CONCISE COMMUNICATION

Implementation of an Antimicrobial Stewardship Program at a 60-Bed Long-Term Acute Care Hospital

Perry G. Pate, MD;[1,a] Donald F. Storey, MD;[1,a] Donna L. Baum, RPh[2]

We implemented an antimicrobial stewardship program at an urban, 60-bed long-term acute care hospital using a strategy of weekly postprescriptive chart audit with intervention and feedback. The results for the first 15 months demonstrated 80% acceptance of recommendations, a 21% reduction in use, and a 28% reduction in cost per patient-day.

Infect Control Hosp Epidemiol 2012;33(4):405-408

Long-term acute care hospitals (LTACHs) treat medically complex patients who need hospital-level care for relatively extended periods, including patients insured by Medicare who in the aggregate must have an average length of stay of 25 days or more.[1] Accumulating reports underscore the potential importance of this particular post-acute-care setting to the epidemiology of healthcare-associated drug-resistant organisms. In a study of 45 LTACHs in 2002–2003, the prevalence of antibiotic resistance among several bug-drug pairs exceeded the 90th percentile values for medical intensive care units participating in the National Nosocomial Infections Surveillance System.[2] In the same study, overall rates of antibiotic use were comparable to rates of participating medical intensive care units. There are reports from LTACHs of high admission colonization rates with multidrug-resistant organisms[3] and of high rates of *Clostridium difficile* carriage.[4] LTACHs have also participated in multifacility outbreaks, including those of linezolid-resistant *Staphylococcus epidermidis*[5] and *C. difficile* infection (CDI)[6] in Ohio and those of multidrug-resistant *Acinetobacter baumanii* in Ohio, Michigan, and the greater Chicago area, where the outbreak involved an OXA-40 carbapenemase–producing organism.[3] More recently, a LTACH played a critical role in a 26-facility outbreak of *Klebsiella pneumoniae* carbapenemase–producing Enterobacteriaceae in Illinois and Indiana by concentrating patients at high risk, amplifying the outbreak by cross-infection, and facilitating dissemination to other facilities through shared patients.[7]

The number of LTACHs has more than quadrupled since 1990, to above 400 by 2009.[1] Nevertheless, to date there has been only a single abstract describing an antimicrobial stewardship program (ASP) implemented in this setting.[8] We report an ASP implemented at an LTACH using a strategy of weekly postprescriptive chart audit with intervention and feedback.

METHODS

Vibra Specialty Hospital of Dallas is a freestanding 60-bed LTACH that has a 6-bed unit for high-acuity patients (including mechanically ventilated patients), an attached wound care clinic, and an open medical staff. In 2008, an infectious diseases (ID) physician was contracted for 10 hours monthly to serve as medical director for infection control and initiate a program with an infection preventionist, whose responsibilities included surveillance and prevention activities for multidrug-resistant organisms, device-related infections, and CDI as well as employee health and nursing education. Active admission surveillance cultures were performed for isolation and cohorting purposes and included cultures of nares for methicillin-resistant *Staphylococcus aureus*, perirectal cultures for vancomycin-resistant *Enterococcus* species, and cultures of wounds, catheter urine, and tracheostomies. An off-site commercial laboratory performed laboratory services, including an enzyme-linked immunoassay for *C. difficile* toxin, and annual antibiograms became available in 2010. ID consultative services were available. Electronic health records and computerized physician order entry were not available.

The medical director for infection control and the director of pharmacy, a clinical pharmacist without specialized ID training, together formed a 2-person antimicrobial stewardship team (AST) in 2009, drafted a stewardship policy for approval by the Pharmacy and Therapeutics Committee and the Medical Executive Committee, and announced the program to the medical staff. Ten additional monthly contract hours were allocated to the medical director for stewardship. Once weekly for approximately an hour, the AST audited available charts of patients receiving systemic antimicrobial agent(s) of any duration, including those of patients initiated on antimicrobials at transferring facilities, for indications, choice of agent(s), planned treatment duration, allergies, and pertinent laboratory, microbiology, and radiographic data. Nonbinding recommendations were placed on the chart using a communication form that did not become part of the permanent medical record. ID consultation was recommended when record review, including review of records from a transferring facility, failed to reveal enough detail to optimize antimicrobial therapy. For an estimated 5 hours weekly, the AST pharmacist prepared charts for review, followed up recommendations within 72 hours with prescribing physicians, and scored recommendations for acceptance. There were no formulary restrictions or preauthorization requirements.

Patient-days, discharges, and patient characteristics were obtained from hospital quality and administrative databases. Incident healthcare-facility-onset laboratory-event CDI rates were calculated per 10,000 patient-days.[9] AST recommendations were tabulated monthly. Facility-wide acquisition and/or return costs and quantities for all systemic antimi-

TABLE 1. Characteristics of Patients Discharged from a 60-Bed Long-Term Acute Care Hospital (LTACH) Before and After Implementation of an Antimicrobial Stewardship Program

Variable	Baseline period	Intervention period	*P*
Period discharges, no.	505	673	
Age, median (IQR), years	67 (54–77)	68 (56–77)	.528[a]
Male sex	275 (54.5)	328 (48.7)	.052[b]
Race			
White	209 (41.4)	289 (42.9)	.593[b]
Black	186 (36.8)	276 (41.0)	.146[b]
Hispanic	75 (14.9)	80 (11.9)	.136[b]
Medicare insurance	433 (85.7)	592 (88.0)	.262[b]
Length of stay, median (IQR), days	23 (18–31)	26 (20–34)	<.001[a]
Primary *ICD-9* diagnosis code(s)			
Skin/subcutaneous tissue	118 (23.4)	172 (25.6)	.388[b]
Respiratory system	71 (14.1)	92 (13.7)	.848[b]
Complications, medical/surgical	70 (13.9)	119 (17.7)	.077[b]
Circulatory system	63 (12.5)	79 (11.7)	.701[b]
Diabetes mellitus	36 (7.1)	33 (4.9)	.108[b]
Musculoskeletal/connective tissue	21 (4.2)	47 (7.0)	.040[b]
Digestive system	16 (3.2)	25 (3.7)	.613[b]
Genitourinary system	12 (2.4)	15 (2.2)	.867[b]
HIV infection	5 (1.0)	3 (0.4)	.299[c]
Neoplasm	3 (0.6)	7 (1.0)	.530[c]
Disposition			
Home/self-care	104 (20.6)	140 (20.8)	.930[b]
Home/home health care	98 (19.4)	126 (18.7)	.767[b]
Skilled nursing facility	103 (20.4)	122 (18.1)	.327[b]
Short-term acute care hospital	69 (13.7)	85 (12.6)	.603[b]
Inpatient rehabilitation facility	47 (9.3)	81 (12.0)	.136[b]
Another LTACH	9 (1.8)	7 (1.0)	.315[b]
Expired	22 (4.4)	31 (4.6)	.838[b]

NOTE. Data are no. (%) of patients, unless otherwise indicated. The baseline period was January 2009–November 2009, and the intervention period was December 2009–February 2011. HIV, human immunodeficiency virus; *ICD-9, International Classification of Diseases, Ninth Revision*; IQR, interquartile range.

[a] Mann-Whitney *U* test.

[b] χ^2 test.

[c] Fisher's exact test.

crobial agents (antibacterial, antifungal, and antiviral, including antiretroviral) were recorded monthly, and defined daily doses (DDDs; World Health Organization Center for Drug Statistics Methodology) were calculated. The χ^2 or Fisher's exact test was performed for comparison of categorical data, and the Mann-Whitney *U* test was performed for comparison of continuous data. All reported *P* values were 2-tailed, with *P* less than .05 used as the level of significance. Statistical calculations were performed using GraphPad Prism, version 5.04.

RESULTS

Patient characteristics for the 11-month baseline period (January 2009–November 2009) and the 15-month intervention period (December 2009–February 2011) are summarized in Table 1. Patient-days were 13,035 and 19,461 for the baseline and intervention periods, respectively. There were 275 patient chart review episodes, from which 251 primary recommendations were made to discontinue 1 or more agents (25%), to modify duration or agent choice (30%), or to obtain ID consultation to clarify indication (21%), duration (15%), or agent selection (9%). A total of 200 (80%) recommendations were implemented, and 39 (15%) were declined. Twelve patients (5%) were discharged before recommendations were acted upon.

There was a 21% reduction in mean monthly antimicrobial use per 1,000 patient-days ($P = .003$) and a 28% reduction in mean monthly cost per patient-day ($P = .004$) during the intervention period, compared with baseline values (Table 2). There were also statistically significant reductions in the use of levofloxacin, all quinolones, linezolid, metronidazole, all antibacterials, and all antifungals. The incident healthcare-facility-onset CDI rate was not significantly changed during the intervention period (11.3), compared with the baseline value (5.3; $P = .138$). Estimated cost savings from averted pharmaceutical purchases alone were $159,580.

TABLE 2. Mean Monthly Antimicrobial Consumption from a 60-Bed Long-Term Acute Care Hospital in Defined Daily Doses (DDDs; World Health Organization Center for Drug Statistics Methodology) per 1,000 Patient-Days and Cost per Patient-Day Before and After Implementation of an Antimicrobial Stewardship Program

Variable	Baseline period	Intervention period	% difference	P[a]
DDDs per 1,000 patient-days				
By agent category				
Antibacterials	914.4	721.0	−21	.007
Antifungals	59.8	33.6	−44	.043
Antivirals	18.8	31.0	65	.317
All agents	993.0	785.6	−21	.003
By selected class				
Carbapenems[b]	47.8	29.0	−39	.078
Cephalosporins	70.3	68.0	−3	.756
Echinocandins	13.3	6.0	−55	.111
Quinolones	150.9	87.1	−42	.005
By selected agent				
Cefazolin	13.1	14.1	8	.627
Ceftriaxone	15.4	20.6	34	.146
Cefepime	20.8	26.5	27	.678
Clindamycin	20.1	9.0	−55	.191
Daptomycin	40.3	25.2	−37	.232
Ertapenem	39.9	21.0	−47	.376
Fluconazole	42.8	23.6	−45	.087
Levofloxacin	129.7	72.6	−44	.022
Linezolid	21.1	8.8	−58	.047
Metronidazole	52.0	35.8	−31	.029
PIP-TZB	100.8	84.7	−16	.177
Tigecycline	5.1	6.5	27	.357
TMP-SMX	21.6	18.4	−15	.351
Vancomycin	160.1	141.6	−12	.604
Cost per patient-day, US$				
Antibacterials	26.9	18.2	−32	.001
All agents	29.0	20.8	−28	.004

NOTE. The baseline period was January 2009–November 2009, and the intervention period was December 2009–February 2011. PIP-TZB, piperacillin-tazobactam; TMP-SMX, trimethoprim-sulfamethoxazole.

[a] Mann-Whitney *U* test.

[b] Doripenem, imipenem, and meropenem.

DISCUSSION

In a 2009 abstract, Kravitz et al[8] reported a 42% use and cost reduction per patient-day from baseline for 11 antibacterial agents during a 12-month stewardship period at a 140-bed Minnesota LTACH using a strategy of twice-weekly chart review. We used a similar strategy in a smaller facility with once-weekly chart reviews. Nevertheless, the relatively long length of stay allowed us to review charts equivalent in number to approximately 40% of patient discharges during the intervention period. Incomplete information from transferring facilities was a common obstacle to effective chart review and a common rationale for a recommendation of ID consultation. The generation of recommended use metrics for all antimicrobial agents was among our greatest challenges. The lack of readily available tools to calculate use metrics may be an important obstacle for others.

Among limitations, we did not formally track patient outcomes. The short study period and a limited number of bacterial isolates, which included isolates from admission surveillance cultures, precluded an analysis of antibiotic resistance trends. Because factors other than antibiotic use may affect CDI risk,[4,10] we were unable to draw conclusions about the higher but statistically unchanged CDI rates between the periods. Likewise, we were unable to draw conclusions about the relationship, if any, between antimicrobial use and period differences in length of stay; patient characteristics, including primary diagnoses, were otherwise similar. In addition, unlike for short-term acute care hospitals, LTACHs are subject to an average length of stay requirement of 25 days or more for Medicare patients as well as patient-specific incentives to avoid "short-stay outliers."[1]

Our results suggest that effective antimicrobial stewardship is possible with limited resources in this epidemiologically important healthcare setting.

https://doi.org/10.1086/664760 Published online by Cambridge University Press

ACKNOWLEDGMENTS

We thank Chi Tran, PharmD, and Andrew Weis, PharmD, for their assistance with antimicrobial stewardship team activities and Linda Hynan, PhD, for her helpful statistical review of the manuscript.

Financial support. P.G.P. received support from Vibra Specialty Hospital, Dallas, Texas, for antimicrobial stewardship activities.

Potential conflicts of interest. All authors report no conflicts of interest relevant to this article. All authors submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest, and the conflicts that the editors consider relevant to this article are disclosed here.

Affiliations: 1. Dallas ID Associates, Dallas, Texas; 2. Vibra Specialty Hospital, Dallas, Texas.

Address correspondence to Perry G. Pate, MD, 5939 Harry Hines Boulevard, Suite 845, Dallas, TX 75235 (pgpate@aol.com).

[a] P.G.P. and D.F.S. contributed equally to this article.

Presented in part: 21st Annual Scientific Meeting of the Society for Healthcare Epidemiology of America; Dallas, Texas; April 1–4, 2011 (Abstract 96).

Received September 29, 2011; accepted December 27, 2011; electronically published March 15, 2012.

 0899-823X/2012/3304-0015$15.00. DOI: 10.1086/664760

REFERENCES

1. Medicare Payment Advisory Commission. *Report to the Congress: Medicare Payment Policy Report.* March 2011. http://medpac.gov/documents/Mar11_EntireReport.pdf. Accessed August 26, 2011.
2. Gould CV, Rothenberg R, Steinberg J. Antibiotic resistance in long-term acute care hospitals: the perfect storm. *Infect Control Hosp Epidemiol* 2006;27:920–925.
3. Weinstein RA, Munoz-Price LS. Long-term acute care hospitals. *Clin Infect Dis* 2009;49:438–443.
4. Goldstein EJ, Polonsky J, Touzani M, Citron DM. *C. difficile* infection (CDI) in a long-term acute care facility (LTAC). *Anaerobe* 2009;15:241–243.
5. Bonilla H, Huband MD, Seidel J, et al. Multicity outbreak of linezolid-resistant *Staphylococcus epidermidis* associated with clonal spread of a *cfr*-containing strain. *Clin Infect Dis* 2010;51:796–800.
6. Jump RL, Riggs MM, Sethi AK, et al. Multihospital outbreak of *Clostridium difficile* infection, Cleveland, Ohio, USA. *Emerg Infect Dis* 2010;16:827–829.
7. Won SY, Munoz-Price LS, Lolans K, Hota B, Weinstein RA, Hayden MK. Emergence and rapid regional spread of *Klebsiella pneumoniae* carbapenemase-producing Enterobacteriaceae. *Clin Infect Dis* 2011;53:532–540.
8. Kravitz GR, Glynn PF, Bornstein PF, Eirtz JJ, Krason DA, Kahn MA. Implementation of an antibiotic stewardship program (ASP) at a long-term acute care hospital (LTACH): fertile ground. In: *Program and Abstracts of the 19th Annual Scientific Meeting of the Society for Healthcare Epidemiology of America.* San Diego: March 18–22, 2009. Abstract 72.
9. National Healthcare Safety Network. *Multidrug-Resistant Organism and* Clostridium difficile *Infection (MDRO/CDI) Module.* June 2011. http://www.cdc.gov/nhsn/PDFs/pscManual/12pscMDRO_CDADcurrent.pdf. Accessed September 4, 2011.
10. Cohen SH, Gerding DN, Johnson S, et al. Clinical practice guidelines for *Clostridium difficile* infection in adults: 2010 update by the Society for Healthcare Epidemiology of America (SHEA) and the Infectious Diseases Society of America (IDSA). *Infect Control Hosp Epidemiol* 2010;31:431–455.