Outpatient Antibiotic Prescribing by Manitoba Clinicians:

Technical Appendix

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Ambulatory Visits

Ambulatory visits include almost all contacts with physicians; this includes office visits, walk-in clinics, home visits, emergency department visits and visits to outpatient departments. In this study, visits to Nurse Practitioners (NP) were excluded from ambulatory care visits due to the inability to link a NP visit to prescription dispensations in the DPIN data. Visits by patients who are inpatients (admitted to an acute care hospital) are not considered ambulatory visits. Outpatient surgeries and diagnostic tests and procedures are also not considered ambulatory visits.

Antibiotics Included in this Study

Antibiotics

ATC Code	Generic Drug Name
J01A TETRACYCLINES	
J01AA02	DOXYCYCLINE
J01AA07	TETRACYCLINE
J01AA08	MINOCYCLINE
J01C β-LACTAM ANTIBACTERIALS, PENICILLINS	
A02BD07	LANSOPRAZOLE, AMOXICILLIN AND CLARITHROMYCIN
J01CA01	AMPICILLIN
J01CA04	AMOXICILLIN
J01CE02	PENICILLIN V
J01CE10	PENICILLIN V
J01CF02	CLOXACILLIN
J01CR02	AMOXICILLIN/CLAVULANIC ACID
J01D OTHER β-LACTAM ANTIBACTERIALS (CEPHALOSPORINS)	
J01DB01	CEPHALEXIN
J01DB05	CEFADROXIL
J01DC02	CEFUROXIME
J01DC04	CEFACLOR
J01DC10	CEFPROZIL
J01DD08	CEFIXIME
J01E SULFONAMIDES AND TRIMETHOPRIMs	
J01EA01	TRIMETHOPRIM
J01EC01*	SULFAMETHOXAZOLE
J01EE01	TRIMETHOPRIM/SULFAMETHOXAZOLE

*These drugs not included in Chapter 3

Antibiotics Continued

ATC Code	Generic Drug Name
J01F MACROLIDES, LINCOSAMIDES AND STREPTOGRAMINS	
A02BD07	LANSOPRAZOLE, AMOXICILLIN AND CLARITHROMYCIN
J01FA01	ERYTHROMYCIN
J01FA02	SPIRAMYCIN
J01FA09	CLARITHROMYCIN
J01FA10	AZITHROMYCIN
J01FF01	CLINDAMYCIN
J01M QUINOLONE ANTIBACTERIALS	
J01MA01	OFLOXACIN
J01MA02	CIPROFLOXACIN
J01MA06	NORFLOXACIN
J01MA12	LEVOFLOXACIN
J01MA14	MOXIFLOXACIN
J01X OTHER ANTIBACTERIALS	
J01XC01*	FUSIDATE
J01XD01	METRONIDAZOLE
J01XE01	NITROFURANTOIN
J01XX01	FOSFOMYCIN
J01XX05	METHENAMINE
J01XX08	LINEZOLID
P01AB01	METRONIDAZOLE
A07A INTESTINAL ANTIINFECTIVES	
A07AA09**	VANCOMYCIN
A07AA12**	FIDAXOMICIN

**These drugs were excluded from Chapters 3 and 4

Charlson Comorbidity Index

The Charlson Comorbidity Index is a method for measuring patient comorbidity based on the International Classification of Diseases (ICD) diagnoses codes of individual patients from physician visits and hospitalizations. Each of the 17 comorbidity categories has an associated weight, based on the adjusted risk of one-year mortality, and the sum of all the weights results in a single comorbidity score for a patient. A score of zero indicates that no comorbidities were found. The higher the score, the more likely the predicted outcome will result in higher resource use or mortality. The Charlson Comorbidity Index was included as a patient-level covariate in regression models predicting appropriate/inappropriate use of antibiotics to adjust for patient comorbidity.

Conditions that Generally Do Not Require Antibiotics

Condition	ICD-9-CM diagnosis codes
Acute bronchitis, exclude in diagnosis on same visit includes ChronicObstructive Pulmonary Disorder (COPD)	466, 490 (exclude COPD: 491, 492, 496)
Asthma and allergic rhinitis	477, 493
Cough	786
Upper respiratory tract infection (i.e., common cold)	460

Conditions that May Require Antibiotics

Condition	ICD-9-CM diagnosis codes	ATC codes for Appropriate Antibiotics	ATC codes for Inappropriate Antibiotics
Acute laryngitis/Tracheitis	464		
Otitis media, includes both acute and chronic	381, 382	none or amoxicillins (J01CA), amoxicillin/clavulinic acid (J01CR), or J01DC (2nd gen cephalosporins), ceftriaxone (J01DD04)	other antibiotics
Pharyngitis, includes acute pharyngitis, acute tonsillitis and strep throat	034, 462, 463	**Model 1:** J01CA or J01CE (penicillins/amoxicillin) + substitution for allergy: macrolides (J01FA) or 1st generation cephalosporin (J01DB) vs inappropriate (other antibiotic) **Model 2:** J01CA or J01CE (penicillins/amoxicillin) vs any other antibiotic	
Pneumonia, includes both bacterial and viral	480, 481, 482, 483, 484, 485, 486	Pneumonia in children: amoxicillin/penicillin (J01CA/J01CE) or none	Pneumonia in children: other antibiotics
Sinusitis, includes both acute and chronic	461, 473		

Conditions that Usually Require Antibiotics

Condition	ICD-9-CM diagnosis codes	ATC codes for Appropriate Antibiotics	ATC codes for Inappropriate Antibiotics
Skin and soft tissue infections including cellulitis and abscess, erysipelas, cellulitis and abscess of finger and toe, impetigo, carbuncles and furuncles and other local infections of the skin and subcutaneous tissue	035, 680, 681, 682, 684, 686	other antibiotics/none	fluroquinolone (J01M)
Urinary tract infections and kidney infections	590, 595	other antibiotics/none	macrolides (J01F)

Hospitalizations

These are inpatient hospitalizations during which patients are formally admitted to the hospital for diagnostic, medical, or surgical treatment and typically stay for one or more days. Multiple admissions of the same person were combined into one hospital episode if an admission occurred within one day of the previous discharge. Out-of-province hospitalizations were not included.

Linking Prescription Dispensations to Health Care Encounters

Prescription dispensations for the Manitoba study population (see Population) were linked to ambulatory (physician) visits, hospitalizations, both in general and pairing diagnosis codes for specific conditions with specific antibiotics.

For Chapter 5 (linkage to physician visits), prescription dispensations from calendar years 2011-2016 were linked to physician visits based on a match of scrambled Personal Health Identification Number (PHIN), prescriber ID and date, with the date of the prescription dispensation being the same day or up to five days after their most recent visit. Linkage

of prescriptions to physician visits is limited to clinicians with a College of Physicians and Surgeons of Manitoba Number (CPSNum) as this enables linkage of prescriber ID on the DPIN prescription record to clinician ID on the physician billing record. Visits from General Practitioners, Paediatricians and Specialists were included; all other providers were excluded. Nurse practitioners (NP) do not have a CPSNum, so we are unable to link prescriptions from NPs to patients' visits to NPs. If patients had multiple physician visits on the same day, to the same clinician, these were considered duplicates for the purpose of linkage to the prescription record, and only one physician visit was kept to be linked to a prescription. Likewise, if multiple antibiotics prescriptions were linked to a single physician visit, only one prescription was linked to that visit to obtain a 1:1 linkage ratio.

Also for Chapter 5 (linkage to hospital visits), dispensations from calendar years 2011-2016 were linked to inpatient hospital episodes based on a match of scrambled PHIN and date, with the date of the prescription dispensation being the same day as hospitalization discharge or up to two days after their hospital stay. Hospital episodes account for transfers between inpatient facilities and a hospital admission that occurs within one day of previous discharge is considered a continuous stay in hospital. A very small number of prescriptions were linked to two hospital episodes; these cases were considered duplicates for the purpose of linkage to the prescription record, and only one hospital episode was kept to be linked to a prescription. If multiple prescriptions were linked to a single hospital episode, only one prescription was linked to that hospital stay to obtain a 1:1 linkage ratio.

For Chapter 6, prescription dispensations from calendar years 2011 and 2016 were linked to physician visits and inpatient hospital episodes as described above for Chapter 5. The aim was to link an antibiotic prescription to specific diagnosed medical conditions, so it was essential to remove any possible duplicate linkages of one prescription to multiple health care encounters. If prescriptions linked to both a visit and hospital episode, then those health care encounters were excluded as an ambiguous linkage. Occurrences of multiple physician visits by a patient to the same physician on the same day were also considered an ambiguous linkage and excluded. However, if a health care encounter was linked to multiple antibiotics prescriptions, only one prescription was linked to that health care encounter to obtain a 1:1 linkage ratio.

For multi-level modelling in Chapter 6, prescription dispensations from calendar years 2014-2016 were linked to physician visits and inpatient hospital episodes as described above for Chapter 5. The aim was to have a unique 1:1 link between specific antibiotic prescriptions to specific diagnosed medical conditions to assess possible inappropriate prescribing patterns. In these analyses any possible ambiguous linkages were excluded, i.e., if prescriptions linked to both a visit and hospital episode, then those health care encounters were excluded; health care encounters that linked to multiple prescriptions were excluded, and occurrences of multiple physician visits by a patient to the same physician on the same day were excluded.

For the purposes of comparing characteristics of linked and unlinked prescriptions in Chapter 5, all matches were allowed, i.e., multiple physician visits or hospital episodes to one prescription or multiple prescriptions to one health care encounter. This analysis was limited to prescriptions in 2014-2016, as starting in 2014 prescriber type information was available in DPIN to inform the linkage rate. Prescriber types include physicians, NPs, midwives, pharmacists, dentists, and optometrists.

Majority of Care Provider

A majority of care provider is a physician from which an individual receives more than 50% of their ambulatory care, as opposed to two or more other providers. Majority of care providers included General Practitioners/Family Physicians as well as Paediatricians for children and Internal Medicine Specialists for senior residents age 60 or older. Majority of care was measured in the two years prior to the physician visit where antibiotics were prescribed (note: measured two years prior to prescription dispensation date for objective 2.5). Individuals with two or fewer ambulatory visits were included as low users of accessing primary care. This indicator of primary care was included as a patient-level covariate in regression models predicting appropriate/inappropriate use of antibiotics to adjust for continuity in access to primary care.

Number of Children in Household

The number of children, stepchildren, grandchildren under age 18 registered within one family were obtained from the Manitoba Health Insurance Registry. The most recent registry family information available within 2 years from an antibiotics prescription dispensation date was used to count all dependents age 18 and younger who were part of the same registry family, i.e., under the same Manitoba Health Registration Number as the resident who was prescribed the antibiotic. The number of children was included as a patient-level covariate in regression models (limited to children only) predicting appropriate/inappropriate use of antibiotics to adjust for family size.

Physician Characteristics

Physician characteristics were included in multi-level models predicting appropriate or inappropriate prescribing of antibiotics for select conditions. Select characteristics were defined via the Provider Registry, which contains demographic and training information on physicians licensed to practice in Manitoba. These included: age as of December 31, 2014, sex, medical training location (classified as Canada, USA or Other), and always fee-for-service payment vs. salaried (if ever paid by salary in 2014-2016). Other characteristics were defined using administrative health data from medical claims and hospital abstracts as follows: the average number of patient visits per day over 2014-2016, limited to days with at least two patients in a day, divided by five; hospital privileges in any year (if an MD number ever appears in hospital data in 2014-2016); always primary care vs any other specialty (based on billings in 2014-2016); and practice location per month, defined as the most frequent RHA of residence of all the patients who visited the physician during each month.

Prescriber Specialty

Specialists are physicians whose practices are focused on a specific area of medicine in which they have undergone additional training. They are identified by a code value in the MDBLOC variable in the Medical Services (Physician Claims) data. All MDBLOC codes other than 11 General/Family Practice, 02 Paediatrics, and 20 Nurse Practitioner/Primary Care Nurse are classified as specialists.

Primary Care Provider

Primary care providers are professionals that provide primary care services to patients in an outpatient setting. In this study, primary care providers include General Practitioners/Family Physicians and Paediatricians. Nurse Practitioners were excluded due to the inability to link a NP visit to prescription dispensations in the DPIN data.

Socio-Economic Factor Index

The Socio-Economic Factor Index (SEFI) is a factor score derived from Census data that reflects non-medical social determinants of health and is used as a proxy measure of socioeconomic status (SES). SEFI scores less than zero indicate more favourable socioeconomic conditions, while SEFI scores greater than zero indicate less ideal socioeconomic conditions. Census variables included in the SEFI are average household income, percent of single-parent households, unemployment rate and high school education rate. SEFI scores were included as a patient-level covariate in regression models predicting appropriate/inappropriate use of antibiotics to adjust for patient SES.