RESEARCH PAPER

Value in Primary Care: Evidence from the Canadian Primary Care Sentinel Surveillance Network

Valeur des soins primaires : les données probantes du Réseau canadien de surveillance sentinelle en soins primaires

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Abstract

Primary care antimicrobial stewardship programs are virtually non-existent. Using electronic medical record (EMR) data for an interrupted time series study, the authors examined the relationship between antibiotic prescriptions for acute respiratory tract infections (RTIs) and the COVID-19 pandemic. The main outcome of the study was to gauge the proportion of

RTI encounters with an antibiotic prescription. The pre-pandemic RTI antibiotic prescribing rate was 27.8%. During the COVID-19 pandemic, prescribing dropped significantly by 9.4% ($p < 0.001$). Almost 750,000 fewer patients could potentially avoid receiving an antibiotic prescription for RTI. The authors also discuss the value of EMR data; their use can help develop insights for health system improvement.

Résumé

Les programmes de gestion des antimicrobiens en soins primaires sont pratiquement inexistants. À l'aide des données du dossier médical électronique (DME) pour une étude de série chronologique interrompue, les auteurs ont examiné la relation entre les prescriptions d'antibiotiques pour une infection aiguë des voies respiratoires (IAVR) et la pandémie de COVID-19. Le principal objectif de l'étude était d'évaluer la proportion de rencontres d'IAVR avec une prescription d'antibiotiques. Le taux de prescription d'antibiotiques pour une IAVR avant la pandémie était de 27,8 %. Pendant la pandémie de COVID-19, la prescription a chuté de manière significative de 9,4 % ($p < 0{,}001$). Près de 750 000 patients de moins pourraient potentiellement éviter de recevoir une prescription d'antibiotiques pour une IAVR. Les auteurs discutent également de la valeur des données du DME, dont l'utilisation pourrait aider à développer des idées pour l'amélioration du système de santé.

Introduction

Value for healthcare in North America has typically been based on the concept of value from different actors' viewpoints, including regulators, insurers, physician organizations and health authorities. Another approach comes from the European Commission's Expert Panel on Effective Ways of Investing in Health (EXPH 2019) that proposes a more holistic approach based on four pillars of value created by the health system that focus on equity, person-centredness and social participation: (1) achievement of best possible outcomes with available resources (technical value), (2) equitable distribution of resources across all patient groups (allocative value), (3) appropriate care to achieve each patient's personal goals (personal value) and (4) contribution of healthcare to social participation and connectedness (societal value) in addition to health itself. Indeed, investments in health have positive returns for both the society and the economy (Bell et al. 2023). Past work demonstrates that investments in health contribute to advances in research and innovation, economic growth and a better society (Boyce and Brown 2019).

The ubiquitous use of antibiotics leads to antimicrobial resistance (AMR) that is now recognized as a major contributor to disease burden and one of the greatest threats to the future of human health. One area ripe for generating value in healthcare is preserving the efficacy of antibiotics through stewardship programs (Feazel et al. 2014; MacDougall and Polk 2008). Antibiotic stewardship (AS) programs combine education, public health surveillance, policies and practice audits to optimize antimicrobial prescribing. Lowering inappropriate antibiotic use can contribute to better outcomes for patients (technical, allocative and personal value) and societal value.

The majority of AS programs are aimed at tertiary care centres (Barlam et al. 2016). That is, there are few programmatic efforts to lower inappropriate antibiotic use in primary care (Keller et al. 2022). Yet, decreasing potentially avoidable antibiotic prescribing (and use) in primary care is essential since this part of the healthcare system could greatly contribute to an overall reduction of antimicrobial-related adverse events and AMR (Hersh et al. 2011; Shapiro et al. 2014). In any given month, an average of 113 people in every 1,000 visit a primary care practice, whereas only eight people in 1,000 are hospitalized (Green et al. 2001). Previous work suggests that between 25% and 46% of antibiotic prescriptions for non-bacterial respiratory infections could be potentially avoidable (Kitano et al. 2021; Silverman et al. 2017). The majority of antibiotic use in healthcare (90% by volume) occurs in the primary care setting where many prescriptions are not indicated (Hersh et al. 2021; Leis et al. 2020). Respiratory tract infections (RTIs) are the leading cause of avoidable antimicrobial use in primary care (PHAC 2020; Silverman et al. 2017).

The COVID-19 pandemic has had a major impact on primary care as there was a more than 89% reduction in preventive care visits and a general decline in primary care visits. With regard to antibiotic prescribing, the long-term repercussions of the COVID-19 pandemic on AMR have been raised as a global concern due to an initial elevated antibiotic use in patients infected with SARS-CoV-2 (Nieuwlaat et al. 2021; van Duin et al. 2020). Antibiotics were frequently being prescribed to patients diagnosed with COVID-19, mainly due to suspected bacterial co-infections (Langford et al. 2020; Lansbury et al. 2020). The overall goal of this work is to provide a use case examining the utility of primary care electronic medical record (EMR) data for identifying potentially avoidable antibiotic use for RTI. The specific objectives of this work are two-fold: (1) to examine pre- and post-pandemic RTI antibiotic prescribing rates; and (2) to examine whether the RTI antibiotic prescribing rates vary by rural/urban, deprivation and mode of visit (in-person versus virtual).

Methods

Study design

Antibiotic prescription rates were analyzed based on an interrupted time series (ITS) quasi-experimental study design before and after the COVID-19 pandemic. We also examined whether prescription rates differed based on mode of visit (in-person versus virtual). The ITS analyses span five years: from before the COVID-19 pandemic (1 January 2017 to 31 March 2020) to after the start of the pandemic (1 April 2020 to 31 December 2021). We used regression modelling to examine whether rates of antibiotic prescribing varied by the service delivery mode after the COVID-19 pandemic.

Data source

We used EMR data from the Canadian Primary Care Sentinel Surveillance Network (CPCSSN). The CPCSSN is a network of networks across Canada that includes 1,500 clinicians and almost two million patients. Contributing clinicians are located in all provinces except Saskatchewan and Prince Edward Island. For the purposes of this work, we used all CPCSSN data except those from Manitoba due to technical challenges in the data extraction process from this provincial network. Across CPCSSN, de-identified data are extracted from various EMR systems (*n* = 11) semi-annually and transformed to a standard CPCSSN schema to form a regional and pan-Canadian data repository. Each EMR system has a different architecture, and even within one EMR system there may be province-specific differences in the EMR structure where information is stored. As such, the transformation of EMR data to meet a standard CPCSSN schema includes advanced data cleaning and coding techniques. These data include information on patients' socio-demographic characteristics, providers, encounters/visits, health conditions, risk factors, biometrics, laboratory results, procedures, medications and referrals (Vijh et al. 2021).

Antibiotic prescribing for patients having a primary care visit (in-person or virtual) for RTI was based on a previously validated case definition (Wong et al. 2022). Potentially avoidable antibiotic use for RTI was based on Choosing Wisely Canada's recommendations (Choosing Wisely Canada 2020). For example, the Choosing Wisely Canada guidelines state that no antibiotics are indicated for an upper RTI (common cold) or bronchitis/asthma. With a diagnosis of sinusitis, a course of antibiotics over five days is recommended if a patient has at least two of the below-mentioned PODS symptoms, one of those being O or D AND symptoms lasting greater than 7–10 days OR the symptoms are severe OR there is no response after a 72-hour trial with nasal corticosteroids. PODS symptoms include the following: P = facial pain/pressure/fullness, O = nasal obstruction, D = purulent nasal or postnasal discharge and S = hyposmia/anosmia (smell) (Choosing Wisely Canada 2020).

Variables of interest

OUTCOME MEASURE

The main outcome is the proportion of RTI visits that resulted in an antibiotic prescription. This value is determined by measuring the number of RTI visits that received a prescription for an oral antibiotic (the antibiotics are listed in Appendix 1: Table A1, available online at longwoods.com/content/27093).

NEGATIVE CONTROL OUTCOME MEASURE

To understand the impact of potential time-varying confounding (Jandoc et al. 2015; Penfold and Zhang 2013; Wagner et al. 2002), we analyzed, as a control outcome, the proportion of visits for urinary tract infections (UTIs) that were treated with an antibiotic. This control outcome was chosen because it has been previously validated (Ouldali et al. 2017; Simonsen et al. 2014) and because UTI is a condition that is often treated with antibiotics but has no overlap with COVID-19 symptoms. Antibiotics used to treat UTI are listed in Appendix 1: Table A2, available online at longwoods.com/content/27093.

For the main outcome measure, we used the previously validated sensitive and specific RTI algorithm (Wong et al. 2022). A diagnosis of RTI includes five syndromes: common cold, pharyngitis, sinusitis, otitis media and acute asthma/bronchitis. We report here on the aggregated RTIs. The negative control, UTI, is determined using a predefined algorithm. In order to minimize misclassification (antibiotics potentially prescribed for infections other than RTI or UTI), we excluded patients who had concomitant infections on the same day.

INDEPENDENT VARIABLE OF INTEREST: COVID-19 PANDEMIC

For the purposes of this study, the start of the COVID-19 pandemic is defined as April 1, 2020.

Statistical analysis

We conducted an ITS analysis using segmented linear regression, with the inclusion of an autoregressive parameter for secular trends and seasonality where appropriate (Jandoc et al. 2015). A time unit of 30 days (one month) was chosen based on the data to provide optimal precision to the model (see Appendix 2, available online at longwoods.com/content/27093). ITS modelling included adjusting for seasonality since the rate of RTI can be higher based on the season (e.g., winter).

SUB-ANALYSIS

To understand the effect of moving to virtual care, we used linear regression to examine antibiotic prescribing in the post-interruption period by service delivery mode (in-person versus virtual). This sub-analysis only includes data from sites with less than 30% missing rate for visit type after the COVID-19 pandemic. Within the sub-analysis dataset, any missing visit types are accounted for by single imputation.

All the work was approved by Queen's University's Research Ethics Board (FMED-6813-21).

Results

There were 1,523,592 patients with a valid birth year and sex; of these, 1,147,699 patients had at least one primary care visit between January 2017 and December 2021. During the time period, there were 316,958 unique patients that had at least one visit for an RTI. Among these patients, 266,598 had at least one visit for an RTI in the pre-pandemic period, 99,683 had at least one visit for an RTI in the post-pandemic period. Table 1 shows that there were more female patients, the median age was 41 years and most lived in an urban

TABLE 1. Sociodemographic characteristics pre- and post-pandemic for patients who visited primary care for an RTI

Characteristic	Pre-COVID-19 pandemic period (January 2017–February 2020)	Post-COVID-19 pandemic period (March 2020–December 2021)
Patients	*n* = 266,598	*n* = 99,683
Sex		
Female	156,929 (58.89%)	59,484 (59.73%)
Age group, years		
0–18	72,497 (27.19%)	24,474 (24.55%)
19–39	61,651 (23.13%)	24,677 (24.67%)
40–64	82,288 (30.87%)	32,111 (32.21%)
65+	50,162 (18.82%)	18,421 (18.48%)
Rurality		
Urban	216,055 (83.16%)	82,227 (84.65%)
Province		
British Columbia	18,597 (6.98%)	9,309 (9.34%)
Alberta	71,299 (26.74%)	27,999 (28.09%)
Ontario	163,567 (61.35%)	57,183 (57.36%)
Nova Scotia	12,141 (4.55%)	4,997 (5.01%)
Newfoundland	877 (0.33%)	188 (0.19%)
Quebec	117 (0.04%)	7 (0.01%)
Deprivation level		
Material		
1 (most deprived)	35,806 (28.41%)	13,617 (27.84%)
2	28,541 (22.64%)	11,191 (22.88%)
3	23,934 (18.99%)	9,440 (19.30%)
4	21,176 (16.80%)	8,123 (16.61%)
5 (least deprived)	16,587 (13.16%)	6,538 (13.37%)
Missing	140,554	50,774
Social		
1 (most deprived)	24,746 (19.63%)	9,161 (18.73%)
2	28,014 (22.23%)	10,609 (21.69%)
3	27,483 (21.80%)	10,840 (22.16%)
4	22,721 (18.03%)	8,942 (18.28%)
5 (least deprived)	23,080 (18.31%)	9,357 (19.13%)
Missing	140,554	50,774

RTI = respiratory tract infection.

area. Where a deprivation score could be created, there was an even distribution of patients in each social deprivation category in both time periods. In contrast, over one in four patients fell into the least materially deprived categories in both time periods.

Our analyses revealed that the prevalence of an acute RTI visit, as a proportion out of all visits to a primary care provider, dropped by 47.3% in the post-COVID-19 pandemic period (from 3.59% to 1.89%). Table 2 shows that the distribution of visits by RTI syndrome remains similar between the pre-COVID-19 pandemic and post-COVID-19 pandemic period for otitis media and sinusitis, with a slight drop for those diagnosed with pharyngitis (1.3%). There was a more substantial drop in visits for patients diagnosed with a common cold (8.4%) and an increase in visits for those diagnosed with bronchitis/asthma (9.5%) in the post-COVID-19 pandemic period. Compared with the pre-COVID-19 pandemic period, in-person visits decreased by 37% and virtual visits correspondingly increased.

TABLE 2. Pre- and post-pandemic visits for those diagnosed with an RTI

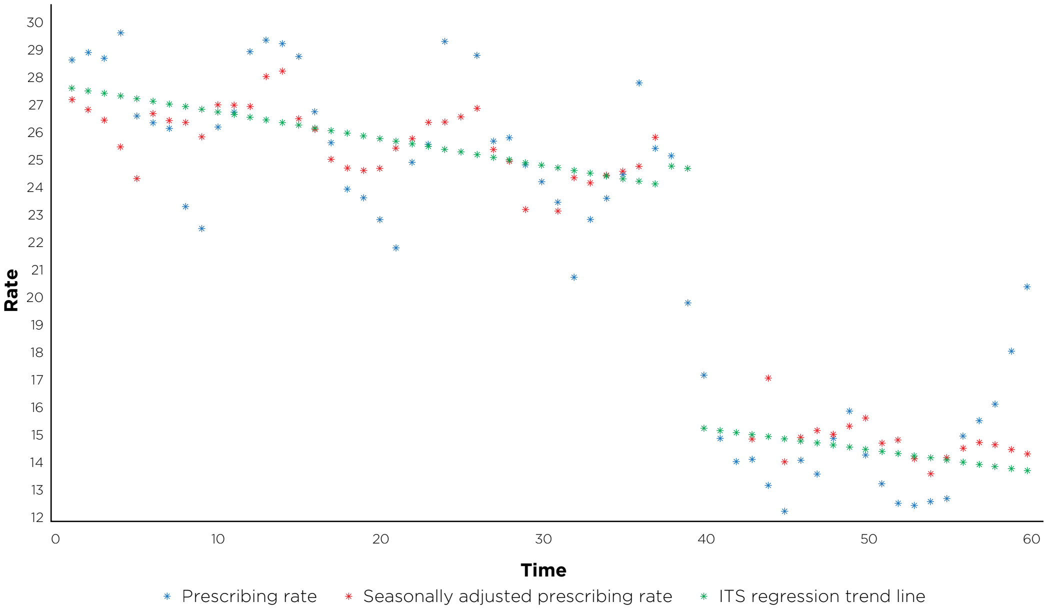
Characteristic	Pre-pandemic period (January 2017–February 2020)	Post-pandemic period (March 2020–December 2021)
Visits	*n* = 518,779	*n* = 162,541
RTI syndrome		
Otitis media	61,416 (11.84%)	19,894 (12.24%)
Common cold	207,978 (40.09%)	51,469 (31.67%)
Sinusitis	55,019 (10.61%)	16,916 (10.41%)
Pharyngitis	57,872 (11.16%)	16,036 (9.87%)
Acute bronchitis/asthma	136,494 (26.31%)	58,226 (35.82%)
Visit type		
Face-to-face	428,848 (73.87%)	67,911 (37.75%)
Virtual	3,287 (0.57%)	67,326 (37.42%)
Missing	148,432 (25.57%)	44,679 (24.83%)

RTI = respiratory tract infection.

Our results show that the pre- pandemic RTI antibiotic prescribing rate was 27.8% in 2017, falling by 0.1% each month. The onset of the COVID-19 pandemic led to a 9.4% statistically significant ($p < 0.001$) drop in prescribing in April of 2020 (see Figure 1). For this same time period, the antibiotic prescribing rates for UTI dropped slightly but was not statistically significant (see Figure A1, available online at longwoods.com/content/27093).

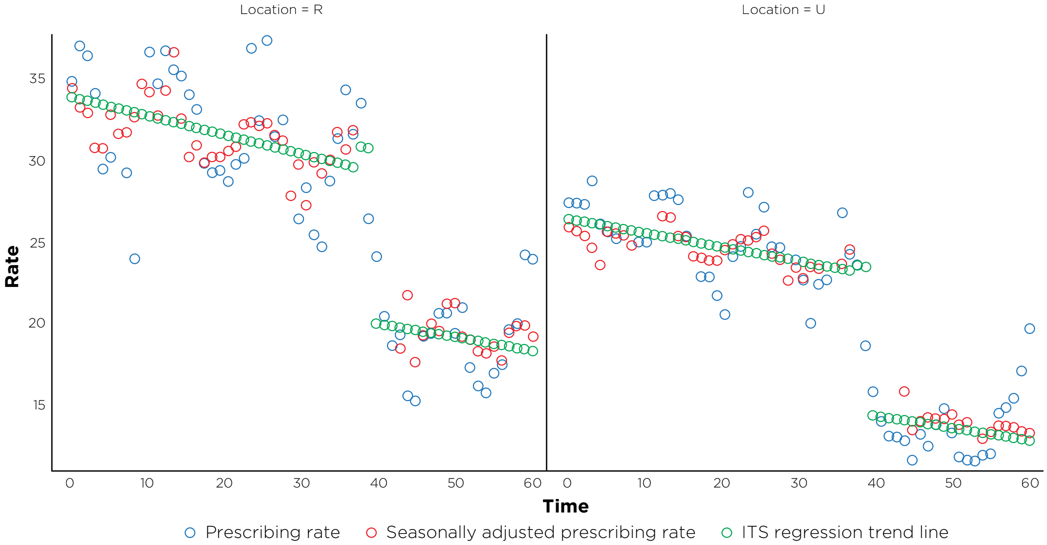
While this observed trend was consistent in both rural and urban settings, the baseline prescribing rate was significantly higher in patients living in a rural setting (see Figure 2).

FIGURE 1. ITS regression of antibiotic prescribing rates for RTI



ITS = interrupted time series; RTI = respiratory tract infection.
Blue asterisks signify the observed monthly prescribing rates over time; red asterisks signify observed monthly prescribing rates with variance adjusted for seasonality; green asterisks signify the regression line.

FIGURE 2. ITS results for antibiotic prescribing rates in rural versus urban settings



ITS = interrupted time series; R = rural; U = urban.
Blue circles signify the observed monthly prescribing rates over time; red circles signify the observed monthly prescribing rates with variance adjusted for seasonality; green circles signify the regression line.

Analyses of antibiotic prescribing rates by provincial CPCSSN site suggests variability in baseline prescribing rates and the subsequent effect of the COVID-19 pandemic on prescribing levels (see Figure A2, available online at longwoods.com/content/27093). British Columbia, Alberta and Ontario had significant ($p < 0.001$) decreases in antibiotic prescribing rates. The same trend was not seen for Nova Scotia or Newfoundland.

Our analyses revealed that patients at all social and material deprivation levels experienced a significant drop in receiving an antibiotic prescription for their RTI (see Table 3). Interestingly, the baseline (pre-COVID-19 pandemic) trend reveals that patients with less social and material deprivation (more privilege) were being prescribed an antibiotic less often over time, with the rate of reduction three times higher than in patients with higher deprivation. This suggests treatment for RTI differed by deprivation level.

TABLE 3. ITS regression of antibiotic prescribing rates for RTI, by social and material deprivation level

Parameter	Estimate	Standard error	*t* value	*p* value
More socially deprived (3–5)[‡]				
Intercept β0	23.6306	0.5804	40.71	<0.0001
Baseline trend β1	-0.0273	0.0271	-1.01	0.3190
Step change immediately after the start of the pandemic β2	-9.4301	1.9172	-4.92	<0.0001
Trend change immediately after the start of the pandemic β3	0.005327	0.0405	0.13	0.8957
Less socially deprived (1–2)[‡]				
Intercept β0	27.4206	0.6568	41.75	<0.0001
Baseline trend β1	-0.0901	0.0308	-2.93	0.0050
Step change immediately after the start of the pandemic β2	-10.9715	2.1734	-5.05	<0.0001
Trend change immediately after the start of the pandemic β3	0.0364	0.0458	0.80	0.4298
More materially deprived (3–5)[‡]				
Intercept β0	25.1660	0.6573	38.28	<0.0001
Baseline trend β1	-0.0137	0.0307	-0.45	0.6571
Step change immediately after the start of the pandemic β2	-8.8168	2.1130	-4.17	0.0001
Trend change immediately after the start of the pandemic β3	-0.0104	0.0447	-0.23	0.8176
Less materially deprived (1–2)[‡]				
Intercept β0	25.3687	0.5932	42.77	<0.0001
Baseline trend β1	-0.0928	0.0278	-3.34	0.0015
Step change immediately after the start of the pandemic β2	-11.0257	1.9688	-5.60	<0.0001
Trend change immediately after the start of the pandemic β3	0.0412	0.0416	0.99	0.3263

ITS = interrupted time series; RTI = respiratory tract infection.

[‡] Significant autocorrelation (seasonality) in the data series; an autoregressive term was included in the model.

Regression modelling shows that RTI prescribing rates did not significantly change based on whether the visit was in-person or virtual (see Table A3, available online at longwoods.com/content/27093).

Discussion

A silver lining of the COVID-19 pandemic was a significant drop in potentially avoidable antibiotic prescribing in primary care. Certainly, the COVID-19 pandemic with its associated public health measures influenced a change in the epidemiology of circulating viruses (Kitano et al. 2021). It is also likely that patients with RTI were seen less often (Knight et al. 2022), because of other factors including: patient choice, more serious healthcare needs taking precedence and any benefits of implementing public health measures that reduced the rates of all communicable diseases (Brueggemann et al. 2021). Nonetheless, extrapolating our findings to the population, there could be almost 750,000 fewer patients prescribed a potentially avoidable antibiotic for RTI in primary care. Put another way, there could be 1.4 million fewer visits where an antibiotic was prescribed. Our analyses suggest evidence that technical value was added in that fewer potentially avoidable antibiotic prescriptions were generated.

The reason for the disparity in which rural areas saw higher antibiotic prescribing for RTI versus urban areas during the first year of the COVID-19 pandemic is not known. One possibility may be related to the differential impact of the COVID-19 pandemic, which saw a lower prevalence of COVID-19 in rural areas but potentially more marked changes in clinician–patient interactions where people were concerned regarding antibiotic supply. It is not surprising that those who had higher material or social deprivation received slightly higher antibiotic prescriptions for RTI compared with those who had lower deprivation. Past work suggests those with low socio-economic status (and, therefore, higher deprivation) have higher use when healthcare services are accessed (Langton et al. 2020). While we did not see any difference in antibiotic prescribing for RTIs by modality of visit, more work is needed to understand if this trend would continue.

Contributions of primary care in decreasing potentially avoidable prescribing could result in increased societal value. The use, including avoidable use, of antimicrobials continues to increase (OECD 2018). Today, the number and breadth of resistant organisms are mounting to unprecedented levels (CCA 2019). The global increase in AMR resulted in over 4.9 million deaths globally in 2019 and $1.4–$4.7 billion in costs to healthcare across North America and Europe (CCA 2019). While the emergence of AMR is a natural process, selection for these traits is facilitated by the overuse of antimicrobials (Olesen et al. 2018).

Consortiums such as the CPCSSN and primary care clinicians in collaboration with federal, provincial and territorial ministries of health could lead efforts in building a pan-Canadian EMR repository as an invaluable resource. These data can be used for practice improvement, health system planning, public health surveillance and policy making, especially when linked to other administrative data. EMR data are an important resource because of clinical data that are held within these electronic charts. Collecting these data once to be used by many actors, ranging from clinicians and practice staff to policy makers, for the purposes of public good and improved quality of healthcare is possible to inform practice improvement and healthcare resource allocation. Indeed, appropriate permissions to use de-identified data for quality improvement, public health surveillance, health system planning and research would be a prerequisite.

In the case of antibiotic prescribing for an RTI, EMR data analyzed by trusted third parties (e.g., CPCSSN in partnership with its network of practising primary care clinicians) could then partner with primary care practices and practice improvement organizations to deliver regular reports about prescribing for RTI at the practice, regional and federal levels. If the target audience was primary care practices, the reports could include Choosing Wisely antibiotic guidelines and alternative tools such as a viral prescription pad for clinicians to use when working with patients who have an RTI. If the target audience were regional or federal, policy makers could partner with primary care and public health leaders to develop strategies to incentivize appropriate prescribing (clinician behaviour) and public health media campaigns aimed at changing patient behaviour.

At the practice level, the ability for individual prescribers to see their own data compared with their peers' data can spur practice improvement. Clinicians' EMR data can be used to develop insights through a plan-study-do-act cycle. Practice teams can tailor treatment by delivering a viral prescription (Choosing Wisely Canada 2020) or other team-based care interventions to help patients meet their healthcare needs.

At the health systems level (provincial, territorial and federal) investment in a pan-Canadian primary care EMR repository develops an essential data source toward a public health communicable and non-communicable disease surveillance system containing data from the community. Primary care practice data could help public health professionals conduct surveillance and community assessments, while access to public health data for primary care team members allows them to observe information on community needs beyond the "micro" practice level and conduct proactive risk identification (Committee on Integrating Primary Care and Public Health et al. 2012). The primary care EMR data fill a gap because accurate measurement of antibiotic prescribing practices, for example, in primary care remains virtually nonexistent in Canada even though existing institutional programs are effective and have resulted in reduced antibiotic use and AMR (Cecchini et al. 2015; Price et al. 2018).

The EMR data ought to be linkable to other existing publicly funded administrative datasets (e.g., hospital discharge abstracts, dispensed medications) to provide additional value for health systems planning. Networks such as the Canadian Primary Care Research Network (https://cpcrn-rcrsp.ca/) and Chronic Disease Networks (CIHR 2022) play important roles in bringing together patients, clinicians and practice-based research learning networks (PBRLNs) and policy and decision makers to carry out further research and development. These networks can create virtual/online collaborative learning communities for PBRLNs (Westfall et al. 2019) where they use the data for learning purposes. For example, our work suggests antibiotic prescribing for RTI in the pre-COVID-19 pandemic period was heterogenous. These learning communities provide opportunities for clinicians and practices of provincial PBRLNs to learn and generate practice knowledge that could be tailored to their provincial context.

Limitations

This work should be interpreted with caution. The EMR data captures what is prescribed in participating practices. It is possible that patients could go elsewhere (e.g., walk-in clinics) to obtain prescriptions. This work captures only data from participating clinicians and clinics; therefore, potentially avoidable antibiotic prescriptions may be underreported. Some of the prescriptions deemed avoidable may, in fact, not be avoidable after considering clinical presentation. We, therefore, have used the term "potentially avoidable" throughout this work. The data are only as accurate as what is entered into the EMR by the clinician. It is possible that RTI was over-reported early during the COVID-19 pandemic. Lower antibiotic prescribing rates in primary care could have occurred given public health efforts to direct people to COVID-19 centres. Finally, EMR data quality efforts are relatively nascent when compared with administrative data. However, this large dataset has shown unique insights not possible with more developed administrative data sources.

Despite its limitations, this study provides evidence for the value of developing EMR data further as a pan-Canadian resource. This resource can be collected once and used by many. Clinicians and their practice staff could use these data for driving practice improvement. Individual clinicians can compare their own data with that of their peers in their practice or geographical area for purposes of individual reflection. Larger practices could work with a practice improvement lead to nudge improvements at the practice level. For example, practices could incorporate reports derived from their EMR data into a plan-do-study-act cycle on decreasing potentially avoidable antibiotic prescriptions for RTI. With appropriate approvals and permissions, researchers and health system planners could use data for directing resources upstream to primary care and public health efforts. One example is Hennepin Health in Minnesota, an accountable care organization with four partners: the Hennepin County Human Services and Public Health Department; the Hennepin County Medical Center; North Point Health, a federally qualified health centre; and the Metropolitan Health Plan, a non-profit, county-run, Medicaid-managed care plan. They all rely on EMR data linked to health plan billings and enrollment and social service records (Sandberg et al. 2014). Data are provided through an electronic dashboard tailored to team members' needs. These data are also used by the care organization to stratify people into risk tiers and to have community health workers and social workers connect those at the highest risk to primary care and other medical, behavioural or social services.

Conclusion

In conclusion, this work uses the case of potentially inappropriate antibiotic prescribing for RTIs to illustrate the value of EMR data. Using these data to inform policies and practices aimed at altering the potentially inappropriate use of antibiotics in primary care can strengthen healthcare systems and improve individuals' healthcare outcomes.

Disclaimer

The statements expressed herein are solely those of the authors and do not reflect those of the data source, the National Institutes of Health, the Department of Health and Human Services or the United States government; no endorsement is intended or should be inferred.

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