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Estimating the information gap between emergency department records of community medication compared to on-line access to the community-based pharmacy records

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Received 8 February 2013
Revised 28 May 2013
Accepted 24 June 2013
Published Online First 16 August 2013

ABSTRACT

Objective Errors in community medication histories increase the risk of adverse events. The objectives of this study were to estimate the extent to which access to community-based pharmacy records provided more information about prescription drug use than conventional medication histories.

Materials and methods A prospective cohort of patients with public drug insurance who visited the emergency departments (ED) in two teaching hospitals in Montreal, Quebec was recruited. Drug lists recorded in the patients' ED charts were compared with pharmacy records of dispensed medications retrieved from the public drug insurer. Patient and drug-related predictors of discrepancies were estimated using general estimating equation multivariate logistic regression.

Results 613 patients participated in the study (mean age 63.1 years, 59.2% women). Pharmacy records identified 41.5% more prescribed medications than were noted in the ED chart. Concordance was highest for anticoagulants, cardiovascular drugs and diuretics. Omissions in the ED chart were more common for drugs that may be taken episodically. Patients with more than 12 medications (OR 2.92, 95% CI 1.71 to 4.97) and more than one pharmacy (OR 3.85, 95% CI 1.80 to 6.59) were more likely to have omissions in the ED chart.

Discussion The development of health information exchanges could improve the efficiency and accuracy of information about community medication histories if they enable automated access to dispensed medication records from community pharmacies, particularly for the most vulnerable populations with multiple morbidities.

Conclusions Pharmacy records identified a substantial number of medications that were not in the ED chart. There is potential for greater safety and efficiency with automated access to pharmacy records.

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To cite: Tamblyn R, Poissant L, Huang A, *et al*. *J Am Med Inform Assoc* 2014;**21**:391–398.

BACKGROUND AND SIGNIFICANCE

Errors in the recording of prescription medication histories are distressingly common in the hospital setting, occurring in upwards of 50–70% of admitted patients.[1–3] Over one quarter of these errors are attributable to incomplete medication histories obtained at the time of admission.[4] In many cases, medication discrepancies lead to interrupted or inappropriate drug therapy during and after hospitalization,[5–7] and are an important contributor to adverse drug events among hospitalized and recently discharged patients.[3 6] Following hospital discharge, the perpetuation of these errors may result in unintended disruptions in essential treatment, drug interactions or therapeutic duplication—all of which have the potential to cause significant clinical harm and result in additional healthcare costs.[7] Indeed, a recent study suggests that there may be a 10% increase in adverse drug events among patients whose medication was unintentionally disrupted by a hospital stay.[6]

Although research in this area remains limited, some studies have shown significant discrepancies between medication lists generated during emergency department (ED) triage and those later verified by a pharmacist.[1–3 7 8] The most common example is the omission of medications taken at home;[2 7] over 59% of medication histories recorded by physicians differ from those collected by pharmacy staff,[2] and although pharmacists are more effective in obtaining an accurate medication history, they are not available for all patient encounters.[9] While computerized provider order entry systems are effective in minimizing the risk associated with prescribing errors, they cannot detect home medication use without linkage to a community pharmacy database.[7] Better methods of obtaining the complete community drug list for each patient upon hospital admission would help to avoid preventable adverse drug events and increase the utility of community pharmacy systems in improving patient safety. The development of health information exchanges (HIE) in the USA and the pan-Canadian electronic health record in Canada are examples of technological infrastructures that could be used to provide access to community pharmacy records.[10 11] What remains unclear is whether access to community-based pharmacy records will provide substantially more information about prescription drug use than conventional medication histories.

Two recent studies, one conducted in Denmark and the other in the USA, set out to evaluate the magnitude of discrepancy between these two sources of information; however, their results were conflicting. In the Danish study, 27% of medications documented in electronic pharmacy records were not reported by patients on admission to an acute medical emergency ward, whereas only 6% of medications reported by patients were omitted from pharmacy records.[12] In contrast, in the American study, 30% of medications reported by patients were not included in an insurance claims

database, possibly because unlike pharmacy records, which record all prescriptions dispensed, insurance claims only include those drugs that are covered.[13] Neither of these studies identified the characteristics of patients at risk of having discrepancies in their medication histories. These data are needed to evaluate the extent to which investment in and maintenance of HIE will produce clinical value for patients.

OBJECTIVE

The purpose of this study was to determine the extent to which community medication histories documented in the ED differed from records of dispensed medications provided by community pharmacies, and the patient and drug-related predictors of discrepancies that could be used to identify higher risk groups.

MATERIALS AND METHODS

Setting

This study took place at two teaching hospitals in Quebec, Canada, where all residents have provincial medical insurance, and approximately 50% of the population is covered by public drug insurance. Claims records for all dispensed medications from Quebec pharmacies and medical services from fee-for-service physicians are maintained at the Régie de l'Assurance Maladie du Quebec (RAMQ) and can be linked using a unique lifetime identifier to create a longitudinal health record for each provincial resident.

Study design and participants

A prospective cohort study was conducted. Individuals who were seen in the ED at the Royal Victoria Hospital and the Montreal General Hospital between 21 May and 27 August 2008, who were 18 years of age or older, reported that they took at least one prescription medication and who had public drug insurance were asked to participate. Research assistants assessed eligibility and sought patient consent. The McGill University Health Centre's ethics committee, the RAMQ, and the provincial privacy commission approved the study.

Data collection and retrieval

For each consenting patient, two different community drug lists were retrieved: one that contained the drug list recorded by the triage nurse and ED staff in the patient's paper-based medical chart at the time of their ED visit, and another obtained from the community pharmacy records of dispensed medications recorded in the administrative databases of the RAMQ. For patients with multiple ED visits during the study period, only information pertaining to their first visit was collected from the ED chart and the community pharmacy records.

Chart retrieval

Trained research assistants reviewed all prescription drugs recorded in the ED section of the patient's hospital chart and entered the community drug list (drug name, strength, form) documented at the time of the visit into an electronic database. To minimize data entry errors, the database auto-generated a list of possible drug names from the first three typed letters; once the drug was selected, the strength and form was selected from a drop-down list, or entered in a free text field if the correct option was not available. If a drug name, strength, or form was missing or illegible, this information was also recorded in the database. All drugs, both prescription and over the counter, were coded by drug identification number, when possible, and/or by the generic drug code (ie, by drug ingredient regardless of manufacturer or format) using a proprietorial classification system (Vigilance Santé).[14] The number of illegible drugs was recorded for each patient, when applicable.

Provincial insurer (RAMQ) medication list retrieval from Quebec pharmacies

For each consenting patient, data on all prescription drugs dispensed from Quebec pharmacies in the year before the ED visit date were retrieved from the RAMQ. Data included medication drug identification number, strength, format, quantity dispensed, the duration of the prescription, and encrypted identifiers for each of the patients, prescribing physician, and dispensing pharmacy. Dispensed drugs were grouped by generic code and those with an active prescription within the 2 months before the ED visit date were classified as current community medications. Patients using medications for chronic conditions may miss 20% of doses (a mean compliance of 80%), and thus a window of 2 months back from the ED visit date was used to identify current medication.

Main outcome

The primary outcome was a discrepancy between community medications that were documented in the ED chart compared to dispensed medication records from the RAMQ databases. A discrepancy was defined as the absence of a drug with the same generic drug code in either the ED or RAMQ drug lists. All illegible drug entries in the ED chart were excluded.

Predictors of discrepancies

Potential patient and drug-related predictors of medication list discrepancies were measured with the aim of identifying subsets of patients who may be at greater risk of an incomplete community medication history. As many jurisdictions do not have access to records of dispensed medications, we assessed patient characteristics that were associated with a greater number of medications in pharmacy-recorded claims relative to the ED chart. Using a combination of medical chart and administrative data, we measured patient age and sex, health conditions that would create potential communication barriers,[15] as well as the number and therapeutic classes of medications as these factors may influence patient recall and communication. Using administrative data we measured the frequency of ED visits, and hospitalization in the past year, as well as the number of pharmacies and physicians involved in prescribing and dispensing as these factors create challenges in the continuity of care. Published algorithms were employed to measure patient and healthcare utilization characteristics.[16–19] Over-the-counter drugs were excluded, as they are not recorded in the pharmacy records.

Statistical analysis

Descriptive statistics were used to characterize the cohort, and to examine the frequency of discrepancies between the ED and Quebec pharmacy dispensing records for prescription drugs, by class and most frequent generic drugs. Multivariate logistic regression was used to estimate the association between patient demographics, health conditions, and healthcare utilization, as well as the likelihood of having more prescribed drugs listed in the pharmacy records than the ED chart. We estimated both the univariate and multivariate associations for each variable. To avoid multi-collinearity, we selected only one variable when multiple variables measuring the same concept were used (eg, number and types of drugs). SAS V.9.2 was used for all analyses.

RESULTS

Overall, 613 patients met the eligibility criteria and were enrolled in the study. The mean patient age was 63.1 years, 59.2% were women, and 32.6% had health conditions that may have created potential communication barriers (table 1). In the year before the ED visit, 45.7% of patients had four or more prescribing physicians, and 7.5% had four or more pharmacies.

Approximately one quarter (26.1%) of patients had more than 12 active prescription drugs documented at the ED visit, either in the hospital chart or through the pharmacy records; 57.3% used at least one over-the-counter medication, and 14.5% had at least one illegible drug in the ED chart (table 2).

The most prevalent over-the-counter medications were acetaminophen, acetylsalicylic acid, multivitamins, and calcium (table 3). For prescribed medications, 30.8% of patients had a single prescribing physician, and 72.4% had a single dispensing pharmacy. Cardiovascular drugs, central nervous system agents, hormones and synthetic substitutes were the most prevalent therapies Pharmacy records documented more active drugs than the ED chart in 75.5% of patients, and in 11.9%, the ED chart listed more medications.

There was concordance between the ED chart and pharmacy records for 45.2% of medications, 41.5% were only identified in the pharmacy records, and 13.4% were only in the ED chart. Concordance was highest for anticoagulants (64.6%), cardiovascular drugs (61.4%), and diuretics (56.2%) (table 4).

Drugs that are taken episodically were more frequently recorded in pharmacy records only (table 4). For example, 80.9% of skin agents, 75.3% of anti-infective drugs, 68.6% of eye, ear nose and throat medications, 46.2% of central nervous system agents, 44.0% of gastrointestinal drugs, and 43.4% of autonomic drugs, such as bronchodilators, were only recorded in pharmacy records. In the case of anti-infective drugs, 91% of patients who used anti-infective agents had a prescription end-date that preceded the ED visit; however, 34% of patients

Table 1 Demographic and healthcare utilization characteristics of the 613 patients in the study population in the year before the ED visit

Demographic characteristics	Mean	SD
Patient age (years)	63.1	18.8
	N	%
<50 years	150	24.5
50–70 years	197	32.1
>70 years	266	43.4
Sex		
Female	363	59.2
Male	250	40.8
Health conditions with communication barriers		
Any condition	200	32.6
Psychiatric disorder*	183	29.9
Social distancing problem†	32	5.2
Physical communication problems‡	3	0.5
Healthcare utilization in past year		
No of ED visits in past year		
No visits	307	50.1
1 Visit	141	23.0
2–3 Visits	104	17.0
≥4 Visits	61	10.0
No of hospitalizations in past year		
No hospitalizations	412	67.2
1 Hospitalization	116	18.9
≥2 Hospitalizations	85	13.9
Continuity of medication management in past year		
No of prescribing physicians in past year		
No information on prescribers	35	5.7
1 Prescriber	84	13.7
2–3 Prescribers	214	34.9
≥4 Prescribers	280	45.7
No of pharmacies in past year		
No information on pharmacies	33	4.5
1 Pharmacy	327	53.3
2–3 Pharmacies	207	33.8
≥4 Pharmacies	46	7.5

*Including diagnoses for depression, anxiety and adjustment disorders, schizophrenia and other psychotic disorders, mood disorder including bipolar and personality disorder.
†Includes alcoholism, drug abuse and homelessness.
‡Includes documented communication difficulties, blindness and deafness.
ED, emergency department.

Table 2 Characteristics of prescribed and OTC medication use at ED visit and discrepancies between ED and pharmacy record sources at the time of the ED visit

No of prescribed drugs (either ED or pharmacy source)	N	%
0 Drugs (only OTC)	8	1.3
1 Drug	36	5.9
2–6 Drugs	220	35.9
7–12 Drugs	189	30.8
>12 Drugs	160	26.1
Patients with ≥1 OTC medication	351	57.3
Patients with ≥1 illegible drug in the ED chart	89	14.5
Drug use by therapy class		
Central nervous system agents	360	58.7
Cardiovascular drugs	363	59.2
Hormones and synthetic substitutes	282	46.0
Blood formation, coagulation and thrombosis	218	35.5
Gastrointestinal drugs	211	34.4
Electrolytic, caloric and water balance	237	38.9
Anti-infective agents	162	26.4
Autonomic drugs	161	26.3
Eye, ear, nose and throat preparations	93	15.7
Other	273	44.5
No of prescribing physicians		
No information on prescribers	45	7.3
1 Prescriber	189	30.8
2–3 Prescribers	265	43.2
≥4 Prescribers	114	18.6
No of pharmacies		
No information on pharmacies	45	7.3
1 Pharmacy	444	72.4
2–3 Pharmacies	114	18.6
≥4 Pharmacies	10	1.6
Differences between pharmacy records and ED chart		
Pharmacy records document more prescribed drugs than ED chart	463	75.5
1 More drug	122	19.9
2–4 More drugs	219	35.7
≥5 Drugs	122	19.9
ED chart documents more prescribed drugs than pharmacy records	73	11.9
1 More drug	31	5.0
2–4 More drugs	25	4.1
≥5 Drugs	17	2.8

ED, emergency department; OTC, over-the-counter.

Table 3 Frequency distribution of OTC drugs documented in the ED chart by therapeutic class and most frequently used drugs

Therapeutic class	N	% of all OTC drugs	% of patients using drug
Central nervous system agents	175	24.8	28.5
Acetaminophen	85	12.1	13.9
ASA	80	11.3	13.1
Ibuprofen	9	1.3	1.5
Electrolytic, caloric and water balance	118	16.7	19.2
Calcium carbonate+vitamin D	35	5.0	5.7
Calcium carbonate	28	4.0	4.6
Calcium citrate	28	4.0	4.6
Blood formation, coagulation and thrombosis	111	15.7	18.1
ASA antiplatelet	85	12.1	13.9
Ferrous sulfate	12	1.7	2.0
Iron-chelated	7	1.0	1.1
Vitamins	95	13.5	15.5
Multivitamins	39	5.5	6.4
Vitamin D3	18	2.6	2.9
Vitamin D	12	1.1	2.0
Gastrointestinal drugs	101	14.3	16.5
Docusate sodium	38	5.4	6.2
Sennosides A–B	21	3.0	3.4
Dimenhydrinate	9	1.3	1.5
Skin and mucous membrane agents	27	3.8	4.4
Petrolatum-white	8	1.1	1.3
Gramicidin+PO Lymyxin B	3	0.4	0.5
Clotrimazole	3	0.4	0.5
Other*	87	11.4	14.1
Quinine sulfate	9	1.3	1.5
Potassium iodide+ammonium chloride	7	1.0	1.1
Products natural miscellaneous	6	0.9	1.0

*Other: Miscellaneous therapeutic agents, antihistamine drugs, respiratory tract agents, diagnostic agents, devices, anti-infective agents, autonomic drugs, eye, ear, nose and throat preparations.
ASA, acetylsalicylic acid; ED, emergency department; OTC, over-the-counter.

were prescribed multiple different anti-infective agents in the past 2 months. Of interest, 9.9% (gastrointestinal drugs) to 18.7% (autonomic drugs) of drugs were listed in the ED chart but were not found in pharmacy records of dispensed medications, at least in the 2 months before the ED visit.

The likelihood of having more drugs documented in pharmacy records than the ED chart was associated with the number of prescribed drugs, and the number of pharmacies, but not age, sex, hospitalizations or communication problems. (table 5). Patients with more frequent ED visits were more likely to have discrepancies in bivariate analysis, but these trends were largely explained by the number of medications and healthcare use and were not significant in multivariate analysis.

Patients using more than 12 drugs were almost three times more likely (OR 2.92, 95% CI 1.71 to 4.97) to have drugs documented in pharmacy records that were not noted in the ED chart. Compared to cardiovascular drugs, anti-infective drugs, blood formation, coagulation and thrombosis drugs, gastrointestinal drugs, and central nervous system drugs were more likely to be documented only in pharmacy records and not the ED chart. The number of prescribing physicians, both in the past year and for current medications, was associated with the likelihood of having more drugs documented in pharmacy records. However, the number of prescribing physicians was also strongly correlated with the number of drugs ($r=0.54$, $p<.0001$), so only the number of drugs was included in the multivariate models. Using more than one pharmacy, both in the past year and for current medication, was associated with more than a threefold increase (OR 3.45, 95% CI 1.80 to 6.59) in the risk of having more medications listed in pharmacy records, even after adjusting for the number of current medications.

DISCUSSION

This study provides insight into the potential value of accessing information electronically from community pharmacy medication records at the time of an ED visit. Pharmacy records identified 41.5% more prescribed medications that were not noted in the ED chart. More vulnerable patients, that is, those with many medications, many prescribing physicians, and multiple ED visits were more likely to have omissions in their ED record of current medications. Although having potential communication problems did not turn out to be a significant predictor of medication discrepancies, patients who were unconscious or agitated would have been less likely to be enrolled in this study because of known consent biases,[20] and thus we probably underestimated these effects. We found that omissions were more common for some groups of medications than others, particularly for therapeutic classes of drugs that may be taken episodically to control symptoms: anxiolytics, analgesics, gastrointestinal drugs, and asthma medications. The clinical significance of discontinuing these medications, even when intended, is substantial as discontinuation results in an adverse event rate of 14.3% (gastrointestinal drugs) to 29.7% (anxiolytics) in older people.[21] These groups of medications are more likely to be 'forgotten' by patients in self-reported surveys of medication use[7 22–24] and ED medication histories[2] when compared to home-based assessment of medicine cabinets,[25 26] and pharmacist review.[2] Although most cardiovascular and anticoagulant medications were documented in both the ED chart and pharmacy records, 29.2% of patients prescribed clopidogrel, and 8.3% of those prescribed warfarin had these medications only documented in pharmacy records. Although ED staff may selectively solicit information about these medications (particularly anticoagulants) as these drugs are frequently involved in adverse drug events,[27–30] there is clearly benefit in obtaining pharmacy records for patients on these medications.

Although pharmacy records of dispensed medications do not reflect actual usage, they can provide a clinically useful proxy. Several validation studies have shown that medication possession ratios calculated from pharmacy records are predictive of various measures of disease control such as blood pressure, glycosylated hemoglobin levels, and asthma exacerbation.[31–35] There is also excellent agreement between dispensing records and the use of antihypertensive drugs.[31 32 36 37] Moreover, if access to dispensed medications records from community pharmacies is automated, there is considerable potential to improve efficiencies for hospital-based pharmacists in documenting the best medication history,[38 39] as the average time spent per patient for this task can range from 13 to 90 min.[7 40 41]

To optimize the utility of access to computerized community-based pharmacy records, a few issues need to be addressed. First, a decision needs to be made about the time window that will be used to retrieve data. In this study, we included medications in the 2 months before the ED visit. For patients with poor compliance, we found that we could only pick up

Table 4 Discrepancies in prescribed drugs between pharmacy records* and the ED chart by therapeutic class

Therapeutic class†	Total	ED only (n, %)	Pharmacy only (n, %)	Documented in both (n, %)
Cardiovascular drugs	903	113 (12.5)	236 (26.1)	554 (61.4)
Atorvastatin	120	13 (10.8)	27 (22.5)	80 (66.7)
Amlodipine	80	3 (3.8)	15 (18.8)	62 (75.5)
Metoprolol	69	8 (11.6)	12 (17.4)	49 (71.0)
Central nervous system agents	716	121 (16.9)	331 (46.2)	264 (36.9)
Lorazepam	64	8 (12.5)	27 (42.2)	29 (45.3)
Naproxen	42	6 (14.3)	28 (66.7)	8 (19.0)
Codeine+acetaminophen	40	6 (15.0)	30 (75.0)	4 (10.0)
Hormones and synthetic substitutes	408	47 (11.5)	134 (32.8)	227 (55.6)
Levothyroxine	97	5 (5.2)	18 (18.6)	74 (76.3)
Metformin	87	7 (8.0)	9 (10.3)	71 (81.6)
Prednisone	38	2 (5.3)	20 (52.6)	16 (42.1)
Blood formation, coagulation and thrombosis	96	15 (15.6)	19 (19.8)	62 (64.6)
Warfarin	48	9 (18.8)	4 (8.3)	35 (72.9)
Clopidogrel	24	1 (4.2)	7 (29.2)	16 (66.7)
Dalteparin	4	1 (25.0)	2 (50.0)	1 (25.0)
Gastrointestinal drugs	232	23 (9.9)	102 (44.0)	107 (46.1)
Pantoprazole	108	13 (12.0)	43 (39.8)	52 (48.1)
Esomeprazole	33	5 (15.2)	14 (42.4)	14 (42.4)
Omeprazole	29	0	13 (44.8)	16 (55.2)
Electrolytic, caloric and water balance	169	17 (10.1)	57 (33.7)	95 (56.2)
Furosemide	65	8 (12.3)	17 (26.6)	40 (61.5)
Hydrochlorothiazide	65	8 (12.3)	20 (30.8)	37 (56.9)
Indapamide	16	1 (6.3)	7 (43.8)	8 (50.0)
Anti-infective agents	239	24 (10.0)	180 (75.3)	35 (14.6)
Ciprofloxacin	36	3 (8.3)	28 (77.8)	5 (13.9)
Amoxicillin	25	2 (8.0)	20 (80.0)	3 (12.0)
Azithromycin	18	2 (11.1)	16 (88.9)	0
Autonomic drugs	249	49 (18.7)	108 (43.4)	92 (36.9)
Salbutamol	74	19 (25.7)	37 (50.0)	18 (24.3)
Tamsulosin	31	5 (16.1)	10 (32.3)	16 (51.6)
Tiotropium	26	4 (15.4)	11 (42.3)	11 (42.3)
Eye, ear, nose and throat preparations	172	25 (14.5)	118 (68.6)	29 (16.9)
Fluticasone	53	8 (15.1)	36 (67.9)	9 (17.0)
Latanoprost	16	2 (12.5)	10 (62.5)	4 (25.0)
Mometasone	16	3 (18.8)	12 (75.0)	1 (6.3)
Skin and mucous membrane agents	89	10 (11.2)	72 (80.9)	7 (7.9)
Betamethasone valerate	8	1 (12.5)	7 (87.5)	0
Mometasone furoate	8	1 (12.5)	7 (87.5)	0
Fluocinonide	6	1 (16.7)	5 (83.3)	0
Other‡	208	22 (10.6)	86 (41.3)	100 (48.1)
Alendronate	31	2 (6.5)	12 (38.7)	17 (54.8)
Risedronate	30	3 (10.0)	11 (36.7)	16 (53.3)
Allopurinol	18	1 (5.6)	5 (27.8)	12 (66.7)
Overall	3481	466 (13.4)	1443 (41.5)	1572 (45.2)

*Active prescribed drugs in the 2 months before the ED visit.
†Includes the three most common drugs in each therapeutic class.
‡Including respiratory tract agents, devices, antineoplastic agents, miscellaneous therapeutic agents, diagnostic agents, vitamins, smooth and muscle relaxants, heavy metal antagonists.
ED, emergency department.

medications that were only documented in the ED chart if we looked back 12 months before the ED visit. In contrast, a shorter time window may be more appropriate to exclude short-term treatments such as antibiotics, which were likely to be 'over-reported' as current medications, because 91% had an end-date that preceded the ED visit. However, of interest was the fact that we found that 34% of patients were taking more than one anti-infective drug in the past 2 months. This information could be relevant to ED staff in detecting adverse anti-infective drug events or in avoiding previous failed treatment choices. To accommodate these issues, the window for retrieving medications for clinical use needs to be adjustable, allowing the user to conduct reviews by time period, therapy class, population, and insurance cost-sharing policies that affect compliance. Mean prescription duration is also an important factor to consider, as in some jurisdictions 3-month durations (versus 1 month in Quebec) are the norm, and thus a longer retrieval window will be needed.

Table 5 Factors associated with discrepancies: more drugs in pharmacy records than documented in the ED chart

Factors	More drugs pharmacy records N (%)	Bivariate analysis OR (95% CI)	Bivariate analysis p Value	Multivariate analysis OR (95% CI)	Multivariate analysis p Value
Patient age (years)					
<50	111 (23.9)	Ref.		Ref.	
50–70	149 (32.0)	1.09 (0.67 to 1.78)	0.72	0.875 (0.504 to 1.518)	0.64
>70	205 (44.1)	1.18 (0.75 to 1.88)	0.47	0.814 (0.470 to 1.412)	0.46
Gender					
Female	273 (58.7)	Ref.			
Male	192 (41.3)	1.09 (0.75 to 1.59)	0.66	1.00 (0.67 to 1.49)	0.99
Communication barrier	158 (34.0)	1.29 (0.86 to 1.94)	0.22	1.08 (0.69 to 1.67)	0.75
No of prescribed drugs					
1 Dug	18 (3.9)	0.66 (0.31 to 1.42)	0.29	0.74 (0.33 to 1.68)	0.47
2–6 Drugs	137 (29.5)	Ref.		Ref.	
7–12 Drugs	121 (26.0)	1.86 (1.16 to 3.00)	0.01	1.99 (1.21 to 3.29)	0.007
≥12 Drugs	166 (33.3)	2.92 (1.80 to 4.76)	<.0001	2.92 (1.71 to 4.97)	<.0001
Therapeutic class†					
Cardiovascular	286 (61.5)	Ref.			
Central nervous system	289 (62.2)	1.64 (1.09 to 2.46)	0.01		
Hormones/synthetic subs.	222 (47.7)	1.11 (0.73 to 1.67)	0.63		
Blood, coag/thrombosis	192 (41.3)	2.96 (1.79 to 4.89)	<.0001		
Gastrointestinal	181 (38.9)	1.69 (1.05 to 2.71)	<.0001		
Electrolytic, caloric and water	196 (42.2)	1.12 (0.71 to 1.76)	0.64		
Anti-infectives	145 (31.2)	3.49 (1.99 to 6.12)	<0.001		
Autonomic	128 (27.5)	0.72 (0.44 to 1.19)	0.20		
Eye, ear, nose and throat	77 (16.6)	0.96 (0.51 to 1.79)	0.89		
Other	236 (50.8)	2.46 (1.57 to 3.86)	<.0001		
ED visits in past year					
No visits	218 (46.9)	Ref.		Ref.	
1 Visit	107 (23.0)	1.28 (0.81 to 2.02)	0.30	1.14 (0.70 to 1.84)	0.61
2–3 Visits	85 (18.3)	1.80 (1.03 to 3.12)	0.04	1.58 (0.86 to 2.89)	0.14
≥4 Visits	55 (11.8)	3.50 (1.49 to 8.23)	0.004	2.33 (0.91 to 5.96)	0.08
Hospitalizations in past year					
No hospitalization	304 (65.4)	Ref.		Ref.	
≥1 Hospitalization	161 (34.6)	1.42 (0.95 to 2.14)	0.09	0.93 (0.58 to 1.50)	0.76
Current pharmacies					
1 Pharmacy	352 (75.7)	Ref.		Ref.	
≥2 Pharmacies	113 (24.3)	3.85 (2.03 to 7.30)	<.0001	3.45 (1.80 to 6.59)	0.0002
Current prescribing MD*					
1 Prescriber	128 (27.5)	Ref.			
2–3 Prescribers	228 (49.0)	5.05 (3.28 to 7.77)	<.0001		
≥4 Prescribers	109 (23.4)	16.50 (6.72 to 40.50)	<.0001		
Pharmacies past year†					
1 Pharmacy	253 (54.4)	Ref.			
2–3 Pharmacies	172 (37.0)	2.06 (1.35 to 3.16)	<.0001		
≥4 Pharmacies	40 (8.6)	2.64 (1.11 to 6.23)	0.03		
Prescribing MD past year*					
1 Prescriber	55 (11.8)	Ref.			
2–3 Prescribers	161 (34.6)	3.50 (2.18 to 5.64)	<.0001		
≥4 Prescribers	249 (53.5)	9.21 (5.45 to 15.44)	<.0001		

*Number of prescribing physicians and number of drugs was strongly correlated (r=0.54) so only number of drugs was included in the model.
†Therapeutic drug classes and number of drugs was correlated so only number of drugs was included in the multivariate model. We selected the utilization variable for number of pharmacies that was most strongly associated with the outcome.
ED, emergency department; MD, physician.

Our results demonstrate the potential value in having access to community-based pharmacy records through infrastructures such as HIE, because they provide more information about prescription drug use compared to conventional medication histories. However, the cost of integrating and sustaining electronic access to these records would need to be justified by either a reduction in professional time for medication history-taking (which is a substantial barrier to the medication reconciliation process), and/or in preventable adverse drug events. To date, cost–benefit models of HIE have been largely theoretical, based on economic modeling of assumed benefits and cost-savings.[42 43] The lack of empirical evidence of the sources and types of cost

saving may be one reason why most regional HIE in the USA have not established viable business models for financial sustainability.[44] A recent evaluation of HIE in ED care in Tennessee is among one of the first studies to provide evidence that HIE implementation can reduce hospitalizations, and in some cases, can reduce diagnostic and laboratory test ordering, producing an annual cost savings of US$1.07 million.[45]

Greater efficiencies and cost savings in professional time could be gained with automated access to pharmacy records if patients were provided with an opportunity to verify the medications they were taking. An interesting approach was evaluated in the Veteran's hospital system. Kiosks were available in the ED for patients to retrieve and verify medications they were actually taking based on records of dispensed prescriptions.[46] A majority of the ED staff agreed that the tool was effective; however, the overwhelming volume of information made identifying discrepancies in the medication lists difficult, and some providers felt that it increased their workload. Despite these shortcomings, the kiosk was successfully integrated in the ED workflow and even patients with poor computer skills were able to use it. Similar features could be included in personal health records and patient portals that are linked to community pharmacy information systems, and this may be a fruitful area for future research.

Limitations that need to be considered are that the study was based in two teaching hospitals where electronic health records were not available. The benefits of automating access to community pharmacy records may be greater for hospitals that are still using paper-based processes as we found that 14.5% of patients had at least one illegible drug in their ED chart, highlighting one of the many benefits of electronic documentation of medication histories. Only publicly insured patients were included, and this subpopulation may be more vulnerable as it includes both older patients and those receiving social assistance. We did not have a definitive 'gold standard' of the current medication list by which the accuracy of the ED list, or the additional drugs identified from community pharmacies could be judged. Moreover, as drug doses and routes were rarely recorded in the chart, we probably underestimated discrepancies related to dose and route.

CONCLUSION

In summary, we found community pharmacy dispensed medication records identified a substantial number of additional medications that were not noted in the ED chart, particularly for the most vulnerable patients. There is potential to gain greater safety and efficiency within hospital ED with automated access to these pharmacy records.

Contributors RT, LP, AH, NW and CMR contributed to the conception and design, acquisition of data, or analysis and interpretation of data, and drafted the article or critically revised it for important intellectual content. TM completed the data analysis and PD contributed to drafting and revising the article. All authors approved the final version to be published.

Funding Funding was provided by the: Canadian Institutes of Health Research.

Competing interests None.

Ethics approval The McGill University Health Centre's ethics committee, the RAMQ, and the provincial privacy commission approved the study.

Provenance and peer review Not commissioned; externally peer reviewed.

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