recommendation that LAIV could be used again during the 2018–2019 influenza season (2019)	Yes	63	74	54	< 0.0001
Recommended LAIV during the 2018–2019 influenza season (2019)	Yes	14	16	11	0.14

FP, family physician; GIM, general internal medicine physician; HD-IIV, high-dose inactivated influenza vaccine; ACIP, Advisory Committee on Immunization Practices; LAIV, live attenuated influenza vaccine

A notable proportion of physicians incorrectly thought ACIP preferentially recommended HD-IIV for adults < 65 years with cardiopulmonary disease (38%) or immunosuppression (48%, Fig. 1).

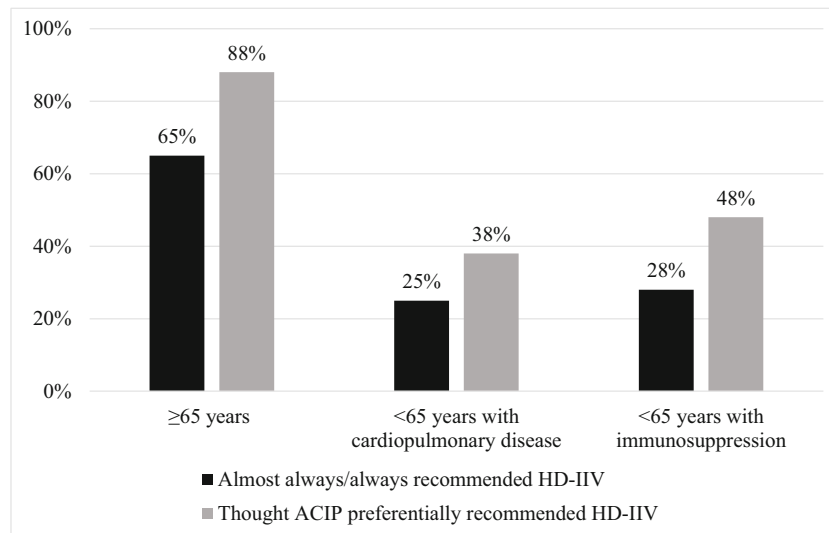
### Physician Knowledge and Practices Related to LAIV (2017 and 2019 Surveys)

Most respondents (88%) were aware of the ACIP recommendation that LAIV should not be used during the 2016–2017 season and few (4%) recommended LAIV during the 2016–2017 season. Sixty-three percent of physicians knew ACIP recommended that LAIV could be used again during the 2018–2019 influenza season. Only 14% of those who were aware LAIV could be used (8% of all respondents) recommended LAIV during the 2018–2019 season (Table 2).

### CONCLUSIONS

Many physicians incorrectly thought ACIP had preferential recommendations for HD-IIV and reported preferentially using HD-IIV for patients ≥ 65 years. Perceptions and practices favoring use of HD-IIV were less common for patients < 65 years with cardiopulmonary disease or immunosuppression, groups for which this vaccine was not licensed. Our findings also show that primary care physicians were well informed of and able to implement the ACIP recommendations related to LAIV for the 2016–2017 influenza season and were less informed of the ACIP recommendations for LAIV during the 2018–2019 season; in both seasons, LAIV was not frequently recommended.

A 2015 study of claims data showed HD-IIV accounted for 32% of influenza vaccines received by patients ≥



Physician recommendation was asked in 2017 and knowledge of ACIP recommendations was asked in 2019. HD-IIV=high-dose inactivated influenza vaccine, FP=family physician, GIM=general internal medicine physician, ACIP=Advisory Committee on Immunization Practices

**Figure 1 Practices and knowledge related to HD-IIV recommendations for different types of adult patients among FPs and GIMs**

65 years in 2012 and adults 18–64 years who received HD-IIV were more likely to have chronic morbidities than those receiving standard dose IIV.<sup>28</sup> Our survey found that many physicians reported “almost always/always” recommending HD-IIV to these groups of patients as well. Although ACIP does not preferentially recommend HD-IIV over other influenza vaccines, provider preferences and recommendations for HD-IIV may be influenced by published studies on vaccine effectiveness. Research has demonstrated HD-IIV is more effective than standard dose IIV at preventing influenza-like illness, laboratory-confirmed influenza, and influenza hospitalizations among adults  $\geq 65$  years.<sup>3–8</sup> A systematic review found HD-IIV to be 18% more effective than standard dose IIV for preventing influenza hospitalization and 20% more effective for preventing influenza-like illness.<sup>3</sup> Based on superior vaccine effectiveness, HD-IIV has also been shown to be more cost-effective than standard dose IIV for prevention of influenza among adults  $\geq 65$  years.<sup>29–31</sup> One study of expenditures among US nursing home residents demonstrated a \$20 per resident increased cost of HD-IIV compared to standard dose IIV and a \$526 per resident net benefit based on decreased expenditures for facilities randomized to HD-IIV.<sup>31</sup>

About one-quarter of physicians we surveyed indicated they “almost always/always” recommend HD-IIV to patients  $< 65$  years with cardiopulmonary disease or immunosuppression. Several studies have demonstrated superior

immunogenicity for HD-IIV compared to standard dose IIV among people  $< 65$  years including healthy adults<sup>32</sup>, people living with HIV<sup>13</sup>, hematopoietic stem cell transplant recipients<sup>33</sup>, solid organ transplant recipients<sup>11</sup>, and oncology patients.<sup>9,12,34</sup> Despite evidence of increased immunogenicity, studies demonstrating increased HD-IIV vaccine effectiveness among adults  $< 65$  years with cardiopulmonary disease or immunosuppression are lacking, and HD-IIV is not licensed for use in adults  $< 65$  years.

Physician preference and recommendation may be influenced by organizational factors as well as published literature. These factors include purchasing decisions that are often made at a clinic or larger health system level. Decision-makers may incorporate published literature about cost effectiveness, guidance from their own expert advisors, and characteristics of their patient population when choosing which vaccine products to purchase. Physician recommendations for different types of influenza vaccine are likely informed by vaccine availability within and organizational guidance from their clinical practice setting.

Influenza vaccination decisions are influenced by patient preference as well as physician preference and recommendation. A majority of physicians surveyed reported that their patients  $\geq 65$  years of age believed they needed HD-IIV. Patient preference may be informed by discussion with their provider and by external factors like direct to consumer advertising about influenza vaccine. A Canadian study provided patients  $\geq 65$  years with information about currently approved influenza vaccines and found

that HD-IIV was preferred by the plurality of respondents.<sup>35</sup> A meta-analysis of influenza-related communication research by CDC found that one reason people cited for receiving an influenza vaccine was active promotion of influenza vaccination through advertisements.<sup>36</sup>

Direct to consumer (DTC) pharmaceutical advertising pervades digital, print, and broadcast media and is often present in pharmacies. Studies of DTC advertising for other drugs have shown advertisements may overemphasize the benefits of a medication, are often not compliant with FDA guidelines, and consumers may misinterpret information about the product being advertised.<sup>37–40</sup> These studies have also noted that DTC advertising tends to focus on new medications that do not always offer significant benefits over older and cheaper medications.<sup>41</sup> We were unable to identify any other peer-reviewed publications specifically examining the impact of DTC advertising for influenza vaccines. More detailed examination of the content, framing, and distribution of DTC advertising for HD-IIV and other types of influenza vaccine might enhance our understanding of patient influenza vaccine preferences.

Whether a result of patient preference or physician recommendation, promotion of HD-IIV at the expense of standard dose IIV may have unintended negative consequences. If patients request HD-IIV and are not able to receive this vaccine from their provider, they may then forgo influenza vaccination altogether. This possibility is particularly concerning for adults  $\geq 65$  years and adults  $< 65$  years with comorbidities who are more susceptible to severe influenza disease. Use of HD-IIV is acceptable and may be preferable in some situations, but preference for HD-IIV over IIV should not lead to people forgoing influenza vaccination if they cannot access HD-IIV.

Almost 90% of physicians knew that ACIP recommended against use of LAIV during the 2016–2017 influenza season. Fewer were aware that LAIV was again recommended for use during the 2018–2019 season. The difference in knowledge may reflect differences in how ACIP recommendations were communicated from public health authorities and medical societies, differences in media coverage of ACIP recommendations or vaccine effectiveness, or changes in the information sources physicians use to learn about influenza vaccine recommendations. FPs and GIMs may be less attuned to changes in recommendations about LAIV because LAIV is only licensed for use in persons aged through 49 years. Therefore, it would not be recommended for a large portion of their patients in any season. However, this would not explain the high level of awareness of the recommendation against LAIV in 2016. Even though a majority of physicians knew that ACIP recommended LAIV could be used again during the 2018–2019 season, only 14% of those who were aware recommended LAIV. This lack of recommendation may

reflect reluctance of physicians or clinical organizations to start using LAIV again due to their concerns about effectiveness or logistical factors associated with starting to stock the vaccine. Additional study to assess information sources that physicians consult for information about vaccination and ACIP recommendations may help explain differences in knowledge and identify avenues for improved communication and education. Future research could include surveys about use of existing immunization education and quality improvement resources from the CDC and professional societies and the development of more resources focused on adult influenza immunization.

This study has several limitations. Respondents and non-respondents may have differed in their practices and experiences related to influenza vaccination. Behaviors and experiences were self-reported in the survey, but actual behavior and vaccine uptake were not assessed. The scope of our study did not include questions about adjuvanted or recombinant influenza vaccines and did not compare trivalent to quadrivalent vaccines. Because we assessed physician practices in 2017 and knowledge and perceptions in 2019, we were unable to examine the association of knowledge about ACIP recommendations and perceptions about vaccine effectiveness on the behavior of recommending HD-IIV. Our survey was limited to primary care physicians and did not include providers from other settings where adults may receive influenza vaccinations.<sup>42</sup>

The availability of several different types of influenza vaccines and changing recommendations about seasonal influenza vaccination have the potential to cause confusion among primary care providers. Patient and provider preference for HD-IIV in some groups of patients has the potential to undermine influenza vaccine uptake if patients forgo standard dose IIV when HD-IIV is not available. Continued study of how both providers and patients interpret and implement recommendations is essential to understand the effect of influenza vaccination decisions made by the ACIP.

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**Supplementary Information** The online version contains supplementary material available at <https://doi.org/10.1007/s11606-020-06347-3>.

**Acknowledgments:** The authors would like to thank Bellinda Schoof, MHA, at the AAFP, Arlene Weissman, PhD, and Linda Harris from the ACP, and the leaders of the AAFP and ACP for collaborating in the establishment of the sentinel networks in family medicine and general internal medicine. The authors would like to thank Erin Burns, Alicia Fry, and Mark Thompson from the Centers for Disease Control and Prevention for assistance developing the survey questions. We would also like to thank all general internists and family medicine physicians in the networks for participating and responding to this survey.

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**Funding** This publication was supported by Cooperative Agreement Number 1 U01 IP000849-03, funded by the Centers for Disease Control and Prevention. Its contents are solely the responsibility of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention or the U.S. Department of Health and Human Services.

**Compliance with Ethical Standards:**

**Conflict of Interest:** None of the authors has any conflicts of interest.

**Financial Disclosures:** None of the authors has any financial disclosures.

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