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Perspectives on the receipt of a COVID-19 vaccine: A survey of employees in two large hospitals in Philadelphia

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ABSTRACT

Background: Health care personnel have been identified by the ACIP as a priority group for COVID-19 vaccination. We conducted a survey in November-December 2020 at two large, academic hospitals in Philadelphia to evaluate the intention of hospital employees to be vaccinated.

Methods: The survey was sent electronically to all employees (clinical and nonclinical staff) at a children's hospital and an adult hospital. The survey was voluntary and confidential. Questions focused on plans to receive a COVID-19 vaccine when available, reasons why employees would/would not get vaccinated, when employees planned to be vaccinated, vaccine safety and efficacy features that would be acceptable, and past history of receipt of other vaccines by the employee and family. Responses were analyzed using univariate and multiple logistic regression methods.

Results: A total of 12,034 hospital employees completed the survey (a 34.5% response rate). Overall, 63.7% of employees reported that they planned to receive a COVID-19 vaccine, 26.3% were unsure, and 10.0% did not plan to be vaccinated. Over 80% of those unsure or unwilling to be vaccinated expressed concerns about vaccine side effects and the vaccines' newness. In multivariable logistic regression, persons planning to take a COVID-19 vaccine were more likely to be older, male, more educated, Asian or White, up-to-date on vaccinations, without direct patient contact, and tested for COVID-19 in the past. No significant difference in intention to be vaccinated was found between those with higher versus lower levels of exposure to COVID-19 patients or the number of previous exposures to patients with COVID-19.

Conclusions: While the majority of hospital employees are planning to receive a COVID-19 vaccine, many are unsure or not planning to do so. Further education of hospital employees about the safety, efficacy, and value of the currently available COVID-19 vaccines is critical to vaccine acceptance in this population.

1. Background

The coronavirus disease 2019 (COVID-19) pandemic continues to aggressively spread throughout the United States with more than 26.1 million cases and 441,831 deaths reported as of February 2, 2021 [1]. COVID-19 is now the leading cause of death in the US [2]. The persistence of the pandemic and its increasing morbidity and mortality, despite current mitigation efforts, underlines the need for COVID-19 vaccines. COVID-19 vaccine development and testing has progressed at rapid speed due to novel vaccine technologies, the unprecedented number of public–private partnerships, vaccine manufacturers, and regulatory agencies focused on a solution, and significant funding from both government and private industry.

A central strategy to mitigating the COVID-19 pandemic is through vaccination. Although vaccination programs are well underway in the US, vaccination can only curtail ongoing transmission of the SARS-CoV-2 virus and reduce the overall severity of the disease if widespread uptake occurs and herd immunity is achieved. Experts estimate that ≥67% of the population must be immune against the SARS-CoV-2 virus to halt transmission [3–6].

Acceptance of vaccination against COVID-19 by the general population has been reported to be less than optimal. Eight polls conducted between May 2020 and October 2020 showed that the percent of adults who planned to receive a COVID-19 vaccine ranged from 35 to 75% with no clear trend over time [7–13].

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Acceptance rates varied by race/ethnicity with lower acceptance among Blacks than Whites [8,9].

In anticipation of the imminent Emergency Use Authorization (EUA) of several COVID-19 vaccine candidates, the CDC's Advisory Committee on Immunization Practices (ACIP) made recommendations for priority groups for vaccination at its December 1, 2020 meeting. Recommendations were made recognizing that supply would be limited when a vaccine was first available. The ACIP recommended that health care personnel should be included in the first group to be offered COVID-19 vaccination as they are on the front lines of pandemic response. Health care settings were recognized as high-risk locations for SARS-CoV-2 exposure and transmission [14,15].

Health care personnel may not only be some of the first persons to receive a COVID-19 vaccine, they will also play an important role in the acceptance of the vaccine in the general population. Patients turn to health care providers for expert medical advice and care, including vaccine recommendations. It is well established that patients are far more likely to receive an immunization when a provider has recommended it [16–23].

In view of the low vaccine acceptance rate in the general population and the priority given to vaccination of health care personnel, we conducted a survey among hospital employees in the weeks prior to imminent COVID-19 vaccine introduction. The purpose of the survey was to understand attitudes toward COVID-19 vaccines which will be new to them, their patients, and their families. We aimed to obtain a better understanding of how hospital employees, both in clinical and nonclinical positions, perceive the new COVID-19 vaccines and their intention to be vaccinated.

2. Methods

We conducted a confidential, voluntary survey between November 13, 2020 and December 6, 2020 at two large, academic hospitals in Philadelphia, one serving children and the other serving adults (henceforth referred to as hospital A and hospital B, respectively). The survey was distributed to all hospital employees regardless of clinical role using REDCAP, an electronic survey instrument. The survey was announced by management at each hospital 1–2 days before being distributed, and 3–4 reminders were sent out over the course of the survey period.

The survey was developed based on results from other studies related to COVID-19 vaccine acceptance in the general population with inclusion of specific questions related to role in the hospital and exposure to COVID-19. A pilot survey was conducted prior to dissemination at the two hospitals to test for feasibility, length of time to complete the survey, and clarity. The survey took 10–15 minutes to complete. The survey questions focused on employee plans to receive a COVID-19 vaccine, timing of vaccine receipt once available, reasons for taking or not taking the vaccine, safety and efficacy features of a vaccine that would or would not be acceptable, who should be vaccinated first, history of exposure to COVID-19 at work, at home or elsewhere, and past history of receipt of other vaccines for the employee or their children. Demographic data collected included hospital of employment, age, gender, race/ethnicity, education, position and area employed in the hospital, duration of employment, and residential area. Assumptions that were communicated to the employees when completing the survey included: 1) The vaccine would be at least 50% effective; 2) The vaccine would be authorized under Emergency Use Authorization (EUA) by the Food and Drug Administration (FDA) and would be recommended by the ACIP for health care workers; 3) COVID-19 was expected to continue to circulate in the US for the next few months; and 4) There would be no cost to receive the vaccine.

The protocol and survey were reviewed by the Institutional Review Board at each hospital and determined to be exempt from human subjects' review.

Analysis included summary statistics (frequencies and percentages) of employee characteristics (age, gender, race or ethnicity, level of education, home residence type, and hospital position) for the entire responding population (12,034 individuals). For each survey question, the percent of individuals who responded to each possible answer was tabulated, excluding those who did not respond to the question along with 9 subjects who indicated they had participated in a COVID-19 vaccine trial. Intention to receive a COVID-19 vaccine (based on a response of yes, no, or unsure) was further stratified by the employee characteristics noted above as well as timing of vaccine receipt, self-health assessment, employee/child vaccination status, number of COVID-19 exposures, risk of exposure, prior COVID-19 testing status, hospital of employment, and years employed (as categorized in Table 3). Difference in rates were determined by Chi square tests with significance level 0.05. Variables shown to have significantly different rates of intention to receive a COVID-19 vaccine in this univariate analysis were included in multiple logistic regression analyses [24]. Significance level 0.05 was used to determine a variable's overall significance in the model when controlling for all other variables as well as a parameter's odds ratio compared to its reference (as shown in Table 4).

3. Results

3.1. Response rate

The survey was sent to 34,865 health care employees at the two hospitals. A total of 12,034 persons (7427 at hospital A and 4607 at hospital B) responded to the survey. The overall response rate was 34.5% (36.8% at hospital A and 31.3% at hospital B).

3.2. Demographics

The demographics of the 12,034 survey respondents are shown in Table 1. The age distribution and racial/ethnicity of the respondents at the two hospitals was comparable. There were more females at hospital A who responded to the survey while there were more employees who lived in an urban setting, more staff in clinical positions, and more employees with postgraduate education who responded to the survey at hospital B.

3.3. Intention to be vaccinated

A total of 11,760 employees (7271 at hospital A and 4489 at hospital B) responded to the survey question about their plans to be vaccinated. Overall, 63.7% of these employees said they planned to receive a COVID-19 vaccine when available under an EUA in the US. The intention to receive a COVID-19 vaccine was 61.6% at hospital A and 67.3% at hospital B. Approximately one quarter (26.3%) of employees (27.6% at hospital A and 24.1% at hospital B) said they were unsure if they would take the vaccine, and 10.0% said that they did not plan to receive the vaccine (10.8% at hospital A and 8.7% at hospital B).

3.4. Vaccine characteristics of importance

Vaccine safety and efficacy were the two COVID-19 vaccine characteristics of most importance to the employees (94.4%% and 82.8%, respectively). Only 28.3% of respondents said they would be willing to receive a vaccine if the side effects they would develop included a high fever, muscle aches, chills, and a headache

Table 1
Demographic Characteristics of 12,034 Hospital Employees who Completed the Survey.

Variable	Parameter	Hospital A (%)	Hospital B (%)	Combined (%)
Age	<40 years	3732 (50.3)	2404 (52.2)	6136 (51.0)
	40–64 years	3020 (40.7)	1692 (36.7)	4612 (39.2)
	65 or older	224 (3.0)	208 (4.5)	432 (3.6)
	Unknown/NR	451 (6.1)	303 (6.6)	754 (6.3)
Gender	Female	5658 (76.2)	2969 (64.5)	8627 (71.7)
	Male	1241 (16.7)	1288 (28.0)	2529 (21.0)
	Other/Unknown/NR	528 (7.1)	350 (7.6)	878 (7.3)
Race/Ethnicity	White	5177 (69.7)	3216 (69.8)	8393 (69.7)
	Black	607 (8.2)	275 (6.0)	882 (7.3)
	Hispanic or Latino	209 (2.8)	99 (2.2)	308 (2.6)
	Asian	440 (5.9)	408 (8.9)	848 (7.1)
	Other/Unknown/NR	994 (13.4)	609 (13.2)	1603 (13.3)
Education	Less than Bachelor's Degree	1108 (14.9)	404 (8.8)	1512 (12.6)
	Bachelor's or Master's Degree	4471 (60.2)	2324 (50.4)	6795 (56.5)
	Postgraduate Degree	1489 (20.1)	1621 (35.2)	3110 (25.8)
	Unknown	359 (4.8)	258 (5.6)	617(5.1)
Home Residence	Urban	2729 (36.7)	1971 (42.8)	4700 (39.1)
	Suburban	4153 (55.9)	2297 (49.9)	6450 (53.6)
	Rural	184 (2.5)	79 (1.7)	263 (2.2)
	Unknown	361 (4.9)	260 (5.6)	621 (5.2)
Hospital Position	Clinical – Direct patient contact	3365 (45.3)	3115 (67.6)	6480 (53.9)
	Some patient interaction	723 (9.7)	350 (7.6)	1073 (8.9)
	Nonclinical - No patient interaction	2371 (31.9)	672 (14.6)	3043 (25.3)
	Other/Unknown	968 (13.0)	470 (10.2)	1438 (11.9)

NR – No response to this question.

Table 2
Reasons Why Employees Would Not Receive a COVID-19 Vaccine Among The Subset who Indicated They Were Unsure or Did Not Plan to be Vaccinated.

Reason	Hospital A (N = 2791)	Hospital B (N = 1470)	Combined (N = 4261)
Concern about side effects	2469 (88.5%)	1326 (90.2%)	3795 (89.1%)
Vaccine is too new	2363 (84.7%)	1216 (82.7%)	3579 (84.0%)
Don't know enough about the vaccine	2201 (78.9%)	1117 (76.0%)	3318 (77.9%)
It may not work	967 (34.6%)	435 (29.6%)	1402 (32.9%)
Concern about getting infected with COVID-19 from the vaccine	753 (27.0%)	331 (22.5%)	1084 (25.4%)
I do not like vaccines	132 (4.7%)	70 (4.8%)	202 (4.7%)
COVID-19 outbreak is not as serious as some people say it is	73 (2.6%)	47 (3.2%)	120 (2.8%)
I do not like needles	56 (2.0%)	22 (1.5%)	78 (1.8%)
I won't have time to get vaccinated	10 (0.4%)	10 (0.7%)	20 (0.5%)
None of the above	16 (0.6%)	7 (0.5%)	23 (0.5%)
Other (specify)[1]	247 (8.8%)	128 (8.7%)	375 (8.8%)

Reasons listed were prespecified in the survey. Employees could select more than one reason why they would not receive a COVID-19 vaccine.
[1] Other includes pregnant, want to get pregnant, breastfeeding, concern about fertility, concern about long term complications, duration of protection unknown, distrust government and pharma, want more data, underlying medical condition (autoimmune disorder, cancer, allergies, diabetes), vaccine development rushed, concern about fetal cell use, don't trust the vaccine, too much conflicting information, no other mRNA vaccine on the market, religious reasons, need to see more data, too much political involvement.

after vaccination that resulted in loss of 2 days at work, while 33.2% of employees said they were unsure if they would take a vaccine with this exact safety profile. Intention to be vaccinated increased with increasing vaccine effectiveness (35.8% willing to receive a vaccine with 50% effectiveness, 61.1% willing to receive a vaccine with 70% effectiveness, and 85.6% willing to receive a vaccine with 90% effectiveness). The number of prior persons vaccinated was an important characteristic of a COVID-19 vaccine for 32.3% of employees.

3.5. Reasons to be vaccinated/reasons not to be vaccinated

The reasons employees most frequently selected for receiving a COVID-19 vaccine included protection of one's family (86.7%) and protecting themselves (82.9%). Other reasons for receiving a COVID-19 vaccine included protecting one's community (68.8%), getting life "back to normal" (59.4%), and a belief that vaccination was the best measure to prevent becoming seriously ill from COVID-19 (58.3%). A desire to travel again was noted by 38.5% of employees.

Table 2 presents the reasons employees selected for not taking a COVID-19 vaccine among those who indicated they were either not planning or unsure about taking the vaccine. The reasons most frequently selected for not wanting to be vaccinated included concern about side effects (89.1%), the vaccine being too new (84.0%), and not knowing enough about the vaccine (77.9%). Other reasons included concerns about the vaccine not working (32.9%) and getting infected with COVID-19 from the vaccine (25.4%).

3.6. Timing of vaccination

Among the 7158 persons who said they planned to be vaccinated and answered the question about timing of vaccination, 5661 (79.1%) said they would receive the vaccine as soon as it was recommended and made available to them, 1367 (19.1%) said they would take the vaccine after it had been administered to others for 3–6 months, and 130 (1.8%) said they would take the vaccine after it had been administered to others for 12 months.

Table 3
Characteristics of Hospital Employees Planning to Receive a COVID-19 Vaccine (Hospitals A & B Combined)[1].

Category	Variable	Parameter	Total Respondents[2]	N (%) Planning To Receive A COVID-19 Vaccine[3]	p-value
Demographics	Age	<40 years	6131	3835 (62.6)	<0.0001
		40–64 years	4708	3073 (65.3)	
		65 or older	432	376 (87.0)	
	Gender	Male	2525	2064 (81.7)	<0.0001
		Female	8622	5181 (60.1)	
		Other/Prefer Not to Answer	253	73 (28.9)	
	Race/Ethnicity	White	8388	5833 (69.5)	<0.0001
		Black	882	262 (29.7)	
		Hispanic or Latino	307	167 (54.4)	
		Asian	845	626 (74.1)	
		Multiple/Other	449	264 (58.8)	
	Education	Less than Bachelor's Degree	1511	618 (40.9)	<0.0001
		Bachelor's or Master's Degree	6792	4120 (60.7)	
		Postgraduate Degree	3105	2583 (83.2)	
	Area of Residence	Urban	4696	3163 (67.4)	<0.0001
		Suburban	6445	4037 (62.6)	
		Rural	263	121 (46.0)	
	Work Location	Hospital A	7271	4480 (61.6)	<0.0001
		Hospital B	4489	3019 (67.3)	
	Years Employed at Hospital	<1 year	984	670 (68.1)	0.0041
		1–4 years	3682	2304 (62.6)	
		5 or more years	6733	4343 (64.5)	
Health of Individual	Self-reported health status	Excellent	3378	2442 (72.3)	<0.0001
		Good or Very Good	7753	4729 (61.0)	
		Fair or Poor	393	208 (52.9)	
Vaccination History	Employee	Up-to-date on most or all vaccines	11,193	7220 (64.5)	<0.0001
		Up-to-date on some vaccines	180	99 (55.0)	
		Unsure if up-to-date	89	38 (42.7)	
		Not up-to-date	62	22 (35.5)	
	Employee's Children[4]	Up-to-date on most or all vaccines	6099	3883 (63.7)	<0.0001
		Up-to-date on some vaccines	110	63 (57.3)	
		Unsure if up-to-date	108	65 (60.2)	
		Not up-to-date	50	13 (26.0)	
Level of Patient Care	Position in the Hospital	Clinical - direct patient contact[5]	6473	4270 (66.0)	<0.0001[8]
		Some patient interaction[6]	1073	536 (50.0)	
		Nonclinical - no patient interaction[7]	3041	1995 (65.6)	
COVID Exposures & Testing	Area of Employment in the Hospital	High Exposure to COVID-19	3042	2019 (66.4)	0.2642
		Moderate Exposure to COVID-19	4883	3156 (64.6)	
		Low Exposure to COVID-19	2594	1705 (65.7)	
	Confirmed COVID-19 exposures at work, home, elsewhere[9]	0	4142	2687 (64.9)	0.7962
		1–4	3047	1954 (64.1)	
		≥5	2528	1627 (64.4)	
	Previous COVID-19 test	Yes	4290	2975 (69.4)	<0.0001
		No	7056	4317 (61.2)	
		Unsure	234	113 (48.3)	

p value indicates significant difference among the parameters for each variable and were derived from tests of multiple proportions.
[1] Excludes individuals who participated in a COVID-19 vaccine clinical trial.
[2] Excludes individuals who did not respond to whether they plan to receive a COVID-19 vaccine.
[3] Answered yes to survey question asking whether they planned to receive a COVID-19 vaccine.
[4] Limited to those with children in the household.
[5] Includes nursing staff, EMT, medical assistant, paramedic, phlebotomist, NP/MD/DO/PA, respiratory therapist, PT/OT/speech therapist.
[6] Includes dietician/nutritionist, environmental services, security, radiology technician, visiting nurse, child life services, patient service representative, social worker, unit clerk, clergy.
[7] Includes administrative, management staff, clinical laboratory personnel, IT support, maintenance, dietary staff, pharmacist, research personnel, volunteer.
[8] p = 0.7452 when comparing those with direct patient contact to those with no patient interaction.
[9] Excludes persons who were unsure of their number of exposures. The rate of persons planning to be vaccinated in this category was 61.0% (1137/1864).

Table 4
Multiple Logistic Regression for Intention to Receive a COVID-19 Vaccine (Yes vs. No/Unsure) Across Those Variables Showing Differences in Univariate Analysis (Table 3).

Category	Variable	Parameter	OR (95% CI)	P-Value
Demographics	Age Group (years)	<40	Reference	<0.0001
		40–64	**1.40 (1.26, 1.56)**	
		≥65	**3.50 (2.50, 4.90)**	
	Gender	Female	Reference	<0.0001
		Male	**2.41 (2.12, 2.75)**	
		Other/Prefer Not To Answer	0.73 (0.42, 1.27)	
	Race/Ethnicity	White	Reference	<0.0001
		Black	**0.23 (0.19, 0.27)**	
		Hispanic or Latino	**0.51 (0.39, 0.67)**	
		Asian	0.87 (0.73, 1.04)	
		Multiple/Other	**0.58 (0.47, 0.73)**	
	Education (Less than Bachelor's Degree)	Less than Bachelor's Degree	Reference	<0.0001
		Bachelor's or Master's Degree	**1.84 (1.59, 2.13)**	
		Postgraduate Degree	**4.59 (3.83, 5.50)**	
	Area of Residence	Urban	Reference	<0.0001
		Suburban	**0.71 (0.65, 0.79)**	
		Rural	**0.41 (0.30, 0.54)**	
	Hospital	Hospital A	Reference	0.7282
		Hospital B	0.98 (0.89, 1.08)	
	Years Employed at Hospital	<1 Year	Reference	0.2674
		1 – 4 Years	0.87 (0.73, 1.03)	
		≥5 Years	0.89 (0.74, 1.06)	
Health of Individual	Self-Reported Health Status	Excellent	Reference	0.0003
		Good – Very Good	**0.81 (0.73, 0.90)**	
		Poor - Fair	**0.73 (0.56, 0.95)**	
Vaccination History	Employee	Up-to date on most or all vaccines	Reference	0.0023
		Up-to-date on some vaccines	0.78 (0.54, 1.13)	
		Not up-to-date	**0.36 (0.18, 0.71)**	
		Unsure	**0.56 (0.32, 0.96)**	
Level of Patient Care	Position in the Hospital	Clinical – Direct Contact	Reference	<0.0001
		Some Patient Interaction	1.12 (0.96, 1.31)	
		Non-Clinical – No Patient Interaction	**1.44 (1.29, 1.61)**	
COVID-19 Testing	Prior COVID-19 Test	Yes	Reference	<0.0001
		No	**0.78 (0.71, 0.86)**	
		Unsure	**0.69 (0.50, 0.95)**	

The regression analysis was performed on 10,067 individuals who answered the question about their intention to be vaccinated as well as all included variables.
Due to the limited number of responses, the category "Prefer Not to Answer" was excluded from both the race/ethnicity and age variables and the category "Other" was excluded from the level of patient care variable.
Parameters with a significant odds ratio compared to the reference are in bold.

3.7. Intention to be vaccinated based on employee characteristics

The difference in the intention of employees to be vaccinated was assessed based on their demographics, hospital of employment, self-reported health status, vaccination history (their own and their children's), level of patient care, level of exposure to COVID-19, and history of COVID-19 testing. A summary of the results and their corresponding statistical significance is shown in Table 3.

3.7.1. Demographic characteristics

There was a significant difference in intention to be vaccinated by hospital of employment (61.6% at hospital A and 67.3% at hospital B) and gender (81.7% of males and 60.1% of females). A higher proportion of older compared with younger employees reported they planned to be vaccinated (87.0% for persons ≥65 year of age versus 65.3% in 40–64 year olds and 62.6% in those <40 years of age). Those employed <1 year at the hospital were more likely planning to be vaccinated than those employed 5 or more years (68.1% and 64.5%, respectively). A higher proportion of persons with a postgraduate degree were planning on being vaccinated than persons with a bachelor's or master's degree or those with less than a bachelor's degree (83.2%, 60.7%, and 40.9%, respectively). Persons reporting that they lived in urban or suburban areas indicated they were more likely to be vaccinated than those living in rural areas (64.6% vs 46.0%).

Significant differences in vaccine acceptance also were noted by race/ethnicity. The reported intention to receive a COVID-19 vaccine was 74.1% in Asians, 69.5% in Whites, 54.4% in Hispanics, 29.7% in Blacks, and 58.8% in multiple/other races.

3.7.2. Personal health status/vaccination history

Those who planned to be vaccinated were more likely to report being in excellent health. The intention to be vaccinated was 72.3% among employees who said their health was excellent versus 52.9% among those who said their health was poor or fair.

History of vaccination among the employees and their children was assessed. Employees who reported that they were up-to-date on most or all routinely recommended vaccines for their age were more likely planning to be vaccinated compared with those employees who reported that they were up-to-date on some or no vaccines (64.5%, 55.0%, and 35.5%, respectively). Employees who intended to be vaccinated were also more likely to report having children who were up-to-date on most or all routinely recommended vaccines for their age compared to those who reported their children were up-to-date on some or no vaccines (63.7%, 57.3%, and 26.0%, respectively).

3.7.3. Exposure to COVID-19

Level of exposure to COVID-19 was assessed using three proxy measures – role in the hospital, area of employment within the hospital, and number of confirmed COVID-19 exposures at work,

home, and/or elsewhere. First, clinical roles involving direct patient care (including, but not limited to physicians, nurses, paramedics, phlebotomists, and emergency medical technicians) were compared to those with some patient interaction (such as dieticians, social workers, and environmental services) and nonclinical roles with no direct patient interaction (such as pharmacists, research staff, or administrative staff). Vaccine acceptance was similar for those in hospital roles with direct patient interaction and those in nonclinical roles with no patient interaction (66.0% and 65.6%, respectively), but declined significantly for those with some patient interactions (50.0%). Second, the area of employment within the hospital was assessed with those having a high level of exposure to COVID-19 (including persons working in a COVID-19 unit, emergency room [ER], or intensive care unit [ICU]) compared with persons with a moderate or low level of exposure to COVID-19 in their daily work. The level of exposure to COVID-19 based on area of employment in the hospital played no role in intention to be vaccinated (66.4% of those with high level of exposure, 64.6% with moderate exposure, and 65.7% with low exposure). Third, there were no differences in the proportion of respondents intending to be vaccinated by number of reported exposures to persons with COVID-19 at work, home, or elsewhere (64.4% for those who reported $\geq$5 exposures, 64.1% for those reporting 1–4 exposures, and 64.9% for those who reported no exposures). A lower proportion (61.0%) of those who were unsure of their exposures planned to be vaccinated.

Employees were also asked if they had ever been tested to see if they had an ongoing COVID-19 infection. Those who had been tested for COVID-19 were more likely planning on being vaccinated compared to those who had never been tested (69.4% vs 61.2%, respectively).

3.8. Multiple logistic regression analysis - intention to be vaccinated

Table 4 presents the results of the multiple logistic regression analysis that includes the 11 variables that were found to be significantly associated with employee intention to be vaccinated in univariate analysis (as shown in Table 3). Several demographic characteristics (race/ethnicity, gender, age, education, and area of residence) as well as self-health assessment, vaccination history, level of patient care, and prior COVID-19 testing remained independently associated with an employee's intention to be vaccinated when controlling for all other variables. The likelihood of intending to be vaccinated was lower among Blacks (OR: 0.23, 95% CI 0.19, 0.27), Hispanics (OR: 0.51, 95% CI 0.39, 0.67), and those reporting multiple/other races (OR: 0.58, 95% CI 0.47, 0.73) compared to Whites. The likelihood of intending to be vaccinated was twice as high among males compared to females (OR: 2.41, 95% CI 2.12, 2.75). Adults $\geq$ 65 years of age were 3.5 times more likely planning to be vaccinated compared with those <40 years of age (OR: 3.50, 95% CI 2.50, 4.90). Employees with a postgraduate degree were > 4 times more likely planning to be vaccinated than persons with less than a bachelor's degree (OR: 4.59, 95% CI 3.83, 5.50). The likelihood of intending to be vaccinated was lower among persons in poor or fair health compared with those in excellent health (OR: 0.73, 95% CI 0.56, 0.95). The likelihood of intending to be vaccinated also was lower among those who were not up-to-date on their vaccinations compared with those who were up-to-date on most or all vaccinations (OR: 0.36, 95% CI 0.18, 0.71). Employees who had no direct contact with patients were 1.4 times more likely planning to be vaccinated compared with those with direct patient care (OR: 1.44, 95% CI 1.29, 1.61). Although the univariate analysis (Table 3) found a difference in those planning to be vaccinated by hospital of employment and years of employment, these two variables were no longer significant in the multiple regression analysis.

4. Discussion

In this study, we aimed to understand how hospital employees view a COVID-19 vaccine, especially in light of the rapidity of vaccine development, the ongoing pandemic, and our evolving knowledge about the disease. To the best of our knowledge, this survey of more than 12,000 employees at two hospitals in Philadelphia is the largest study conducted to assess intent to receive a COVID-19 vaccine in healthcare workers to date. Our results demonstrate that while the majority of respondents intend to receive a COVID-19 vaccine, one third are unsure or do not intend to be vaccinated despite their role as hospital employees, including many frontline care providers.

The overall rate of acceptance of a COVID-19 vaccine in our survey was 64%, similar to the results of earlier studies in healthcare personnel. Vaccine acceptance rates were assessed among 829 healthcare staff in Israel, 609 healthcare workers in Los Angeles, and 168 medical students in Southeast Michigan [25–27]. These surveys showed that willingness among health care providers and medical students to receive a COVID-19 vaccine varied widely (61–78%, 32.3%, and 77%, respectively).

In 2019, the World Health Organization identified vaccine hesitancy (defined as the reluctance or refusal to vaccinate despite the availability of vaccines) as one of the top 10 threats to global health [28]. More recently, vaccine hesitancy has been described as one of the biggest challenges in the fight against COVID-19 [25]. The results of this survey suggest that hospital employees share some of the same concerns about COVID-19 vaccines as the general public including their newness and a general lack of knowledge about the vaccines, particularly their safety profiles. The rate (64%) of intention to be vaccinated in this population of healthcare employees was fairly similar to the range of 42–75% reported in other studies in the general population [7–13]. This suggests that a substantial number of healthcare employees, like the general population, may have reservations about a new vaccine. Healthcare professionals, as the first persons to be vaccinated, need to be viewed as vaccine consumers first and then as healthcare professionals and vaccine recommenders. Health care providers will not only need to vaccinate their patients, but vaccinate them with confidence based on personal experience and full knowledge of the risks and benefits of the available vaccines.

We expected that hospital employees with direct patient contact, those working in an area with high exposure to COVID-19 (such as the COVID-19 unit, ER, or ICU), and/or those reporting more confirmed exposures to COVID-19 patients (at work, home, or elsewhere) would be more interested in vaccination in view of their increased exposure to the SARS-CoV-2 virus. While 66% of employees engaged in clinical roles with direct patient contact expressed an intention to be vaccinated, the rate was equally high (65.6%) in employees with nonclinical responsibilities and no patient contact. However, when controlling for other employee characteristics, those with no patient contact were significantly (OR: 1.44, 95% CI 1.29, 1.61) more likely to be planning to be vaccinated compared with those with direct patient contact. This suggests that initial efforts to increase vaccination rates in these two academic hospitals may require more focus on health care personnel with clinical facing roles despite their higher probability of exposure to SARS-CoV-2. An employee's role in the hospital was significantly associated with characteristics such as race/ethnicity and education level (Chi square p values < 0.00001), These associations warrant further examination as they may result in modification of our measured associations between employee role and intention to be vaccinated.

We did not expect to find that intention to be vaccinated would not differ based on the employee's level of exposure to COVID-19

in their work area or number of reported exposures to COVID-19 patients. We also expected that employees working in a hospital treating a significant number of adults with COVID-19 would be more interested in vaccination than those working in a children's hospital with a lower COVID-19 case load, and this is supported by our results. The finding that hospital of employment was not significant in the multiple logistic regression analysis suggests that both the employee demographics and characteristics of the employee's work dictate the intention to be vaccinated and not necessarily the location of employment.

An earlier study in Israel reported that healthcare staff involved in the care of COVID-19 positive patients were more likely to report interest in vaccination, while our study showed little difference in intent to vaccinate among employees working in a COVID-19 unit, the ER or ICU with a high level of exposure to COVID-19 patients compared with those with a low level of exposure to COVID-19 patients [25]. Furthermore, our results suggested no difference in the perceived risk of COVID-19 versus benefit of vaccination between staff with direct patient care and those with no patient interactions or those who reported a higher compared to a lower number of exposures to persons with COVID-19. One possible explanation for these findings is that staff with no direct patient interactions or those with a low risk of exposure to the SARS-CoV-2 virus in both hospitals, although not in direct contact with COVID-19 patients, consider themselves to be at equally high risk of COVID-19 simply because they work in hospitals in a large city with a high COVID-19 attack rate. Another possibility is that persons in nonclinical roles may live in neighborhoods where community exposure is more likely (i.e. crowding, multigenerational homes, or fewer persons working from home). Nonclinical staff could also see themselves as high risk because they may not have access to the same level of personal protective equipment (PPE) as their clinical colleagues, and therefore, could feel less protected against the SARS-CoV-2 virus. Some healthcare workers who have not been exposed or previously infected may feel more confident in and comfortable with PPE and other preventive measures other than a new vaccine. There may also be other factors contributing to risk perception and acceptance of a COVID-19 vaccine that we did not measure in this survey.

Our study showed that of the hospital employees who planned to be vaccinated, nearly four out of five (79%) intended to do so as soon as the vaccine was made available to them. While the remaining employees (21%) planned to wait 3–12 months before being vaccinated, this was considerably lower than the rate reported in the survey of healthcare workers in Los Angeles (conducted almost two months before our survey) in which 66.5% intended to delay vaccination [26]. The rapid desire to be vaccinated in our study only a few months later may be the result of the availability of more clinical data on the vaccines proposed for EUA, more data on the disease and its transmission, and/or the continued surge of COVID-19 across the US.

Intention to receive a COVID-19 vaccine was lower in Black and Hispanic employees in our survey compared to Asians and Whites. These results were not unexpected in view of the lower COVID-19 vaccine acceptance rates reported in Blacks in the general adult population and lower rates of vaccine acceptance for influenza vaccine among Blacks and Hispanics as reported by the CDC in the 2018–19 influenza season [8,9,29]. These results are particularly concerning considering that Blacks and Hispanics/Latinos are disproportionately affected by COVID-19 both in terms of infection rates and mortality [30]. These results highlight the need for educational efforts targeted at addressing prevalent concerns about COVID-19 vaccines among Blacks and Hispanics and using trusted sources to deliver these messages.

We found that the intention to be vaccinated was significantly higher among males than females. A study in healthcare staff in Israel reported a similar finding as did a study of acceptance rates in the general US population [25]. A systematic review and meta-analysis of COVID-19 clinical outcomes found that males constituted a significantly higher proportion of those who had adverse clinical outcomes and died from COVID-19 [31]. The increased morbidity and mortality associated with COVID-19 in males may explain why men in our survey were more likely to accept a COVID-19 vaccine.

Previous vaccine history for either the hospital employee or their children was found to be a good indicator of whether an employee was planning to receive the COVID-19 vaccine. This finding suggests that persons who generally believe in the value of vaccines and/or follow the routine recommendations for vaccination are planning on being vaccinated. Our results are supported by the study in Israel in which the most significant predictor for acceptance of a potential COVID-19 vaccine among healthcare staff was current influenza vaccination [25].

Our survey showed that the intention to be vaccinated was lower among persons whose self-assessment of their health was poor-fair or good-very good compared to those reporting excellent health. These results suggest that additional efforts are needed to better educate employees about their individual risk for COVID-19, especially among those in fair or poor health. It will also be important to assess whether employees believe that their underlying health condition(s) may increase the risk of adverse events after vaccination and to provide appropriate vaccine safety information.

We were encouraged to see that intention to be vaccinated directly correlated with vaccine efficacy. Now that we know that the efficacy of the two vaccines approved for use in the US under an EUA is 94–95%, we are optimistic that vaccine acceptance may be higher than reported here [32,33].

According to the WHO, ‘‘health workers, especially those in communities, remain the most trusted advisor and influencer of vaccination decisions, and they must be supported to provide trusted, credible information on vaccines" [28]. The recommendation of a health care provider is the single most important predictor of vaccination [16–23]. Therefore, vaccine acceptance among health care professionals will be important in establishing confidence in the general public in these new vaccines. Sharing their own vaccination experience is an excellent way for health care providers to encourage their patients to receive a vaccine.

This study has several limitations. With a response rate of ~35%, the results may not be fully representative of the population at the two hospitals and may not be easily extrapolated to other hospital settings. We had no ability to compare the demographics of the survey respondents to the nonrespondents. However, our response rate was within the range (34–56%) of other surveys conducted on this topic [26,27]. In addition, acceptance of COVID-19 vaccines may have changed since this survey was conducted, as more clinical data on vaccine safety and efficacy became available in December 2020, when two COVID-19 vaccines were approved for use in the US under an EUA [32,33]. We also did not explore other factors that could explain some of our results including access to PPE and healthcare-related attitudes, beliefs, and risk perception in this population. Lastly, while our survey reports the intention of healthcare employees to be vaccinated, this may not translate into actual vaccine acceptance.

The strengths of the survey are several fold. To our knowledge, the sample size (more than 12,000 hospital employees) is the largest of any survey conducted in the United States on this topic to date. Inclusion of two hospitals with different patient populations allowed for comparison of responses in different settings. Inclusion of both clinical and nonclinical staff allowed for comparisons based on likely exposure to the SARS-CoV-2 virus.

The prospect for control of the ongoing COVID-19 pandemic can best be addressed through vaccination, and healthcare employees

will be a key priority group for COVID-19 vaccination to ensure that we can maintain a healthy and robust healthcare workforce. Healthcare employees may also play an important role in increasing vaccine acceptance in the community through endorsement of COVID-19 vaccination and the provision of education about COVID-19 vaccine to others. However, even among a group at high risk of exposure, vaccine hesitancy is an important barrier. Our results highlight prevalent concerns that can be addressed as well as beliefs that can be leveraged through educational initiatives about the safety, efficacy, and value of COVID-19 vaccination. In particular, efforts also should be focused on promoting vaccine acceptance across all racial and ethnic groups through tailored strategies that target specific concerns and questions among those who are most hesitant. Only then will we achieve optimal protection for healthcare workers who are critical in this pandemic response, as well as ensure that health care employees can serve as role models for their patients, families and friends and effectively communicate about the value of COVID-19 vaccination.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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