RESEARCH PAPER

Human Vaccines & Immunotherapeutics 11:3, 704–712; March 2015; © 2015 Taylor & Francis Group, LLC

Factors affecting uptake of recommended immunizations among health care workers in South Australia

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Keywords: healthcare workers, hospitals, influenza, pertussis, vaccination

Abbreviations: HCW, health care worker; MMR, Measles Mumps Rubella; HUW, high uptake ward; LUW, low uptake ward

Despite the benefits of vaccination for health care workers (HCWs), uptake of recommended vaccinations is low, particularly for seasonal influenza and pertussis. In addition, there is variation in uptake within hospitals. While all vaccinations recommended for HCWs are important, vaccination against influenza and pertussis are particularly imperative, given HCWs are at risk of occupationally acquired influenza and pertussis, and may be asymptomatic, acting as a reservoir to vulnerable patients in their care. This study aimed to determine predictors of uptake of these vaccinations and explore the reasons for variation in uptake by HCWs working in different hospital wards. HCWs from wards with high and low influenza vaccine uptake in a tertiary pediatric and obstetric hospital completed a questionnaire to assess knowledge of HCW recommended immunizations. Multiple logistic regression was used to determine predictors of influenza and pertussis vaccination uptake. Of 92 HCWs who responded, 9.8% were able to identify correctly the vaccines recommended for HCWs. Overall 80% of respondents reported they had previously received influenza vaccine and 50.5% had received pertussis vaccine. Independent predictors of pertussis vaccination included length of time employed in health sector ($P < 0.001$), previously receiving hepatitis B/MMR (measles, mumps, rubella) vaccine ($P < 0.001$), and a respondent being aware influenza infections could be severe in infants ($p = 0.023$). Independent predictors of seasonal influenza vaccination included younger age ($P < 0.001$), English as first language ($P < 0.001$), considering it important to be vaccinated to protect themselves ($P < 0.001$), protect patients ($p = 0.012$) or awareness influenza could be serious in immunocompromised patients ($p = 0.030$). Independent predictors for receiving both influenza and pertussis vaccinations included younger age ($P < 0.001$), time in area of work ($P = 0.020$), previously receiving hepatitis B vaccine ($P = 0.006$) and awareness influenza could be severe in infants ($P < 0.001$). A knowledge gap exists around HCW awareness of vaccination recommendations. Assessment of the risk/benefit value for HCWs and their patients, determines uptake of HCW immunization programs and should be considered in promotional HCW vaccination programs.

Introduction

The benefits of health care worker (HCW) vaccination are well documented.[1-7] Despite this, HCW uptake of recommended vaccines is low[2,8-16], particularly for seasonal influenza and pertussis.[13,16-19] In Australia, both pertussis and seasonal influenza vaccines are recommended for all HCWs[17] however providing free influenza vaccine is a policy decision for each hospital or state and is not uniform across Australia.[20]

Influenza virus infection causes a wide spectrum of disease, from no or minimal symptoms, to respiratory illness with systemic features, and/or multisystem complications and death from primary viral or secondary bacterial pneumonia.[17] Most severe influenza cases and deaths occur among people with chronic medical conditions, in infants and young children, the elderly and pregnant women.[2] HCWs are exposed to patients with influenza in the workplace and are at risk of occupationally acquired influenza and transmission of infection to patients and other HCWs.[2]

Bordetella pertussis is a highly contagious bacterium causing respiratory illness that may result in significant morbidity including pneumonia, convulsions, apnoea, encephalopathy, acute respiratory distress and in death[21], with infants aged less than 6 months of age having the highest rate of pertussis related

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Submitted: 09/25/2014; Revised: 12/02/2014; Accepted: 12/16/2014
http://dx.doi.org/10.1080/21645515.2015.1008886

complications.[22] HCWs have a higher risk of exposure to pertussis due to occupational contact and may be asymptomatic, acting as a reservoir to vulnerable patients in their care.[23-25] With low uptake of pertussis vaccine among HCWs[13,18,26] nosocomial outbreaks have been reported.[4,27-31]

In the workplace environment, it is plausible that vaccination recommendations and practices for some vaccinations may influence the uptake of other vaccines. In addition, if there exists a culture of poor support from management and peers and there is misinformation about official recommendations and vaccination benefits, then it may be difficult for staff to seek out this preventative health measure. The influence that family and friends can have new parents vaccinating their baby it is well documented. Equally, HCWs are likely to be effected by those around them when making decisions related to vaccinations, particularly when their co-workers are also recommended to receive them.

No studies have explored differential uptake within the same occupational category, with little documented about staff attitudes and behavior toward seasonal influenza vaccination within the ward culture.

At one metropolitan pediatric hospital, we identified that despite access to the same seasonal influenza vaccination program, differential uptake between hospital wards exists.

The aims of this study were to: examine reasons for differential uptake of the influenza and pertussis vaccines by HCWs working in different hospital wards and describe and explore motivators and barriers to uptake of the seasonal influenza vaccine by HCWs. A secondary outcome was to explore the relationship between uptake of seasonal influenza vaccination and uptake of pertussis vaccination by HCWs.

Results

Survey population

At the time of the survey the hospital's Workforce Reporting & Analysis Directorate estimated that approximately 196 full or part-time staff worked on the 3 high uptake wards (HUW) and approximately 227 staff worked on the 3 low uptake wards (LUW). We were unable to provide a breakdown of the male/female staff ratios for these wards as we do not have access to demographic data for all ward staff, only those who completed the survey. Ninety-four (94) hard copy questionnaires were returned. We are unaware of how many staff knew about the survey or how many took a survey and didn't return it. No respondents selected to complete the survey online. Data were excluded from 2 respondents; one a nursing student who had not previously worked at the hospital and another had completed only demographic questions. There was an even distribution of respondents by age. The majority of respondents were female (94.6%), worked part-time (63%) or full time (35.9%), from Australia (80.4%) and spoke English as their first language (92.4%) (**Table 1**). A higher proportion of respondents were from HUWs (59.8%) than LUWs (40.2%) however this difference was not significant (Pearson's Chi-Square 1.840 $p = 0.060$).

Knowledge and understanding of workplace vaccinations

The majority (95.5%) of HCWs were aware there are vaccines recommended specifically for HCWs, however only 9.8% ($n = 9$) could correctly identify them (**Table 2**) and while more respondents from HUWs (10.9%) were able to identify all of them than LUWs (8.1%) this was not significant (Fisher's Exact Test $p = 0.736$). In terms of vaccination history, only 16.5% of respondents reported having ever received all HCW recommended vaccines (MMR, pertussis, influenza, hepatitis B and varicella) with more respondents from HUWs (20%) receiving them than LUWs (11.1%) (**Table 3**) however this was not significant (Fisher's Exact Test $p = 0.388$). There were no significant differences between the proportions of HCWs from HUWs compared to LUWs in terms of identifying vaccines recommended specifically for HCWs or having received any of the recommended vaccines using Fisher's Exact Test.

HCWs reported continuing to work despite having symptoms suggestive of influenza and pertussis such as sore throat (75.8%), rhinorrhoea (69.2%), generalized aches and pains (51.6%), persistent cough (30.8%) and fever (20.9%).

The reasons HCWs receive the influenza vaccine was dominated by self-protection (75.6%), followed by protection of patients (47.4%) and protecting their family (19.2%) (**Fig. 1**). This was in contrast to reasons HCWs considered vaccines in general to be important in which 47.6% of respondents were motivated by self-protection, followed by protection of patients (25.6%) and preventing spread of infection, (25.6%). Concern about potential side effects, prevented 15.2% of respondents from receiving vaccines, with an allergic reaction being the greatest concern for this group of respondents (50.0%) followed by muscle aches and pains (42.9%) soreness at injection site (35.7%), high fever (35.7%) or getting the disease (35.7%), red arm (14.3%) and fainting (7.1%).

Hospital influenza immunization program

All respondents were aware of the hospital's annual influenza vaccination program, with 92.4% reporting they had ever received the seasonal influenza vaccine through the program. A greater proportion of HCWs from HUWs (94.5%) reported that they had ever received the seasonal influenza vaccine through the program than LUWs (89.2%) however this was not significant (Fisher's Exact Test $p = 0.433$). HCWs were aware of the program through promotional materials (33.8%), ward or department communications (23.1%), mobile influenza vaccine trolley (18.5%) and immunization nurse visits (16.9%). A smaller number found out through other HCWs (12.3%) with 9.2% reporting the program was 'common knowledge'.

Overall of those who had ever participated in the hospital influenza immunization program ($n = 85$), 81.0% reported they did so annually. More respondents from HUWs (82.4%) reported receiving the vaccine annually than LUWs (78.8%) however this was not significant (Fisher's Exact Test $p = 0.778$) A small number (8.6%, $n = 7$) reported issues accessing the program. Issues included not having time to leave the ward for vaccination once they had missed the 'flu trolley' and clinics not being available when they worked i.e. night duty/weekends. The

Table 1. Demographic details of participants

Variable	Levels	Number of respondents	Percent %
Age Group (years)	21–30	28	30.4%
	31–40	26	28.3%
	41–50	22	23.9%
	>50	16	17.4%
Sex	Male	5	5.4%
	Female	87	94.6%
Work Status	Full time	33	35.9%
	Part time	58	63.0%
	Casual	1	1.1%
Country of birth	Australia	74	80.4%
	United Kingdom	9	9.8%
	other EU countries	5	5.4%
	Asia	2	2.2%
	Refused	1	1.1%
	Africa	1	1.1%
First language is English	No	7	7.6%
	Yes	85	92.4%
Highest educational qualification obtained	Certificate/Diploma	12	13.2%
	High school certificate or less	3	3.3%
	Bachelor	54	59.3%
	Post Grad certificate/Diploma	18	19.8%
	PhD	1	1.1%
	Other*	3	3.3%
Category of Health Care Worker	Nurse	75	81.5%
	Admin Staff	3	3.3%
	Doctor	1	1.1%
	Allied Health	2	2.2%
	Other (not specified)	5	5.4%
	Midwife	6	6.5%
Time working in health sector	< 12 months	5	5.4%
	1–5 years	23	25.0%
	6–10 years	15	16.3%
	11–15 years	14	15.2%
	16+ years	35	38.0%
Time working in area / ward	< 12 months	13	14.3%
	1–5 years	30	33.0%
	6–10 years	19	20.9%
	11–15 years	8	8.8%
	16+ years	21	23.1%
Hours per week in area/ward	<15 hours	1	1.1%
	15–30 hours	33	35.9%
	30+hours	58	63.0%
High or Low uptake ward of seasonal influenza vaccine in 2012	High uptake ward	55	59.8%
	Low uptake ward	37	40.2%

*College membership =1, Hospital based nurse/midwife training = 1, Masters =1.

majority of respondents (82.1%, n = 69) reported their supervisor being supportive of them leaving their areas to receive the vaccine, others did not feel supported (3.6%, n = 3) or this was not applicable for them (13.1%, n = 11).

85% of HCWs preferred receiving the influenza vaccine at the workplace, 4.5% preferred their family doctor while 5.6% had no preference or did not want to receive it (4.5%). The greatest influence on their preference was convenience (84.2%).

Uptake of recommended vaccines

Differences between high and low uptake wards

The association between working on a HUW/LUW and pertussis and influenza vaccinations was investigated using logistic regression. 'Ever having received pertussis vaccine' versus work area showed no significant association (OR 1.8 (CI 0.77, 4.2); p = 0.172). Similarly, there was no significant association for 'received influenza vaccine in the last year' vs. ward area (OR 2.2 (CI 0.77, 6.30); (p = 0.137) or between 'ever having received pertussis vaccine and received influenza vaccine in the last year' versus ward area (OR 2.11 (CI 0.87, 5.13); (p = 0.099).

Pertussis

Only 55.4% of respondents knew that the pertussis vaccine was recommended for HCWs, with less (50.5%) stating they had received the vaccine. A high proportion (45.6%) of HCWs had looked after a child with complications from pertussis,

Table 2. Knowledge of recommended health care worker vaccines

Could you please list vaccines you think are recommended for health care workers?	Overall		High uptake wards		Low uptake wards	
	Number	Percent %	Number	Percent %	Number	Percent%
Listed all recommended (MMR, Pertussis, Influenza, Hep B & Varicella)	9	9.8%	6	10.9	3	8.1
Diptheria	10	10.9%	8	14.5%	2	5.4%
Tetanus	22	23.9%	17	30.9%	5	13.5%
Pertussis	51	55.4%	34	61.8%	17	45.9%
measles-mumps-rubella	28	30.4%	20	36.4%	8	21.6%
Measles	1	1.1%	1	1.8%	0	0.0%
Mumps	1	1.1%	1	1.8%	0	0.0%
Rubella	2	2.2%	1	1.8%	1	2.7%
Influenza	79	85.9%	45	81.8%	34	91.9%
Polio	2	2.2%	2	3.6%	0	0.0%
Hepatitis B	60	65.2%	35	63.6%	25	67.6%
Hepatitis A	19	20.7%	15	27.3%	4	10.8%
Hepatitis (not specified)	5	5.4%	4	7.3%	1	2.7%
Tuberculosis	13	14.1%	9	16.4%	4	10.8%
Varicella	19	20.7%	13	23.6%	6	16.2%
Other[a]	10	10.9%	8	14.5%	2	5.4%

[a]Other included vaccines and comments: H1N1 n = 1, 'All childhood vaccines/diseases' n = 2, 'Flu A' n = 1, 'Swine flu' n = 1, 'Hep C' n = 2, 'and they should include Hep A' n = 1, 'free immunology, TB test' n = 1.

with a similar proportion (47.6%) thinking the pertussis vaccine was one of the most important vaccines for HCWs to receive. Only 33.0% thought they were at risk of contracting pertussis.

In terms of disease severity, 96.7% thought that pertussis infection in infants <6 months of age could be severe/very severe, 91.2% thought that pertussis was contagious/very contagious and while 96.7% felt it important/ very important to receive the pertussis vaccine to protect their patients, less (82.4%) thought it was important/very important to receive the pertussis vaccine to protect themselves. Most (88.0%) HCWs strongly agreed that a HCW working in a hospital has an obligation to be vaccinated against pertussis.

Predictors associated with pertussis vaccination

Independent predictors of having ever received a pertussis vaccine included ever having received hepatitis B or MMR vaccine and understanding that influenza could be severe in infants (**Table 4a**). While a HCWs length of time in the health sector was also significantly associated with pertussis vaccination (global $P < 0.001$), no pair-wise comparisons were significant (**Table 4a**).

Seasonal influenza

Despite 85.9% knowing that the seasonal influenza vaccine was recommended, only 80% of HCWs stated they had received it in the last 12 months (n = 72) with 95.6% ever previously receiving it, either as part of the hospital's seasonal influenza

Table 3. Health care worker vaccination history

Which of the following vaccinations have you ever received (either at this workplace or elsewhere)?	Overall		High uptake wards		Low uptake wards		
		Number[a]	Percent %	Number	Percent %	Number[a]	Percent %
Had received all recommended vaccines (MMR, Pertussis, Influenza, Hepatitis B &Varicella)	15	16.5%	11	20.0%	4	11.1%	
HepB	60	65.9%	39	70.9%	21	58.3%	
Pertussis	46	50.5%	31	56.4%	15	41.7%	
Varicella	22	24.2%	16	29.1%	6	16.7%	
BCG	15	16.5%	10	18.2%	5	13.9%	
Influenza	87	95.6%	53	96.4%	34	94.4%	
MMR	36	39.6%	24	43.6%	12	33.3%	
HepA	27	29.7%	14	25.5%	13	36.1%	
Tetanus	4	4.4%	4	7.3%	0	0.0%	
Typhoid	5	5.5%	4	7.3%	1	2.7%	
Other[b]	4	4.4%	4	4.4%	0	0.0%	

[a]Missing data n = 1 (one respondent provided no response).
[b]Other: Diphtheria n = 1, Small pox n = 2, Cholera n = 1, Yellow fever n = 1, whatever was required to commence working' n = 1.

program or elsewhere. The majority (80.7%) thought they were at risk of contracting influenza with 60.7% thinking it was an important vaccine for HCWs to receive. 72.2% of HCWs had looked after a patient with complications from influenza.

Overall 90.0% thought it was important to receive the influenza vaccine to protect patients. In terms of specific patients, 100% thought influenza could be severe/very severe in immunocompromised patients, with less (96.7%) thinking influenza in infants could be severe/very severe and 92.1% thought influenza in pregnant women could be severe/very severe. 79.4 % of HCWs strongly agreed that HCWs working in a hospital have an obligation to be vaccinated against seasonal influenza.

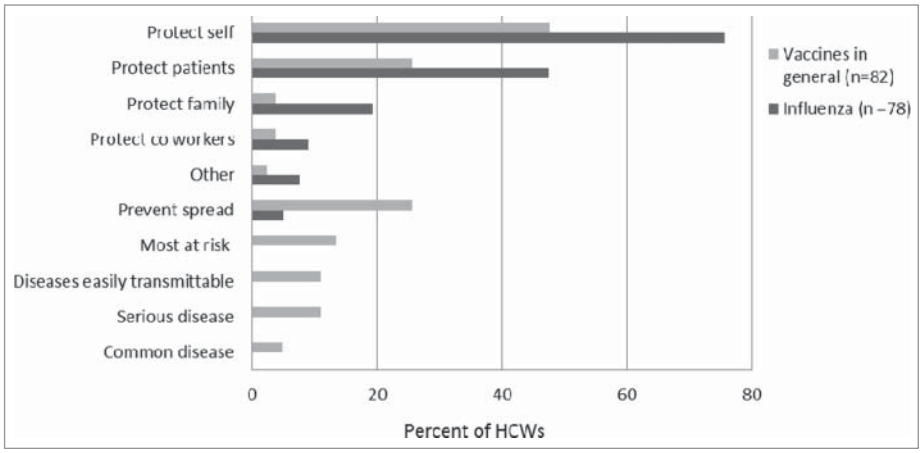

Figure 1. Reasons Health Care Workers receive vaccinations.

Predictors associated with seasonal influenza vaccination

Independent predictors of seasonal influenza vaccine included younger age, English as a first language, believing it was important to be vaccinated to protect themselves, believing it was important to be vaccinated to protect patients, and being aware influenza could be serious in immunocompromised patients (**Table 4b**). While ever having received the influenza vaccine at the hospital was significant at the univariate level ($p = 0.007$) it was not retained in the final model.

Predictors of receiving both the pertussis vaccine and seasonal influenza vaccine

A multiple logistic regression model was developed to determine predictors of receiving both pertussis and influenza vaccine,

Table 4a. Logistic Generalized Estimating Equation for ever had pertussis vaccination versus multiple predictors/confounders, accounting for clustering on ward

		Univariate Model		Multivariate Model	
Variable	**Level**	**Odds Ratio (95% CI)**	**Stepdown Bonferroni P value**	**Adjusted Odds Ratio (95% CI)**	**Global P value**
Age	31–40	0.60 (0.44, 0.82)	0.005		
	41–50	0.54 (0.28, 1.04)			
	>50	0.50 (0.25, 1.03)			
	21–30	1.0			
Highest Education Level	Bachelor vs Diploma or less	2.97 (1.87, 4.71)	<0.001		
	Bachelor	1.65 (1.01, 2.69)			
	Diploma or less	0.56 (0.26, 1.17)			
	Postgraduate	1.0			
Length of time in health sector	<12 months	2.25 (0.47, 10.67)	<0.001	2.75 (0.59, 12.80)	<0.001
	1–5 years	1.50 (0.51, 4.45)		3.35 (0.51, 21.99)	
	6–10 years	2.25 (1.43, 3.54)		0.92 (0.41, 2.08)	
	11–15 years	2.70 (1.11, 6.57)		1.37 (0.52, 3.62)	
	16+ years	1.0		1.0	
Length of time in area of work	<12 months	3.66 (1.28, 10.46)	<0.001		
	1–5 years	1.32 (0.55, 3.19)			
	6–10 years	1.81 (1.16, 2.81)			
	11–15 years	2.71 (0.56, 13.02)			
	16+ years	1.0			
Received Hepatitis B vaccine	Yes	11.22 (5.23, 24.07)	<0.001	18.16 (3.38, 97.47)	<0.001
	No	1.0		1.0	
Received MMR vaccine	Yes	12.19 (4.48, 33.18)	0.001	9.35 (4.14, 21.13)	<0.001
	No	1.0	-	1.0	
Received Hepatitis A vaccine	Yes	5.46 (2.77, 10.77)	<0.001		
	No	1.0	-		
How severe do you think influenza infections in infants can be?	For every 1 point increase in severity	1.36 (1.18, 1.57)	0.002	1.63 (1.07, 2.49)	0.023

Table 4b. Logistic Generalized Estimating Equation for had influenza vaccination in past year vs. multiple predictors/confounders, accounting for clustering on ward

		Univariate Model		Multivariate Model	
Variable	**Level**	**Odds Ratio (95% CI)**	**Stepdown Bonferroni P value**	**Odds Ratio (95% CI)**	**Global P value**
Age group	31–40	0.28 (0.14, 0.55)	<0.001	0.12 (0.04, 0.37)	<0.001
	41–50	0.43 (0.10, 1.87)		0.26 (0.04, 1.90)	
	>50	0.81 (0.21, 3.20)		0.38 (0.07, 1.99)	
	21–30	1.0		1.0	
English as first language	English first language	6.57 (2.82, 15.33)	0.002	5.29 (1.90, 14.71)	0.002
	English not first language	1.0			
Aware pertussis was a recommended vaccine for health care workers	Yes	1.75 (1.33, 2.31)	0.008		
	No	1.0			
How important do you think it is to receive the influenza vaccine annually to protect yourself?	Important	6.40 (3.79, 10.80)	<.001	3.36 (2.04, 5.54)	<0.001
	Not important	1.0		1.0	
How severe do you think influenza infections in immunocompromised patients can be?	For every 1 point increase in severity	1.89 (1.45, 2.46)	0.003	1.62 (1.05, 2.51)	0.030
How important do you think it is to receive the influenza vaccine to protect patients?	For every 1 point increase in severity	1.48 (1.20, 1.82)	0.026	1.29 (1.06, 1.58)	0.012
Ever received the flu vaccine at this hospital	Yes	6.57 (2.80, 15.43)	0.007		
	No	1.0			

with younger age, receiving the hepatitis B vaccine and thinking influenza could be severe in infants being independent predictors. A HCW's length of time in the health sector was also significantly associated with receiving both the pertussis vaccine and seasonal influenza vaccine (global p = 0.019), no pair-wise comparisons were significant (**Table 4c**).

Discussion

HCWs had limited awareness of recommendations and only a minority were fully immunized according to HCW recommendations. Our findings are similar to that of a 2002 study that found only 18% of HCWs at a Victorian hospital were fully vaccinated.[14] A recent review in Australia found rates of HCW seasonal influenza vaccine coverage to be between 16.3% and 58.7%.[19]

Our finding that 80.0% of respondents had received the influenza vaccine in the last year, with 95.6% having ever received it is higher than expected compared with the overall hospital uptake, suggesting that respondents were likely to be favorable to vaccination. This may have biased our results, as non-immunizers may have been less inclined to complete the questionnaire.

In terms of having had the influenza vaccination in the past year, the finding that younger HCWs were significantly more

Table 4c. Logistic Generalized Estimating Equation for ever had pertussis and had influenza vaccination in past year versus multiple predictors/confounders, accounting for clustering on ward

		Univariate Model		Multivariate Model	
Variable	**Level**	**Odds Ratio (95% CI)**	**Stepdown Bonferroni P value**	**Odds Ratio (95% CI)**	**Global P value**
Age group	31–40 years	0.38 (0.22, 0.64)	0.030	0.32 (0.18, 0.58)	<0.001
	41–50 years	0.46 (0.13, 1.61)		0.40 (0.03, 4.94)	
	>50 years	0.48 (0.20, 1.15)		0.47 (0.06, 3.74)	
	21–30 years	1.0		1.0	
Length of time in area of work	<12 months	3.20 (0.90, 11.32)	<0.001	4.03 (0.37, 43.81)	0.020
	1–5 years	1.11 (0.34, 3.59)		2.15 (0.37, 12.40)	
	6–10 years	1.45 (0.65, 3.27)		2.25 (0.21, 24.20)	
	11–15 years	1.20 (0.28, 5.19)		1.81 (0.38, 8.52)	
	16+ years	1.0		1.0	
Received Hepatitis B vaccine	Yes	6.16 (2.65, 14.32)	0.003	9.70 (1.92, 48.91)	0.006
	No	1.0		1.0	
How severe do you think influenza infections in infants can be?	For every 1 point increase in severity	1.83 (1.59, 2.10)	<0.001	2.23 (1.44, 3.46)	<0.001

likely to have received the influenza vaccine may be explained by more junior staff receiving pre-employment screening as they enter the workforce. This finding differs from a meta-analysis by Riphagen-Dalhuisen[32] who found age (>40 years) to be a significant predictor. Higher rates of influenza vaccination usually occur in older individuals as they become more at risk of influenza complications through age and chronic disease onset. The fact that English as a first language was also a significant predictor reveals that language is an important barrier even for HCWs. We were unable to determine whether this barrier is associated with a lack of knowledge of the recommendations or awareness of the hospital seasonal influenza program and/or access to it. Other Australian studies[33-35] have reported previous receipt of the influenza vaccine to be associated with vaccination or intention to be vaccinated.

While responses to questions about disease severity indicated awareness, questions about motivation would indicate self-protection to be a strong cue to action. A review[36] examining attitudes and predictors for accepting or rejecting vaccination in HCWs found a wide range of misconceptions or lack of knowledge about influenza infection and a lack of convenient access to the vaccine. The majority of reviewed studies reported self-protection to be the most important reason for vaccination. In terms of influenza, as expected, HCW self-protection was a highly significant predictor of vaccination for seasonal influenza, which other studies[37-38] have noted. Our finding for support for the obligation to be vaccinated against influenza (79.4%) is higher than that reported by Seale[39] who found only 46.8% of respondents in a survey of two tertiary hospitals in Sydney supported a policy of compulsory influenza vaccination for HCWs. This was despite 91.3% of HCWs at these hospitals strongly supporting a policy of compulsory vaccination for other vaccines recommended for HCWs that was introduced in NSW in 2007.[39] Believing it was important to be vaccinated to protect patients and that influenza could be serious in immunocompromised patients, were also associated with higher uptake and are similar to findings reported by Riphagen-Dalhuisen [32] who found being willing to protect oneself or protect at-risk patients to be associated with uptake. Our results suggest for influenza vaccine, an understanding of the benefit of patient protection may be a key motivator for HCWs. However, this could also be explained by the high proportion of survey respondents who were vaccinated for influenza relative to the hospital HCW population.

Only 50.5% of respondents had received the pertussis vaccine which is concerning but is higher than in a recent national survey of French HCWs showing coverage to be only 11.4%.[26] Our study showed that to receive the pertussis vaccine, acceptance of the receipt of other recommended vaccines for HCWs (hepatitis B and MMR) is important. The underlying reasons for the finding that pertussis immunization is low in a highly vaccinated group requires further investigation. However, it is likely either to be explained by low awareness of adult pertussis vaccination or poor recall of vaccination history. Our positive correlation that receipt of pertussis vaccine was associated with being aware that influenza infections could be severe in infants was unexpected and warrants further investigation.

In terms of following recommendations and receiving both the pertussis and influenza vaccines, the finding that younger HCWs and HCWs who had received the hepatitis B vaccine more likely to have received both vaccines may indicate that processes such as pre-employment screening and acceptance of the other recommended vaccines for HCWs is important. However, this may also be explained by the fact that younger healthcare workers are more likely to have received the hepatitis B vaccine prior to clinical placements while in university.

Overall HCW awareness of recommended vaccines was low. Vaccine prevention measures are not reviewed systematically for individual HCWs and educational provision to HCWs does not appear to be consistent. The use of a structured process such as using HCWs' required annual registration renewal may be one way to increase awareness of the recommendations and facilitate HCWs to act. The fact that many HCWs reported they came to work exhibiting symptoms suggestive of influenza is concerning. This is similar to findings of Peadon's study that found 85% of HCW who had experienced a cough lasting 2 or more weeks had continued to work.[40] Further research to identify the motivators for working against hospital policies in this context is a priority.

The strengths of this study include the chance for HCWs to provide anonymous responses to a detailed questionnaire on topics for which they may have strong opinions or feel they know little about without recourse from peers.

The study results are limited by the number of responses and confinement of the study population to a pediatric and obstetric hospital, although the views and values in relation to vaccination may be similar across hospitals both adult and pediatric. As this was a cross-sectional study, results are limited in time. Also, participation required awareness of the survey on the ward and the majority of respondents were nurses (81.5%) with only 1 doctor responding. In addition, the disproportionately higher number of females reflects the fact that the majority of respondents were nursing staff, which is a predominantly female industry.

Respondents were self-selected; while the incentive used may have helped some to participate it is possible that the majority of respondents may be inherently different from non-respondents. It is also possible that responses were confounded by a HCW's prior experiences and knowledge. We also relied on self-reported vaccination history and HCWs may not have completed the survey independently, but collaborated with colleagues.

Our findings suggest a knowledge gap exists particularly around awareness of vaccination recommendations for HCWs. HCWs assessment of the risk/benefit value for themselves and their patients, appears to be an important factor in determining uptake of HCW vaccination and should be considered in promotional programs. Further studies are required that capture 'non-vaccinators' to fully explore the barriers identified and factors related to uptake of the recommended vaccinations for HCWs.

Methods

Study design

This cross-sectional study was performed between July and December 2013 at a tertiary pediatric and obstetric hospital in Adelaide, Australia, with over 5,000 births per year. There are 17 wards at the hospital, 11 pediatric and 6 obstetric wards. The hospital is the leading provider of specialist care for children with acute and chronic conditions in South Australia, as well as the State's largest maternity and obstetric service. In 2011/12, there were 45,000 Pediatric Emergency Department presentations and over 5,000 births. The hospital's 2013 influenza program included a 2 month period of access to an immunization nurse stationed at the hospital cafeteria, a mobile "flu trolley" visiting wards and a clinical practice consultant available to provide vaccinations as required. There were no outbreaks of influenza or pertussis on the wards during the time of the questionnaire.

Survey questionnaire

Questions were designed to assess participants' immunization history and knowledge associated with recommended HCW immunizations, risks of not being immunized for pertussis and influenza, acceptance of the hospital's seasonal influenza vaccination program and to identify facilitators and barriers to uptake. A scale of 1-10 was used to assess participants' beliefs about how severe pertussis and influenza could be in infants, with 1 being not severe and 10 being severe. The questionnaire was only available in English.

Participant recruitment

To ensure a broad representation of HCW views on immunization, the 3 highest uptake wards and 3 lowest uptake wards were selected based on an average of the last 3 years uptake in the staff seasonal influenza vaccination program. Three wards had the most consistently high and low uptake. The three highest wards were >73% (73%, 74% and 74%) and 3 lowest wards were below 53 %(32%, 52% and 53%) in the 2012 staff seasonal influenza vaccination program. Study data were collected through a paper based questionnaire, left on wards for respondents to anonymously complete with the option to complete the questionnaire on-line. To encourage participation, an incentive draw was provided for each ward, with one person from each ward randomly selected to receive a $50 voucher.

Statistical analyses

Logistic regression was used to examine the association between work area (low vs. high influenza vaccine uptake wards based on influenza vaccine uptake in the previous year (2012) and pertussis and influenza vaccinations. Univariate analysis identified potential variables to be included in a multivariate analysis in which logistic regression was used. Multivariable analysis was used to develop 3 models associated with HCW vaccination; (1) ever having received a pertussis vaccine, (2) receiving the seasonal influenza vaccination in the past year and (3) ever having received a pertussis vaccination and receiving an influenza vaccine within the past year to determine predictor variables. A logistic generalized estimating equation was used, taking into account clustering on work area. Stepdown Bonferroni P values were calculated to adjust for multiple comparisons. Variables were included in the initial model and were removed one by one from the model starting with the highest P-value, until only variables with P-values of <0.05 remained. Associations between variables and outcomes are reported as odds ratio's with 95% confidence intervals. Statistical analyses were performed using SPSS version 21 (Armonk, NY: IBM Corp) and SAS Version 9.3 (SAS Institute Inc., Cary, NC, USA).

The study protocol was reviewed and approved by the Women's and Children's Health Network, Human Research Ethics Committee, Adelaide, South Australia.

Disclosure of Potential Conflicts of Interest

HM is an investigator on vaccine studies sponsored by Industry. Her institution has received grants from GSK, Sanofi Pasteur, Pfizer for investigator led research. HM has not received any personal payments from industry. The other remaining authors report no conflicts of interest. Some of the data contained in this manuscript was presented in a poster at the Public Health Association of Australia 14th National Immunization Conference, 17–19 June 2012 in Melbourne, Australia.

Acknowledgments

We thank and acknowledge the statistical support from Susanne Edwards of the Data Management and Analysis Center, University of Adelaide.

Funding

This study was supported financially by GlaxoSmithKline (GSK). Helen Marshall is a recipient of an NHMRC Career Development Fellowship (1016272).

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