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Patterns of antimicrobial use for respiratory tract infections among older residents of long-term care facilities

Paschalis Vergidis¹, Davidson H. Hamer^{1,2,3,4,5}, Simin N. Meydani^{4,5,6}, Gerard E. Dallal^{4,5}, and Tamar F. Barlam¹

¹Section of Infectious Diseases, Department of Medicine, Boston University School of Medicine, Boston, Massachusetts

²Department of International Health, Boston University School of Public Health, Boston, Massachusetts

³Center for Global Health & Development, Boston University, Boston, Massachusetts

⁴Jean Mayer USDA Human Nutrition Research Center on the Aging, Tufts University, Boston, Massachusetts

⁵Friedman School of Nutrition Science and Policy, Tufts University, Boston, Massachusetts

⁶Department of Pathology, Sackler Graduate School of Biochemical Sciences, Tufts University, Boston, Massachusetts

Abstract

OBJECTIVE—To describe patterns of antimicrobial use for respiratory tract infections (RTIs) among elderly residents of long-term care facilities (LTCFs).

DESIGN—Data from a prospective, randomized, controlled study conducted from April 1998 through August 2001 to investigate the effect of vitamin E supplementation on RTIs were analyzed.

SETTING—Thirty-three LTCFs in the greater Boston area.

PARTICIPANTS—617 residents aged ≥65 years of participating LTCFs

MEASUREMENTS—RTIs, categorized as common cold, influenza-like illness, pharyngitis, sinusitis, acute bronchitis, and pneumonia, were studied for appropriateness of antimicrobial use, type of antibiotics used, and factors associated with their use. For cases where drug treatment was administered, we rated antibiotic use as appropriate (when an effective drug was used), inappropriate (when a more effective drug was indicated), or unjustified (when use of any antimicrobial was not indicated).

RESULTS—Of 752 documented episodes of RTI, overall treatment was appropriate in 79% of episodes, inappropriate in 2%, and unjustified in 19%. For acute bronchitis, treatment was appropriate in 34% and unjustified in 65% of cases. For pneumonia, treatment was appropriate in 87% of episodes. Among the most commonly used antimicrobials, macrolide use was unjustified in 43% of cases; macrolides were the most frequently used drug class for treatment of the common cold. No statistical significant differences in the patterns of antibiotic use were observed when

Corresponding author: Tamar F. Barlam, MD, MSc. Boston University School of Medicine. One Boston Medical Center Place, Dowling 3 North. Boston, MA 02118. Phone: 617-414-5190, fax: 617-638-8070. tbarlam@bu.edu. **Alternate corresponding author:** Davidson H. Hamer, MD, Center for Global Health and Development, Crosstown 3rd floor, 801 Massachusetts Avenue, Boston, MA 02118. Phone: 617-414-1267, fax: 617-414-1261. dhamer@bu.edu.

stratified by age, gender, race or co-morbid conditions including diabetes mellitus, dementia and chronic kidney disease.

CONCLUSION—Antimicrobials are unjustifiably used for one-fifth of RTIs and over two-thirds of cases of acute bronchitis, thus suggesting a need for programs to improve antibiotic prescribing at LTCFs.

Keywords

antimicrobial use; respiratory tract infections; long-term care facilities

INTRODUCTION

Admission to long-term care facilities (LTCFs) is increasingly common among the elderly. Current projections indicate that 43% of people over the age of 60 will use a LTCF at some point in their lifetime, and more than 85% of such persons will be long-stay residents (longer than one year). According to the 2004 National Nursing Home Survey, nearly 1.5 million Americans were living in nursing homes, of whom 88.3% were aged 65 years and older and 45.2% were aged 85 years and older.¹ Current projections indicate that the number of Americans needing long-term care will double between 2000 and 2050.

Infections occur with higher frequency among residents of LTCFs compared to community-dwelling elderly and rank among the most common causes of hospitalization and emergency room visits. There is the potential for extensive antimicrobial use, some of which might be inappropriate. This patient population is at high risk for adverse drug reactions given the physiological effects of aging on different organ systems. Therefore, any unnecessary medications should be avoided. The potential for emergence of resistant pathogens and their transmission to other nursing home residents poses another substantial risk related to antibiotic use.

Few studies have been published describing the patterns of antimicrobial use in this setting, despite the growing geriatric population. Moreover, in the United States there are limited national or regional data on antimicrobial prescribing patterns in LTCFs. In this study we evaluated patterns of antibiotic use for upper and lower respiratory tract infections (RTIs) in a cohort of nursing home residents in Massachusetts. We also analyzed variables related to antibiotic administration. This analysis can inform the need for the establishment of antimicrobial stewardship programs at LTCFs.

METHODS

Study design

We used data collected during a previously completed randomized, double-blind, placebo-controlled trial designed to investigate the effect of vitamin E supplementation on RTIs in a nursing home population.² Data were collected from April 1998 through August 2001. The Tufts Medical Center Institutional Review Board approved the original study protocol and informed consent form.

A total of 617 subjects were enrolled and randomized to either vitamin E or placebo. Participants were recruited from 33 LTCFs in the Boston area. Eligibility criteria were: age 65 years or older; life expectancy more than 6 months; no anticipated discharge within 3 months; not room-bound for the past 3 months; absence of active neoplastic disease; no tube feeding, no hemodialysis; no intravenous or urethral catheters for the last 30 days; no tracheostomy or chronic mechanical ventilation; no antibiotic treatment for at least 2 weeks;

no chronic corticosteroid treatment (prednisone more than 10 mg/day or equivalent dose); no use of immunosuppressive drugs; BMI ≥ 18 kg/m²; serum albumin ≥ 3.0 g/dL; able to swallow pills; willing to receive influenza vaccine; and willing to provide informed consent. LTCFs were of different sizes with varying number of prescribing practitioners, located in affluent and low socioeconomic areas, affiliated with academic institutions, Veterans Affairs hospitals, or community hospitals.

During the study period, study nurses collected information weekly relating to RTIs. The antibiotics used and the duration of treatment were also recorded. At the end of the study, the data were evaluated by two of the study physicians and RTIs were categorized into one of 7 categories based on the following diagnostic criteria:

- Acute bronchitis. At least 2 of the following signs or symptoms had to be present: increased frequency and severity of cough, new or increased sputum production, burning substernal chest discomfort with coughing or deep inspiration, and fever ($T \geq 38^{\circ}\text{C}$). Radiological evidence of pneumonia excluded this diagnosis.
- Pneumonia. Symptoms could include cough with or without sputum production, chest pain, dyspnea, and fever. Signs of infection included elevated temperature ($\geq 38^{\circ}\text{C}$), tachycardia, tachypnea, abnormal breath sounds, and dullness to percussion of the chest. The diagnosis required radiological findings of 1 or more new pulmonary infiltrates.
- Common cold. At least 1 of the following signs or symptoms had to be present: rhinorrhea or stuffy nose (nasal obstruction) or sneezing, plus 1 or more of the following: sore or scratchy throat, dry cough, hoarseness, or low-grade fever (temperature no greater than 1°C above normal range). Symptoms had to be new and not due to allergies.
- Influenza-like illness. Fever of $\geq 38^{\circ}\text{C}$ (100.4°F) plus new or increased dry cough and 1 or more of the following signs or symptoms: chills, new headache or eye pain, myalgias, malaise or loss of appetite, or sore throat.
- Pharyngitis. Symptoms of a sore or scratchy throat and at least 1 of the following abnormalities on pharyngeal examination: erythema, exudate, ulceration, vesicles, or edema.
- Sinusitis. Symptoms could include facial pain, purulent nasal discharge, and/or nasal congestion. If x-rays were available, the finding of mucosal thickening, opacities or air fluid levels confirmed the diagnosis.

Criteria for appropriateness of use were based on clinical guidelines developed by professional societies and published during the study period.^{3, 4} We modified a previously developed scale to rate antimicrobial use for each documented infection.⁵⁻⁷ For cases where drug treatment was administered, we rated antibiotic use as appropriate (when an effective drug was used), inappropriate (when a more effective drug was indicated), or unjustified (when use of any antimicrobial was not indicated). For cases of infection where no antibiotics were administered, we rated treatment as appropriate (when use of an antimicrobial was not indicated), or unjustified (when use of an antimicrobial was indicated). We also identified cases where records were insufficient for categorization.

More specifically, for each type of infection we defined appropriateness of use as follows: We considered the use of antimicrobials unjustified for the treatment of bronchitis in the absence of COPD. Similarly, not treating acute bronchitis in the presence of COPD was deemed unjustified. Indeed, placebo-controlled trials have failed to support a role for antimicrobial treatment of uncomplicated acute bronchitis.⁸ On the other hand, there is

evidence in support of a benefit for the use of antimicrobials in moderate to severe exacerbations of underlying chronic obstructive pulmonary disease (COPD).⁹

Antibiotic treatment of pneumonia was appropriate when treated with an effective drug and inappropriate when a more effective drug was indicated. Cases that were left untreated, were rated as unjustified. For common cold and influenza-like illness no antibiotic use was considered appropriate.¹⁰ Treated episodes were rated as unjustified.

Antibiotic treatment of pharyngitis is appropriate only for those patients with group A beta-hemolytic streptococcus as the causal agent. Patients were screened for the presence of the four Centor criteria: history of fever, tonsillar exudates, absence of cough, and tender anterior cervical lymphadenopathy. Antibiotics were considered appropriate in patients with three or four criteria and those with two criteria and a positive rapid antigen test or throat culture.¹¹

Antibiotic therapy was considered appropriate for patients who met the criteria for the clinical diagnosis of sinusitis with symptoms lasting for more than 7 days and for those with severe symptoms-especially those with unilateral facial pain-regardless of duration of illness.¹²

We excluded episodes of acute otitis media as there were very few cases (n = 5), most studies have been conducted in the pediatric population and treatment in adults is largely extrapolated from studies in children.

Statistical methods

We compared patterns of antimicrobial use by infection type and the appropriateness of use for each antibiotic class. In addition, we investigated whether there were differences in prescribing practices based on patient age, gender, race, or smoking status, or presence of diabetes mellitus, COPD, dementia or chronic kidney disease. We used the chi square test for comparison of proportions between groups. Analysis was performed using SAS (version 9.2).

RESULTS

Among 617 study participants, 393 patients developed one or more RTIs during the study period (Table 1). Of those, 226 received antibiotic treatment whereas 167 did not. The mean age in both groups was 84 years. Most participants were female and Caucasian. One fourth had COPD and half had underlying dementia.

There were 752 documented episodes of RTI which were categorized as follows: 101 episodes of acute bronchitis (89% treated, 11% untreated), 193 episodes of pneumonia (96% treated, 4% untreated), 389 episodes of common cold (14% treated, 86% untreated), 17 episodes of influenza-like illness (24% treated, 76% untreated), 41 episodes of pharyngitis (15% treated, 85% untreated), 11 episodes of sinusitis (55% treated, 45% untreated).

As presented in Table 2, overall treatment was considered appropriate in 79% of episodes, inappropriate in 2%, and unjustified in 19%. For acute bronchitis, treatment was appropriate in 34% and unjustified in 65% of cases. For pneumonia, treatment was appropriate in 87% and inappropriate in 13% of cases. Antibiotic treatment was unjustified for 54 episodes (14%) of common cold. Accordingly, 335 episodes of common cold were appropriately not treated.

Appropriateness ratings separated by antibiotic class are presented in Table 3. Fluoroquinolones and cephalosporins were the most commonly used antibiotics, and were

prescribed appropriately in two thirds of cases. For the diagnosis of pneumonia and acute bronchitis, the fluoroquinolones were the most commonly administered medications at 41% and 32%, respectively. Cephalosporins ranked second for pneumonia treatment. Macrolides were used appropriately in 46% of cases, but their use was unjustified in 43% of cases. For example, macrolides were the most commonly used drug class for common colds at 28% and the second most frequently used class of agent for acute bronchitis, at 23%.

Appropriateness ratings for RTIs treated with antibiotics were stratified by age, sex, race, smoking status, and presence of medical comorbidities and are presented in Table 4. No statistical significant differences in the patterns of antibiotic use were observed between residents aged 65 through 79 and those aged 80 or older, or among different genders or races, or among patients with diabetes mellitus, dementia or chronic kidney disease. Antimicrobials were more commonly administered appropriately in those with underlying COPD as compared with those without obstructive lung disease.

DISCUSSION

In the present study we evaluated patterns of antimicrobial use among older residents of LTCFs in the Boston area. Overall treatment was considered appropriate in 79% of episodes. In 2% an alternative antimicrobial was indicated. In 19% no antibiotic was indicated. Treatment was commonly unjustified in cases of acute bronchitis. For the common cold, antimicrobials were unjustifiably used only in 14% of cases. Demographic characteristics, and the presence of diabetes mellitus, dementia or chronic kidney disease, were not found to be associated with unjustifiable use.

Patients residing in LTCFs who become ill may not be as thoroughly evaluated as patients in an acute health care setting. This may result in unnecessary antibiotic use. A point-prevalence study conducted in 53 LTCFs in Rochester, New York, evaluated whether the work-up for infection prior to initiating treatment was satisfactory. There was sufficient evidence to start an antibiotic in only 62.4 % of the cases.¹³ In a 12-month survey of 3,899 patients in 52 nursing homes in Maryland, criteria for minimal diagnostic evaluation were met in only 11% of cases of infection.¹⁴ More serious infections were better evaluated. Nevertheless, 31% of patients with a RTI were not examined by a physician. Finally, in a prospective 12-month observational study of 2,408 patients in 22 facilities in Ontario, Canada, diagnostic criteria for RTIs were met in only 58% of cases.¹⁵

In our study, we focused on the appropriateness of antimicrobial prescription practices. There are limited published data in the past decade on the patterns and appropriateness of antibiotic use for RTIs in LTCFs. In a 1987 study, for 120 infections in 96 patients in two nursing homes in Portland, Oregon, the treatment was rated as appropriate in 49% of cases, inappropriate in 42% and unjustified in 9%.⁶ In contrast to this study, we rated appropriateness based on specific diagnoses. For pneumonia, common cold and pharyngitis, treatment was usually appropriate. Indeed, only 14% of the study patients received antimicrobial therapy for the common cold. In contrast, treatment was commonly unjustified for acute bronchitis with no documented evidence of underlying COPD. Macrolides were disproportionately used for inappropriate indications--the treatment of common colds and acute bronchitis--compared with other drug classes including fluoroquinolones.

Appropriateness of antimicrobial use has been studied in the outpatient setting in the general population. In the 1996 National Ambulatory Medical Care Survey, among 13.9 million office visits, antibiotics were prescribed for 60% of episodes of acute bronchitis, 47% of upper RTI, and 46% of the common cold.¹⁶ In a more recent retrospective study for the period of November 2003 to February 2004, among 2,270 visits to 14 emergency

departments, antimicrobials were prescribed in 72% of cases of acute bronchitis and 38% of viral upper RTIs for patients of all ages.¹⁷ Similar to our study, rates of inappropriate prescription for bronchitis were high. Interestingly, upper RTIs were more frequently treated inappropriately in the acute care setting than in our study. In the geriatric population, a prospective study performed from November 2000 through February 2001 in medical practices in Denver, Colorado, identified 706 episodes of acute bronchitis among patients above the age of 65. Fifty eight percent of those patients were treated with antimicrobials.¹⁸

Fluoroquinolones were the most commonly prescribed medications for RTIs in our study. Those agents were used appropriately in only two-thirds of cases. In a previous study conducted in a LTCF caring for 703 residents, 100 ciprofloxacin treatments for urinary, lower respiratory tract and skin and soft tissue infections were reviewed retrospectively.¹⁹ Similarly to our findings, in 23% of cases, ciprofloxacin was given for an inappropriate indication and, in 5% of cases, a more effective antibiotic was available.

Cephalosporins and macrolides were also frequently prescribed in our study. Similarly, in a study by Benoit et al. conducted from September 2001 through February 2002 in 73 nursing homes in four US states, fluoroquinolones (38%), first-generation cephalosporins (11%), and macrolides (10%) were the three most commonly used medications for any type of infection.²⁰ Among the three drug classes, the use of macrolides was most frequently unjustified. Macrolides were used mainly for cases of acute bronchitis, similar to our findings.

Elderly individuals aged 80 years or above may be more frail than their younger counterparts. However, we did not observe an increase in inappropriate antibiotic use among those elderly residents nor were there gender-specific differences in patterns of antimicrobial use. In the study by Benoit et al.,²⁰ which was conducted from September 2001 through February 2002, COPD was associated with higher rates of antimicrobial usage in both univariate and multivariate analysis. In our study, based on the definitions we used, we found that medications were more commonly administered appropriately in those with underlying COPD as compared with those without obstructive lung disease. This observation may be due to the fact that we defined use of antibiotics for acute bronchitis as appropriate in the setting of COPD and not due to better physician practices. In fact, physicians were as likely to prescribe antibiotics for acute bronchitis whether or not the patients had COPD, suggesting they believed that use was appropriate in all their patients with acute bronchitis.

There are certain limitations in our study. The original study was primarily designed to evaluate the effect of vitamin E supplementation on RTIs, and not patterns of antibiotic use. The diagnosis of infection was primarily based on clinical criteria. For example, a chest X-ray was only obtained in patients thought to be suffering from pneumonia at the discretion of the nursing home physician. Milder episodes of pneumonia may have been incorrectly diagnosed as acute bronchitis. The data were collected between 1998 and 2001 and use may have changed since this time period. However, major drug classes used for RTIs have remained stable. Linezolid, a newer antibiotic, which was not available at the time of the study, is infrequently used for RTI therapy. Treatment guidelines have not changed significantly from the study period; hence observations from this cohort are still relevant for current practice.

Another limitation is that the study was conducted in LTCFs located in the Boston area only. Nonetheless, the study subjects were residing in LTCFs of various sizes, or number of prescribing practitioners, and were affiliated with different hospitals. Indeed, the rate and pattern of infection reported in this study were not that different that those reported

nationally. Certain patients, such as immunocompromised hosts, were excluded from the study. Moreover, there is a wide variation of antimicrobial prescription practices among different institutions. Thus the results may not be generalizable.

Appropriateness of antimicrobial use may be controversial in this patient population. Recommendations for treating acute bronchitis are based mainly on studies of younger, otherwise healthy individuals, and may not apply to elderly patients with several underlying comorbidities. Thus episodes of acute bronchitis may indeed warrant antimicrobial treatment in the geriatric population, but were the primary diagnosis associated with significant inappropriate use in our study.

In 2000, the Society of Hospital Epidemiology of America published recommendations regarding assessment and empiric treatment of infections in LTCFs, including acute RTIs.²¹ Minimal standards for antimicrobial stewardship programs were also proposed in order to optimize judicious medication use. Many acute care hospitals have established such programs, but similar interventions are usually lacking in LTCFs.

In conclusion, we prospectively studied the treatment of RTIs in residents of 33 long-term care facilities. We described patterns of antimicrobial use based on indication, and rated the appropriateness of their use. Data on the appropriateness of antimicrobial use in elderly residents of LTCFs are sparse. Antimicrobials were inappropriately used for one-fifth of RTIs and for over two-thirds of cases of acute bronchitis. Macrolides were the antibiotic class most commonly used without justification. Our data suggest that opportunities to improve antimicrobial prescribing at LTCFs exist. Programs to promote the rationale use of antimicrobials and minimize toxicity, cost, and emergence of resistant pathogens should be instituted at LTCFs.

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Table 1

Demographic characteristics and comorbidities of study participants.

	Patients with RTIs who received antibiotic treatment (n=226)	Patients with RTIs who did not receive antibiotic treatment (n=167)	Patients without RTIs (n=224)
Age in years, mean (range)	84.81 (66–103)	84.79 (66–99)	84.61 (65–102)
Gender			
Male	68 (40%)	42 (25%)	59 (35%)
Female	158 (35%)	125 (28%)	165 (37%)
Race			
White, not Hispanic	215 (36%)	158 (27%)	210 (36%)
Black, not Hispanic	7 (32%)	6 (27%)	9 (41%)
Asian	3 (33%)	2 (22%)	4 (44%)
Hispanic	1 (50%)	0	1 (50%)
COPD			
Yes	63 (41%)	41 (27%)	49 (32%)
No	163 (35%)	126 (27%)	175 (37%)
Diabetes mellitus			
Yes	49 (39%)	27 (22%)	49 (39%)
No	177 (36%)	140 (28%)	175 (35%)
Dementia			
Alzheimer's	21 (29%)	20 (27%)	31 (43%)
Non-Alzheimer's	82 (35%)	65 (28%)	87 (37%)
No dementia	123 (40%)	82 (26%)	106 (34%)
Renal disease			
CKD	9 (37%)	5 (21%)	11 (42%)
No renal disease	217 (37%)	161 (27%)	213 (36%)

RTI: Respiratory tract infection. COPD: Chronic obstructive pulmonary disease. CKD: Chronic kidney disease.

Table 2

Appropriateness of antimicrobial use based on type of respiratory tract infection diagnosis

	Appropriate	Inappropriate	Unjustified
Acute bronchitis	35 (34%)	0	66 (65%)
Pneumonia	168 (87%)	18 (9%)	7 (4%)
Common cold	335 (86%)	0	54 (14%)
Influenza-like illness	13 (76%)	0	4 (24%)
Pharyngitis	35 (85%)	0	6 (15%)
Sinusitis	6 (55%)	0	5 (45%)
Total	592 (79%)	18 (2%)	142 (19%)

For records with insufficient data no ratings were performed.

Table 3

Appropriateness ratings per antimicrobial class for treated episodes of RTIs

	Appropriate	Inappropriate	Unjustified	Insufficient data
Fluoroquinolones	87 (65%)	6 (4%)	28 (21%)	13 (10%)
Cephalosporins	67 (66%)	4 (4%)	24 (24%)	7 (7%)
Macrolides	38 (46%)	0	36 (43%)	9 (11%)
Penicillin	13 (24%)	4 (8%)	32 (60%)	4 (8%)
Tetracyclines	5 (26%)	0	11 (58%)	3 (16%)
Sulfonamides	4 (33%)	2 (17%)	5 (42%)	1 (8%)

Antibiotics used were: amoxicillin, ampicillin, ampicillin/sulbactam, azithromycin, cefaclor, cefpodoxime, cefprozil, ceftriaxone, cefuroxime, cephalexin, ciprofloxacin, clarithromycin, clindamycin, dicloxacillin, doxycycline, erythromycin, gatifloxacin, gentamicin, levofloxacin, metronidazole, trimethoprim/sulfamethoxazole, trovafloxacin

Table 4

Appropriateness ratings stratified by age, sex, race, smoking status, presence of co-morbid medical conditions for episodes that were treated with antibiotics

	Appropriate	Inappropriate	Unjustified	p-value
Age				
Less than 80	68 (58%)	2 (2%)	36 (31%)	0.32
80 or older	148 (51%)	15 (5%)	100 (34%)	
Gender				
Male	143 (52%)	13 (5%)	96 (35%)	0.32
Female	73 (54%)	4 (3%)	40 (30%)	
Race				
White, non-Hispanic	204 (52%)	17 (4%)	132 (34%)	0.93
Black, non-Hispanic	7 (63%)	0	3 (27%)	
Asian	3 (75%)	0	1 (25%)	
Hispanic	2 (100%)	0	0	
COPD				
Yes	96 (71%)	5 (4%)	24 (18%)	<0.001
No	120 (44%)	12 (4%)	112 (41%)	
Diabetes mellitus				
Yes	168 (52%)	15 (5%)	110 (34%)	0.68
No	48 (58%)	2 (3%)	26 (31%)	
Dementia				
Alzheimer's	20 (56%)	1 (3%)	11 (31%)	0.97
Non Alzheimer's	75 (53%)	6 (5%)	43 (31%)	
No dementia	122 (52%)	10 (4%)	83 (35%)	
Renal disease				
CKD	6 (46%)	0	4 (31%)	0.72
No kidney disease	209 (53%)	17 (4%)	131 (33%)	

For records with insufficient data no ratings were performed.