hospital length of stay, census, or patient mix. The overall cost of linezolid use over the 16 months after CPOE-ASP implementation resulted in a cost savings of more than $638,000, compared to 16 months prior to CPOE-ASP implementation. If annualized on the basis of cost per month in a stable census setting, the savings at our hospital would have been approximately $479,000 yearly.

Following the opening of our community hospital in 2005, linezolid use had become widespread and was substantially greater than the 1.5 DDD/1,000 PTD reported by Polk et al[7] in 130 hospitals over a 12–month period in 2002–2003, prior to the increasing prevalence of VRE infections currently being seen. Although education decreased linezolid use to 28 DDD/1,000 PTD, the additional decrease in its use to 7 DDD/1,000 PTD was realized following the initiation of the CPOE-ASP. The decrease in linezolid use during the 32-month period of the study was not attributable to a decrease in the hospital census or patient mix. Furthermore, the decrease in linezolid use impacted neither the length of stay for patients with skin and soft tissue infections nor the incidence of VRE infections.

The threat of antimicrobial resistance has given rise to guidelines for the appropriate use of antibiotics.[8] Although several studies have described the effectiveness of multi-antimicrobial ASPs that are pharmacist based[1-4] and with CPOE systems utilizing clinical decision support tools,[9] this report demonstrates the substantial savings that can be realized from optimizing the use of a single costly antibiotic. Given the substantial budgetary challenges in hospitals today, interventions such as ours have the potential for being used to enhance the feasibility of directing sustained administrative support for these types of programs. While limited to the experience of a single nonacademic community hospital, our findings support the benefits of a highly targeted intervention to optimize the utilization of a valuable antibiotic with substantial potential for overutilization.

ACKNOWLEDGMENTS

Potential conflicts of interest. J.L.P. reports being on the speakers' bureau for Cubicin. B.Q.N. and P.C.C. 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.

John Leander Po, MD, PhD;[1] Bao Q. Nguyen, PharmD;[1] Philip C. Carling, MD[2]

Affiliations: 1. Department of Medicine, Banner Estrella Medical Center, Phoenix, Arizona; 2. Infectious Diseases Section, Boston Medical Center, Boston, Massachusetts, and Caritas Carney Medical Center, Dorchester, Massachusetts.

Address correspondence to John Leander Po, MD, PhD, Banner Estrella Medical Center, 9305 West Thomas Road, Suite 380, Phoenix, AZ 85037 (john.po@bannerhealth.com).

Infect Control Hosp Epidemiol 2012;33(4):434-435

 0899-823X/2012/3304-0024$15.00. DOI: 10.1086/664766

REFERENCES

1. Septimus EJ, Owens RC Jr. Need and potential of antimicrobial stewardship in community hospitals. *Clin Infect Dis* 2011: 53(suppl 1):S9–S14.
2. LaRocco A Jr. Concurrent antibiotic review programs: a role for infectious diseases specialists at small community hospitals. *Clin Infect Dis* 2003;37(5):742–743.
3. MacDougall C, Polk RE. Antimicrobial stewardship programs in health care systems. *Clin Microbiol Rev* 2005;18(4):638–656.
4. Carling P, Fung T, Killion A, Terrin N, Barza M. Favorable impact of a multidisciplinary antibiotic management program conducted during 7 years. *Infect Control Hosp Epidemiol* 2003;24(9):699–706.
5. Shojania KG, Jennings A, Mayhew A, Ramsay C, Eccles M, Grimshaw J. Effect of point-of-care computer reminders on physician behaviour: a systematic review. *Can Med Assoc J* 2010;182(5): E216–E225.
6. Clemett D, Markham A. Linezolid. *Drugs* 2000;59(4):815–827.
7. Polk RE, Fox C, Mahoney A, Letcavage J, MacDougall C. Measurement of adult antibacterial drug use in 130 hospitals: comparison of defined daily dose and days of therapy. *Clin Infect Dis* 2007;44:664–670.
8. Dellit TH, Owens RC, McGowan JE Jr, et al; Infectious Diseases Society of America; Society for Healthcare Epidemiology of America. Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America guidelines for developing an institutional program to enhance antimicrobial stewardship. *Clin Infect Dis* 2007;44(2):159–177.
9. Pestotnik SL, Classen DC, Evans RS, Burke JP. Implementing antibiotic practice guidelines through computer-assisted decision support: clinical and financial outcomes. *Ann Intern Med* 1996; 124(10):884–890.

A Computer-Assisted Prescription System to Improve Antibacterial Surgical Prophylaxis

To the Editor—Growth of antibacterial resistance is a public health issue that was associated with antibiotic consumption.[1] Although not always easily implemented,[2] different strategies to improve patterns of antibacterial use in hospitals, including computer-assisted systems,[3] have been suggested, and their effect in reducing antimicrobial resistance was reported.[4]

Hospital da Luz is a 4-year-old, paper-free, 190-bed private general hospital in Lisbon, Portugal. On January 1, 2011, a new computer-assisted prescription tool was implemented to improve antibacterial use patterns. The hospital's internal protocol for antibacterial surgical prophylaxis was introduced into the prescription tool. In surgical prophylaxis, prescribers are required to specify the antibacterial, the type of surgery, and the duration of the course (intraoperative, 24 hour, or 48 hour). When selection is not in accordance with the internal protocol, an alert is issued, and when confirmed, a justification e-mail is sent out to the pharmacy and the antibiotic committee. This e-mail contains the reasons for selection and a free text field for comments. We aimed to assess the pattern of use of antibacterials for surgical prophylaxis and the compliance with the hospital's internal protocol using a new computer-assisted prescription tool.

A retrospective observational study was conducted including all antibacterial prescriptions in Hospital da Luz during the first month after the implementation of the antibacterial computer-assisted tool. All antibacterial prescriptions for systemic use were extracted from the electronic medical records and analyzed. Prescriptions for patients younger than 18 years of age were excluded. The study was approved by the Hospital da Luz ethics committee.

Descriptive statistical analyses were performed. Statistical association in crosstabs was analyzed through a χ^2 test for categorical variables and a Kendall τ-c test for 2 ordinal variables.

A total of 913 patients were admitted to the hospital during the study period, with 81.1% ($n = 740$) prescribed with 952 different antibacterial courses. The mean length of stay was 4.5 days (standard deviation, 9.9). Prescribed antibacterial therapeutic classes are presented in Table 1. Traditionally restricted antibacterials in Hospital da Luz (vancomycin, linezolid, and ertapenem) represented 1.2% ($n = 11$) of the total antibacterial use.

In 4.9% ($n = 47$) of cases, the reason for prescription was not identified. The remaining 905 courses were prescribed for surgical prophylaxis (67.8%), empiric treatment (27.6%), culture-directed antibiotic treatment (2.8%), and nonsurgical prophylaxis (1.8%). Antibacterials used in surgical prophylaxis ($n = 614$) are presented in Table 1. Significantly different prescription patterns between prophylaxis and other indications were found (χ^2 test, $P < .001$; Table 1). A 100% compliance with the internal protocol in 4 types of surgery (neurosurgery, cardiothoracic, vascular, and orthopedic) was found, and compliance was greater than 90% in head and neck and gastroduodenal surgeries. Penicillins were used in 5.2% of gynecologic and obstetric surgeries, quinolones were used in 18.8% of urologic and in 2.6% of colorectal surgeries, and imidazole derivatives were used in 61.4% of colorectal and in 3.2% of urologic surgeries. However, none of the latter classes are currently included in the internal protocol. Traditionally restricted antibacterials in the hospital were not used for prophylaxis.

The prophylaxis duration was as follows: 50.9% intraoperative only, 36.1% 1-day, 10.9% 2-day, 1.3% 3-day, 0.5% 4-day, and 0.3% 5-day duration. Duration longer than 48 hours was identified for 3 of therapeutic classes: 16.7% of the total quinolones used in prophylaxis, 2.1% of second-generation cephalosporins, and 2.0% of first-generation cephalosporins. Forty-eight-hour prophylactic courses were identified in all types of surgery. Prophylactic courses longer than 48 hours were found in 8% of cardiothoracic surgeries, 3.2% of urologic surgeries, 3.0% of head and neck surgeries and orthopedic surgeries, 2.1% of neurosurgeries, and 6.3% of other surgeries.

Traditional (noncomputerized) antibacterial restriction systems have been in use for several years, demonstrating their value with a limited number of antibacterials. After implementing the computer-assisted prescription tool, we achieved a high compliance of antibacterial selection with the hospital's internal protocol. Nevertheless, noncompliance was found for gynecologic, obstetric, urologic, and colorectal surgeries. In gynecologic and obstetric surgeries, although cefoxitin is the recommended antibacterial by the internal protocol, we found that cefazolin was prescribed in more than 90% of these surgeries. This shows a more conservative prescription pattern, which is also recommended in most published guidelines.[5] In urologic surgeries, a scattered prescription pattern was identified including cefoxitin, cefazolin, ciprofloxacin, ceftriaxone, and 2 nonrecommended associations: ceftriaxone plus metronidazole and cefoxitin plus metronidazole. In colorectal surgeries, the most prescribed antibacterial was metronidazol, which is not in accordance with the internal protocol, and guidelines do not recommend its use as a single agent.[5,6]

Regarding prophylaxis duration, the internal protocol recommends intraoperative administration for most procedures, up to 24 hours in some orthopedic surgeries, and, although controversial and in disagreement with some guidelines,[5,7] up to 48 hours in cardiothoracic, vascular, and orthopedic surgeries involving prosthetic material. Prophylaxis up to 24 hours appeared in all types of surgery, resulting in 36.1% of prophylactic courses, which could be considered a high proportion following European guidelines[8] but not the US Surgical Infection Prevention Project.[5] Prophylaxis up to 48 hours was found in 10.9% of the courses, which may be excessive even for the internal protocol recommendations. Neither the internal protocol nor recent guidelines[5] support prophylaxis longer than 48 hours. Our results revealed that about 2% courses exceeded 48 hours, especially in cardiothoracic surgeries (8%).

Our results show a general compliance with the hospital's internal protocol by using the computer-assisted prescription tool. However, there is still room for improvement in surgical antibacterial prophylaxis practices. Additionally, some weaknesses of the internal protocol should be debated between surgeons and the infection control committee. A comprehensive analysis of the justifications from the computer-assisted tool would help to improve the internal protocol.

ACKNOWLEDGMENTS

We would like to acknowledge Andrade Gomes, MD; Andreia Duarte, PharmD; and Teresa Salgado, PharmD, MSc, for their participation in data gathering and analysis.

Financial support. Partial support for presenting preliminary results at the First International Conference on Prevention and Infection Control (ICPIC) was provided by Pfizer and the ICPIC Organizing Committee.

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.

Joana F. Rodrigues, PharmD;[1] André Casado, MD;[2] Carlos Palos, MD;[2] Cláudia Santos, PharmD;[1] Aida Duarte, PhD;[3] Fernando Fernandez-Llimos, PhD[4]

Affiliations: 1. Pharmacy Department, Hospital da Luz, Lisbon, Portugal; 2. Intensive Care Unit, Hospital da Luz, Lisbon, Portugal; 3. Department of Microbiology and Immunology, Faculty of Pharmacy, Research Institute for Medicines and Pharmaceutical Sciences, University of Lisbon, Lisbon, Portugal; 4. Department of Social Pharmacy, Faculty of Pharmacy, Research Institute for Medicines and Pharmaceutical Sciences, University of Lisbon, Lisbon, Portugal.

Address correspondence to Fernando Fernandez-Llimos, PhD, Departamento de Socio-Farmacia, Faculdade de Farmacia, Universidade de Lisboa, Avenida Professor Gama Pinto, 1649-003 Lisboa, Portugal (f-llimos@ff.ul.pt).

Presented in part: International Conference on Prevention and Infection Control; Geneva; June 29–July 2, 2011.

Infect Control Hosp Epidemiol 2012;33(4):435-437

 0899-823X/2012/3304-0025$15.00. DOI: 10.1086/664923

REFERENCES

1. Bronzwaer SL, Cars O, Buchholz U, et al. A European study on the relationship between antimicrobial use and antimicrobial resistance. *Emerg Infect Dis* 2002;8:278–282.
2. Johannsson B, Beekmann SE, Srinivasan A, Hersh AL, Laxminarayan R, Polgreen PM. Improving antimicrobial stewardship: the evolution of programmatic strategies and barriers. *Infect Control Hosp Epidemiol* 2011;32:367–374.
3. Owens RC Jr. Antimicrobial stewardship: concepts and strategies in the 21st century. *Diagn Microbiol Infect Dis* 2008;61:110–128.
4. Davey P, Brown E, Fenelon L, et al. Interventions to improve antibiotic prescribing practices for hospital inpatients. *Cochrane Database Syst Rev* 2005Ot 19:CD003543.
5. Bratzler DW, Houck PM; Surgical Infection Prevention Guidelines Writers Workgroup. Antimicrobial prophylaxis for surgery: an advisory statement from the National Surgical Infection Prevention Project. *Clin Infect Dis* 2004;38:1706–1715.
6. Anonymous. Antimicrobial prophylaxis for surgery. *Treat Guidel Med Lett* 2009;7:47–52.
7. Edwards FH, Engelman RM, Houck P, Shahian DM, Bridges CR; Society of Thoracic Surgeons. The Society of Thoracic Surgeons practice guideline series: antibiotic prophylaxis in cardiac surgery. I. Duration. *Ann Thorac Surg* 2006;81:397–404.
8. Scottish Intercollegiate Guidelines Network. *Antibiotic Prophylaxis in Surgery.* Edinburgh: Scottish Intercollegiate Guidelines Network, 2008.