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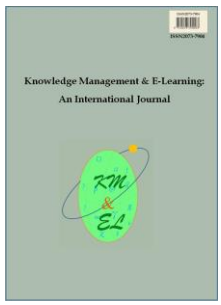

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Pharmacist's perception of the impact of electronic prescribing on medication errors and productivity in community pharmacies

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Abstract: Paper-based prescriptions have been used for several decades by many healthcare practitioners. The literature suggests that several challenges are associated with handwritten prescriptions that might impact patients' safety and medication errors. Electronic prescribing (e-prescribing) has been developed to phase out handwritten and computer-generated prescriptions that are printed on paper or faxed directly to a dispensing pharmacy. This research aimed to examine pharmacists' thoughts about the e-prescribing impact on their practice. We also evaluated the adoption rate of e-prescribing by assessing the proportion of electronic prescriptions (e-Rx) received in community pharmacies across the Canadian provinces. This research was conducted as a secondary analysis of the 2016 National Survey of Community-Based Pharmacists: Use of Digital Health Technology in Practice by Nielson. The survey was conducted in collaboration between Canada Health Infoway and the Canadian Pharmacy Association. The target population of the survey was Canadian pharmacists who were in community practice. The provinces included in this research were Ontario, Quebec, Saskatchewan, Alberta, and British Columbia (n = 450). The findings of this study suggest that community pharmacists in Canada were willing to embrace e-prescribing to support their practice. Most of pharmacists thought that e-prescribing was a useful tool to reduce medication errors and improve efficiency in pharmacies. However, the largest proportion of prescriptions issued by prescribers continue to be in paper form, whether handwritten or computer-generated. Further research is needed to investigate the barriers to the adoption of e-prescribing systems among primary care practitioners in Canada.

Keywords: Electronic prescribing; Electronic prescriptions; Medication errors;

Community pharmacy; Pharmacy productivity; Adoption

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1. Introduction

Electronic prescribing systems (e-prescribing) have been identified as a way of enhancing patient safety and improving clinical care. E-prescribing has been developed to phase out handwritten and computer-generated prescriptions that are printed on paper or faxed directly to the dispensing pharmacy. E-prescribing was established to reduce transcribing errors resulting from poor legibility, missing information, and the use of non-standard abbreviations. Realizing the potential economic benefits and improvement of the quality of care, Canada is investing more than $100 million to establish a national e-prescribing platform. However, the perception of community pharmacists of the impact of e-prescribing on medication errors and productivity has not been studied before. There are a very limited number of studies that target community pharmacists. Little is known about the adoption rate of e-prescribing among prescribers after efforts were made to introduce the technology in primary care practices in Canada. Therefore, pharmacists' input about their perceptions of e-prescribing systems is an essential step towards the successful adoption and diffusion of these systems. The main goal of an e-prescribing system is to establish an electronic, direct communication between the prescriber and the pharmacist. The successful implementation and adoption of systems requires mutual acceptance and collaboration between these end-users. It has been reported that some e-prescribing systems were not optimally utilized by some pharmacies, who chose not to use them for various reasons (Grossman et al., 2007).

The objective of this research was to assess if there is a relationship between the pharmacists in the different provinces and their perception of the impact of e-prescribing on medication errors and their pharmacy's productivity. Additionally, this research aimed to evaluate the sources of the prescriptions received in the community pharmacy as a measure of the adoption rates of e-prescribing among prescribers. This paper consists of two sections: the first section provides background information about e-prescribing and the implied benefits of implementing these systems. The second section includes analyses

of the 2016 National Survey of Community-Based Pharmacists conducted by Canada Health Infoway (Infoway) and the Canadian Pharmacists Association (CPhA) to assess the use of digital health technology in practice.

2. Background and literature review

2.1. Handwritten paper-based prescriptions

In Canada, a prescription is defined as "an authorization from a practitioner to dispense a specified drug or device for use by a designated individual or animal" (Legislative Assembly of the Province of British Columbia, n.d.). The most traditional way of conveying prescription information to a pharmacy is through a handwritten paper prescription documents that is given directly to the patient. Moreover, prescribers that use electronic medical record (EMR) systems in their practice can generate these prescriptions electronically. These EMR-generated prescriptions are either printed and handed to the patient or faxed directly to the patient's pharmacy of choice. Prescriptions may also be received verbally over the telephone from the prescriber to the pharmacist. Verbal orders for medications occur less often. Based on the CPhA 2016 survey, verbal prescriptions were estimated to on average represent 7.4% of the total prescriptions received in community pharmacies.

Handwritten prescriptions have been used for several decades by many health care practitioners. Prescribers prefer these prescriptions for various reasons, including the concerns about spending more time generating prescriptions by other methods (Schectman et al., 2005). However, the literature suggests that several challenges are associated with handwritten prescriptions that might impact a patients' safety and medication errors. It has been identified that prescribing errors were more common with handwritten orders, with an average error rate of 1.3 per prescription (Garbutt et al., 2005). The most reported problems with handwritten prescriptions are related to missing information and illegible writing. Having to rectify these problems causes interruptions to the pharmacist's workflow and requires more time to be spent on clarifications. Handwritten prescriptions could also be misinterpreted by the pharmacy staff leading to dispensing errors and exposing the patient to the risk of receiving unintended treatments.

2.2. E-prescribing in community pharmacies

E-prescribing is a health technology solution that has been used to improve the quality of patient care, reduce physicians' and pharmacists' errors, and decrease malpractice claims (Salmon & Jiang, 2012). The definition of e-prescribing varies among different countries. For example, in Canada, e-prescribing is defined as the secure creation and transmission of a prescription between an authorized prescriber and a patient's pharmacy of choice using an EMR system and a pharmacy management software (PMS) (PrescribeIT, 2019). In contrast, in the United States (US), e-prescribing is defined as the use of a computer or handheld device to send a prescription to a pharmacy of the patient's choice (Healthcurrent, n.d.). Alternatively, the British National Health Service has defined e-prescribing as the use of electronic systems to promote and facilitate the communication of a medicine order and provide a comprehensive audit trail for the entire process (de las Mercedes Martínez Sánchez, 2013).

Although there are many e-prescribing definitions, an e-prescribing definition that draws on all the different country definitions outlined above, is a prescription order that is

created and digitally signed by the prescriber using an EMR system, which is transmitted directly to the pharmacy through a secure link between the prescriber and the PMS. An e-prescribing system requires a platform that allows for two-way communication between the prescriber and the pharmacy, which enables the prescriber to renew, modify, or revoke a prescription electronically. At the same time, it allows the pharmacy to submit prescription renewal requests and clarification queries directly to the prescriber. The terms electronic prescribing, e-prescribing, and electronic prescription (e-Rx) are used interchangeably in the literature. For this research, the term e-prescribing has been used to refer to the information technology system that generates an e-Rx.

2.3. Benefits and risks of implementing e-prescribing

The most-reported cause for dispensing errors or near misses in community pharmacies was related to illegible prescriptions (de las Mercedes Martínez Sánchez, 2013). In hospitals, poor readability of handwritten prescriptions was determined to be the main cause of transcribing errors (Hartel et al., 2011). There are substantial benefits associated with the implementation of e-prescribing systems. The main benefit of e-prescribing is the reduction of dispensing errors due to the illegibility of handwritten prescriptions. These e-prescribing systems are usually integrated with a drug formulary decision support system (FDSS). An e-prescribing system integrated with FDSS helped in changing the prescribing habits of some healthcare providers. This change was associated with a reduction in prescribing the more-expensive alternative, which led to significant savings in the cost of prescription medications (McMullin et al., 2005).

The safety improvements associated with using e-prescribing systems are mainly attributed to integrated clinical decision support systems (CDSS). CDSS are efficient tools for reducing drug-related problems (Glassman et al., 2002). They provide various safeguards and warnings during the prescribing process, including drug-drug interactions, drug-allergy, and drug-disease contraindication alerts. In the US, using e-prescribing systems supported by CDSS has been estimated to have a cost-saving of $3.5 billion (Hillestad et al., 2005). These savings resulted from a reduction in ambulatory care costs related to prescribing errors and adverse drug problems. Another advantage of e-Rx's is related to improving medication compliance rates. For example, in the US, a study showed an increased rate for picking up prescription medications, when generated electronically compared to handwritten prescriptions (Surescripts, 2012).

However, some risks were associated to the use of e-prescribing systems in the community pharmacies. Some errors were identified in e-Rxs that required a pharmacist intervention to resolve the problem and complete the dispensing process. The most common e-prescribing error was related to ambiguities regarding the directions about the use of e-Rxs that could lead to medication errors and potential safety risks (Franklin et al., 2013; Kauppinen et al., 2017). System usability challenges were also identified that led to incorrect selection of medication doses or dosage forms that could have a direct impact on patients' safety, if they were not identified by pharmacists (Franklin et al., 2013; Gilligan et al., 2012).

3. E-prescribing models

The first generation of e-prescribing models involved reviewing patient information and entering the prescription order on a stand-alone system that is not connected externally to other systems (Motulsky et al., 2013). The main purpose of using these models was to

enhance patient safety due to the integrated CDSS that helped reduce the risk of drug-related adverse effects. The second generation of e-prescribing systems involves an electronic exchange of medical data including patient demographics, prescription information, and electronic signature. Primary care providers and pharmacies are required to be connected through an e-prescribing network that enables this exchange to occur (Grossman et al., 2012). This network allows for the transfer of new prescriptions, refill requests, and the ability to cancel or change an existing order. The transmission of e-Rx from the prescriber to the pharmacy can follow either the push or the pull model (Motulsky et al., 2015) (Fig. 1). The push model involves a direct transfer of the e-Rx from the prescriber to the patient's pharmacy of choice. The Canada Health Infoway version of e-prescribing (PrescribeIT, 2019) and the US Surescripts (Surescripts, n.d.) are examples of the push model system. On the other hand, the pull model includes uploading the e-Rx to a central repository that can be accessed by any authorized pharmacy connected to the system. Quebec, Finland, Denmark, and Sweden are using the pull model for dispensing their e-Rx (Gagnon et al., 2015; Hammar et al., 2011; Kauppinen et al., 2017).

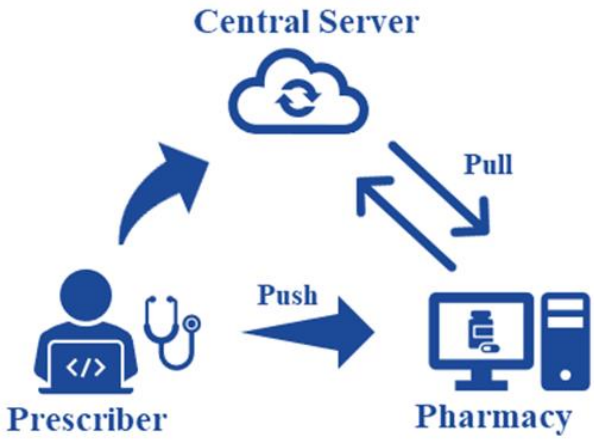

Fig. 1. Different models for e-Rx transmission between prescribers and pharmacy systems

3.1. E-prescribing internationally

E-prescribing systems are widely used and highly adopted in Europe and the US compared to Canada. Sweden was a pioneer country in e-prescribing, having been the first to successfully transfer an e-Rx in 1984 (Klein, 2011). Denmark and Sweden reported using their e-prescribing system daily across their countries (Mäkinen et al., 2011). In Germany, illegible handwritten prescriptions have been identified as the specific cause for entering incorrect information related to drugs into a pharmacy system and e-prescribing was suggested as a corrective action (Stojković et al., 2018). In Finland, a fully operational and nationwide e-prescribing system has been mandated by law. Their implementation process was initiated in steps starting with all the community pharmacies in 2012, then the public health division in 2013, and finally the private health care providers in 2015 (UEF, n.d.). All healthcare providers were obliged to implement the system by 2017, after which handwritten prescriptions were only permitted as a backup plan for system failures (Kauppinen et al., 2017).

The implementation of an e-prescribing system in one country is a very complex undertaking. However, the European Union (EU) has succeeded to extend the use of e-prescribing systems across borders. For example, Finland and Estonia managed to integrate their e-prescribing systems to allow their patients to fill their prescriptions in either country (European Commission, n.d.). Their ultimate objective is to enable EU citizens to have access to dispensed prescriptions anywhere in Europe. In Canada, e-prescribing was first piloted in Ontario in 2009 as an initiative to improve their healthcare services (E-Health Ontario, 2009). Given the widespread adoption of e-prescribing among the different countries, Infoway started a collaborative effort with health authorities across Canada and pharmacy industry stakeholders to create a national e-prescribing service called "PrescribeIT®". Since its first launch in 2017, six provinces have demonstrated interest in PrescribeIT®, including Alberta, Ontario, Manitoba, Nova Scotia, New Brunswick, and Newfoundland and Labrador (PrescribeIT, n.d.).

Community pharmacists are one the most trusted healthcare professionals as they are very accessible and have an integral role in the patient care plan. Ensuring the patients are better informed, pharmacist-patient interactions reduced unnecessary hospital admissions and medication adverse events (Thomas et al., 2014). However, most of the published literature has mainly focused on hospital pharmacies. Few published studies focused on pharmacists' perception in Quebec, Canada (Motulsky et al., 2008, 2019). To the best of our knowledge, no publication was identified that attempted to evaluate the adoption rates of e-prescribing across the Canadian Provinces.

Community pharmacists' perceptions of the impact of e-prescribing on their workflow is a relevant tool for measuring their inclination towards adopting and using an e-prescribing system. On the other hand, the proportion of e-Rxs received in community pharmacies in the different provinces could be utilized as an effective measure for the rate of adoption of e-prescribing among primary care practitioners in the community. As a measure for the success of the implementation process of e-prescribing systems, adoption rates among prescribers and pharmacists need to be identified and evaluated. As well, recognizing the root cause for low adoption rates is important to allow decision-makers to take appropriate measures to overcome the barriers to adoption.

4. Methods

4.1. Research objectives

The main objective of this research was to examine the pharmacists' inclination to adopt and use a national e-prescribing system in the five Canadian provinces included in this research. The research questions were as follows:

1. Is there a relationship between the pharmacists in the different provinces and their perception of the impact of e-prescribing on medication errors and pharmacy productivity?
2. Is there a relationship between the provinces where pharmacists are located, and the different types of prescriptions received?

4.2. Research design

This research was conducted as a secondary analysis of the 2016 National Survey of Community-Based Pharmacists: Use of Digital Health Technology in Practice (Nielsen,

2016). Secondary use of data is a feasible approach to review and capitalize on readily available pre-collected data from the target population. The research is an observational study with a retrospective component. The data was collected via a Web-based survey, that was conducted in collaboration between Infoway and the CPhA. The widespread use of this type of survey has contributed to the accessibility of the Internet, low cost, and convenient means for data collection (Alessi & Martin, 2010). Similar surveys were conducted in 2010 and 2014 in Canada (Canada Health Infoway & Canadian Pharmacists Association, 2019). The objective of these surveys was to promote the use of digital innovations among community pharmacists and to identify any undesirable outcomes that might impact adoption.

4.3. Sample

The target population of this research was Canadian community pharmacists, who are currently in practice. The pharmacists were invited to participate in an online survey about the use and benefits of digital health for pharmacy practice. The survey was developed by Infoway in collaboration with the CPhA. It was managed and hosted by Nielson, an independent data analytics company (Nielsen, n.d.). In Canada, more than 27,000 pharmacists are practicing in community pharmacies (NAPRA and ANORP, n.d.). The survey was expected to reach about 17,000 members of the CPhA. No data were available about the details of the invitations sent per province. The response rate to this survey was around 3.14%. Research has identified that the response rate to Internet-based surveys has been declining (Baruch & Holtom, 2008; Sheehan, 2001). However, Eysenbach suggested that low response rates are common for Internet-based surveys, and their findings should not be rejected as a result (Eysenbach, 2004). Factors related to the questionnaires themselves and the time taken by participants to complete a survey can contribute to a poor response rate. A low response rate can introduce a non-response bias, which might impact the validity and generalizability of the results.

4.4. Sample

The survey took place in Canada. Canada is comprised of ten provinces, including Ontario, Quebec, Nova Scotia, New Brunswick, Manitoba, British Columbia, Prince Edward Island, Saskatchewan, Alberta, and Newfoundland and Labrador. Along with three territories, including, the Northwest Territories, Yukon, and Nunavut. Canada is considered the world's second-largest country. Community pharmacists in Canada are healthcare professionals who can provide a variety of health and medication management services to the public (CPhA, n.d.a). Most Canadian pharmacists work in a community setting. Pharmacists provide oversight over the medication handling process, and review medications and care plans for their patients. The scope of pharmacists' practice has evolved over the years from traditional dispensing to advanced physician-independent prescribing authorities in certain provinces (Alberta College of Pharmacy, 2018; CPhA, n.d.b).

4.5. Survey

The purpose and the estimated length of time to be complete the survey was provided in a short introduction at the beginning of the survey. To assure the confidentiality of the participants, it was stated that only aggregate results would be reported by Nielson. A contact e-mail was provided to report any technical or functional challenges with the questionnaire. The survey consisted of 28 questions and can be accessed through this link

https://doi.org/10.5683/SP2/3BI57S. The questions collect some demographic information about the participants' practice as well as information about the average number of prescriptions filled in their pharmacy. Other questions were designed to assess the perceived benefits of using the electronic provincial DIS.

In the survey, eight questions were related to e-prescribing. Three of which were not accessible, and they were omitted by Nielson for proprietary reasons. In a question related to e-prescribing, participants were asked to estimate the percentage of the total weekly prescriptions received from a list of different sources. The other relevant questions to this research were related to the pharmacists' practice and their perception of the impact of using e-prescribing on medication errors and the pharmacy's productivity.

Table 1
Number of participants in the two waves of data collection

Province	Wave 1	Wave 2	Total
Ontario	40	113	153
Quebec	88	22	110
Saskatchewan	59	10	69
Alberta	19	42	61
British Columbia	57	0	57
Nova Scotia	8	18	26
Manitoba	5	12	17
New Brunswick	3	13	16
Newfoundland and Labrador	7	9	16
Prince Edward Island	7	2	9
Yukon	1	0	1
Total	294	241	535

5. Data collection

The data collection process was conducted two times. The first round of data collection was conducted over a 4-week period between October 04 to 31, 2016. Invitations were sent by the CPhA through an e-mail that contained a link to the online survey which was available in both languages, English and French. The CPhA, Infoway, and the other provincial pharmacy associations also used online promotional materials on their main Web pages to prompt the pharmacists towards completing the survey. An incentive draw for one of two $250 pre-paid Visa cards, was offered to the participants who completed the survey during the first wave (n = 294). The draw was facilitated by a third party arranged by Nielson. To increase the sample size, another 4-week period was used for the second wave of data collection, from December 02 to 31, 2016. The data collection involved another 241 participants (Table 1). As this was an open survey, instructions were provided for the participants who have completed the survey during the first wave not to retake it to avoid duplication. A reminder e-mail was circulated to the pharmacists to increase the response rate along with a reminder about their eligibility for the incentive draw.

6. Measures

The sample was limited to the provinces with 50 or more respondents due to the low response rate to the survey. This measure was applied to allow for the detection of statistical significance between the variables included in the analyses. The provinces included in this research were Ontario, Quebec, Saskatchewan, Alberta, and British Columbia (n = 450).

6.1. Impact of e-prescribing on medication errors

The source of the data for this research was the pharmacists' responses to the survey questionnaires. One question was specific to the participants' opinion about the impact of e-prescribing on medication errors, whether they thought that it would: "(1) decrease medication errors, (2) do no change to medication errors, (3) increase medication errors, or (4) do not know/need to learn more". To avoid violating the assumption of Chi-square statistics, that no more than 20% of the expected cell count should be under 5 (Macdonald, 2018), all the responses were dichotomized into two groups. The impact of e-prescribing on medication errors was examined by whether the respondent indicated that it will "decrease medication errors" or "other". The "other" group was computed by aggregating the number of responses for those who indicated "no change in medication errors, increase medication errors, and do not know/need to learn more".

6.2. Impact of e-prescribing on pharmacy productivity

Another survey question aimed at assessing the pharmacists' perception of the impact of e-prescribing on pharmacy productivity was also used in the analyses. The participants were asked to specify if an e-prescribing system was implemented in their pharmacy, and if it would: "(1) greatly increase, (2) increase, (3) no change, (4) decrease, (5) greatly decrease productivity, or (6) not sure/need to learn more". Based on Chi-square test assumptions, we described the responses using two groups: (1) increase productivity, and (2) others. The "increase productivity" group was computed by adding up the number of responses of "greatly increase" and "increase". While the "others" group included the "no change, decrease, greatly decrease, and not sure/need to learn more" responses combined. Table 2 contains a brief description of the original variables and values used in the dataset.

6.3. The percentage of the different prescription types received

To determine the proportion of e-Rxs received compared to others, the respondents were asked to estimate the percentage of the total weekly prescriptions received in their pharmacies from the different sources. Nine sources were listed including: (1) telephone, (2) handwritten and brought in by the patient, (3) handwritten and faxed to the pharmacy, (4) EMR/Computer-generated auto-fax, (5) EMR/Computer-generated manual fax, (6) EMR/Computer-generated printout (brought in by patient), (7) e-prescribing (transmitted directly to pharmacy system from a prescriber's EMR), (8) accessed through an electronic provincial drug information system (DIS), (9) other (please specify). The total for the listed sources should add to 100%.

Table 2
Description of the original variables in the dataset before computations

Measure	Description	Format	Type
Provinces (Q1)	The location of the respondent's pharmacy practice.	Categorical	Independent
Impact on medication error (Q17)	The pharmacists' perception of the impact of using e-prescribing on medication errors. There are 4 groups: - Decrease medication errors - No change in medication errors - Increase medication errors - Do not know, need to learn more	Categorical (4 groups)	Dependent
Impact on pharmacy's productivity (Q18)	The pharmacists' perception of the impact of using e-prescribing on their pharmacy's productivity in the long-term. There are 6 groups: - Greatly increase - Increase - No change - Decrease - Greatly decrease - Not sure, need to learn more	Categorical (6 groups)	Dependent
Percentage of weekly prescriptions (Q15)	The pharmacist's estimate for the percentage of the sources for the total weekly prescriptions received in their pharmacy practice. There are 9 sources provided that have to add to 100%: - Telephone - Handwritten and brought in by patient - Handwritten and faxed to pharmacy - EMR/Computer-generated auto-fax - EMR/Computer-generated manual fax - EMR/Computer-generated printout (brought in by patient) - e-Prescribing (transmitted directly to pharmacy system from a prescriber's EMR) - Accessed through an electronic provincial drug information system (DIS) - Other	Continuous	Dependent

Based on the participants' responses, the main sources of prescriptions were aggregated into (1) verbal, (2) handwritten (brought in by patient or faxed to the

pharmacy combined), (3) EMR-generated faxed (auto-fax and manual fax, combined), (4) EMR-generated printed (brought in by patient), and (5) e-Rx. The e-Rxs included in the analysis were restricted to the prescriptions transmitted directly to the PMS from a prescriber's EMR to comply with the Canadian definition of e-Rx. No imputation procedure was required since no missing data were identified in the data.

The dataset was analyzed using the statistics program IBM SPSS version 25. Descriptive statistics, Levene's test, Brown-Forsythe test and Games-Howell post hoc tests were used, and the p-value < 0.05 was considered to be statistically significant. The Games-Howell test was used to compare different combinations of the groups of different provinces to assess the statistical significance between them. The dataset is openly accessible and can be obtained from DOI:10.5683/SP2/3BI57S.

7. Ethics approval

Since this research was a secondary analysis on a publicly available dataset, ethics approval was not required. An ethics exemption was obtained from the University of Victoria Ethics Board.

8. Results

8.1. Respondents

In total, 535 survey responses were received. Invitations to participate were sent to more than 17,000 pharmacists over 4 weeks in two waves between October 4th to 31st and December 2nd to 31st, 2016. The response rate was around 3.14%. The responses were received from the 10 Canadian provinces and the 3 territories. The highest percentage of respondents was from the pharmacists in Ontario (n = 153), followed by Quebec (n = 110), and Saskatchewan (n = 69). Table 3 provides the frequency distribution of the respondents according to their provinces.

Table 3
Frequency distribution of the respondents (rank-ordered)

Province	Number of respondents (%)
Ontario	153 (28.6%)
Quebec	110 (20.6%)
Saskatchewan	69 (12.9%)
Alberta	61 (11.4%)
British Columbia	57 (10.7%)
Nova Scotia	26 (4.9%)
Manitoba	17 (3.2%)
New Brunswick	16 (3.0%)
Newfoundland and Labrador	16 (3.0%)
Prince Edward Island	9 (1.7%)
Yukon	1 (.2%)

Note. Percentages may not add to 100% due to rounding; n = 535

To identify statistical significance, only provinces with a sample size of 50 or more were included. The sample size included in this research (n = 450) represented

around 84% of the total respondents. Owing to the small sample size, provinces with fewer than 50 participants were excluded from the analysis (n = 85). Table 4 provides the frequency distribution of the respondents from the provinces included in the analysis of this research, along with their distribution based on gender.

Table 4
Frequency distribution of the respondents included in the analyses (rank-ordered)

Item	Number of respondents (%)
Province	
Ontario	153 (34.0%)
Quebec	110 (24.4%)
Saskatchewan	69 (15.3%)
Alberta	61 (13.6%)
British Columbia	57 (12.7%)
Total	450 (100%)
Gender	
Female	237 (52.7%)
Male	213 (47.3%)
Total	450 (100%)

8.2. The pharmacists' perception of the impact of e-prescribing on medication errors and pharmacy productivity

The first objective of this research was to assess if there is a statistical relationship between the different provinces and the pharmacists' perceptions of the impact of e-prescribing on medication errors and pharmacy productivity. Cross-tabulations were used to compare whether the pharmacists thought that e-prescribing would decrease medication errors or not. The analysis was conducted using Pearson Chi-Square test. Most pharmacists (66%) thought that the use of e-prescribing would lower the rate of medication errors. Pearson Chi-Square test showed that the variances between the different provinces were statistically significant ($p < .05$). Table 5 shows the percentages of pharmacists by the province who believed that e-prescribing would decrease the number of medication errors.

Table 5
Pharmacists' perception of the impact of e-prescribing on medication errors (rank-ordered)

Province	Decrease	Other*
Ontario	73.2% (112)	26.8% (41)
Quebec	68.2% (75)	31.8% (35)
British Columbia	64.9% (37)	35.1% (20)
Alberta	60.7% (37)	39.3% (24)
Saskatchewan	52.2% (36)	47.8% (33)

Note. Pearson Chi-Square, $p < .05$; N = 450; *Other includes respondents' answer categories of "no change", "increase medication errors", and "do not know/need to learn more" combined

The second component of the first objective was to evaluate if there is a relationship between the provinces and the pharmacists' perceptions of the impact of e-prescribing on pharmacy productivity. The analysis was repeated using Pearson Chi-Square to identify the statistical significance between the two groups of respondents. Table 6 shows the groups of pharmacists who thought that e-prescribing would increase pharmacy productivity and those who did not. Most of the pharmacists (70%) indicated that e-prescribing systems would have a positive impact on productivity in their pharmacies. However, the difference between the two groups in the different provinces was not statistically significant (p = .277).

Table 6
Pharmacists' perception of the impact of e-prescribing on pharmacy productivity (rank-ordered)

Province	Increase	Other*
Ontario	78.4% (112)	21.6% (33)
Quebec	77.3% (75)	22.7% (25)
Saskatchewan	72.5% (50)	27.5% (19)
Alberta	70.5% (43)	29.5% (18)
British Columbia	64.9% (37)	35.1% (20)

Note. Pearson Chi-Square, p = .277; N = 450; *Other includes respondents' answer categories of "no change", "decrease medication errors", "greatly decrease" and "not sure/need to learn more" combined

8.3. The different types of prescriptions received in the community pharmacies

To determine if there was a statistical significance between the prescription types received among the provinces, the different sources of prescriptions were assessed using one-way ANOVA. The average percentage of the different types of prescriptions received in the 5 provinces is reported in Tables 7 to 11.

Table 7
One-way ANOVA comparison of the average percent of verbal prescriptions received per province (rank-ordered)

Group	Average percent of weekly verbal orders	N	P-value*
Ontario	8.84	153	< .001
Alberta	6.97	61	
British Columbia	6.35	57	
Quebec	5.61	110	
Saskatchewan	4.55	69	

Note. * Levene's p < .001, p-value based on equal variances not assumed

Using Brown-Forsythe test, the estimated percentage of verbal prescriptions received was significantly different (p <.001) between the different provinces (Fig. 2). The highest reported estimate for verbal prescriptions was from Ontario (average 8.84%, 95% CI 7.703 – 9.982%, p < .001). The lowest reported estimate for verbal prescriptions was from Saskatchewan (average 4.55%, 95% CI 2.620 – 6.481%, p < .001).

The Games-Howell post hoc test showed a decline in the average number of verbal prescriptions received between Ontario and Quebec and the difference was statically significant ($p < .001$, equal variances not assumed). There was a similar decline between Ontario and Saskatchewan ($p < .05$, equal variances not assumed).

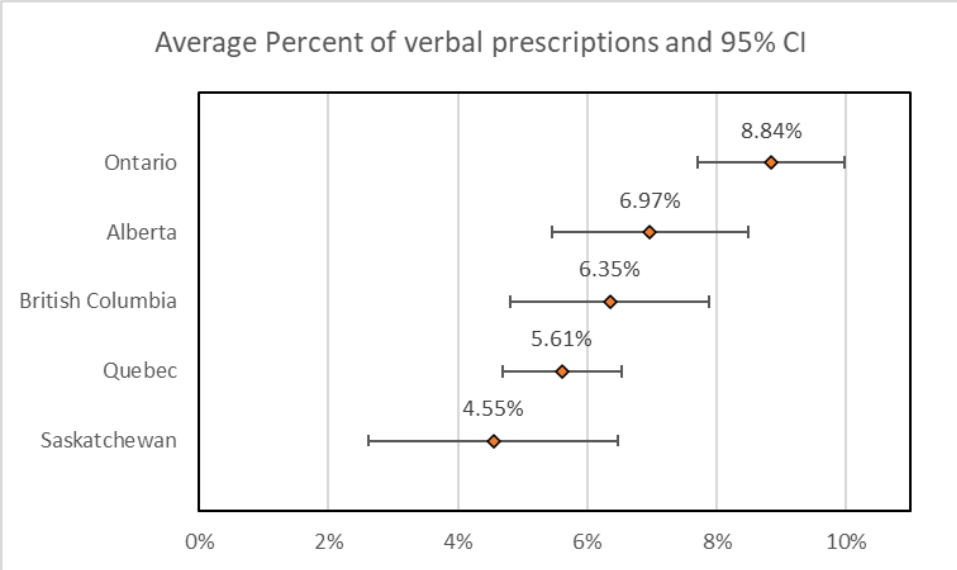

Fig. 2. Comparison of the average percent of verbal prescriptions received per province and 95% confidence intervals. Brown-Forsythe, $p < .001$, N = 450.

Table 8
One-way ANOVA comparison of the average percent of handwritten prescriptions received per province (rank-ordered)

Group	Average percent of weekly handwritten orders	N	P-value*
Quebec	66.62	110	< .001
Ontario	44.53	153	
Alberta	41.67	61	
British Columbia	39.53	57	
Saskatchewan	23.91	69	

Note. * Levene's $p < .001$, p-value based on equal variances not assumed

The Brown-Forsythe test showed that the percentage of handwritten prescriptions received was significantly different ($p < .001$) between the different provinces (Fig. 3). The pharmacists in Quebec estimated that 66.62% of the prescriptions received in their pharmacies were handwritten (95% CI 62.107 – 71.128%, $p < .001$). Saskatchewan had the lowest average of handwritten prescriptions of 23.91% (95% CI 19.719 – 28.107%, $p < .001$).

The Games-Howell post hoc test showed a statistical significance ($p < .05$, equal variances not assumed) in the average number of handwritten prescriptions received between all the provinces, except when comparing Ontario to Alberta and British Columbia who were not significantly different.

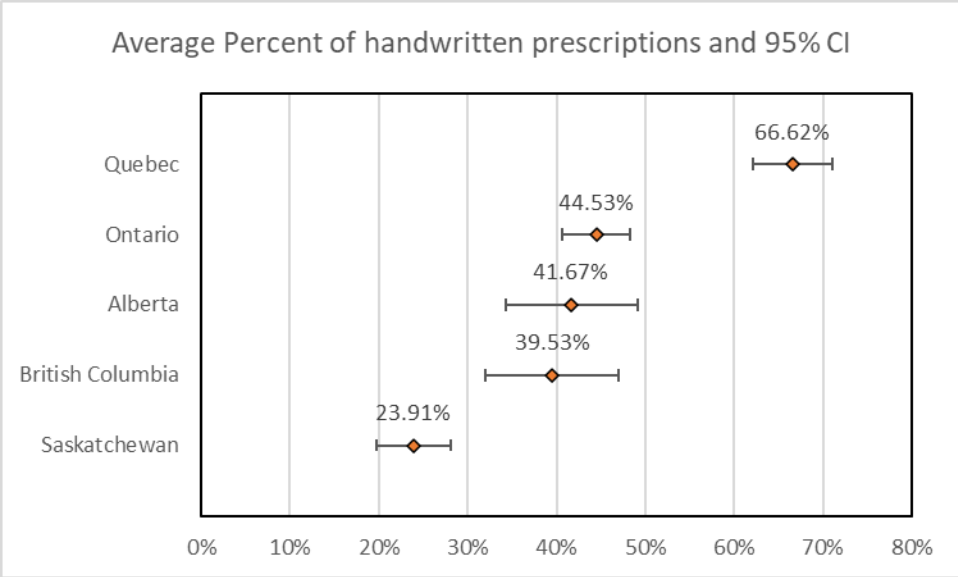

Fig. 3. Comparison of the average percent of handwritten prescriptions received per province and 95% confidence intervals. Brown-Forsythe, $p < .001$, N = 450.

Table 9
One-way ANOVA comparison of the average percent of EMR-faxed prescriptions per province (rank-ordered)

Group	Average percent of weekly EMR-faxed orders	N	P-value*
Saskatchewan	56.75	69	< .001
Ontario	27.35	153	
Alberta	12.95	61	
British Columbia	12.25	57	
Quebec	10.75	110	

Note. * Levene's $p < .001$, *p*-value based on equal variances not assumed

In Saskatchewan, 56.75% of the prescriptions received were EMR-generated and faxed directly to the pharmacies (95% CI 51.562 – 61.945%). Brown-Forsythe test showed a statistical significance ($p < .001$) between the proportions of EMR-faxed prescriptions in the different provinces (Fig. 4). Using Games-Howell, comparing the average EMR-faxed prescriptions between each province was significantly different ($p < .001$) except when comparing Alberta to British Columbia and Quebec.

The pharmacists in British Columbia estimated that 39.23% of the prescriptions received in their pharmacies were EMR-generated but printed and handed to the patient (95% CI 32.488 – 45.967%). The lowest proportion of EMR-printed prescriptions was 12.80%, reported from Saskatchewan (95% CI 9.607 – 15.986%). The participating provinces showed a statistically significant difference in the percentages of EMR-printed prescriptions received in their pharmacies (Brown-Forsythe, $p < .001$) (Fig. 5).

Table 10
One-way ANOVA comparison of the average percent of EMR-printed prescription per province (rank-ordered)

Group	Average percent of weekly EMR-printed orders	N	P-value*
British Columbia	39.23	57	< .001
Alberta	35.97	61	
Ontario	16.12	153	
Quebec	13.85	110	
Saskatchewan	12.80	69	

Note. * Levene's $p < .001$, p-value based on equal variances not assumed

The comparisons of the means between British Columbia and Alberta, Ontario to Quebec and Saskatchewan were not significant. Games-Howell test was significant ($p < .001$) for every other comparison.

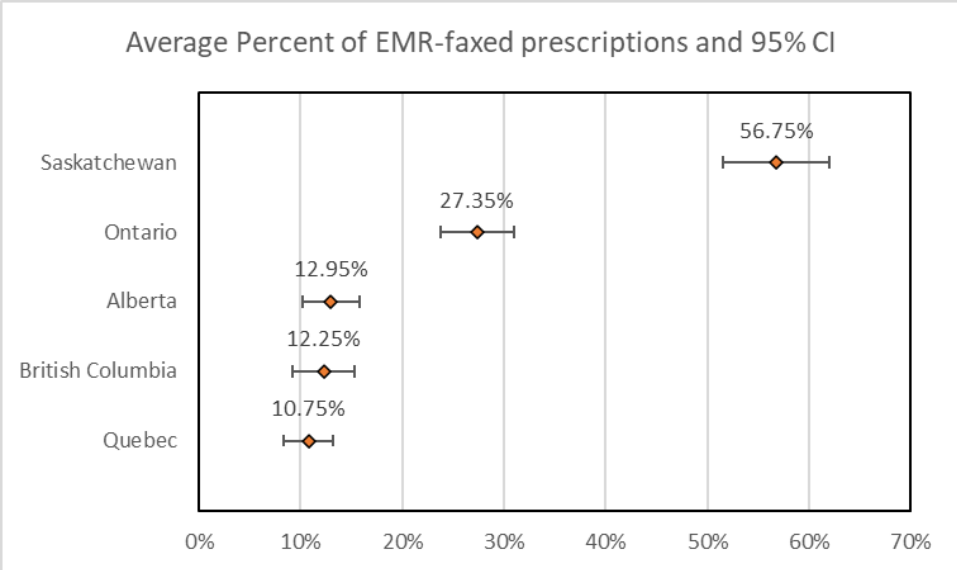

Fig. 4. Comparison of the average percent of EMR-faxed prescriptions per province and 95% confidence intervals. Brown-Forsythe, $p < .001$, N = 450.

Table 11
One-way ANOVA comparison of the average percent of e-Rx received per province

Group	Average percent of weekly e-Rx orders	N	P-value*
Ontario	1.97	153	< .05
British Columbia	1.37	57	
Saskatchewan	0.77	69	
Alberta	0.66	61	
Quebec	0.55	110	

Note. * Levene's $p < .05$, p-value based on equal variances not assumed

Levene's statistic was significant ($p < .05$) but the Brown-Forsythe test showed that the percentage of e-Rx received was not significantly different across the provinces (Fig. 6). Games-Howell post hoc tests were also not significant for every comparison. The highest reported proportion of e-Rx received was 1.97% in Ontario (95% CI .767 – 3.166%). The pharmacies in Quebec received on average .55% of their prescriptions as e-Rx (95% CI .049 – 1.041%).

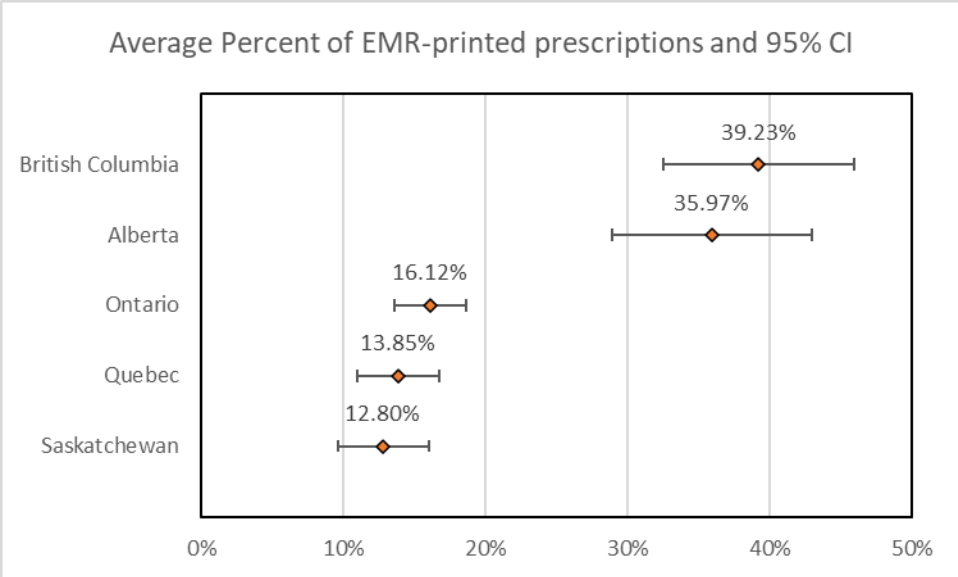

Fig. 5. Comparison of the average percent of EMR-printed prescriptions per province and 95% confidence intervals. Brown-Forsythe, $p < .001$, N = 450.

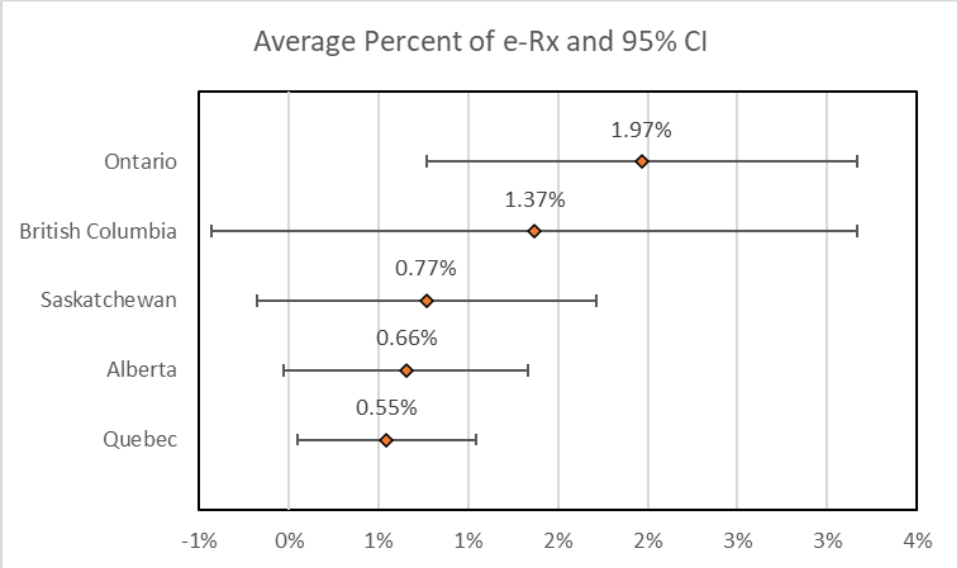

Fig. 6. Comparison of the average percent of e-Rx received per province and 95% confidence intervals. Brown-Forsythe, $p = .158$, N = 450

9. Discussion

This research aimed to examine the attitudes of Canadian community pharmacists towards e-prescribing and its benefits (i.e., that would support their practice). We also tried to assess the e-prescribing adoption rate among prescribers by evaluating the proportion of e-Rx received in the pharmacies compared to the other sources. The results of this research demonstrated that Canadian pharmacists are inclined to adopt new technologies that would support their practice. There was a significant difference between the pharmacists in the different provinces and their perception of the impact of e-prescribing on medication errors. Out of 450 pharmacists included in this research, 66% reported that e-prescribing would reduce medication errors and 62.4% thought that the technology was important for enhancing the quality of care. The potential of e-prescribing systems in reducing medication errors can be explained by reducing the risk of transcribing errors due to poor legibility in handwritten prescriptions (Franklin et al., 2013). Other safety measures for enhancing patients' safety include automated alerts and clinical decision support systems (Bright et al., 2012).

More than 70% of the pharmacists in the survey indicated that e-prescribing would increase productivity in their pharmacies. A disruption in the pharmacy workflow occurs when ambiguities are identified on any prescription. These discrepancies are usually resolved by the pharmacist contacting the prescriber for clarification. These clarification calls were less common for e-Rx when compared to other prescription sources (Phillips et al., 2015). The pharmacist interventions cause interruptions in the workflow, and delays in the dispensing process. This research demonstrated a low adoption rate of e-prescribing among primary care prescribers in Canada. The highest estimate of e-Rx received in pharmacies was 1.97%, reported from Ontario (95% CI .767 – 3.166%). This low estimate reflected the small proportion of electronically transmitted prescriptions compared to handwritten orders. On average, 43% of prescriptions received in the community pharmacies in Canada are still handwritten. In Quebec, it was reported that 66.6% of their prescriptions were handwritten compared to only .55% were received electronically. This finding is consistent with other studies conducted in community pharmacies in Quebec (Motulsky et al., 2015, 2019).

The potential benefits of improving patients' safety and reducing medication errors are the attributes that advocate for promoting e-prescribing use worldwide. However, adoption rates are still not meeting expectations, especially in primary care. Barriers contributing to the low adoption rates included fear of the negative impact on the prescriber's efficiency, concerns about the cost of the system, time constraints during the patients' visits, and the need to change the prescribing habits (Gilligan et al., 2012; Pizzi et al., 2005). This indicates that there is a need for improvement in the current versions of e-prescribing systems.

Nevertheless, there is a high potential for increasing the proportion of e-Rxs received in the pharmacies. This study suggests that a high number of the prescriptions received in Canadian pharmacies were generated electronically using an EMR system. But these prescriptions were either printed or faxed to the pharmacy. If e-Prescribing was enabled in these prescribers' EMR-systems, a significant increase could be observed in the proportion of e-Rx transmitted. However, no information was available to determine whether the prescribers issuing EMR-generated prescriptions had e-prescribing features enabled in their systems or not.

The CPhA predicted in 2012 that e-Rxs are going to be the main format for generating prescriptions in Canada (Canadian Medical Association (CMA) and Canadian

Pharmacists Association (CPhA), 2012). However, as of 2020, the national e-prescribing platform (PrescribeIT®) is only used in a few local communities in Ontario, Alberta, and New Brunswick (PrescribeIT, n.d.). This research is adding to the body of knowledge by highlighting the poor adoption rates of e-prescribing in Canada and the need for more innovative measures to overcome the barriers to adoption. Almost all the pharmacists in Canada rely on health information technology to support their practice and reported that these tools would improve their productivity and enhance patients' safety (Leung et al., 2016). The results of this research suggest that the Canadian community pharmacists are inclined to adapt and use innovative solutions to deliver better care.

This study had two main limitations. The first limitation was the low response rate of the survey, which was around 3% that greatly impacted the sample size. The low response rate is a common challenge in survey studies and could increase the potential for non-response bias (Mannetje et al., 2011). Non-response is a major shortcoming in research employing surveys for data collection as it can lead to uncertainty about the representativeness of the sample to the target population. However, it has been argued that non-response bias is not always associated with low response rates (Choung et al., 2013). Although statistical significance was identified between the different provinces for the impact of e-prescribing on medication errors, the data do not allow for the conclusions to be generalized due to the small sample size. No information was available about the non-participating pharmacists nor the reasons that led to it.

The second limitation of this research was the use of self-reported tools in the survey to identify the pharmacists' thoughts about e-prescribing. This technique is commonly used in sample survey research. However, response bias is a recognized limitation for research using self-reported tools (Rosenman et al., 2011). The data quality using these tools is subject to the respondents' motivation in providing a genuine response. The validity of the findings based on this data collection method could be subject to debate and cannot be generalized.

This research reviewed the pharmacists' perspective on the impact of e-prescribing on their professional roles in community pharmacies across the Canadian provinces. The findings of this research add to the body of knowledge as the literature on community pharmacists' practice is scarce. To the best of our knowledge, no study was identified about the pharmacists' perception of e-prescribing systems across multiple jurisdictions in Canada. Almost 96% of the licensed pharmacies in Canada are community pharmacies (NAPRA and ANORP, 2019), however, most of the literature studies were conducted to evaluate the impact of e-prescribing on medication safety in hospital pharmacies (Ahmed et al., 2016; Jheeta & Franklin, 2017). Little is known about the impact of e-prescribing on the rates of medication errors and efficiency in community pharmacies. There is also a gap in knowledge about the different e-prescribing models and their impact on efficiency.

Further research is needed to assess the adoption rate of e-prescribing among prescribers. We also need to determine whether the practitioners' generating prescriptions through an EMR-system have an e-prescribing feature enabled in their system, but they decided to opt-out from using it or not. Future research is also needed regarding the consumer medication information provided to the patients (Monkman et al., 2020), especially those involved in electronic prescriptions.

10. Conclusion

Pharmacists have demonstrated high adoption rates for new technologies and tools that could support their practice. Many pharmacists, whether in the community or hospital pharmacies, cannot imagine performing their duties without the use of computers and information technologies. E-prescribing systems have been developed to eliminate the potential for transcribing errors that may occur from handwritten scripts. The results of this research suggest that the Canadian community pharmacists were committed to adopting new technologies that would better support their practice including e-prescribing systems. However, most prescriptions received in the community pharmacies were handwritten. This finding indicates the low adoption rates of e-prescribing among prescribers in Canada. In all the provinces, a high proportion of the prescriptions received were electronically generated using an EMR system, but they were either printed on paper or faxed to the pharmacy. This result suggests a potential for an increased proportion of e-Rx transmitted to pharmacies in the future.

Author Statement

The authors declare that there is no conflict of interest.

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