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MAJOR ARTICLE

National Cohort Study of Homebound Persons Living With Dementia: Antibiotic Prescribing Trends and Opportunities for Antibiotic Stewardship

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Background. Over 7 million older Americans are homebound. Managing infections in homebound persons presents unique challenges that are magnified among persons living with dementia (PLWD). This work sought to characterize antibiotic use in a national cohort of PLWD who received home-based primary care (HBPC) through the Veterans Health Administration.

Methods. Administrative data identified veterans aged ≥65 years with ≥2 physician home visits in a year between 2014 and 2018 and a dementia diagnosis 3 years before through 1 year after their initial HBPC visit. Antibiotics prescribed orally, intravenously, intramuscularly, or by enema within 3 days of an HBPC visit were assessed from the initial HBPC visit to death or December 31, 2018. Prescription fills and days of therapy (DOT) per 1000 days of home care (DOHC) were calculated.

Results. Among 39 861 PLWD, the median age (interquartile range [IQR]) was 85 (78–90) years, and 15.0% were Black. Overall, 16 956 (42.5%) PLWD received 45 122 prescription fills. The antibiotic use rate was 20.7 DOT per 1000 DOHC. Telephone visits and advanced practice provider visits were associated with 30.9% and 42.0% of fills, respectively. Sixty-seven percent of fills were associated with diagnoses for conditions where antibiotics are not indicated. Quinolones were the most prescribed class (24.3% of fills). The overall median length of therapy (IQR) was 7 (7–10) days. Antibiotic use rates varied across regions. Within regions, the median annual antibiotic use rate decreased from 2014 to 2018.

Conclusions. Antibiotic prescriptions were prevalent in HBPC. The scope, appropriateness, and harms of antibiotic use in homebound PLWD need further investigation.

Keywords. antibacterial agents; antimicrobial stewardship; dementia; home care services.

In the United States, a growing population of persons rarely leave home or leave home only with assistance or significant difficulty [1, 2]. These persons are considered homebound. It is estimated that 7 million older adults were homebound in 2020, a number far greater than the nursing home population with whom they share many similarities [1, 2]. Homebound persons are often unable to access office-based primary care, and outpatient services cannot address the full scope of their needs [3]. Home-based primary care (HBPC) provides one method for homebound persons to obtain comprehensive care.

There are unique challenges to the evaluation and management of infection in HBPC. Patients who receive HBPC have numerous risk factors for infection including frailty, functional impairments, and multimorbidity [4–7]. These patients may exhibit nonspecific features of infection, and nearly 80% are persons living with dementia (PLWD) who may not be able to express localizing symptoms [1, 2, 8]. Suspected infections are commonly diagnosed among PLWD [9]. Concurrently, HBPC providers have limited access to diagnostic testing in the home and frequently rely on caregivers to help assess clinical changes among homebound PLWD [10]. Implementation guidelines for antibiotic stewardship from the Infectious Diseases Society of America (IDSA) and Society for Healthcare Epidemiology of America (SHEA) do not address this special population [11]. The overall complexity of clinical decision-making in HBPC raises the prospect of widespread antibiotic use.

There is a paucity of data regarding antibiotic prescribing in HBPC. Prior work has been restricted to single-center analyses of urinary tract infection using historical data that have limited generalizability [12]. Comprehensive studies of antibiotic prescriptions in large populations in HBPC are lacking. There is a need to evaluate antibiotic prescribing in HBPC to reduce harms

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associated with antibiotics. Antibiotics predispose to infection with multidrug-resistant organisms and *Clostridioides difficile.* Additionally, many antibiotics are potentially inappropriate in older adults, and polypharmacy and age-associated physiologic changes increase the risk of adverse drug events [8, 13]. This study sought to characterize antibiotic prescription dispensing in a national cohort of homebound PLWD who received HBPC.

METHODS

Study Design

This cohort study identified patients who received HBPC within the Veterans Affairs (VA) health care system between January 1, 2014, and December 31, 2018. This time period coincides with the first 5 years of the Veterans Health Administration Directive 1031, which required all VA acute care facilities to implement, maintain, and evaluate antimicrobial stewardship programs [14]. The VA is the largest integrated health care system in the United States and provides care through 170 medical centers over 22 geographic regions. The HBPC program operates in 139 medical centers and served >55 000 patients in 2018 through interdisciplinary care teams consisting of primary care providers (eg, physicians and advanced practice providers [APPs] including physician assistants or advanced practice registered nurses), nurses, psychologists, psychiatrists, social workers, therapists, dietitians, and pharmacists [15].

Data Source

Data were obtained from the VA Corporate Data Warehouse (CDW), a comprehensive database that auto-extracts from the electronic medical record all patient encounters, demographics, pharmacy utilization, and vital status information from October 1999 through the current time [16]. CDW contains International Classification of Diseases, Ninth and Tenth Edition, Clinical Modification diagnosis codes that are entered by providers and associated with patient encounters. Prescription medications from non-VA health care systems were not evaluated. Approximately 20% of PLWD may receive prescription medications from non-VA health care systems through the Medicare Part D prescription drug program [17].

Study Population

PLWD who received longitudinal care through HBPC were included in the cohort if the following inclusion criteria were met: (1) receipt of ≥2 in-person home visits by a physician within a calendar year, (2) age ≥65 years at the time of the initial physician home visit, and (3) a diagnosis of dementia [18–22]. Dementia was defined as a corresponding diagnosis code (Appendix A) from 1 inpatient or 2 outpatient encounters [23]. Due to increased screening for dementia following enrollment in HBPC, diagnosis codes were assessed from encounters within 3 years before to 1 year after the initial physician home visit [6]. The follow-up period for all cohort members was defined as the date of the first in-person home visit by a physician after January 1, 2014, to the date of death or December 31, 2018, whichever came first.

Estimates of Antibiotic Prescription Fills

To describe antibiotic use in HBPC, multiple prescribing metrics were examined. These included (1) the proportion of patients who filled an antibiotic prescription; (2) the antibiotic use rate, defined as days of therapy (DOT) per 1000 days of home care (DOHC); (3) the total number of antibiotic prescription fills; (4) length of therapy, defined as DOT divided by number of antibiotic prescription fills; and (5) the antibiotic fill rate, defined as the number of antibiotic prescription fills per 1000 DOHC. To identify antibiotics prescribed by an HBPC provider, antibiotic prescription fills were included if they had a fill date within 3 calendar-days before or after an HBPC visit. Antibiotics administered orally, intravenously, intramuscularly, or by enema were evaluated. Those with a subcutaneous, topical, vaginal, ophthalmic, otic, or nasal route of administration were excluded. Consistent with IDSA and SHEA guidelines, 1 DOT was defined as the administration of a single antibiotic on a given day regardless of the number of doses or dosing strength [11]. DOHC were defined as the number of days from the initial physician home visit to the end of follow-up.

Diagnosis Codes Associated With Antibiotic Prescription Fills

Antibiotic prescription fills were associated with diagnosis codes from HBPC visits that occurred within 3 calendar-days of the fill date (eg, for antibiotics with fill dates on June 10, 2018, diagnosis codes from HBPC visits between June 7, 2018, and June 13, 2018, were evaluated). This time window was adapted from previously described methods and the knowledge that logistical challenges of home care may cause HBPC visits to occur after antibiotic prescriptions are filled [10, 24]. Because HBPC visits may occur with any member of the interdisciplinary care team, diagnosis codes from HBPC visits were classified using a hierarchy. Initially, diagnosis codes from HBPC visits with providers who were licensed to prescribe antibiotics were identified. Diagnosis codes from HBPC visits with physicians were identified first, and if none were detected, then diagnosis codes from HBPC visits with APPs were identified. If no diagnosis codes from HBPC visits with any of the aforementioned providers were identified, then diagnosis codes from HBPC visits with other providers (eg, pharmacists) were utilized.

The appropriateness of antibiotic prescription fills was assessed by adapting a comprehensive classification scheme of diagnosis codes [24]. This classification scheme was designed to apply to any administrative data set and was derived from methods used previously [25, 26]. Categories included “always” if the diagnosis code represented a condition that is almost always treated with antibiotics (eg, pneumonia), "sometimes" if the diagnosis code represented a condition that is occasionally treated with antibiotics (eg, acute otitis media), and "never" if the diagnosis code (1) represented an infectious condition that is not treated with antibiotics (eg, viral infection), (2) represented a noninfectious condition that is not treated with antibiotics (eg, diabetes mellitus) and was therefore noninformative, or (3) was absent. Antibiotic prescription fills were then assigned into 1 of 3 mutually exclusive categories describing whether the diagnosis code justified antibiotics: "always" if associated with at least 1 "always" diagnosis code, "sometimes" if associated with at least 1 "sometimes" code but no "always" codes, and "never" if associated with only "never" codes.

Analysis

Descriptive statistics were used to characterize patients who did and did not fill antibiotic prescriptions by age (65–74, 75–84, and 85 years and older), sex, self-reported race (White, Black, other, and unknown, including missing, unknown, or declined to answer), Hispanic ethnicity, marital status (married, divorced/separated, never married/single, and widowed), comorbidities, region, and mortality. Comorbidities were identified using diagnosis codes from 1 inpatient or 2 outpatient encounters in the year before the initial physician home visit and were selected a priori based on their potential to predispose to infection or antibiotic-associated harms. Comorbidities included diabetes, congestive heart failure, cerebrovascular disease, cardiopulmonary disease, peripheral vascular disease, and renal disease [27]. As prescribing patterns may vary regionally, the region in which patients resided was encoded by Veterans Integrated Service Networks (VISN) as follows: Northeast (VISNs 1, 2, and 3), Mid-Atlantic (VISNs 4, 5, 6, 9, and 10), South (VISNs 7, 8, 16, and 17), Midwest (VISNs 11, 12, 15, 19, and 23), and West (VISNs 18, 20, 21, and 22).

Antibiotic prescription fills were categorized by class, number of patients, number of fills, total DOT, visit type (telephone or in-person), and provider type (physician, APP, registered nurse or licensed practical nurse, or other). Given the high potential for harm associated with quinolones and recommendations from the Centers for Disease Control and Prevention, IDSA, and SHEA to reduce quinolone use, prescription fills were further stratified by quinolones and described with respect to patient and provider characteristics [11]. Finally, antibiotic prescription fills were examined over time. Because of the known variation in prescribing patterns by geography, the Jonckheere-Terpstra test of trend was used to evaluate whether the median annual antibiotic use rate varied over time within each region [28, 29]. All analyses were conducted using SAS 9.4 (Cary, NC, USA).

Ethics Statement

This study was reviewed by the Institutional Review Board at the Veterans Affairs Connecticut Healthcare System and the Human Investigation Committee at Yale University and deemed exempt from review.

RESULTS

Study Cohort

Between 2014 and 2018, there were 7 201 418 HBPC visits among 173 776 patients. Of these, 77 863 patients received ≥2 physician home visits within a calendar year and were aged ≥65 years at the time of the initial physician home visit. After excluding patients lacking a dementia diagnosis (n = 35 192) and patients who filled an antibiotic >3 days before or after an HBPC visit (n = 2810), a total of 39 861 patients from 128 medical centers were identified. The median age at the time of the initial physician home visit (interquartile range [IQR]) was 85 (78–90) years. Overall, 97.0% were male, 15.0% were Black, 6.4% were of Hispanic ethnicity, and 30.0% were from the Southern United States (Table 1). The median duration of follow-up (IQR) across all cohort members was 513 (257–935) days. Over half (56.7%) of patients died during follow-up.

Antibiotic Prescription Fills

Overall, 42.5% of patients filled at least 1 antibiotic prescription within 3 days of an HBPC visit. Among patients who filled an antibiotic prescription, the largest proportion were aged ≥85 years (46.5%), White (74.9%), married (52.0%), or diagnosed with diabetes (42.2%) (Table 1). The overall antibiotic use rate was 20.7 DOT per 1000 DOHC (Table 2). The antibiotic use rate per year varied across regions, with the lowest rates observed in the Northeast (Figure 1). Within each region, the median annual use rate decreased over time.

A total of 45 122 antibiotic prescription fills were identified during the study period (Table 2). Nearly one-third (30.9%) of fills were associated with HBPC telephone visits, and 42.0% were associated with APP visits. The most common antibiotic classes filled included quinolones (24.3%), aminopenicillins (16.6%), and sulfonamides/related agents (12.3%). Among fills for quinolones, 45.2% occurred in patients aged ≥85 years and 32.3% occurred in patients from the South (Table 3).

Across all antibiotic prescription fills, the median length of therapy (IQR) was 7 (7–10) days. The median length of therapy (IQR) ranged from 7 to 10 days among the most common classes (quinolones, 7.0 [6–10] days; aminopenicillins, 10.0 [7–10] days; and sulfonamides/related agents, 10.0 [7–10] days). The overall antibiotic fill rate was 1.8 fills per 1000 DOHC.

Associated Diagnosis Codes

Sixty-seven percent of antibiotic prescription fills were associated with diagnosis codes for conditions where antibiotics are almost never indicated. Of these, the majority were associated with noninfectious noninformative diagnoses, such as chronic

Table 1. Characteristics of Homebound Persons Living With Dementia who Received Home-Based Primary Care Within the Veterans Affairs Health Care System According to Antibiotic Prescription Fills, 2014–2018

Characteristic	Total (n = 39 861), No. (%)	No Fills (n = 22 905), No. (%)	≥1 Fill (n = 16 956), No. (%)
Age			
65–74 y	7028 (17.6)	3522 (15.4)	3506 (20.7)
75–84 y	12 676 (31.8)	7117 (31.1)	5559 (32.8)
≥85 y	20 157 (50.6)	12 266 (53.6)	7891 (46.5)
Male sex	38 658 (97.0)	22 282 (97.3)	16 376 (96.6)
Race			
White	29 517 (74.0)	16 823 (73.5)	12 694 (74.9)
Black	5989 (15.0)	3336 (14.6)	2653 (15.7)
Other	1024 (2.6)	598 (2.6)	426 (2.5)
Unknown	3331 (8.4)	2148 (9.4)	1183 (7.0)
Ethnicity[a]			
Non-Hispanic	36 705 (93.6)	21 024 (93.8)	15 681 (93.4)
Hispanic	2486 (6.4)	1383 (6.2)	1106 (6.6)
Marital status[b]			
Married	21 665 (54.8)	12 928 (56.9)	8737 (52.0)
Divorced/separated	6643 (16.8)	3505 (15.4)	3138 (18.7)
Never married/single	1882 (4.8)	1037 (4.6)	845 (5.0)
Widowed	9333 (23.6)	5244 (23.1)	4089 (24.3)
Comorbidities			
Diabetes	15 227 (38.2)	8069 (35.2)	7158 (42.2)
Chronic pulmonary disease	11 590 (29.1)	5580 (24.4)	6010 (35.4)
Cerebrovascular disease	10 417 (26.1)	5422 (23.7)	4995 (29.5)
Renal disease	7570 (19.0)	3951 (17.3)	3619 (21.3)
Peripheral vascular disease	7565 (19.0)	3806 (16.6)	3759 (22.2)
Congestive heart failure	6484 (16.3)	3125 (13.6)	3359 (19.8)
Region			
Northeast	4551 (11.4)	3056 (13.3)	1495 (8.8)
Mid-Atlantic	11 238 (28.2)	6405 (28.0)	4833 (28.5)
South	11 943 (30.0)	6789 (29.6)	5154 (30.4)
Midwest	6481 (16.3)	3487 (15.2)	2994 (17.7)
West	5648 (14.1)	3168 (13.8)	2480 (14.6)
Death during follow-up			
No	17 244 (43.3)	9867 (43.1)	7377 (43.5)
Yes	22 617 (56.7)	13 038 (57.0)	9579 (56.5)

[a]Ethnicity unknown (n = 667).

[b]Marital status unknown (n = 338).

or other conditions (Figure 2). The most common diagnosis codes in this category included essential hypertension (18%), organic brain syndromes (13%), and diabetes mellitus without complication (10%). Less than 1% (n = 25/45 122) of fills had no associated diagnosis code from an HBPC visit. Fourteen percent of antibiotic prescription fills were associated with diagnosis codes for conditions where antibiotics are almost always indicated, including urinary tract infection (10%), pneumonia (2%), and gastrointestinal infection including *Clostridioides difficile* infection (1%). Nineteen percent of antibiotic prescription fills were associated with diagnosis codes for conditions where antibiotics are sometimes indicated including lower respiratory infections (9%), skin and soft tissue infections (7%), and ear, nose, and throat infections (1%).

DISCUSSION

Despite the substantial challenges that providers face in diagnosing and treating infections among homebound PLWD, there has been limited prior work evaluating antibiotic use in this population. This study aimed to address this gap in knowledge by conducting the first systematic description, to our knowledge, of antibiotic prescriptions among PLWD receiving HBPC. In this national study of nearly 40 000 homebound PLWD who received HBPC, the prevalence of antibiotic prescriptions was substantial. Over 40% of homebound PLWD filled at least 1 antibiotic prescription within 3 days of an HBPC visit between 2014 and 2018. Quinolones were the most frequently filled antibiotic class, and the median length of therapy was often prolonged. Additionally, 67% of prescription fills lacked diagnosis codes that justified antibiotics, most commonly due to the presence of noninfectious noninformative conditions. Collectively, these findings underscore the need for further investigation regarding the scope, appropriateness, and harms of antibiotic use in in-home care settings.

This work suggests that the rate of antibiotic use in HBPC approaches the rate of antibiotic use in some nursing homes. A recent analysis of 1664 nursing homes found a rate of 30 DOT per 1000 resident-days among long-stay residents [30]. The current study identified a rate of 30.0 DOT per 1000 DOHC in the Midwest in 2014. Moreover, it is probable that the current study underestimated the use of antibiotics in HBPC. Antibiotic prescriptions that were filled in non-VA locations were not evaluated, and nearly 20% of veterans, including those living with dementia, receive antibiotics from external sources each year [17, 31]. Additionally, the DOHC denominator did not exclude time intervals spent in nursing homes or hospitals, which may vary among patients. These findings have added significance given that increasing numbers of patients receive home care each year, and the annual risk of becoming homebound is 3–5 times greater than the risk of becoming a nursing home resident [2, 32, 33]. In addition, whereas literature regarding the role of antibiotic stewardship in nursing homes is abundant, reports concerning antibiotic stewardship in home care are scarce [12].

Notably, the most common antibiotics prescribed to homebound PLWD were quinolones despite their classification by the American Geriatrics Society as potentially inappropriate medications in older adults [13]. In 2016, the Food and Drug Administration (FDA) issued a warning that the serious side effects associated with quinolones generally outweigh the benefits for patients with uncomplicated urinary tract infections, one of the most commonly diagnosed infections in older adults including PLWD [34]. Moreover, quinolones have been associated with aortic aneurysm, rupture, and dissection, prompting the FDA to issue a subsequent warning advising that quinolones be avoided in older adults [35]. In this study, all patients

Table 2. Distribution of Antibiotic Prescription Fills in Homebound Persons Living With Dementia Within 3 Days of a Home-Based Primary Care Visit

Antibiotic Class[a]	Patients	Fills	DOT	Fills per 1000 Days of Home Care	DOT per 1000 Days of Home Care	Length of Therapy, Median (IQR), d
Total	16 956	45 122	529 633	1.76	20.69	7 (7–10)
Quinolones	6841	10 969	99 106	0.43	3.87	7 (6–10)
Penicillins, amino Derivatives	4981	7501	71 966	0.29	2.81	10 (7–10)
Sulfonamides/related agents	3667	5555	81 948	0.22	3.20	10 (7–10)
Cephalosporins, 1st generation	3516	4810	58 236	0.19	2.28	10 (7–10)
Tetracyclines	3377	5388	94 318	0.21	3.68	10 (7–14)
Erythromycins/macrolides	3116	4662	46 948	0.18	1.83	5 (5–5)
Cephalosporins, 3rd generation	1252	1714	14 070	0.07	0.55	7 (5–10)
Lincomycins	1088	1429	13 886	0.06	0.54	10 (7–10)
Cephalosporins, 2nd generation	803	1056	10 518	0.04	0.41	10 (7–10)
Metronidazole	730	887	9722	0.03	0.38	10 (7–14)
Vancomycin oral	226	389	7528	0.02	0.29	14 (10–28)
Penicillin-G related Penicillins	122	180	3737	0.01	0.15	10 (7–14)
Linezolid	93	111	1034	0.00	0.04	7 (5–10)

Abbreviations: DOT, days of therapy; IQR, interquartile range.

[a]Findings shown are restricted to antibiotic classes administered to 50 or more patients.

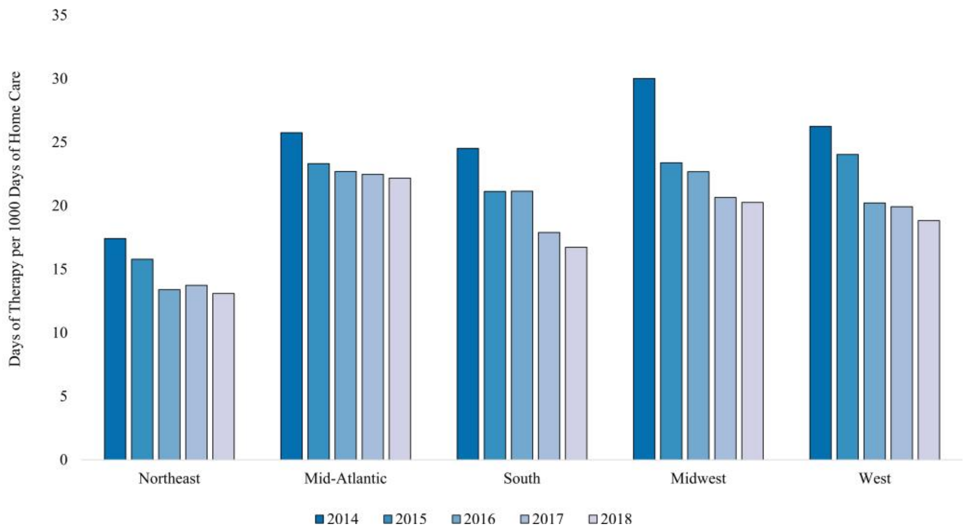

Figure 1. Antibiotic prescription fills within 3 days of a home-based primary care visit among homebound persons living with dementia as measured by days of therapy per 1000 days of home care per year stratified by region and year. The median annual rate of antibiotic prescription fills varied over time within the Northeast ($P < .0001$), Mid-Atlantic ($P = .0009$), South ($P < .0001$), Midwest ($P < .0001$), and West ($P < .0001$). The number of patients alive per year was 13 196 in 2014, 17 572 in 2015, 20 444 in 2016, 22 894 in 2017, and 23 327 in 2018. The number of deaths per year was 2206 in 2014, 3913 in 2015, 4835 in 2016, 5580 in 2017, and 6083 in 2018.

were older adults, and nearly half of quinolone fills occurred in patients aged ≥85 years. It is possible that the perceived risk of decompensation among frail homebound PLWD may motivate providers to prescribe quinolones due to their broad spectrum of activity, high bioavailability, and ease of dosing. Additionally, length of therapy may be prolonged due to the potential challenges of obtaining diagnostic or confirmatory testing in HBPC and the difficulty of assessing response to therapy in homebound PLWD.

It is necessary to better understand clinical reasoning and documentation practices among HBPC providers. Two-thirds of antibiotic prescription fills were associated with conditions where antibiotics are almost never indicated. It is notable that many of these associated diagnoses represented noninfectious conditions that provide minimal insight as to the justification for antibiotics. Qualitative interviews of HBPC providers and manual audits of antibiotic prescriptions may provide more information regarding the rationale for antibiotic treatment. It is also possible that providers may not accurately record the indication for antibiotics using diagnosis codes. Prior work from primary care clinics in the VA health care system found that the condition for which an antibiotic was prescribed was not

Table 3. Characteristics of Antibiotic Prescription Fills in Homebound Persons Living With Dementia by Specified Antibiotic Class, 2014–2018

Characteristic	Quinolones (n = 10 969), No. (%)	Non-Quinolones (n = 34 153), No. (%)
Age		
65–74 y	2347 (21.4)	8531 (25.0)
75–84 y	3663 (33.4)	11 294 (33.1)
≥85 y	4959 (45.2)	14 328 (42.0)
Male sex	10 574 (96.4)	32 976 (96.6)
Race		
White	7979 (72.7)	26 086 (76.4)
Black	2024 (18.5)	5071 (14.9)
Other	313 (2.9)	900 (2.6)
Unknown	653 (6.0)	2096 (6.1)
Ethnicity[a]		
Not Hispanic	10 138 (93.1)	32 014 (94.4)
Hispanic	749 (6.9)	1898 (5.6)
Marital status[b]		
Married	5583 (51.3)	17 567 (51.9)
Divorced/separated	2096 (19.3)	6554 (19.4)
Never married/single	507 (4.7)	1652 (4.9)
Widowed	2700 (24.8)	8088 (23.9)
Comorbidities		
Diabetes	4869 (44.4)	15 278 (44.7)
Chronic pulmonary disease	4073 (37.1)	13 878 (40.6)
Cerebrovascular disease	3571 (32.6)	10 584 (31.0)
Renal disease	2494 (22.7)	7863 (23.0)
Peripheral vascular disease	2608 (23.8)	8229 (24.1)
Congestive heart failure	2198 (20.0)	7587 (22.2)
Region		
Northeast	786 (7.2)	2691 (7.9)
Mid-Atlantic	3144 (28.7)	10 547 (30.9)
South	3538 (32.3)	9745 (28.5)
Midwest	2086 (19.0)	6185 (18.1)
West	1415 (12.9)	4985 (14.6)
Provider		
Physician	1338 (12.2)	3967 (11.6)
APP	4734 (43.2)	14 206 (41.6)
RN or LPN	3951 (36.0)	12 567 (36.8)
Other	946 (8.6)	3413 (10.0)

Abbreviations: APP, advanced practice practitioner; RN or LPN, registered nurse or licensed practical nurse.

[a]Ethnicity unknown (n = 323).

[b]Marital status unknown (n = 375).

listed in primary or secondary diagnosis codes in 54.5% of encounters [36]. Improved documentation is necessary to support large-scale assessments of antibiotic prescribing in HBPC.

Findings from this investigation support the rationale for additional pharmacoepidemiologic studies of antibiotic use in HBPC. Half of patients received a length of therapy >7 days. However, recent clinical trials support the safety and effectiveness of shorter courses for common infections in older adults including urinary tract infection and community-acquired pneumonia [37, 38]. Telephone visits were associated with nearly one-third of prescriptions, and prior data suggest that antibiotics prescribed by telephone are largely empiric and broad-spectrum [39]. Consistent with prior national studies, this work identified regional variation in the antibiotic use rate [28]. It is possible that variation in comorbid conditions, provider characteristics, access to health care, and health care–seeking behavior among homebound PLWD may contribute to the observed regional variation. Additionally, within each region, there was variation in the median annual antibiotic use rate over time. This may be attributable, at least in part, to the implementation and maintenance of antimicrobial stewardship programs across all VA acute care facilities in 2014 [14].

These data have implications for the design and implementation of antibiotic stewardship interventions tailored to HBPC. To inform potential outcome measures, more precise estimates of time in HBPC are needed. This may be possible using administrative data sets, such as the HBPC Masterfile. Antibiotics dispensed by pharmacies outside the VA health care system should be included in future estimates. This may be ascertained through the use of linked data from the VA and Centers for Medicare and Medicaid Services. Additionally, studying the structure of HBPC interdisciplinary care teams (eg, presence or number of pharmacists) may provide clues as to the feasibility of potential interventions. For example, antibiotic stewardship interventions in HBPC might engage pharmacists, who have been shown to increase appropriate prescribing and reduce potentially inappropriate medications in HBPC [40]. There may be a role for telehealth to expand access to specialists, an identified need in HBPC, with expertise in antibiotic stewardship [9]. Furthermore, there are limited data regarding the use of diagnostic testing (eg, urine cultures, respiratory virus panels, chest x-rays, blood tests) in HBPC. Future studies of antibiotic stewardship in HBPC may consider evaluating access to and utilization of diagnostic testing before antibiotic prescribing.

This work has several limitations. Cohort members were identified using home visits by a physician rather than HBPC enrollment files. This criterion may lack sensitivity for HBPC patients. Nevertheless, this approach has been adapted from prior work [18–22]. The initial home visit by a physician also may not represent the time of HBPC enrollment. However, the potential for bias is low given that HPBC patients average >3 visits per month across all interdisciplinary care team members including primary care providers [6]. Despite evaluating antibiotic prescription fills, it is unknown whether cohort members actually consumed antibiotics as prescribed. Finally, the method by which antibiotic prescriptions were associated with HBPC providers and diagnosis codes was adapted from prior investigations [24–26]. Medical record review will be required to establish the magnitude and direction of any misclassification bias. Categorizing the appropriateness of antibiotic prescription fills was also limited by the use of diagnosis codes and lack of confirmatory diagnostic testing.

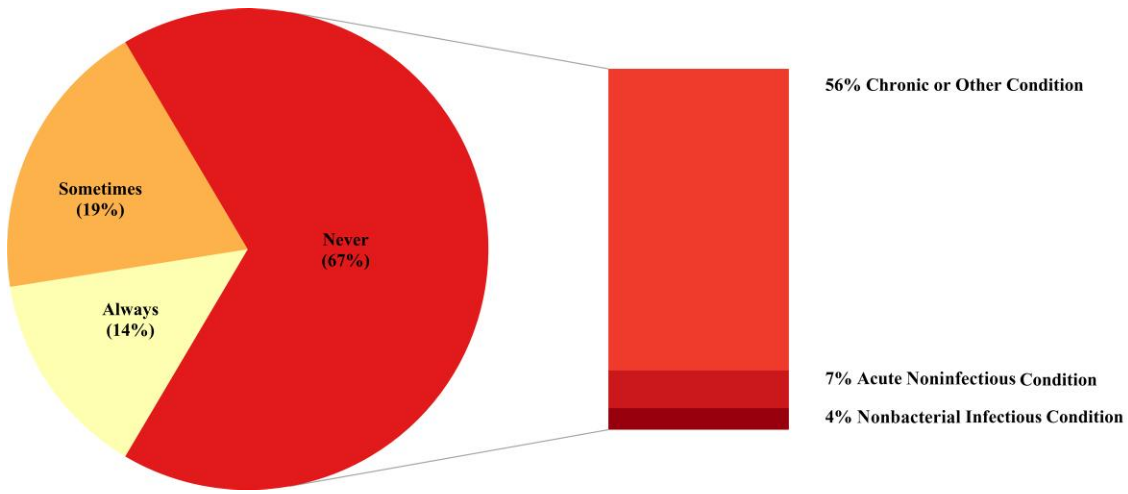

Figure 2. Diagnosis codes associated with antibiotic prescriptions within 3 days of a home-based primary care visit among homebound persons living with dementia between 2014 and 2018 (n = 45 122) categorized by conditions where antibiotics are almost always indicated (14%), conditions where antibiotics are sometimes indicated (19%), and conditions where antibiotics are never indicated (67%).

In summary, between 2014 and 2018, antibiotic prescription fills were widespread among homebound PWLD who received HBPC. Quinolones were the most filled class, and length of therapy was often prolonged. A substantial fraction of fills were associated with telephone visits, APP visits, and diagnoses for conditions where antibiotics are almost never indicated. Additionally, antibiotic use rates varied across regions. This study establishes a foundation for further investigation in antibiotic stewardship in the unique and understudied setting of home care.

APPENDIX A

Diagnosis codes from all coding positions (eg, principal diagnosis, secondary diagnosis, etc.) were used to identify dementia from inpatient and outpatient encounters as specified below.

ICD-9 Codes

Applied to data before October 1, 2015:

331.0, 331.11, 331.19, 331.2, 331.7, 290.0, 290.10, 290.11, 290.12, 290.13, 290.20, 290.21, 290.3, 290.40, 290.41, 290.42, 290.43, 294.0, 294.10, 294.11, 294.20, 294.21, 294.8, 797.

ICD-10 Codes

Applied to data on or after October 1, 2015:

F01.50, F01.51, F02.80, F02.81, F03.90, F03.91, F04, G13.8, F05, F06.1, F06.8, G30.0, G30.1, G30.8, G30.9, G31.1, G31.2, G31.01, G31.09, G94, R41.81, R54.

Supporting Resources

Please see algorithms for "Alzheimer's Disease," "Non-Alzheimer's Dementia," and "Alzheimer's Disease and Related Disorders or Senile Dementia" for additional information. Available at: https://www2.ccwdata.org/web/guest/condition-categories-chronic. Last accessed August 9, 2022.

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Patient consent. The design of the work has been approved by local ethical committees, and the names of the authorizing bodies are stated in the paper.

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