Antibiotic Use in Ontario Facilities That Provide Chronic Care

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OBJECTIVE: **To determine the incidence and variability of antibiotic use in facilities which provide chronic care and to determine how often clinical criteria for infection are met when antibiotics are prescribed in these facilities.**

DESIGN: **A prospective, 12-month, observational cohort study.**

SETTING: **Twenty-two facilities which provide chronic care in southwestern Ontario.**

PARTICIPANTS: **Patients who were treated with systemic antibiotics over the study period.**

MEASUREMENTS: **Characteristics of antibiotic prescriptions (name, dose, duration, and indication) and clinical features of randomly selected patients who were treated with antibiotics.**

RESULTS: **A total of 9,373 courses of antibiotics were prescribed for 2,408 patients (66% of the patients in study facilities). The incidence of antibiotic prescriptions in the facilities ranged from 2.9 to 13.9 antibiotic courses per 1,000 patient-days. Thirty-six percent of antibiotics were prescribed for respiratory tract infections, 33% for urinary infections, and 13% for skin and soft tissue infections. Standardized surveillance definitions of infection were met in 49% of the 1,602 randomly selected patients who were prescribed antibiotics. Diagnostic criteria for respiratory, urinary, and skin infection were met in 58%, 28%, and 65% of prescriptions, respectively. One third of antibiotic prescriptions for a urinary indication were for asymptomatic bacteriuria. Adverse reactions were noted in 6% of prescriptions for respiratory and urinary infections and 4% of prescriptions for skin infection.**

CONCLUSIONS: **Antibiotic use is frequent and highly variable amongst patients who receive chronic care. Reducing antibiotic prescriptions for asymptomatic bacteriuria represents an important way to optimize antibiotic use in this population.**

KEY WORDS: **antibiotic use; chronic care facilities; infection. J GEN INTERN MED 2001;16:376–383.**

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The study was presented in part at the 38th Interscience Conference on Antimicrobial Agents and Chemotherapy, San Diego, Calif, September 24–27, 1998.

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Antibiotics are frequently prescribed to older adults who reside in long-term care facilities. The median rate of systemic antibiotic use reported in this population is 7 courses per 1,000 resident-days, which is similar to the incidence of antibiotic use in acute care hospitals.[1–5] Although the spread of multiresistant bacteria poses the greatest challenge to acute care hospitals,[6] the detection of antibiotic-resistant bacteria in long-term care facilities, including multiresistant Enterobacteriaceae, enterococci resistant to aminoglycosides or vancomycin, and methicillin-resistant *Staphylococcus aureus*, has led to increasing concern about the use of antibiotics in this population.[7–15] The potential for bacterial resistance, adverse drug reactions, and the financial costs associated with antibiotic use warrant that they be prescribed judiciously to older persons residing in long-term care facilities.[16] Although bacterial infections in this population are common,[17,18] between 22% and 89% of antibiotic prescriptions in residents of long-term care facilities have been described as inappropriate.[2,3,19,20]

For clinicians, the decision whether or not to prescribe an antibiotic to a long-term care facility resident can be difficult. Often, clinical signs are nonspecific, and the resident may not be capable of expressing symptoms due to cognitive, hearing, or speech impairment. Frequently, important microbiological diagnostic sources, such as sputum cultures, cannot be obtained, and diagnostic tools, such as x-rays, are not easily available. It is not surprising that the prescription of antibiotics for residents of long-term care facilities is most often empiric, i.e., without the benefit of Gram stain or culture results.[16] Relatively few studies have evaluated the appropriateness of the initiation of empiric antibiotics in residents of long-term care facilities.[2,3,19]

We conducted a prospective study to determine the incidence and variability of antibiotic use in facilities providing chronic care in southwestern Ontario. Using standardized consensus definitions of infection for long-term care facilities,[21] we also determined how often clinical criteria for infection were met when antibiotics were prescribed in these facilities.

METHODS

Study Facilities

The majority of patients who receive chronic care in Ontario are older than 65 years and require more than 3 hours of nursing care per day.[22] This population is similar to residents of skilled nursing homes in the United States. In Ontario, chronic care is provided both by chronic care hospitals and by acute care hospitals with chronic care beds. Therefore, both types of facilities were enrolled in this study. Specialized chronic care hospitals (such as respiratory, spinal cord, or psychiatric facilities) and units providing primarily rehabilitation or palliative care were excluded. All 33 eligible facilities providing chronic care in south-central and southwestern Ontario were invited to participate in the study.

Each of the participating facilities and the institutional review board of the University of Toronto approved the study.

Data Collection

Patients who were being treated with systemic antibiotics were identified prospectively over the 12-month study period (November 1996 to October 1997) by each facility's infection control practitioner through daily review of pharmacy records. Data collected included the name of the antibiotic prescribed, route, start and stop date of administration, and site of infection for which the antibiotic was prescribed. Number of beds, staffing characteristics, and antibiotic-related policies were also recorded for each study facility.

To document the clinical features present in patients for whom antibiotics were prescribed, a random sample of 10 antibiotic courses, stratified by the presumed site of infection, was selected at 4-month intervals. Since smaller facilities generate fewer prescriptions, all antibiotic courses were reviewed for facilities with less than 75 beds. Data abstracted from patient charts included patient demographic, clinical, and laboratory information. Outcomes of antibiotic treatment, including adverse reactions and death, were also recorded. Since lower respiratory, urinary, and skin and soft tissue infections comprise the majority of bacterial infections in long-term care facilities,[17,18] prescriptions for these indications were assessed to see if they fulfilled diagnostic criteria based on definitions of infection for long-term care facilities[21] (Table 1). In the absence of a validated reference standard for assessing antibiotic use, these clinical definitions, although intended for surveillance purposes, provide a conservative standard for assessing antibiotic prescribing. To ensure accurate data abstraction, an audit of the chart abstraction at each facility for at least 5 of the first 10 prescriptions was performed. Data abstraction was considered acceptable if 80% or more of the items matched.

Statistical Analysis

Data entry was performed using EPI-INFO (Version 6.02, CDC, Atlanta, Ga). Logistic regression using

Table 1. Definitions[21]

Infection Type	Symptoms and Signs
Lower respiratory tract infection	At least 3 of the following: a) New or increased cough b) New or increased sputum production c) Fever (≥38°C) d) Pleuritic chest pain e) New or increased physical findings on chest exam f) New/increased shortness of breath or respiratory rate more than 25 per minute or worsening mental or functional status
Urinary tract infection	1. If the resident does not have a chronic indwelling catheter and has at least 3 of the following signs and symptoms: a) Fever (≥38°C) or chills b) New or increased burning pain on urination, frequency, or urgency c) New flank or suprapubic pain or tenderness d) Change in character of urine e) Worsening of mental or functional status 2. If the resident has an indwelling catheter and has at least two of the following signs or symptoms: a) Fever (≥38°C) or chills b) New flank or suprapubic pain or tenderness c) Change in character of urine d) Worsening of mental or functional status
Skin and soft tissue infection	One of the following criteria must be met: 1. Pus present at a wound, skin, or soft tissue site 2. Four or more of the following signs or symptoms: a) Fever (≥38°C) or worsening mental/functional status; and/or, at the affected site, the presence of new or increasing b) Heat c) Redness d) Swelling e) Tenderness or pain f) Serous drainage

binomial random effects (Egret for Windows, Cytel Software Corporation, Cambridge, Mass) was performed to assess factors potentially associated with fulfillment of standardized criteria for infection. Values for variables at the level of the facility were clustered; all individuals prescribed antibiotics in the same facility shared the same value for these variables. A random effects model was used so as to capture the systematic differences between facilities that may not have been associated with other measured variables. Models for lower respiratory tract infection, urinary infection, and skin and soft tissue infection were constructed.[17,18] Potential risk factors for the prescription of antibiotics for asymptomatic bacteriuria, defined as a positive urine culture in the absence of urinary symptoms, were also assessed using a random effects model. For all models, variables with $P < .2$ were selected using a backwards stepwise approach. Variables with $P \geq .05$ were removed from the model. To estimate the extent to which the variation in the rate of antibiotic use was explained by the infection rate, an analysis of variance was performed using PROC REG (SAS, Version 7.0, Cary, NC). Since infection rates were not directly assessed in this study, a rate for each type of infection (lower respiratory, urinary, skin and soft tissue) was estimated by multiplying the rate of antibiotic use (number of courses of antibiotics per 1,000 patient-days) by the proportion of episodes for which antibiotics were prescribed that met the surveillance definition for each type of infection. This calculation is based on the assumption that episodes that met surveillance definitions were true infections.

RESULTS

Twenty-two of 33 eligible facilities (10 chronic care and 12 acute care hospitals) agreed to participate in the study. Facilities that participated were more likely to have more chronic beds (mean, 182 beds) than those that refused (mean, 93 beds) ($P < .001$). Ten study facilities were situated in metropolitan areas, 6 in semirural areas, and 6 in rural areas (Table 2). Nine of the facilities had an academic affiliation. Facilities with such an affiliation had more beds on average than facilities without an academic affiliation (mean number of beds, 443 vs 232, respectively; $P = .03$). All facilities had a pharmacy and therapeutics committee and most (18 of 22) had antibiotic restriction policies.

Table 2. Characteristics of the Study Facilities

Characteristic	*n* (%)
Location	
Metropolitan	10 (45)
Semirural	6 (27)
Rural	6 (27)
Pharmacy and therapeutics committee	22 (100)
Antibiotic subcommittee	18 (82)

Table 3. Description of Antibiotic Prescriptions

Characteristic	
Antibiotics prescribed, *n*	9,373 courses
Incidence of antibiotic prescriptions, mean per 1,000 patient-days	7.3 courses
Residents exposed to at least 1 course antibiotics, %	66
Mean duration of antibiotics, d (range)	9 (1 to 365)
Indications, %	
Lower respiratory tract infection	36
Urinary infection	33
Skin and soft tissue infection	13
Miscellaneous other infections	9
Prophylaxis	5
Fever with no known focus	2

During the 12 months of the study, there were 9,373 courses of antibiotics prescribed in 1,276,053 patient-days of surveillance, for a mean of 7.3 courses of antibiotics per 1,000 patient-days (Table 3). The incidence of antibiotic prescriptions in the 22 facilities ranged from 2.9 to 13.9 antibiotic courses (or 138 to 211 defined daily dosages) per 1,000 patient-days. Antibiotics were prescribed on 6% of all patient-days. Over the 12-month study period, 2,408 (66%) of the 3,656 patients in study hospitals received at least 1 course of antibiotics. Of these, 36% received only 1 course of antibiotics, 21% received 2 courses, 13% received 3 courses, and 28% received 4 courses or more. The mean duration of a course of antibiotics was 9 days (range, 1 to 365 days).

Thirty-six percent of antibiotics were prescribed for lower respiratory tract infections, 33% for urinary tract infections, 13% for skin and soft tissue infections, 5% percent for prophylaxis, and 2% for fever where the focus of infection was unknown. Nine percent of prescriptions were for a variety of other presumed infections, including otitis media, superficial eye infections, and gastroenteritis. The most commonly prescribed antibiotics were trimethoprim-sulphamethoxazole, ciprofloxacin, amoxicillin, and cephalexin (17%, 17%, 13%, and 9% of antibiotics prescribed, respectively). Ciprofloxacin and amoxicillin were the most commonly prescribed antibiotics for lower respiratory infections (20% and 17%, respectively) (Table 4). For urinary infections, trimethoprim-sulphamethoxazole, norfloxacin, and ciprofloxacin were most commonly prescribed (33%, 15%, and 15%, respectively). Cloxacillin and cephalexin (29% and 24% of prescriptions, respectively) were the most commonly prescribed antibiotics for skin infections. Seventy-six percent of prescriptions were administered orally, 13% were administered through a gastrostomy or jejunostomy tube, 8% were administered intravenously, and 3% were administered intramuscularly. Sixty-five percent of prescriptions were orders written after the patient

Table 4. The 10 Most Commonly Prescribed Antibiotics for Respiratory, Urinary, and Skin or Soft Tissue Indications

Respiratory Tract Infections		Urinary Tract Infections		Skin and Soft Tissue Infections	
Antibiotic	Prescriptions, *n* (%)	Antibiotic	Prescriptions, *n* (%)	Antibiotic	Prescriptions, *n* (%)
Ciprofloxacin	690 (20)	Trimethoprim-sulfa	1,047 (33)	Cloxacillin	367 (29)
Amoxicillin	593 (17)	Norfloxacin	477 (15)	Cephalexin	305 (24)
Cefuroxime	411 (12)	Ciprofloxacin	469 (15)	Ciprofloxacin	211 (17)
Trimethoprim-sulfa	335 (10)	Amoxicillin	375 (12)	Clindamycin	44 (4)
Cephalexin	247 (7)	Nitrofurantoin	231 (7)	Amoxicillin	41 (3)
Clindamycin	169 (5)	Cephalexin	126 (4)	Trimethoprim-sulfa	41 (3)
Erythromycin	169 (5)	Ofloxacin	85 (3)	Erythromycin	38 (3)
Cefaclor	138 (4)	Gentamicin	65 (2)	Metronidazole	12 (1)
Clarithromycin	127 (4)	Ampicillin	54 (2)	Tetracycline	17 (1)
Ceftriaxone	96 (3)	Cefuroxime	38 (1)	Amoxicillin-clavunate	8 (1)

was assessed by a physician, 30% were verbal orders; the origin of the order for 5% of the prescriptions was not clear.

Clinical and Laboratory Features

The mean age of the 1,602 patients whose charts were reviewed was 75 years; 51% of patients were male, and 61% were totally dependent in activities of daily living. Cough and fever were the most common clinical features of the 646 patients with presumed respiratory infection (Table 5). An elevated white blood cell count ($>10 \times 10^9$/L) was noted in 54% of the 215 patients in whom the test was obtained. Fifty percent of patients receiving antibiotics for a respiratory indication had a chest x-ray, and, of these, 50% had an infiltrate compatible with pneumonia. Five-hundred eighty-two patients, 40% with indwelling urinary catheters, were treated with antibiotics for a urinary indication. New or increased urinary incontinence and fever were the most common symptoms (Table 5). Thirty percent of patients treated with antibiotics for a urinary indication had asymptomatic bacteriuria. Of the 474 patients treated for skin and soft tissue infections, 64% percent were treated for cellulitis, 23% for infected decubitus ulcers, and 5% for an infection at either a gastrostomy or jejeunostomy site. The most common clinical findings at the site of infection were erythema and tenderness (Table 5). The white blood cell count was elevated in 25% of the 88 patients in whom it was ordered.

Table 5. Clinical Features of Patients Who Received Antibiotics for Respiratory, Urinary, or Skin and Soft Tissue Indications

Indication	Clinical Features	Patients (%)
Respiratory	Cough	75
	Fever	39
	Tachypnea	31
	Change in mental status	29
	Rhinorrhea	12
Urinary	New or increased incontinence	27
	Fever	23
	Change in mental status	21
	Dysuria	15
	Frequency	13
Skin and soft tissue	Erythema	73
	Tenderness	57
	Swelling	51
	Purulent drainage	42
	Warmth	38
	Change in mental status	12
	Fever	11

Antibiotic Prescriptions and Standardized Long-term Care Definitions of Infection

Overall, 49% of antibiotic prescriptions for infection met standardized surveillance definitions. Fifty-eight percent of prescriptions reviewed met diagnostic criteria for lower respiratory infection, 28% met standardized criteria for urinary infection, and 65% met standardized definitions for skin infection.

For respiratory prescriptions, univariate analysis showed that diagnostic criteria for lower respiratory tract infection were less likely to have been met when the facility where the antibiotics were prescribed had an antibiotic subcommittee (odds ratio [OR], 0.51; 95% confidence intervals [95% CI], 0.29 to 0.90, P = .02) (Table 6). The following variables were entered in the multivariable model: total beds, presence of physician on duty, restricted reporting, availability of an infectious diseases consultant, restricted antibiotic formulary. Logistic regression analysis using binomial random effects revealed that the likelihood of indications for a prescription meeting standard definitions of lower respiratory tract infection increased with increasing number of total beds in the facility (OR, 1.15 per 100 beds; 95% CI, 1.04 to 1.27; P = .01) and decreased with an antibiotic subcommittee at the facility (OR, 0.45; 95% CI, 0.27 to 0.71; P = .01).

When factors associated with meeting urinary diagnostic criteria were examined by univariate analysis, diagnostic criteria were more likely to have been met for prescriptions from larger facilities (more total beds, OR, 1.28 per 100 beds; 95% CI, 1.05 to 1.56, P = .01) and from facilities with more chronic beds (OR, 1.71 per 100 beds; 95% CI, 1.22 to 2.39; P = .01) (Table 7). These variables, along with

Table 6. Univariate and Logistic Regression Analysis for Lower Respiratory Tract Infection*

Variable	Unadjusted OR (95% CI)	*P* Value	Adjusted OR (95% CI)	*P* Value
Total beds, per 100 beds	1.10 (1.04 to 1.21)	.06	1.15 (1.04 to 1.27)	.01
Chronic beds, per 100 beds	1.02 (0.80 to 1.29)	.90	—	—
Presence of physician on duty	1.52 (0.89 to 2.60)	.13	—	—
Restricted reporting	1.66 (0.83 to 3.2)	.15	—	—
Availability of an infectious diseases consultant	1.44 (0.84 to 2.47)	.18	—	—
Infection control practitioner full-time equivalents	0.91 (0.74 to 1.12)	.38	—	—
Restricted antibiotic formulary	1.60 (0.95 to 2.7)	.08	—	—
Presence of an antibiotic subcommittee	0.51 (0.29 to 0.90)	.51	0.45 (0.27 to 0.71)	.01
Seven-day (vs 10-day) automatic stop date for antibiotic orders	0.92 (0.49 to 1.72)	.79	—	—

* *Binomial random effects used to assess factors associated with prescriptions meeting definitons for lower respiratory tract infection. Adjusted odds ratios (ORs) of variables kept in the final model are presented. CI indicates confidence interval.*

restricted reporting were retained for the logistic regression random effects model. The final model showed that prescriptions from larger facilities (OR, 1.21 per 100 beds; 95% CI, 1.01 to 1.44; $P = .04$) and from facilities with more chronic beds (OR, 1.5 per 100 beds; 95% CI, 1.04 to 2.19; $P = .03$) were associated with meeting diagnostic criteria, while prescriptions from facilities where antibiotic reporting was restricted were less likely to meet definitions (OR, 0.34; 95% CI, 0.14 to 0.86; $P = .02$). There were no significant predictor variables for prescriptions for asymptomatic bacteriuria in either univariate or multivariable analysis.

For skin and soft tissue infection, the availability of an infectious diseases consultant was the only variable associated with meeting the definition of infection in univariate analysis (OR, 2.31; 95% CI, 1.07 to 4.97; $P = .03$) (Table 8). This was the only variable retained in the multivariable model.

The analysis of variance revealed that the surrogate infection rate (number of episodes treated with antibiotics multiplied by the proportion of episodes meeting surveillance definitions for infection) accounted for 62%, 87%, and 89% of the variance in the antibiotic prescription rate for lower respiratory, urinary, and skin and soft tissue infections, respectively (adjusted R^2, 0.62, 0.87, and 0.89, respectively; $P < .001$ for each model).

Adverse Reactions and Deaths

For both urinary tract and respiratory infections, 6% of prescriptions resulted in an adverse reaction, while 4% of prescriptions for skin infection were complicated by an adverse reaction. Nausea accounted for 34% of adverse reactions, rash for 19%, diarrhea for 11%, and yeast infection for 8%. Adverse reactions occurred in 30% of prescriptions for amoxicillin-clavulinic acid, 8% of prescriptions for trimethoprim-sulphamethoxazole, 8% of prescriptions for clindamycin, 4% of prescriptions for ciprofloxacin, 4% of prescriptions for cefuroxime, 4% of prescriptions for cephalexin, and 3% of prescriptions for amoxicillin. Death within 3 weeks of symptom onset occurred in 10% of antibiotic prescriptions for a respiratory indication and in 2% of episodes where

Table 7. Univariate and Logistic Regression Analysis for Urinary Tract Infection*

Variable	Unadjusted OR (95% CI)	*P* Value	Adjusted OR (95% CI)	*P* Value
Total beds, per 100 beds	1.28 (1.05 to 1.56)	.01	1.21 (1.01 to 1.44)	.01
Chronic beds, per 100 beds	1.71 (1.22 to 2.39)	.01	1.50 (1.04 to 2.19)	.03
Presence of physician on duty	0.97 (0.27 to 3.44)	.97	—	—
Restricted reporting	0.52 (0.19 to 1.36)	.18	0.34 (0.14 to 0.86)	.02
Availability of an infectious diseases consultant	0.97 (0.31 to 3.0)	.95	—	—
Infection control practitioner full-time equivalents	1.49 (0.87 to 2.55)	.14	—	—
Restricted antibiotic formulary	1.21 (0.49 to 3.01)	.67	—	—
Presence of an antibiotic subcommittee	1.56 (0.61 to 4.1)	.35		
Seven-day (vs 10-day) automatic stop date for antibiotic orders	0.57 (0.17 to 1.94)	.37		

* *Binomial random effects used to assess factors associated with prescriptions meeting definitons for urinary tract infection. Adjusted odds ratios (ORs) of variables kept in the final model are presented. CI indicates confidence interval.*

Table 8. Univariate and Logistic Regression Analysis for Skin and Soft Tissue Infections*

Variable	Unadjusted OR (95% CI)	*P* Value	Adjusted OR (95% CI)	*P* Value
Total beds, per 100 beds	1.13 (0.95 to 1.35)	.21	—	—
Chronic beds, per 100 beds	0.92 (0.69 to 1.24)	.61	—	—
Presence of physician on duty	0.70 (0.32 to 1.54)	.38	—	—
Restricted reporting	0.74 (0.25 to 2.2)	.59	—	—
Availability of an infectious diseases consultant	2.31 (1.07 to 5.0)	.03	2.31 (1.07 to 5.0)	.03
Infection control practitioner full-time equivalents	1.06 (0.58 to 1.95)	.85		
Restricted antibiotic formulary	1.17 (0.50 to 2.72)	.72		
Presence of an antibiotic subcommittee	0.95 (0.37 to 2.46)	.92		
Seven-day (vs 10-day) automatic stop date for antibiotic orders	0.70 (0.24 to 2.02)	.51		

* *Binomial random effects used to assess factors associated with prescriptions meeting definitons for skin and soft tissue infections. Adjusted odds ratios (ORs) of variables kept in the final model are presented. CI indicates confidence interval.*

antibiotics were prescribed for urinary or skin indications.

DISCUSSION

Our findings indicate that antibiotics are frequently prescribed for patients who receive chronic care in Ontario. The mean incidence of antibiotic use in the 22 study facilities (7.3 courses per 1000 patient-days) falls within the reported range of antibiotic use in other types of long-term care facilities (2 to 12 courses per 1,000 resident-days).[1–4] Exposure to at least 1 course of antibiotics occurred in 66% of patients in our study, similar to the report by Montgomery et al. where 76% of nursing home residents received at least 1 course of antibiotics over a 12-month period.[2] The majority (82%) of prescriptions were for respiratory, urinary, and skin infections, which is consistent with previous reports.[3,4,19,20]

Variability in the incidence of antibiotic prescriptions between facilities (2.9 to 13.9 antibiotic courses per 1,000 patient-days) was considerable. Most of the variance in the antibiotic prescription rate, at least for urinary and skin and soft tissue infections (adjusted R^2, 0.87 and 0. 89, respectively), was explained by differences in our estimates of infection rates. This data suggests that baseline risks for urinary and skin and soft tissue infections between the study facilities differed considerably. These findings are in contrast to the report by Mylotte, where 50% of the variance in overall antibiotic prescriptions in a cohort of nursing home patients was unexplained by rates of infection.[1] The lower variance explained by the estimated lower respiratory infection rate (62%) in our study suggests that factors other than the infection rate were important in driving antibiotic use for lower respiratory tract infections. A limitation of this analysis of variance is that the infection rate was calculated assuming that existing surveillance definitions of infection reflect true infections; however, no better definition of infection currently exists.

Although most of the variability in rates of antibiotic prescription for urinary tract infections appears to be explained by underlying infection rates, 30% of prescriptions for urinary indications were for asymptomatic bacteriuria. Asymptomatic bacteriuria, the presence of significant bacteriuria in the urine without urinary symptoms, is a common condition in elderly, institutionalized individuals. The prevalence of asymptomatic bacteriuria increases with age, occurring in up to 50% of elderly women and 35% of men who reside in long-term care facilities.[23] Asymptomatic bacteriuria should be treated in populations at high risk of developing subsequent infection, such as children and pregnant women. However, there is compelling evidence to support not treating asymptomatic bacteriuria in older adults who are institutionalized. Randomized controlled trials of antibiotic treatment for asymptomatic bacteriuria in elderly, institutionalized individuals have demonstrated harm rather than treatment benefit,[24–27] and the risk of selecting for antimicrobial resistance is of increasing concern.[13–17] Despite this, our findings are in keeping with previous studies: older institutionalized adults with asymptomatic bacteriuria frequently receive antibiotic therapy.[2,3,19] These data highlight the need to understand why the evidence of clinical trials has not been adopted into practice, and for an interventional strategy to reduce antibiotic prescribing for asymptomatic bacteriuria in older persons who reside in long-term care facilities.

Relatively few studies have evaluated the appropriateness of antibiotic prescribing in long-term care facilities. Zimmer et al. developed minimum criteria based on Centers for Disease Control surveillance definitions of infection.[19,28] The authors conducted a survey of patients on systemic antibiotics in 42 skilled nursing homes and found that 62% of prescriptions met minimum criteria for initiating antibiotics.[19] Eighty-eight percent of prescriptions for respiratory tract infections and 65% of prescriptions for urinary infection met criteria. Using criteria adapted from Zimmer et al., Montgomery and colleagues reported that 57% of prescriptions in their study met the criteria.[2] Eighty percent of lower respiratory tract infections, 30% of urinary infections, and 70% of skin infections met minimum criteria. In our study, standardized definitions of infection were met in about half of antibiotic prescriptions. Our results are similar to those of Montgomery et al., who found that 28% of prescriptions for urinary infection and 70% of those for skin infection met their criteria.[2] However, a lower proportion of prescriptions for lower respiratory tract infections met definitions in our study (58% compared with the 87% reported by Montgomery et al.[2]). This is probably a reflection of the more stringent criteria for infection used in our study.

Size of the facility was independently associated with fulfillment of definitions for respiratory and urinary infections (OR, 1.15 per 100 beds and OR, 1.21 per 100 beds, respectively); however, the magnitude of these effects are minimal and therefore of little clinical importance. Greater opportunity for educational exposure in larger compared with smaller facilities is a potential explanation for these results, since facilities with a university affiliation were more likely to be large. For skin and soft tissue infections, prescriptions from facilities with the availability of a microbiologist or infectious disease physician were twice as likely to meet definitions compared with those without these specialists. This provides some evidence to support specialist consultation. In contrast, presence of an antibiotic subcommittee (OR, 0.45; 95% CI, 0.27 to 0.74) was associated with failure for meeting criteria. Of the 6 facilities with an antibiotic subcommittee, 5 had a subcommittee on the basis of being affiliated with an acute care facility, 1 as part of a comprehensive drug evaluation program. None could identify specific difficulty with antibiotic use in their facility as a reason for implementing the subcommittee. Similarly, for urinary infections, restricted reporting (selective antibiotic reporting by the microbiology laboratory) in the facilities was instituted because of microbiology laboratory practice standards, not because of difficulty with antibiotic prescribing. It is likely that these associations represent confounding by one or more unmeasured variables. For example, it is possible that characteristics pertaining to individual patients (which were not collected) may have played a role.

Trimethoprim-sulphamethoxazole and ciprofloxacin were the most commonly prescribed antibiotics, each accounting for 17% of prescriptions. The fact that ciprofloxacin was the most commonly prescribed antibiotic for respiratory tract infection, accounting for 20% of prescriptions, is disconcerting. The activity of ciprofloxacin against *Streptococcus pneumoniae*, an important cause of pneumonia in this population,[29] is only moderate.[30] The frequent use of ciprofloxacin for respiratory infections is particularly concerning given the increasing rates of quinolone resistance amongst isolates of *Streptococcus pneumoniae* obtained from older adults.[31] Although our aim was not to systematically evaluate the use of specific antimicrobial agents, this observation is in keeping with a report where half of specific antimicrobials were considered inappropriate.[20] Strategies to help improve physicians' choice of antimicrobials for patients receiving chronic care are needed.

Strengths of this study include the prospective collection of data and the use of multivariable modeling to determine factors associated with meeting criteria for infection. This study evaluated antibiotic prescribing in view of clinical features present at the time of the initiation of therapy. A general limitation of assessing empiric antibiotic use is that since microbiological diagnosis is not assessed it is possible that prescriptions for lower respiratory tract infections caused by viral agents, and therefore not requiring antibiotics, are classified as appropriate. A specific limitation of this study is that the standardized definitions of infection used may have been too stringent. These definitions, although clinical, were intended for surveillance purposes and not to assess appropriateness of antibiotic use. However, in the absence of a validated reference standard for appropriateness, we believe that using these standards represents a reasonable, albeit conservative, guide for assessing antibiotic use. A major challenge to researchers is to develop better diagnostic assessments for infection of older adults residing in long-term care facilities.

This study demonstrates that antibiotic use is extensive and highly variable amongst patients who receive chronic care. Reducing antibiotic prescriptions for asymptomatic bacteriuria represents an important way to optimize antibiotic use in this population.

This study was supported by a grant from the Physicians Services Incorporated Foundation.

We would like to thank the infection control practitioners, administrators, and other staff at the participating study facilities for their help in data collection. We also thank Lorraine Moss for help in data management.

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