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Original Study

Utilization of Antibiotics in Long-Term Care Facilities in British Columbia, Canada

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A B S T R A C T

Background: Antibiotic use is highly prevalent in long-term care facilities (LTCFs); a resident's annual exposure to at least 1 course of antibiotic is approximately 50% to 80%. The objective of this study was to understand the extent of antibiotic use in the population of residents in British Columbia's (BC) LTCFs from 2007 to 2014.

Methods: Antibiotic prescription data for LTCF residents was extracted from the central prescription database and linked to the physician billing plan to obtain antibiotic indication. Total defined daily dose (DDD) per 1000 residents per day was calculated.

Results: Our database had 381 LTCFs with an average of nearly 24,694 residents annually and 419,036 antibiotic prescriptions. Antibiotic utilization did not change dramatically between 2007 and 2014, ranging from 39.2 in 2007 to 35.2 DDD per 1000 residents per day in 2014. Although usage of most antibiotics declined, use of moxifloxacin, amoxicillin-clavulanate, doxycycline, and amoxicillin increased significantly. The indication most frequently linked to prescription was urinary tract infection (6.58 DDD per 1000 residents per day), with nitrofurantoin, ciprofloxacin, and trimethoprim/sulfamethoxazole being the most commonly prescribed agents. This was followed closely by prescriptions for respiratory infections (5.34 DDD per 1000 residents per day), with moxifloxacin being the most commonly prescribed antibiotic, primarily for upper respiratory tract infection (URTI), whereas doxycycline is used commonly for lower respiratory tract infection. Duration of antibiotic therapy in LTCF residents has decreased significantly from 9.29 days to 7.3 days per prescription in 2014.

Conclusion: Antibiotic use in LTCFs is high relative to the general population. Our study underscores that stewardship in LTCFs should continue to focus on length of treatment, appropriate detection of urinary tract infections, and avoidance of treating URTIs with antibiotics.

Antibiotics are the most prescribed drug in long-term care facilities (LTCFs); a resident's annual exposure to at least 1 course of antibiotic is approximately 50% to 80%.[1,2] This is not surprising, as most residents are elderly with comorbid conditions living in close proximity. Notably, long-term care residents are prone to urinary tract infections (UTIs), skin and soft tissue infections (SSTIs), and respiratory tract infections (RTIs).[1,3]

Numerous studies have reported increasing use of broad-spectrum antibiotics as well as inappropriate use of antibiotics.[4–8] For example, studies have found that antibiotics are prescribed for asymptomatic bacteriuria in two-thirds of the elderly within LTCFs.[9–11] Overuse of antibiotics in LTCFs as well as use of broad-spectrum agents increases the potential for multidrug resistance. Furthermore, LTCFs can act as reservoirs for multidrug-resistant organisms and potentially transfer them to other settings (eg, transfers to hospitals, health care professionals returning to community).[12,13] Inappropriate antibiotic use also increases the risk of adverse drug events and conditions for which LTCF residents are particularly susceptible, such as *Clostridium difficile* infection.[14]

The authors declare no conflicts of interest.

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To address the challenges of antibiotic resistance, antimicrobial stewardship efforts have been developed in acute care settings, where multidisciplinary teams of health care workers promote judicious antibiotic use. Antimicrobial stewardship programs (ASPs) address the "appropriate selection, dosing, route, and duration of antimicrobial therapy."[15,16] ASPs in the hospital setting have been effective in reducing *Clostridium difficile* infection rates, antibiotic usage, and reduced pharmacy expenditures.[17,18] While considering enhanced efforts in antimicrobial stewardship in British Columbia's (BC) LTCFs,[19,20] this study was launched to characterize antibiotic use in the full population of residents in care.

Methods

In Canada, residential care facilities vary, ranging from small homes for persons with physical or developmental disabilities to large-scale facilities primarily for elderly seniors. In general, all residential care facilities fall under the term "long-term care facilities," which refers to facilities that provide nursing care to the elderly and disabled in the community.

The Ministry of Health in BC houses several health care–related databases, which have comprehensive information on most of the population that lives in BC (population of 4.6 million). One of these systems is PharmaNet, a centralized data system that links all pharmacies with every prescription dispensed through community pharmacies. All antimicrobials are recorded in this system except those used for treatment of sexually transmitted infections and human immunodeficiency virus. The antibiotic information was extracted from this database under Plan B data, a pharmaceutical coverage plan for LTCF residents.

We also used the Medical Service Plan (MSP) billing system that records all reimbursement claims submitted by health practitioners for medically required services provided to BC residents, including the diagnostic codes. Antibiotic prescriptions from January 1, 2007, to December 31, 2014, were extracted from PharmaNet with anonymous patient identifiers that were then used to match to the MSP billing system for indication (ie, diagnostic codes). A prescription was assigned a diagnostic code using an algorithm that matches prescriptions in which the dispensing date occurred within 5 days of a practitioner service date on an MSP billing claim. If a practitioner service date was associated with more than 1 diagnostic code, or multiple service dates fell within the 5-day period of a prescription dispensing date, then a hierarchy was applied to link only the most relevant diagnostic code to the prescription.

Antibiotics were classified based on the Anatomical Therapeutic Chemical (ATC) classification system developed by World Health Organization (WHO). Defined daily dose (DDD) was used to calculate consumption rates as the number of DDDs consumed daily for every 1000 long-term care residents (DDD per 1000 residents per day). Provincial population estimates were obtained from BC stats. Long-term care population denominator values were estimated from the BC Ministry of Health Home and Community Care database that records each individual commencing or ending a stay at one of BC's LTCFs. Using client prescription records associated with "Plan B" PharmaCare coverage to identify which facilities were associated with Plan B coverage, the Ministry provided a monthly cross section of the residents in each "Plan B" LTCF by gender and age group. To calculate annual estimates, monthly totals of all residents across all "Plan B" facilities in a given year were averaged. Due to the cross-sectional nature of these denominator estimates, person-time (DDD per resident-days) could not be determined, thus DDD per 1000 residents per day was used as a proxy measure. The MSP diagnostic codes were based on the ninth revision of the *International Classification of Diseases* developed by WHO, commonly referred to as ICD-9. We grouped several indications within the classification of UTIs, SSTIs, and RTIs (Appendix Table A1).

We analyzed the data first with respect to overall rate of antibiotic use, then according to use of the 7 major classes and finally we evaluated clinically relevant antibiotics being used within each class such as tetracycline and doxycycline for the class of tetracyclines [J01A]; penicillin V, amoxicillin, ampicillin, amoxicillin/clavulanate, and cloxacillin within the class of penicillins [J01C]; cephalexin, cefuroxime, and cefixime for the class of cephalosporins [J01D]; trimethoprim/sulfamethoxazole [J01E]; erythromycin, clarithromycin, and azithromycin for the class of macrolides [J01FA]; clindamycin for the class of lincosamides [J01FF]; ciprofloxacin, levofloxacin, and moxifloxacin for the class of quinolones [J01M]; and nitrofurantoin within the class of other antibacterials [J01X]. For all of the groupings, we also evaluated changes in use by gender, age group, and indication. All analyses were performed using SAS 9.4 (SAS Institute, Cary, NC), and R version 3.3.1. Linear yearly trends of antibiotic consumption were explored using the Spearman correlation test, and the antibiotic consumption rate between 2 individual years or groups were compared using the Poisson test. All tests were 2-tailed at the 5% significance level.

Ethics was granted by the University of British Columbia under the certificate H09-00650.

Results

Overall Antibiotic Use in BCs LTCFs

There were 197,548 residents in 381 LTCFs, averaging 24,694 residents per year (Table 1). As there were a total of 119,483 residents who received antibiotics in our prescription claims database, more than half of all residents in LTCFs (60.5%) were prescribed antibiotics. Most residents were between the ages of 80 and 89 years (44.2%). Additionally, women were overrepresented among residents prescribed antibiotics (n = 133,753; 67.7%). Residents in the cohort represented all 5 health authorities in BC, although the largest proportion were from the Fraser Health Authority (29.8%) followed by Vancouver

Table 1
Demographics for Long-Term Care Residents Between 2007 and 2014

Characteristic	2007 n (%)	2014 n (%)	Overall (2007–2014) n (%)
Cohort total	22,347	26,527	197,548
Age group, y			
<20	1 (0.004)	1 (0.003)	16 (0.008)
20–39	65 (0.3)	91 (0.3)	642 (0.3)
40–49	200 (0.9)	171 (0.6)	1,520 (0.8)
50–59	524 (2.3)	625 (2.4)	4706 (2.4)
60–69	1228 (5.5)	1694 (6.4)	11,719 (5.9)
70–79	4071 (18.2)	4525 (17.1)	33,999 (17.2)
80–89	10,159 (45.5)	11,103 (41.9)	87,250 (44.2)
90+	6099 (27.3)	8316 (31.4)	57,697 (29.2)
Gender			
Female	15,280 (68.4)	17,685 (66.7)	133,753 (67.7)
Male	7026 (31.4)	8833 (33.3)	63,618 (32.2)
Unknown	41 (0.2)	8 (0)	178 (0.1)
Health authority			
Interior	4394 (19.7)	5724 (21.6)	40,840 (20.7)
Fraser	6952 (31.1)	7625 (28.7)	58,853 (29.8)
Vancouver Coastal	6307 (28.2)	6562 (24.7)	51,948 (26.3)
Vancouver Island	3891 (17.4)	5637 (21.2)	38,691 (19.6)
Northern	803 (3.6)	980 (3.7)	7,217 (3.7)
Diagnosis			
UTI	10,475 (23.9)	10,181 (18.5)	90,114 (21.5)
RTI	5070 (11.5)	5653 (10.3)	47,333 (11.3)
SSTI	2910 (6.6)	2967 (5.4)	25,519 (6.1)
Other infections	15,530 (35.4)	22,848 (41.4)	156,358 (37.3)
Unmatched	9913 (22.6)	13,477 (24.4)	99,712 (23.8)
Number of antibiotic prescriptions	43,898	55,126	419,036