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Factors Affecting Pharmacist-Administered Vaccine Injection and Adherence Rates in Canada

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ABSTRACT

Public health legislation that has increasingly enabled pharmacist administration of influenza vaccine in Canadian provinces has paralleled increases in the percentage of the public receiving the vaccination since the 2105/16 influenza season. Pharmacists now administer more influenza vaccine injections than any other health professional. This study was conducted to determine provincial legislation and public funding criteria that could similarly increase level of population immunization through percentage of vaccines administered by pharmacists for five multi-dose vaccines. A second objective was to compare follow-up injection adherence rates for pharmacist-administered vaccines versus those administered by doctors or other healthcare professionals. Results of this retrospective data analysis of 351,852 patients across Canada suggest that immunization and adherence rates of pharmacist-administered vaccines is positively associated with increasing levels of enabling legislation, public health coverage and prescribing rights of pharmacists such as that found in the province of Alberta.

Keywords: Pharmacist, Immunization, Vaccine, Adherence, Public health

INTRODUCTION

Although the scope of pharmacy practice in Canada has evolved significantly over the past number of years, it has done so in different manners and at varying rates across the provinces and territories. As of January 2021, pharmacists in all jurisdictions in Canada except the Northwest Territories and Nunavut possess varying levels of immunization and injection prescribing and administration authority [1]. As of September 2019, pharmacists in all of the provinces with injection authority were permitted to administer influenza vaccine that is reimbursed by public health programs for the total population and/or for high-risk groups and/or to members of the provincial drug reimbursement plan [2].

Four provinces (Alberta, New Brunswick, Nova Scotia and Prince Edward Island) have granted prescribing authority for specific vaccines according to province for pharmacists with appropriate training [3]. During the 2015/16 influenza season, pharmacists in all provinces except Quebec had authority to provide influenza injections, and since that time the number of pharmacist-administered injections in every province with pharmacist injection authority has continued to rise each year. As a result, in the 2018-2019 influenza season pharmacies became the number one provider of influenza vaccines in Canada, providing 34% of influenza injections *vs* 30% for physician offices [4]. Importantly, the percentage of the Canadian population receiving influenza vaccine has improved in tandem with increases in pharmacist-administered influenza vaccine [5]. Pharmacist scope of practice to include delivery and/or prescribing immunizations other than influenza vaccine varies widely across the provinces, as does public health funding to pay for the vaccines and/or pharmacist injection services and pharmacist prescribing privileges [6]. Some of the vaccines that pharmacists are permitted to administer require more than one dose to be fully effective.

With the knowledge that pharmacist administration of a publicly funded vaccine increases immunization rates among the public, we sought to determine the effect of pharmacist scope of practice, level of public funding and pharmacist prescribing rights on uptake of pharmacist services for administration of five multi-dose vaccines (Engerix B®, Gardasil®, Havrix®, Shingrix®, Twinrix®). A second objective was to compare the subsequent dosing adherence rates of the multi-dose vaccines for those first injected by pharmacists *vs* those first injected by doctors or other healthcare providers (doctors/other HCPs).

MATERIALS AND METHODS

We designed a nationwide retrospective database analysis of aggregate vaccine dispensing and injection service billing from all Shoppers Drug Mart pharmacy locations across Canada. Shoppers Drug Mart represents the Canadian retail pharmacy market well, as it exceeds 20% of the Canadian retail pharmacy market share. Ethics board approval was obtained, and through the use of a data extraction agent, prescription and service claim data from all provinces (Excluding

Quebec) was extracted and transferred to a Microsoft Excel® sheet for patients who received any of the five studied multi-dose vaccines between April 2017 and April 2018. As consent could not be obtained for all 429,785 patients, tight measures were taken to ensure that blinding occurred. Each patient name was replaced with a unique, randomly assigned patient ID number during data extraction process, and the data was provided to researchers with only the ID number and patient demographics to identify individual patient regimens. Raw data was kept confidential and securely shared only with those participating in the data analytics process [7].

Vaccines included in the study were Engerix-B® and Engerix-B® Paediatric for hepatitis B, Gardasil® for HPV, Havrix® for hepatitis A, Shingrix for herpes zoster and the Twinrix® and Twinrix® junior vaccines for combined hepatitis A and B protection. Data was extracted for 429,785 patients. One excel row was obtained for each anonymous patient number with the gender and age of the patient when the first vaccine was dispensed, the name of the vaccine dispensed, the pharmacy number dispensing the medication, the relative population of the pharmacy area (urban, rural or suburban), and the dispensing and in-pharmacy injection history. When filled, the vaccines dispense dates and fill quantity for the first fill, second fill, and third fill were provided. A date was also provided for any injection if the patient file had been billed an injection fee within 3 weeks of the dispense date of the corresponding injection. The dates for the first, second and third injection where applicable were provided. As a result, a key assumption for the study was that any injection service provided within 3 weeks of the vaccine dispense date was assumed to be for the corresponding studied dispensed vaccine, and not for another vaccine around the same time period.

If the patient file was not billed an injection fee within 3 weeks of the corresponding vaccine dispense date, the patient was assumed to have picked up the medication at the pharmacy and had it administered by a different HCP. The identity of the prescriber (pharmacist or other) was also documented for each vaccine dispensed, though since this study included provinces in which the pharmacist does not have the authority to prescribe vaccines, this information was not analysed. For patients who received a regimen of four injections of one vaccine (only applicable for Twinrix®, with a rapid administration schedule available), adherence was based on billing of an injection fee within 3 weeks of the dispense date, regardless of whether or not the dispense date was within the usual administration window.

In order to limit parental influence on adherence, patients 18 years and under were excluded from the analysis, as well as any patients receiving paediatric versions of the vaccines studied, regardless of age. Once exclusions were taken into account, 351,852 patients were included in the overall analysis.

For the data analysis, a new column was added to the excel file in which each patient's regimen was assigned a 2-letter code for 2 injection vaccine regimens, or a 3-letter code for 3 injection vaccine regimens to enable assessment of adherence. The 3 letters used were "D" for "doctor or other HCP", "P" for "Pharmacist" and "I" for "Incomplete" (i.e., injection completed by doctor or other HCP, pharmacist, or injection not provided and therefore regimen incomplete). If a dispense date was provided within 3 weeks of the usual administration window but no injection fee was billed, a "D" was coded for a vaccine injected by a doctor/other HCP. If a dispense date was provided within 3 weeks of the usual administration window and a pharmacist injection service fee was also billed within that time, a "P" was coded. If the vaccine was not dispensed within the usual administration window, implying the vaccination regimen was incomplete; an "I" was coded. Therefore, for example, if a patient was dispensed and was administered 2 out of 3 vaccine doses from their pharmacist, but did not have the third dose dispensed, this row was coded "PPI".

The tableau© data visualization and analytics tool with data algorithms was then used to reorganize the data according to the codes. The data was analyzed in two phases. In the first phase, to achieve the objective of quantifying overall vaccine adherence rates, these codes were organized according to the vaccine received the province, and the completion rate (either receiving 1, 2 vaccines).

In the second phase, in order to compare percentage of vaccines administered by pharmacists or doctors/other HCPs and adherence rates according to administration by pharmacists or doctors/other HCPs, only those patients who stayed with the same provider for administration of their vaccines were included, regardless of whether or not the regimen was completed. Patients with both a "D" and "P" in their regimen code, which were very low in number, were therefore excluded from the analysis [8].

The adherence rate for each province, vaccine and chosen HCP (i.e., pharmacist or doctor/other HCP) was cumulated to determine a total adherence rate according to administration by pharmacists or other HCPs across the country and according to province.

RESULTS

Patient demographics and numbers of vaccine injections received according to specific vaccines are summarized in Table 1. Most of the injections dispensed in the Shoppers Drug Mart locations were for the Twinrix® vaccine, of which three times as many vaccines (122,894) were dispensed than the least dispensed vaccine, Engerix B® (36,131). The mean age of individuals receiving one of the immunizations varied by vaccine from a minimum of 31 years for Gardasil 9 to a maximum of 65 years for Shingrix. Females and males represented 59% and 41% of patients respectively. The majority of prescriptions were filled at locations coded as "Suburban" which is representative of the locations of the majority of Shoppers Drug Mart locations (Table 1).

Tables 2 and 3 show the percentage of injections provided by a doctor/other HCP or a pharmacist for each of the initial or follow-up injections of vaccines included in the study. Although the majority of first injections were administered by doctors/other HCPs overall, percentage administered by doctors/other HCPs *vs* pharmacists varied by vaccine and by province (Table 2). Of the vaccines studied, Alberta pharmacists provided the highest percentage of injections overall (73.2%) *vs* doctors/other HCPs compared to the pharmacists of other provinces, followed by British Columbia (49.2%). Shingrix was administered more often by pharmacists than the other vaccines included in the study (Table 3). This was a generally consistent finding for all of the provinces where pharmacists provided Shingrix immunization [9].

Table 4 shows a comparison of first injection rates and adherence rates of pharmacist injection providers *vs* doctors/other HCPs in each province. It also provides provincial comparisons of scope of practice, level of public health coverage/pharmacist reimbursement for providing injections, level of prescribing rights for qualified pharmacists and year of first vaccination authority. Compared to other provinces, Alberta leads in all categories except in number of immunizations permitted to administer, since most provinces are able to administer the majority of vaccines available. In 2006, Alberta's pharmacists became the first pharmacists in the country to provide vaccinations.

Adherence rates to follow-up vaccinations were generally not good for all of the vaccines administered. Adherence rate percentages of vaccines administered by doctors/other HCPs *vs* pharmacists varied according to province, with patients receiving vaccines from Alberta pharmacists receiving their first and second follow-up injections 12% more often than patient receiving vaccines from doctors/other HCPs.

Demographics	Havrix® 1440	Shingrix	Engerix B®	Gardasil 9®	Twinrix®	All Vaccines
All patients						
Vaccine	51,931	83,914	36,131	44,209	122,894	339,079
Age						
19-28	21,730	76	8,560	22,018	19,267	71,651
29-38	12,790	203	7,828	13,400	23,956	58,177
39-48	6,762	776	7,400	6,165	28,460	49,563
49-58	5,544	22,170	6,275	1,991	27,063	63,043
59-64	2,432	19,594	2,786	394	12,066	37,272
65+	2,562	41,015	3,196	187	11,887	58,847
Unknown Age	111	80	86	54	195	526
Average Age	36	65	42	31	45	-
Gender						
Male	21,014	36,750	14,263	9,794	56,492	138,313
Female	30,842	47,104	21,809	34,370	66,274	200,399
Unknown	75	60	59	45	128	367
Urban-rural breakdown						
Urban	-	-	-	-	-	45,403
Rural	-	-	-	-	-	50,526
Suburban	-	-	-	-	-	255,923

Table 1: Demographics of study population.

Prov	Havrix (hepatitis A)				Engerix (hepatitis B)				Twinrix (hepatitis A and B)			
	HCP	First	Inj1	Adh1	First	Inj1	Adh1	Adh2	First	Inj1	Adh1	Adh2
AB	D	3348	36.00%	12%	1709	23.60%	24%	11%	1709	23.60%	24%	11%
	P	6673	64.00%	17%	5519	76.40%	32%	16%	5519	76.40%	32%	16%
BC	D	4686	56.10%	16%	2523	70.40%	35%	17%	2523	70.40%	35%	17%
	P	3661	43.90%	12%	1063	29.60%	35%	17%	1063	29.60%	35%	17%
MB	D	1233	77.10%	15%	636	78.80%	39%	20%	636	78.80%	39%	20%
	P	367	22.90%	18%	171	21.20%	33%	17%	171	21.20%	33%	17%
NB	D	1057	60.40%	29%	704	70.60%	25%	11%	704	70.60%	25%	11%
	P	694	39.60%	17%	293	29.40%	31%	15%	293	29.40%	31%	15%
NL	D	503	85.10%	21%	175	88.40%	46%	27%	175	88.40%	46%	27%
	P	88	14.90%	10%	23	11.60%	35%	17%	23	11.60%	35%	17%
NS	D	716	53.00%	16%	381	66.50%	26%	17%	381	66.50%	26%	17%
	P	635	47.00%	18%	192	33.50%	32%	17%	192	33.50%	32%	17%
ON	D	24356	94.00%	22%	21911	97.60%	39%	19%	21911	97.60%	39%	19%
	P	1564	6.00%	11%	530	2.40%	28%	10%	530	2.40%	28%	10%
SK	D	1190	95.20%	18%	290	96.30%	38%	0%	290	96.30%	38%	0%
	P	69	4.80%	6%	11	3.70%	9%	0%	11	3.70%	9%	0%
Canada	D	37089	73.00%	20%	28329	78.40%	37%	18%	28329	78.40%	37%	18%
	P	13751	27.00%	15%	7802	21.60%	32%	16%	7802	21.60%	32%	16%

Abbrevations: Prov: Province; HCP: Health Care Professional; Inj: Injection; Adh: Adherence; D: Doctor; P: Pharmacist; AB: Alberta; BC: British Columbia; MB: Manitoba; NB: New Brunswick; NL: Newfoundland; NS: Nova Scotia; ON: Ontario; SK: Saskatchewan

Table 2: Immunization rates for vaccines against hepatitis A and/or hepatitis B.

Prov	HCP	Gardasil (Human papilloma virus)				Shingrix (shingles)		
		First	Inj1	Adh1	Adh2	First	Inj1	Adh1
AB	D	1606	25.20%	49%	30%	1697	15.50%	29.50%
	P	4765	74.80%	64%	40%	9247	84.50%	45.20%
BC	D	2179	47.60%	50%	29%	4164	36.30%	36.30%
	P	2394	52.40%	51%	26%	7638	64.70%	46.10%
MB	D	543	64.60%	59%	37%	559	34.90%	29.90%
	P	298	35.40%	58%	34%	1042	65.10%	44.60%
NB	D	376	61.90%	57%	34%	531	30.50%	36.20%
	P	231	38.10%	57%	31%	1210	69.50%	42.10%
NL	D	63	82.90%	56%	25%	0	0	n/a
	P	13	17.10%	15%	0%	0	0	n/a
NS	D	403	54.70%	50%	28%	1103	45.30%	41.30%
	P	334	45.30%	51%	22%	1332	54.70%	41.80%
ON	D	27229	89.90%	62%	38%	38584	77.40%	38.90%
	P	3073	10.10%	53%	22%	11259	22.60%	36.10%
SK	D	611	87.30%	58%	31%	1162	63.30%	43.10%
	P	89	12.70%	27%	6%	673	36.70%	38.20%
Canada	D	33010	74.70%	60%	37%	47800	59.60%	38.30%
	P	11197	25.30%	57%	31%	32401	40.40%	41.80%
Abbrevations: Prov: Province; HCP: Health Care Professional; Inj: Injection; Adh: Adherence; D: Doctor								

Table 3: Immunization rates for vaccines against HPV or shingles.

Province	Number immunizations permitted to administer	Public health coverage / Pharmacist reimbursement	Prescribing rights	First injection rate (RPh)	Adherence rate *vs* other providers
AB	+++	+++	+++	73.20%	+12%
BC	+++	++	-	49.30%	+6%
NB	+++	-	++	44.60%	+3%
NS	+++	-	++	44.90%	-1%
MB	+++	+	-	38.20%	+8%
SK	+++	-	-	14.10%	-6%
NL	+++	-	-	13.80%	-7%
ON	++	-	-	10.70%	-3%
Note: +++: Highest level among provinces; ++: Second highest level among provinces; +: Third highest level among province; - Does not exist in province					

Table 4: Comparison of provincial factors affecting first injection and adherence rates for multi-dose vaccines administered by pharmacists *vs.* other providers.

As shown in Tables 2 and 3, adherence rate comparisons of vaccines administered by pharmacists *vs* those administered by doctors/other HCPs varied among provinces [10].

DISCUSSION

Immunize Canada states that "immunization against disease has likely saved more lives in the past 50 years than any other medical intervention" [7]. However, with issues such as anti-vaccine sentiment, apathy and lack of awareness, Canada is still not reaching immunization goals set by the Public Health Agency of Canada [5]. It is apparent that strategies to improve immunization uptake by patients includes evidence-based public education, immunization awareness campaigns and facilitated access to vaccines [5]. As the most accessible health care professional and a trusted health information resource, pharmacists have the potential to be of great value in all of these areas [3]. Recent history of the influence of pharmacist involvement in increasing influenza immunization uptake by Canadians helps to provide important perspective with respect to this potential [4].

As legislation enabling pharmacists to inject influenza vaccine, and public health coverage for the cost of administration of the vaccine has increased across Canada's provinces, so have the number of Canadians immunized against influenza [4]. During the 2017/18 flu season, the percentage of Canadians receiving their influenza vaccine in pharmacies exceeded those receiving the vaccine in physician's offices for the first time [4]. Based on information gleaned from patient surveys, preference for pharmacist-administered influenza vaccination is associated with convenience as well as positive experiences with the quality of service delivered. Surveys also suggest that even more people would have used the pharmacist service if they had realized that it was offered [8].

Adherence to scheduled follow-up injections of multi-dose vaccines is vitally important for desired outcomes. Individuals who receive only the first injection of a multi-dose regimen are only partially protected or not protected at all [9]. A study of vaccine completion rates completed in Alberta for hepatitis B and for combination hepatitis A and B found completion of the multi-dose vaccines to be 48% and 51.4% respectively for the year 2016 [10]. Measures to vastly improve the adherence to multi-dose vaccine follow-up doses are indicated if the anticipated outcomes of immunization are to be achieved.

Increasing the percentage of the population that is immunized as well as completion of recommended immunization protocols in Canada has been declared as an important public health goal [7]. The pharmacist-administered influenza vaccine experience suggests that expanding pharmacist scope to include additional immunization protocols could professionals according to the following three factors;

lead to important increases in the numbers of Canadians receiving recommended vaccine regimens. We set out to test this hypothesis by exploring differences in immunization rates and follow up adherence rates across the provinces for pharmacists versus other health professionals according to the following three factors;

- Number of immunizations permitted to administer.
- Provincial public health coverage of administered immunizations.
- Prescribing rights of pharmacists as they pertain to immunizations.

Adherence rates for follow-up injections of multi-dose vaccines follow a similar pattern to first injection rates, with Alberta pharmacists exceeding other providers in providing follow-up injections by 12% on average. Saskatchewan, Newfoundland and Ontario, with no public health coverage for vaccines other than influenza, fewer vaccines eligible for pharmacist injection and no prescribing rights fell far below other provinces with respect to both first injection rates and adherence rates in this study. This supports the hypothesis that these factors play an important role in patient choice for provision of immunizations [11].

It is interesting to look at immunization trends according to particular multi-dose vaccines and factors that may affect first injection percentages and/or adherence rates to the scheduled follow-up doses.

Shingrix is an example of a multi-dose immunization that requires two injections and is not sponsored by public health in any province except Ontario (for 65-70 year old patients only). This means that physicians, like pharmacists, must also charge patients for the administration and cost of this vaccination. In comparing Shingrix first injection rates according to provider in Table 3 to aggregate first injection rates for all five immunizations, we observe that first injection rates by pharmacists compared to other providers are significantly higher for Shingrix than for the other vaccines in every province. The study did not include methods to assess causation of results; however we speculate that pharmacists are more comfortable with recommending Shingrix than the other multi-dose immunizations studied. This may be a result of very specific indications for use of the vaccine in every patient 55 years of age or older and proactive promotion of the product by both the manufacturer and the pharmacy. The Shingrix.ca website suggests that individuals 55 years of age and older get their first Shingrix injection at the same time they receive their influenza injection. This protocol may be followed by a number of pharmacies. Finally, since patients need to pay for the vaccine in the majority of cases regardless of provider, the accessibility of pharmacist services compared to making an appointment to see a physician may be a factor. Despite increased pharmacist first injection percentages, adherence rates remain an issue for the second injection; with a follow-up injection rate of less than 50% across all provinces (although pharmacist-administered Shingrix adherence rates *vs* other providers were higher in AB, BC, MB and NB). This outcome demonstrates an urgent need for improved systems of follow-up in this area for all healthcare providers.

As shown in Table 2, Twinrix® (hepatitis A plus hepatitis B vaccine) was the most utilized of the five vaccines assessed in this retrospective analysis. Prescribing rights seem to be the biggest factor in pharmacist first injection percentage, with Alberta, New Brunswick and Nova Scotia comprising three of the four provinces that had first injection rates of the vaccine by pharmacists above 40%. British Columbia is the fourth province with a pharmacist administration rate above 40%. With its long history of immunization authority for pharmacists, and public health coverage for many of the vaccines administered by pharmacists, most pharmacies in British Columbia offer immunization and travel vaccine administration. Adherence rates for the 2nd injection of Twinrix® are highest among all immunizations in this study, with pharmacist administration showing the highest adherence rates in provinces with pharmacist prescribing rights. The rapid immunization schedule of 0, 7, 21 days that many people use before travel may be a factor here.

As outlined in Table 5, Havrix® (hepatitis A vaccine) is used instead of Twinrix® when hepatitis B protection has already been provided in earlier years *via* provincial public health programs. The adherence rate for Havrix® is lowest of all vaccines for all providers. This may be due to the effectiveness of the vaccine after even one dose and the fact that it is effective even up to the day before travel [12]. Administration for first injection percentages of pharmacists *vs* doctors/other HCPs are similar to those seen with Twinrix®, as circumstances (i.e., mostly travel) are similar for use of the two immunizations in adults.

Engerix-B® (hepatitis B vaccine) was administered by pharmacists the least often compared to doctors/other HCPs of the vaccines studied in all provinces except Alberta. Many individuals in Canada age 40

Immunization	Indications in Adults	Factors affecting patient demographic and schedule	Adult dosing Schedule
Shingrix (Herpes Zoster vaccine)	Prevention of Herpes Zoster in adults 50 years of age and older [11].	Not covered by provincial public health plans [11].	One dose followed by second dose 2 to 6 months later [11].
Havrix® (Hepatitis A vaccine)	Active immunization against hepatitis A infection.	Used for travel instead of Twinrix by individuals receiving hepatitis B vaccine at earlier age [12].	Primary or Travel: One dose followed by booster dose 6-12 months later [12].
Engerix B® (Hepatitis B vaccine)	Active immunization against hepatitis B infection.	In adults, have many indications. Twinrix more popular for travel due to combination of Hepatitis A and B in one injection [12].	Standard: One dose at 0, 1 and 6 months.12 Rapid: 0, 7, 21 days (4th dose recommended 1 year after 1st dose) [12].
Twinrix® (Hepatitis A+ Hepatitis B vaccine)	Active immunization against hepatitis A and hepatitis B infection.	In adults, most often used for travel needs.	Standard: One dose at 0, 1 and 6 months Rapid: 0, 7, 21 days. 12 months [12].
Gardasil® (Human papillomavirus vaccine)	Immunization for: Girls and women age 9-45 against cervical, vulvar and vaginal cancer and age 9-26 for anal cancers. Boys and men age 9-26 years for anal cancer and anogenital warts [13].	Public health coverage according to age group, gender and risk factors varies by province.	Depending on age -Three dose: 0, 2 and 6 months, or Two dose: At least six months between doses [14].

Table 5: Indications and factors affecting patient demographic for study immunizations.

or younger would have received hepatitis B vaccination through school-based immunization programs [13]. There are many indications for hepatitis B vaccine in adulthood other than travel protection. They would most often occur in a situation where a medical doctor is involved and immunization would most likely take place as soon as indication is uncovered. With respect to travel, Twinrix® would be more likely used than hepatitis B on its own. It is concerning to see that adherence rates for the second injection are less than 40% except for one instance, and 20% or less for the third injection in the series.

The indications for Gardasil® are shown in Table 5. Adherence rates for the first and second follow-up injection were similar to Twinrix® and higher than Shingrix and the hepatitis vaccines. Once again, first injection rates by pharmacists were highest in Alberta, followed by British Columbia, Nova Scotia and New Brunswick. Adherence rates for first and second follow-up injections were similar for pharmacist *vs* other provider administration except for Alberta where the rates were higher for pharmacist administration in both cases. Limitations of this analysis include assumptions associated with interpretation of data.

For data analysis it was assumed that any injection service provided within 3 weeks of the vaccine dispense date was for the particular vaccine dispensed within that period. If the patient file was not billed an injection fee within 3 weeks of the particular vaccine dispense date, the patient was assumed to have picked up the medication and taken it to a different healthcare provider for administration [14]. There are various circumstances where these assumptions may not apply. For example, some patients do not use the same pharmacy all the time and patients who "transfer" their prescription to another pharmacy would not be captured as completing the series, and would be regarded within this data analysis as an "incomplete" series, though they may actually have completed the series. We predict that this applies to few patients as the vast majority of patients use the same pharmacy for all of their prescriptions [15]. Although the number of prescriptions filled provides a good representation of injections received, this representation will not be perfect. Some patients may call to fill their vaccine prescription within the scheduled three-week period but forget or delay picking it up, which would be incorrectly recorded as an adherent event. Shoppers Drug Mart has an auto-refill service, whereby patients sign up to have their prescriptions automatically refilled when due. A reminder is triggered when it is time for the patient to pick up the prescription, either by text message or email. Though most patients do pick up their prescriptions for immunizations and have them injected, we acknowledge that this is an underlying assumption of all patients in the study.

Additional limitations are associated with patient circumstances that fall outside the norm. Some vaccinations may have been received outside of the scope of this study, whether through publicly funded school programs, at other pharmacies or directly through a physician's office or clinic. Primary care providers may order a test for anti-Hepatitis A or anti-Hepatitis B immunoglobins before prescribing Havrix® or Engerix-B®. If underlying immunogenicity exists from vaccinations given in the patient's history, they may only be required to receive one dose. Under these unusual circumstances the patient would be classified as non-compliant, when in fact this is how the vaccine was intended to be scheduled.

The results of this retrospective analysis serve to support the view that the three factors listed in Table 4 (namely number of immunizations permitted to administer, public health coverage/pharmacist reimbursement and pharmacist prescribing rights) impact the percentage of pharmacist-administered vaccines and adherence rate of multi-dose vaccines in each province. Table 4 shows the relationship between these three factors and each province's overall injection rates and adherence rates. The outcomes suggest that injection rates and adherence rates tend to increase according to the level of the three identified factors that exist in each province. Alberta pharmacists are the only pharmacists in Canada with the opportunity to prescribe, administer and be reimbursed for all vaccines. As shown in our retrospective analysis, Alberta pharmacists provide immunizations to a significantly higher percentage of patients than pharmacists of any other province for all immunizations assessed. Furthermore, Alberta pharmacists administer a higher percentage of the immunizations included in this analysis than all other providers in the province. With respect to injection adherence, Alberta pharmacists provide a higher percentage of follow-up doses of multi-dose vaccines than all other providers, regardless of province. On the other end of the spectrum, Newfoundland, Saskatchewan and Ontario, with no pharmacist prescribing rights and no public health coverage or pharmacist reimbursement, show very low percentages of vaccines administered compared to other providers and lower overall adherence rates than the other provinces.

CONCLUSION

In this retrospective analysis of five multi-dose vaccines, the level of pharmacist-administered *vs* doctor/other HCP first injections and higher overall adherence to follow-up injections was associated in each province with the level of legislation that enabled pharmacists to administer and prescribe vaccines to a greater degree and with public health payment. The results suggest that to increase the level of immunization nationally, and thereby improve public health, all provinces should aspire to the Alberta model of care where pharmacists are most enabled by the legislative and public health factors identified.

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CONFLICT OF INTEREST

The authors of this publication declare no conflict of interest.

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