Lona Mody, MD; and Suzanne Bradley, MD

Infection Prevention Research in Nursing Homes

The number of older adults in the United States is expected to increase from almost 38.9 million in 2008 to 63.5 million by 2025.[1] In the past 2 decades, measures to reduce health care costs have led to reductions in hospitalizations and lengths of stay and an increasing demand on nursing homes (NHs) to provide care for an aging population with complex medical conditions.

The VA operates 133 community living centers (CLCs, formerly known as Extended Care Centers or Nursing Home Care Units) nationwide, serving about 10,000 veterans a day. The mission of VA CLCs is to provide a dynamic array of services in person-centered environments that meet the individual needs of residents, providing excellent health care and quality of life.[2]

Infections in NHs and CLCs increase the mortality and morbidity of residents, lead to hospital transfers, compromise residents' quality of life, and generate additional costs for the facilities as well as for the hospitals. Every year about 2 million infections occur in residents in NHs and are responsible for a substantial proportion of resident transfers to acute care hospitals. About 3% to 15% of residents will acquire an infection during their NH stay.[3]

The charge of the Infection Prevention in Aging (IPA) Research Program at the Ann Arbor VA Geriatric Research, Education and Clinical Center (GRECC) is to prevent and reduce infections among NH residents, particularly those infections due to antibiotic-resistant bacteria, with the overarching goal of improving quality of care and disease outcomes. Infection prevention practices in NHs are often adopted from acute care facilities. Few clinical interventional studies evaluating these practices have been performed in NHs, and the types of NHs studied have been limited. There is a great need to understand which infection control practices are most effective in nonhospital settings and whether these interventions can be effectively implemented by a wide variety of facilities that provide skilled care. In response to this need, our IPA Research Program has developed and fostered a network of NHs where infection prevention research can be conducted in collaboration with investigators from Geriatric Medicine, Infectious Diseases, and Health Services Research and Development.

The specific goals of our IPA Research Program are to evaluate the current state of NH health care workers' (HCWs) knowledge and compliance with current infection control recommendations, determine the extent of the problem of antibiotic resistance in NHs, and investigate effectiveness of infection prevention programs in reducing infections and antimicrobial resistance.

INFECTION PREVENTION RESEARCH IN NURSING HOMES: STUDIES USING SURVEY METHODOLOGY

While we know that infections and antimicrobial-resistant pathogens pose significant problems in NHs, we don't know how nonacademic, free-standing NHs cope with this daunting dilemma. We conducted survey-based studies to understand the extent of adoption of infection control practices in NHs.

Infectious Control Practices Survey

To gather preliminary information on compliance with infection control guidelines, we sent a survey to infection control practitioners/directors of nursing at 105 NHs (community-based, non-VA) in southeast Michigan. Despite the Centers for Disease Control and Prevention recommendations, 35% of the facilities had no

Dr. Mody is a research scientist and associate director of the GRECC at the VA Ann Arbor Healthcare System in Michigan and is associate professor of internal medicine in the Division of Geriatric and Palliative Care Medicine at the University of Michigan in Ann Arbor. **Dr. Bradley** is a research scientist at the GRECC and professor of internal medicine in the Divisions of Infectious Diseases and Geriatric and Palliative Care Medicine.

The VHA's Geriatric Research, Education and Clinical Centers (GRECCs) are designed for the advancement and integration of research, education, and clinical achievements in geriatrics and gerontology throughout the VA health care system. Each GRECC focuses on particular aspects of the care of aging veterans and is at the forefront of geriatric research and clinical care. For more information on the GRECC program, visit the Web site (http://www1.va.gov/grecc/). This column, which is contributed monthly by GRECC staff members, is coordinated and edited by Kenneth Shay, DDS, MS, director of geriatric programs for the VA Office of Geriatrics and Extended Care, VA Central Office, Washington, DC.

Table 1. Relationship between indwelling device use and microbial colonization

Type of indwelling device	Odds ratio for colonization*	*P* value
Any device		
MRSA: any site	2.0	0.04
MRSA: groin	4.8	0.006
MRSA: perianal	3.6	0.011
CTZ^R GNB: any site	5.6	0.003
Urinary catheter		
MRSA: groin	4.5	0.001
MRSA: perianal	4.3	0.006
CTZ^R GNB: any site	7.8	0.002
Feeding tube		
MRSA: any site	2.4	0.035
MRSA: groin	5.8	0.018
MRSA: oropharynx	3.3	0.02
MRSA: perianal	3.5	0.05
CTZ^R GNB: any site	7.3	0.006

*Adjusted for age, comorbidity, and functional status.

written policy for the care of feeding tubes, and 25% had no written policy for the care of urinary catheters. Additionally, 15% had no written policy for methicillin-resistant *Staphylococcus aureus* (MRSA), and 25% had no written policy for vancomycin-resistant enterococci (VRE). Surveillance to monitor infections varied extensively among these NHs.[4]

Next, HCWs at 4 NHs in Michigan were asked to complete a previously validated questionnaire assessing their knowledge, beliefs, attitudes, and motivation toward hand hygiene and the role of fingernails in colonization and transmission of pathogens. Most HCWs (84%) reported that hand hygiene was a useful first-line measure to prevent infections in residents, but only 61% knew how long hands should be washed. HCWs who believed that artificial or long fingernails were unrelated to pathogen transmission were less motivated to improve hand hygiene compared with those who believed that fingernails were a source of such transmission. Thus, knowledge and beliefs regarding hand and nail hygiene influenced HCWs' motivation to improve their hand hygiene practices.[5]

Using mail-in surveys to a nationwide random sample of NHs (community-based, non-VA), we have also shown that NHs have to scramble to receive their vaccine supply in times of shortage and that disaster preparedness (specifically pandemic preparedness) is challenging.[6,7] These studies show that the infection control recommendations put forward by various organizations have not been universally accepted or implemented. This study also underscores the need to understand the barriers and facilitators to diffusion of evidence-based practices and policies in NHs.

HOW COMMON IS ANTIMICROBIAL RESISTANCE IN NHS?

Prevalence of Cephalosporin-Resistant Gram-Negative Bacilli (GNB) in NHs

Epidemiology of MRSA and VRE in NHs and CLCs has been well-studied.[8-11] However, resistance in gram-negative bacilli (R-GNB) poses an even greater and immediate threat to patients because so few treatment options are available or in development. In collaboration with investigators from the Portland and Pittsburgh VA Medical Centers, we retrospectively assessed the prevalence of ceftazidime resistance (CTZ^R) among GNB at 3 VA CLCs. Our findings indicated that there was significant regional variation in the prevalence of R-GNB and CTZ^R among our VA CLC clinical isolates that approached 10%.[12] In a more recent study, we showed that impaired functional status or need for assistance with eating was predictive of colonization with R-GNB.[13]

Role of Indwelling Devices: Colonization With MRSA, VRE, and R-GNB

A study of the relationship between indwelling-device use and microbial colonization was conducted in 14 NHs.[14] Cultures were obtained from multiple anatomic sites. Overall, 51% of all residents were colonized with at least 1

resistant organism: 63% in residents with indwelling devices and 40% in residents without any devices (odds ratio 2.52; $P = .004$). The type of indwelling device was closely associated with the site of colonization and colonizing organism (eg, increased MRSA colonized the oropharynx in patients with enteral feeding tubes, but that association was not found in patients with urinary catheters).

Next, we explored whether residents with indwelling devices were more likely to harbor *S aureus* at multiple body sites (Table 1).[15] Overall, 28/29 residents (97%) with colonization at 4 or more sites had an indwelling device.[12] Similarly, 16/16 residents with colonization at 4 or more sites had an indwelling device. Of interest was also the fact that of 39 residents with MRSA at a single site, 22 residents were colonized at sites other than nares. Eighteen of these 22 residents had indwelling devices.

In general, the nares are the major reservoir for colonization with *S aureus* and MRSA. Many studies have used nares cultures alone to ascertain colonization. Our results have implications for infection control practice and future research. First, a significant proportion of NH residents harbor *S aureus* and MRSA at sites other than the nares. Presence of indwelling devices increases the likelihood of being colonized at multiple sites. Thus, NH residents with devices should be targeted for intensive infection control measures. Second, extensive extranasal colonization with *S aureus* and MRSA in this population has vital implications in planning for prospective surveillance and interventional studies designed to eradicate *S aureus* and MRSA colonization. Active surveillance using nares cultures alone may not be sufficient to identify all carriers.

These studies suggest that the epidemiology of MRSA in NHs is evolving, resistance among GNB is a significant issue, and residents with indwelling devices are at a substantially higher risk of colonization and possibly infection with these pathogens.

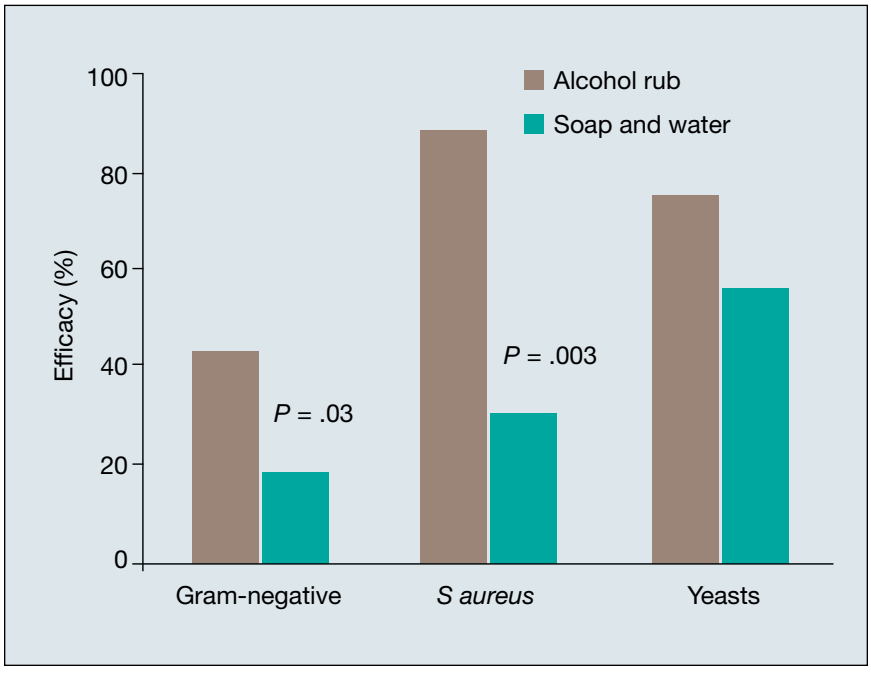

Figure 1. Efficacy of eradicating pathogens with an alcohol-based rub vs soap and water

INFECTION PREVENTION RESEARCH IN NURSING HOMES: INTERVENTIONAL STUDIES

After defining epidemiology of antibiotic resistance in NHs and conducting surveys to identify gaps in adoption of infection prevention practices, we conducted intervention studies to identify practical, portable, efficient infection prevention models for NHs.[16,17]

First, we assessed the introduction of alcohol-based hand rub cleansing in NHs and its effectiveness in reducing pathogens on the hands of HCWs, as well as improving hand hygiene compliance.[16] We found that 65% of HCWs' hands were colonized with GNB, 49% with yeast, 20% with MRSA, and 9% with VRE. After an educational intervention and introduction of an alcohol-based hand rub, HCWs were more likely to report hand cleansing before wound care and felt that the alcohol-based hand rub was more convenient and faster than traditional soap-and-water cleansing. Additionally, the alcohol-based hand rub method was significantly more effective in eradicating GNB and *S aureus* on HCWs' hands than was soap and water (Figure 1). This study demonstrated the effectiveness of an infection control intervention in improving compliance with a vital infection control practice in an NH setting.

In another randomized controlled trial we showed that mupirocin, a topical anti–staphylococcal agent, is very effective in eradicating *S aureus* colonization, with a trend toward fewer infections in the treatment group.[17]

Targeted Infection Prevention Program (TIP)

More recently, our group is engaged in a multi-NH National Institutes of Health-funded cluster randomized study to reduce antimicrobial resis-

tance and infections in NH residents with indwelling devices. The intervention program includes enhanced barrier precautions, such as wearing gowns and gloves when providing assistance with daily activities, for all NH residents with indwelling devices; active screening for multidrug-resistant organisms and infections using surveillance cultures and standardized infection definitions; a hand hygiene promotion program; and an in-service infection prevention educational program.[18]

SUMMARY

Initiating effective infection prevention strategies in NHs is challenging. Infection control recommendations put forward by various national organizations have not been universally accepted or implemented. For resource-limited NHs, targeting interventions to groups at high risk of colonization and infection, such as residents with indwelling urinary catheters and feeding tubes, may be a prudent strategy to increase adherence with infection control practices. Introduction of an alcohol-based hand rub is an effective and well-accepted strategy to reduce carriage of pathogens on the hands of HCWs. Our GRECC team is committed to conducting sound, rigorous infection prevention and quality improvement studies that will benefit veterans and residents of community-based NHs alike.

Author disclosures

The authors report no actual or potential conflicts of interest with regard to this article.

Disclaimer

The opinions expressed herein are those of the authors and do not necessarily reflect those of Federal Practitioner, *Quadrant HealthCom Inc., the U.S. Government, or any of its agencies. This article may discuss unlabeled or investigational use of certain drugs. Please review complete prescribing information for specific drugs or drug combinations—including indications, contraindications, warnings, and adverse effects—before administering pharmacologic therapy to patients.*

REFERENCES

1. National Center for Health Statistics. Health, United States, 2010: With Special Feature on Death and Dying. Hyattsville, MD. 2011.
2. VHA Handbook 1142.01, August 13, 2008, Criteria and Standards for VA Community Living Centers. http://www.va.gov/vhapublications/Viewpublication.asp?pub_ID=1736. Accessed December 8, 2011.
3. Strausbaugh LJ, Joseph CL. The burden of infection in long-term care. *Infect Control Hosp Epidemiol.* 2000;21(10):674-679.
4. Mody L, Langa KM, Saint S, Bradley SF. Preventing infections in nursing homes: A survey of infection control practices in southeast Michigan. *Am J Infect Control.* 2005;33(8):489-492.
5. Aiello AE, Malinis M, Knapp JK, Mody L. The influence of knowledge, perceptions, and beliefs, on hand hygiene practices in nursing homes. *Am J Infect Control.* 2009;37(2):164-167.
6. Mody L, Langa K, Malani P. Impact of the 2004-2005 influenza vaccine shortage on immunization practices in long-term care facilities. *Infect Control Hosp Epidemiol.* 2006;27(4):383-387.
7. Smith PW, Shostrom V, Smith A, Kaufmann M, Mody L. Preparedness for pandemic influenza in nursing homes: A 2-state survey. *JAMA.* 2008;300(4):392-394.
8. Strausbaugh LJ, Jacobson C, Sewell DL, Potter S, Ward TT. Methicillin-resistant *Staphylococcus aureus* in extended-care facilities: Experiences in a veterans' affairs nursing home and a review of the literature. *Infect Control Hosp Epidemiol.* 1991;12(1):36-45.
9. Murphy S, Denman S, Bennett RG, Greenough WB III, Lindsay J, Zelesnick LB. Methicillin-resistant *Staphylococcus aureus* colonization in a long-term-care facility. *J Am Geriatr Soc.* 1992;402(3):213-217.
10 Trick WE, Weinstein RA, DeMarais PL, et al. Colonization of skilled-care facility residents with antimicrobial-resistant pathogens. *J Am Geriatr Soc.* 2001;49(3):270-276.
11. Benenson S, Cohen MJ, Block C, Stern S, Weiss Y, Moses AE. Vancomycin-resistant enterococci in long-term care facilities. *Infect Control Hosp Epidemiol.* 2009;30(8):786-789.
12. Mody L, Bradley SF, Strausbaugh LJ, Muder RR. Prevalence of ceftriaxone and ceftazidime-resistant gram-negative bacteria in long-term-care facilities. *Infect Control Hosp Epidemiol.* 2001;22(4):193-194.
13. Bradley SF, Rao AS, Markham K, Bonomo R, Mody L. Rates of resistant gram-negative bacilli in an attached nursing home approach rates in hospital [abstract 552]. Paper presented at: 41st Annual Scientific Meeting of the Infectious Diseases Society of America. San Diego, CA; 2003.
14. Mody L, Maheshwari S, Galecki A, Bradley SF, Kauffman CA. Indwelling device use and antibiotic resistance in nursing homes: Identifying a high-risk group. *J Am Geriatr Soc.* 2007;55(12):1921-1926.
15. Mody L, Kauffman CA, Donabedian S, Zervos M, Bradley SF. Epidemiology of *Staphylococcus aureus* colonization in nursing home residents. *Clin Infect Dis.* 2008;46(9):1368-1373.
16. Mody L, McNeil SA, Sun R, Bradley SE, Kauffman CA. Introduction of a waterless alcohol-based hand rub in a long-term-care facility. *Infect Control Hosp Epidemiol.* 2003;24(3):165-171.
17. Mody L, Kauffman CA, McNeil SA, Galecki AT, Bradley SF. Mupirocin-based decolonization of *Staphylococcus aureus* carriers in residents of 2 long-term care facilities: A randomized, double-blind, placebo-controlled trial. *Clin Infect Dis.* 2003;37(11):1467-1474.
18. Mody L, Bradley SF, Galecki A, et al. Conceptual model for reducing infections and antimicrobial resistance in skilled nursing facilities: Focusing on residents with indwelling devices. *Clin Infect Dis.* 2011;52(5):654-661.