Web exclusive

Who knows more about immunization?

Survey of public health nurses and physicians

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Abstract

Objective To report the findings of a knowledge survey of nurse and physician immunization providers.

Design Cross-sectional postal survey assessing demographic characteristics and vaccine knowledge.

Setting British Columbia (BC).

Participants Nurse and physician immunization providers in BC.

Main outcome measures Knowledge of vaccine-preventable diseases, vaccines in general, and vaccine administration and handling practices.

Results Survey responses were received from 256 nurses and 292 physicians (response rates of 48.6% and 18.3%, respectively). Most nurses (98.4%) reported receiving immunization training outside of the academic setting compared with 55.6% of physicians. Overall, nurse immunizers scored significantly higher than physician immunizers on all 3 domains of immunization knowledge (83.7% vs 72.8%, respectively; $P<.001$). Physicians scored highest on the vaccine-preventable disease domain and least well on the general vaccine domain. Nurses with more experience as health care providers scored higher. Physicians scored higher if they were female, served patient populations predominantly younger than 5 years, or received immunization training outside of academic settings.

Conclusion In BC, nurse immunizers appear to have higher overall immunization knowledge than physicians and are more likely to receive immunization training when in practice. Physician immunizers might benefit most from further training on vaccines and vaccine administration and handling.

EDITOR'S KEY POINTS

- Nurses on average scored significantly higher than doctors in all 3 domains of immunization knowledge (ie, vaccine-preventable diseases, vaccines, and vaccine administration and handling practices).
- More physicians than nurses reported receiving education about immunization provision during their academic studies (51.2% and 43.7%, respectively), but nurses were more likely than physicians to report receiving immunization training outside of the academic setting (98.4% and 55.6%, respectively).
- Improving the immunization knowledge of health care professionals and their patients might alter attitudes and subjective norms and thus increase the uptake of immunization by both health care professionals and their patients.

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Exclusivement sur le web

Qui connaît le mieux la vaccination?

Enquête auprès d'infirmières et de médecins

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Résumé

Objectif Présenter les résultats d'une enquête portant sur les connaissances des infirmières et des médecins qui font de la vaccination.

Type d'étude Enquête postale transversale évaluant les caractéristiques démographiques des sujets et leurs connaissances sur la vaccination.

Contexte La Colombie-Britannique (C.-B.).

Participants Infirmières et médecins qui font de la vaccination en C.-B.

Paramètres à l'étude Connaissance des maladies que la vaccination peut prévenir, des vaccins en général et de leurs modes d'administration et de manipulation.

Résultats Un total de 256 infirmières et de 292 médecins ont répondu à l'enquête (taux de réponse respectifs de 48,6 % et 18,3 %). La plupart des infirmières (98,4 %) mentionnaient avoir reçu une formation en immunisation en-dehors du contexte académique, contre 55,6 % des médecins. Dans l'ensemble, les infirmières vaccinant avaient des scores significativement supérieurs à ceux des médecins, et ce, dans les 3 domaines de connaissance étudiés (83,7 % vs 72,8 %, respectivement; $P<,001$). Les médecins obtenaient leurs meilleurs scores dans le domaine des maladies pouvant être prévenues par la vaccination et leurs moins bons dans celui des vaccins en général. Les infirmières qui avaient plus d'expérience comme soignantes avaient des scores plus élevés. Parmi les médecins, ceux qui avaient des meilleurs scores étaient des femmes, vaccinaient principalement une clientèle de moins de 5 ans ou avaient reçu une formation sur la vaccination en-dehors du contexte académique.

Conclusion En C.-B., les infirmières qui vaccinent semblent avoir une meilleure connaissance globale de la vaccination que les médecins; elles sont aussi plus susceptibles de recevoir une formation sur ce sujet une fois en pratique. Les médecins qui vaccinent pourraient surtout bénéficier d'une formation supplémentaire sur les vaccins et sur leur mode d'administration et de manipulation.

POINTS DE REPÈRE DU RÉDACTEUR

- Les infirmières avaient des scores significativement plus élevés que les médecins pour chacun des 3 domaines de connaissance sur la vaccination (c.-à-d. les maladies que la vaccination peur prévenir, les vaccins et leur mode d'administration et de manipulation).
- Plus de médecins que d'infirmiers disaient avoir reçu une formation sur la vaccination durant leurs études universitaires (51,2 % et 43,7 %, respectivement) alors que les infirmières étaient plus susceptibles que les médecins de recevoir des formations sur la vaccination en-dehors du contexte académique (98,4 % et 55,6 %, respectivement).
- Le fait d'améliorer les connaissances des soignants et des patients sur la vaccination pourrait modifier les attitudes et les opinions au sujet de la vaccination et ainsi augmenter le taux de vaccination, tant chez les soignants que chez leurs patients.

Cet article a fait l'objet d'une révision par des pairs.
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Immunization is an effective public health intervention that is responsible for the control of life-threatening infectious diseases and prevention of more than 2 million deaths worldwide each year.[1] However, the general population receives conflicting information about the importance and safety of immunizations from a variety of sources including health care professionals (HCPs) and the media.[2,3]

Recommendations from HCPs can influence the behaviour of their patient populations. Several studies suggest that a strong recommendation from an HCP to receive immunization is among the most important determinants of immunization behaviour.[4-6] Conversely, poor communication of key information about vaccines might result in missed vaccination opportunities.[7-9] In addition, HCPs with lower levels of immunization knowledge are less likely to receive immunization themselves.[10]

In British Columbia (BC), the 2 main groups of immunization providers (IPs) are public health nurses and physicians (family physicians and pediatricians). The experience of IPs in the provision of immunizations, independent of vocation, is intuitively a positive predictor of immunization knowledge. Indeed, several studies have found a positive relationship between HCP age and uptake of personal influenza vaccination (odds ratios 1.07 to 2.8).[11-17]

Improving the immunization knowledge of HCPs and their patients might alter attitudes and subjective norms and thus increase the uptake of immunization by both HCPs and their patients. The literature identifying factors that influence immunization knowledge is limited and inconsistent. Recent studies suggest that physicians might have better vaccine knowledge than nurses and that this accounts for relatively higher rates of physicians receiving vaccinations.[18-20] Another recent study suggests that differences in vaccine knowledge of nurses depends on their work setting.[21]

This study seeks to elucidate immunization knowledge by type of IP and knowledge domains in order to identify where additional immunization training could be beneficial.

METHODS

Design

A postal survey of all identified IPs in BC was conducted from April to June 2005. The survey recipients received 1 of 2 surveys that elicited either immunization knowledge, or attitudes, beliefs, and reported practice. The findings of the attitudes, beliefs, and reported practices survey have been previously published.[22]

A questionnaire was administered to 125 IPs (nurses and physicians) from across Canada to identify their perceptions of the important areas of immunization knowledge. We identified 3 key domains: vaccine-preventable diseases (VPD), vaccines (VAC), and vaccine administration and handling practices (VAH). Vaccine administration and handling practices included vaccine risk communication, vaccine contraindications and adverse event reporting, vaccine administration, and vaccine handling. The survey instrument was developed to target knowledge in these 3 domains and was further validated and refined through field testing.

The final survey included 2 main sections: participant demographic and practice characteristics; and knowledge items. Participant characteristics included age, sex, ethnicity, immunization provision setting (primary setting, community size, patient population younger than 5 years of age), experience (years as an HCP, years providing immunization, previous immunization training during academic education, and receiving immunization training outside of an academic setting), and sources of information often used. The VPD section had 30 questions, the VAC section had 34, and the VAH section had 59. All questions had true or false responses.

Sample

Nurses were identified as IPs through the health units of BC. All health units provided a nonnominal count of regular nursing staff that provided immunizations. Each health unit received a letter informing them about the study, followed 2 weeks later by a package of the study materials including a sealed envelope for each IP nurse containing an introduction letter, the survey, and an addressed, stamped envelope.

Physicians specializing in family practice, general practice, and pediatrics were identified through the College of Physicians and Surgeons of British Columbia directory service. Each identified physician received information through a newsletter followed by an envelope containing study materials similar to those received by each nurse. A return slip was included in the physician envelope to decline participation and to identify nonimmunizers.

Analytic strategy

Incomplete surveys were defined as surveys missing 50% or more of the responses in any knowledge domain or 20% or more of the overall knowledge test. Incomplete surveys were not included in the analysis. Missing responses in the completed surveys were treated as incorrect responses.

Frequencies and means were used to describe categorical and continuous variables, respectively, and χ^2 and Mann-Whitney *U* tests were used to compare nurses and physicians where appropriate. Repeated-measures ANOVA (analysis of variance) was used to compare performance between sections of the knowledge survey

for both physicians and nurses. Violation of sphericity was corrected using the Greenhouse-Geisser estimates of sphericity. Multivariate linear regression was conducted separately for nurses and physicians to identify predictors of overall performance on the immunization knowledge survey. To ensure each knowledge domain received equal weighting, the proportion of correct responses for each section was averaged to obtain the overall score then multiplied by 100 for each respondent. Independent variables were included in the multivariate model if they had a significance level of $P<.10$ in bivariate linear regression. Age, years as an HCP, and years performing immunizations were highly correlated (Spearman's correlation >0.70); therefore, only years as an HCP was included in the multivariate model. Model diagnostics were examined to ensure that both multiple linear regression models met the assumptions of linearity, normality, and heteroscedasticity. An α level of .05 was used to determine statistical significance. All analyses were performed using SPSS, version 14.0.

This study was approved by the University of British Columbia behavioural research ethics board.

RESULTS

As shown in **Figure 1**, of 2364 deliverable surveys, 527 were delivered to nurses at public health units and 256 (48.6%) were returned. A total of 1837 were delivered to physicians' offices: 238 physicians reported not providing immunizations and 292 (18.3%) of 1599 potentially immunizing physician surveys were returned.

Several significant differences in demographic characteristics between the 2 groups were noted. The nurses were generally younger, with more than 7 times as many individuals aged 21 to 30 years compared with physicians, and were more likely to be white (**Table 1**). Most nurses (98.8%) were female compared with 50.2% of physicians ($P<.01$).

The immunization provision settings for nurse and physician IPs differed; most nurses reported the main setting to be the public health unit and physicians reported it to be private practice, which reflects immunization provision in BC (**Table 1**). In addition, more nurse IPs reported servicing smaller communities: more than 60% of physicians were in a community with a population greater than 100 000 compared with less than one-third of the nurses. Finally, nurses were more likely to provide immunizations to populations with a greater proportion of individuals younger than 5 years of age relative to physicians.

Although nurse and physician IPs in our sample spent a similar number of years as HCPs, nurse IPs had significantly fewer years of experience providing immunizations (**Table 1**; $P<.01$). More physicians than nurses reported receiving education about providing immunizations during their academic studies (51.2% and 43.7%, respectively), but nurses were more likely to report receiving immunization training outside of the academic setting (98.4% of nurses and 55.6% of physicians).

The 2 sources of immunization information most often used by nurses and physicians in BC were the Canadian or BC immunization manuals or guides (62.1% of nurses and 34.4% of physicians) and their local health departments (21.6% of nurses and 37.2% of physicians) (**Table 2**).

On average, nurses scored significantly higher in all 3 domains of immunization knowledge (**Table 3**; $P=.01$ to $P<.001$). Both nurse ($F_{1,7437}=11.6$, $P<.001$) and physician ($F_{1,6397}=133.2$, $P<.001$) IPs in BC exhibited significant differences in the 3 key domains of the immunization knowledge survey. Post hoc analyses of repeated-measures ANOVA revealed that nurse IPs performed

Figure 1. Solicitation and enrolment of survey participants

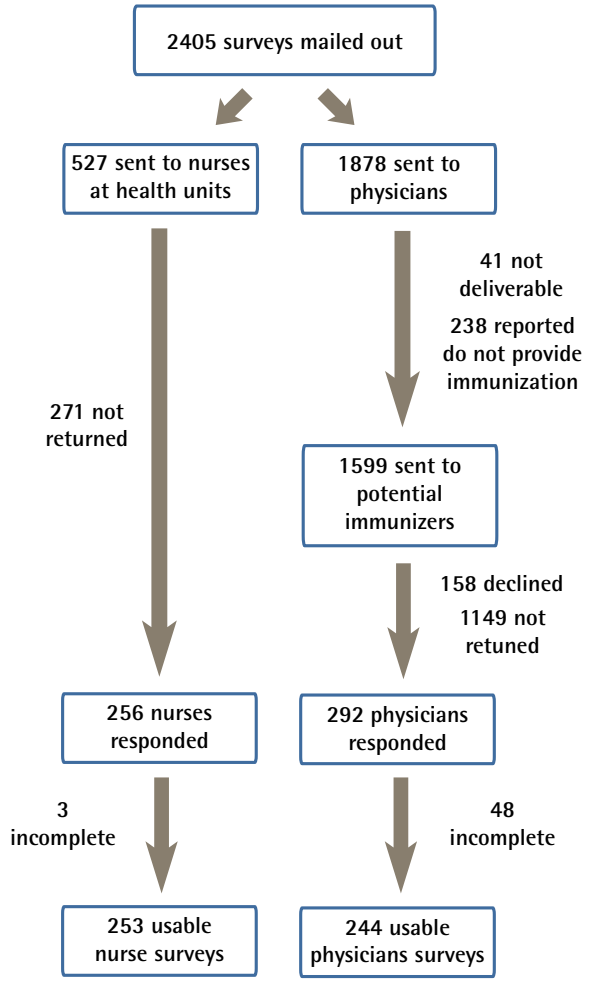

Table 1. Characteristics of nurse and physician immunization providers in British Columbia

CHARACTERISTIC	NURSES* (N = 253)	PHYSICIANS* (N = 244)	*P* VALUE†
Age, y, n (%)			< .01
• 21-30	38 (15.0)	5 (2.1)	
• 31-40	54 (21.3)	55 (22.6)	
• 41-50	94 (37.2)	91 (37.4)	
• 51-60	60 (23.7)	70 (28.8)	
• ≥ 61	7 (2.8)	22 (9.1)	
Sex, n (%)			< .01
• Male	3 (1.2)	121 (49.8)	
• Female	250 (98.8)	122 (50.2)	
Ethnicity, n (%)			< .01
• White	232 (92.1)	183 (75.3)	
• Chinese	4 (1.6)	42 (17.3)	
• South Asian	5 (2.0)	11 (4.5)	
• Aboriginal	3 (1.2)	0 (0)	
• Mixed or other	8 (3.2)	7 (2.9)	
Community size, n (%)			< .01
• > 5000	31 (12.7)	16 (6.7)	
• 5001-10 000	21 (8.6)	6 (2.5)	
• 10 001-30 000	35 (14.3)	28 (11.7)	
• 30 001-50 000	31 (12.7)	10 (4.2)	
• 50 001-100 000	47 (19.2)	30 (12.5)	
• > 100 000	80 (32.7)	150 (62.5)	
Proportion of patient population younger than 5 y, n (%)			< .01
• 0-10	69 (32.1)	146 (61.1)	
• 11-25	63 (29.3)	72 (30.1)	
• 26-50	16 (7.4)	10 (4.2)	
• 51-75	38 (17.7)	7 (2.9)	
• 76-100	29 (13.5)	4 (1.7)	
Primary setting of immunization provision, n (%)			NA
• Hospital	0 (0)	11 (4.5)	
• Private practice	0 (0)	176 (72.4)	
• Public health unit	222 (88.1)	2 (0.8)	
• Walk-in clinic	0 (0)	17 (7.0)	
• Other or mixed	30 (11.9)	37 (15.2)	
Years as health care provider, mean (SD)	18.5 (10.8)	19.8 (10.0)	.26
Years providing immunization, mean (SD)	11.4 (8.9)	17.9 (9.9)	< .01
Received education on immunization provision during academic studies, n (%)			< .01
• Yes	108 (43.7)	124 (51.2)	
• No	76 (30.8)	32 (13.2)	
• Do not remember	63 (25.5)	86 (35.5)	
Received training on immunization provision outside of academic studies (eg, conference workshops, in-servicing, orientation, etc), n (%)			< .01
• Yes	247 (98.4)	135 (55.6)	
• No	4 (1.6)	89 (36.6)	
• Do not remember	0 (0)	19 (7.8)	

NA—not applicable.
*Numbers might not add to total because of missing data.
†Categorical comparisons were made with χ^2 tests; comparisons of continuous data were made with Mann-Whitney *U* tests.

significantly better on the VAH section than the VPD ($P<.001$) or VAC ($P=.016$) sections of the immunization knowledge survey. Physician IPs scored highest on the VPD section and lowest on the VAC section. All comparisons between domains within the group of physician IPs were statistically significant ($P<.001$).

All relevant demographic and immunization provision characteristics were considered for inclusion in the multivariate model. For nurses, the variables of community size, patient population younger than 5 years of age, primary setting of immunization provision, and years of experience as an HCP met the inclusion criteria. Because more than 95% of nurses were female and received training on immunization provision outside of academic settings, neither variable was included in the model. Results from the multivariate model can be found in **Table 4**. Nurses with more years as HCPs scored higher on overall knowledge. Nurses practising in communities with 10 000 to 30 000 people also scored higher than nurses practising in communities with fewer than 5000 people.

For physicians, the variables of sex, patient population younger than 5 years of age, and whether they received training outside of academic settings met the inclusion criteria (**Table 5**). Female physicians, those who received training outside of academic settings, and those with patients younger than 5 years of age accounting for more than 50% of their patient population had higher overall knowledge scores.

Table 2. Source of immunization information most often used by nurse and physician immunization providers in British Columbia

SOURCE	NURSES, N (%)	PHYSICIANS, N (%)
Canadian or British Columbia immunization manuals or guides	144 (62.1)	62 (34.4)
Local health department	50 (21.6)	67 (37.2)
Public Health Agency of Canada	7 (3.0)	15 (8.3)
Colleagues	13 (5.6)	5 (2.8)
Medical organization	1 (0.4)	12 (6.7)
Internet	1 (0.4)	6 (3.3)
Continuing medical education	0 (0)	5 (2.8)
Journals	0 (0)	2 (1.1)
Multiple sources	16 (6.9)	6 (3.3)

DISCUSSION

Our study is unique in that it assessed 3 domains of immunization knowledge and compared these domains within and between IP disciplines. We found nurse IPs

Table 4. Multiple regression analyses of overall immunization knowledge of nurses: $R^2=0.130$.

VARIABLE	COEFFICIENT	SE	*P* VALUE
Community size			
• > 5000	Reference		
• 5001-10 000	2.68	2.16	.217
• 10 001-30 000	4.38	1.83	.017
• 30 001-50 000	2.64	1.90	.165
• 50 001-100 000	2.69	1.76	.128
• > 100 000	1.58	1.53	.303
Proportion of patient population younger than 5 y			
• 0-10	Reference		
• 11-25	0.68	1.23	.581
• 26-50	0.58	2.08	.780
• 51-75	1.33	1.47	.364
• 76-100	-2.85	1.66	.087
Primary setting of immunization provision			
• Public health unit	Reference		
• Other	-2.86	1.59	.073
• Years as health care provider	0.17	0.05	< .001

SE—standard error.

Table 3. Results from the knowledge test by profession

KNOWLEDGE SECTIONS (MAXIMUM SCORE)	NURSES		PHYSICIANS		*P* VALUE*
	MEAN (SD) NO. CORRECT	MEAN (SD) PROPORTION CORRECT OUT OF 100	MEAN (SD) NO. CORRECT	MEAN (SD) PROPORTION CORRECT OUT OF 100	
Vaccine-preventable diseases (30)	24.6 (3.1)	82.0 (10.2)	24.0 (2.5)	80.1 (8.3)	.01
Vaccines (24)	20.0 (3.2)	83.5 (13.3)	15.7 (3.6)	65.4 (15.1)	< .001
Vaccine administration and handling (59)	50.5 (4.2)	85.6 (7.1)	43.0 (4.7)	72.9 (7.9)	< .001
Total (113)	95.1 (8.1)	84.2 (7.2)	82.8 (7.7)	73.2 (6.8)	< .001
Average score of each section	NA	83.7 (7.9)	NA	72.8 (7.4)	< .001

NA—not applicable.
*Comparisons were made with Mann-Whitney *U* tests.

Table 5. Multiple regression analyses for overall immunization knowledge of physicians: $R^2 = 0.106$.

VARIABLE	COEFFICIENT	SE	*P* VALUE
Sex			
• Male	Reference		
• Female	2.71	0.95	.005
Proportion of patient population younger than 5 y			
• 0–10	Reference		
• 11–25	0.88	1.06	.405
• 26–50	-0.69	2.34	.768
• 51–75	7.76	2.74	.005
• 76–100	6.85	3.59	.058
Received training on immunization provision outside of academic studies			
• No or do not remember	Reference		
• Yes	2.11	0.92	.023

SE—standard error.

performed better than physician IPs in every domain. This is contrary to several recent studies suggesting that physicians have better vaccine knowledge than nurses.[18-20] However, the study by Esposito et al employed a questionnaire that placed a greater emphasis on general medical knowledge than the practical aspects of immunization provision that our survey addressed.[19] In fact, we found less disparity between the physician and nurse IP results in the VPD domain. Wicker and Rose focused on pertussis immunization knowledge,[20] which might not be generalizable to knowledge of all immunizations, which is what we examined in our study.

Nearly all nurse IP respondents reported immunization training in practice. In contrast, many physician IPs reported not receiving immunization training in practice; of note, we found physicians without training had significantly lower overall immunization knowledge. Public health authorities might offer regular immunization in-services to their public health nursing staff. Immunization courses are widely available and many are offered online. They can be taken as part of mandatory immunization competency for nurses and continuing medical education requirements for physicians.[23-26]

Physicians scored lower on the VAC and VAH domains; these are important issues, as physicians store the vaccines in their offices and administer them to their patients. Physicians should be encouraged to participate in immunization education that includes these perspectives.

Surveys can obtain cross-sectional data from a wide geographic area with relative ease; however, generalizability of results might be limited by the response rate. Although use of the College of Physicians and Surgeons of British Columbia directory service to contact the physicians ensured anonymity, it precluded sending nonresponders reminders, some of whom might not provide immunization to their patients. The poor response rate of the physician sample has the potential for response bias and lack of generalizability.

The response rate for our knowledge survey was lower than the survey of attitudes, beliefs, and reported practices that was administered to nurses and physicians simultaneously (48.6% vs 67% for nurses and 18.3% vs 22% for physicians).[22] Although the surveys had similar numbers of questions, the knowledge survey might have a higher perceived response burden, as participants were required to recall facts rather than report attitudes and beliefs.

We cannot determine why the nurses scored higher than the physicians. Nurse knowledge might be higher and reflect their participation in training; in fact, we found physicians who had additional non-academic training had higher knowledge scores. However, we cannot determine if nurses were more thorough or used resources to answer the knowledge questions. More physician IPs returned incomplete surveys but this could be owing to their lack of knowledge or the inability to spend sufficient time answering the survey. We recommend future studies record the time taken to complete the survey and either determine if resources are used or request that participants not use resources.

We were unable to identify an existing knowledge survey; therefore, we developed and field-tested our instrument with input from nurse and physician IPs. Therefore, the survey has face validity, although the construct validity of each item has not been rigorously tested.

Both multiple regression models had a significant F statistic but a low R^2 value, indicating that other variables not measured by the survey might play a role in predicting knowledge score.

Conclusion

British Columbia nurse IPs scored higher on overall immunization knowledge than physicians and were more likely to have received immunization training when in practice. Physician IPs' knowledge might be improved by further training, especially about vaccines in general, and their administration and handling.

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Contributors
All authors contributed to the concept and design of the study; data gathering, analysis, and interpretation; and preparing the manuscript for submission.

Competing interests
None declared

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