

SHEA Position Paper

Antimicrobial Resistance in Long-Term-Care Facilities

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ABSTRACT

During the last quarter century, numerous reports have indicated that antimicrobial resistance commonly is encountered in long-term-care facilities (LTCFs). Gram-negative uropathogens resistant to penicillin, cephalosporin, aminoglycoside, or fluoroquinolone antibiotics and methicillin-resistant *Staphylococcus aureus* have received the greatest attention, but other reports have described the occurrence of multiply-resistant strains of *Haemophilus influenzae* and vancomycin-resistant enterococci (VRE) in this setting. Antimicrobial-resistant bacteria may enter LTCFs with colonized patients transferred from the hospital, or they may arise in the facility as a result of mutation or gene transfer. Once present, resistant strains tend to persist and become endemic. Rapid dissemination also has been documented in some facilities. Person-to-person transmis-

sion via the hands of healthcare workers appears to be the most important means of spread. The LTCF patients most commonly affected are those with serious underlying disease, poor functional status, wounds such as pressure sores, invasive devices such as urinary catheters, and prior antimicrobial therapy. The presence of antimicrobial-resistant pathogens in LTCFs has serious consequences not only for residents but also for LTCFs and hospitals. Experience with control strategies for antimicrobial-resistant pathogens in LTCFs is limited; however, strategies used in hospitals often are inapplicable. Six recommendations for controlling antimicrobial resistance in LTCFs are offered, and four priorities for future research are identified (*Infect Control Hosp Epidemiol* 1996;17:129-140).

INTRODUCTION

The purpose of this position paper is to direct attention to the problem of antimicrobial resistance in long-term-care facilities (LTCFs) and its import for patients, facilities, and the healthcare system as a whole; to recommend strategies for control; and to identify priorities for future research. The term "LTCF" refers to facilities that provide for the biopsychological needs of persons with sustained self-care deficits and includes nursing homes, chronic disease hospitals, rehabilitation centers, foster and group homes, institutions for the mental-

ly retarded, etc. In the United States, the greatest number of LTCF residents live in the estimated 20,000 nursing homes that are scattered across the country.

STATEMENT OF THE PROBLEM *Occurrence of Antimicrobial-Resistant Pathogens in LTCFs*

Antimicrobial-resistant bacteria in LTCFs have been documented repeatedly in the medical literature since the early 1970s.¹ Information has originated from either surveillance studies of infections in

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LTCF residents or from outbreak investigations. While initial reports described β -lactam or aminoglycoside-resistant gram-negative bacilli, principally isolated from the urine of catheterized residents, recent reports have highlighted other resistant pathogens, notably methicillin-resistant *Staphylococcus aureus* (MRSA). There are no comprehensive surveys, but data available from surveillance studies and focused investigations indicate that antimicrobial-resistant pathogens are encountered frequently in LTCFs. It should be noted, however, that LTCFs are affected unequally and that both prevalences and patterns of resistant pathogens vary considerably from one facility to another.

Only one study has examined prospectively more than one form of resistance in a single facility. Terpenning and colleagues at the Ann Arbor Veterans Affairs (VA) Nursing Home Care Unit (NHCU) screened all residents during a 2-year period for colonization or infection with MRSA, enterococci with high-level resistance (HLR) to gentamicin, and gram-negative bacilli resistant to either gentamicin or ceftriaxone.² During the first year, $22.7 \pm 1\%$ (mean \pm SEM) of residents were colonized with MRSA, $20.2 \pm 1\%$ of residents were colonized with enterococci expressing HLR to gentamicin, and $12.6 \pm 1\%$ of residents were colonized with resistant gram-negative bacilli. The latter two rates were unchanged during the second year of the study, when MRSA colonization rates were reduced with mupirocin decolonization therapy. During the study, 49.6% of the infections with an identified etiology were caused by one of the antibiotic-resistant pathogens. Piecemeal observations from surveillance studies and outbreak investigations suggest that the experience at the Ann Arbor VA NHCU is not atypical.

Gram-negative uropathogens. Urine cultures from LTCF residents often yield antimicrobial-resistant pathogens. These include highly resistant strains of bacteria belonging to genera that usually are susceptible to most antimicrobial agents when isolated from the urine of nonhospitalized patients. Ampicillin-resistant isolates of *Escherichia coli* and cephalothin-resistant isolates of *Klebsiella* species, which are very common in LTCFs, exemplify this phenomenon.³⁻⁶ Other resistant urinary pathogens belong to genera that are noted for resistance to multiple agents. For example, *Providencia* species, which often are resistant to β -lactam and aminoglycoside antibiotics, frequently are isolated in LTCFs from the urine of catheterized residents, but rarely are recovered in other settings.⁶⁻¹⁰ Two studies comparing the antimicrobial susceptibility profiles

of LTCF urinary isolates with those from hospitalized patients found that the LTCF isolates generally were more resistant.^{3,11} Thus, gram-negative bacilli isolated from the urine of LTCF residents demonstrate resistance to many antimicrobial agents and number among the most resistant microbes known.

Aminoglycoside resistance in gram-negative uropathogens has been observed repeatedly.^{2,3,5,6,11-16} For example, in a 1-day prevalence study conducted in seven nursing homes in Salt Lake City, Utah, 33% of the gram-negative uropathogens were resistant to gentamicin.⁴ Similarly, in a prevalence study conducted in a VA NHCU in suburban Cleveland, gentamicin-resistant gram-negative bacilli were isolated from the urine of 16% of the residents.¹⁵ In an in vitro susceptibility study of urine, blood, and wound isolates from residents of more than 100 nursing homes in Oklahoma, 55% of the 33 *Enterobacter aerogenes* strains and 61% of the 284 *Pseudomonas aeruginosa* strains were resistant to gentamicin.¹⁶ Resistance to trimethoprim and the combination of trimethoprim-sulfamethoxazole has been documented frequently in LTCFs.^{3-6,11,16,17} Wingard et al, for example, detected colonization of urine or perineum with trimethoprim-resistant gram-negative bacilli in 52% of residents at a VA NHCU who were surveyed at quarterly intervals over a 2-year period.¹⁷

Resistance to fluoroquinolone antimicrobials also has been reported. Prospective surveillance in seven skilled nursing facilities in southern California found that approximately one third of *Pseudomonas* isolates and 12% of *Enterobacteriaceae* recovered from urine were norfloxacin resistant.¹⁰ In the study of isolates from Oklahoma nursing home residents, 50% of *P. aeruginosa* strains, 59% of *Providencia stuartii* strains, and 73% of *Acinetobacter calcoaceticus* strains were ciprofloxacin resistant.¹⁶ Lastly, resistance to β -lactam (eg, penicillin and cephalosporin) antibiotics has been noted commonly in LTCF uropathogens.^{3-6,11,13,16} The most worrisome report of β -lactam antibiotic resistance described an outbreak involving 29 patients in a chronic-care facility in Massachusetts caused by ceftazidime-resistant strains of *Klebsiella pneumoniae* and other members of the family *Enterobacteriaceae*.¹⁸ In the susceptibility study of isolates from Oklahoma nursing home residents, 25% of the 72 strains of *Citrobacter freundii* were resistant to imipenem.¹⁶

MRSA. Strains of MRSA, frequently resistant to multiple other antimicrobial agents, are the most thoroughly studied resistant pathogens in LTCFs. Following the initial report by Storch and colleagues of an MRSA outbreak in a St Louis-area

skilled-care facility,¹⁹ the medical literature blossomed with reports of MRSA in LTCFs from all around the United States, including California, New York, Illinois, Michigan, Minnesota, Pennsylvania, Washington, Oregon, Maryland, and Kentucky.¹⁹⁻³¹ These reports encompass community and VA facilities, large and small facilities, urban and nonurban facilities, and adult and pediatric facilities.

Three regional surveys in Minnesota, New York, and Oregon further attest to this phenomenon. In 1989, of 395 LTCFs in Minnesota (88%), 12% reported MRSA cases.³¹ Eight percent of these facilities identified MRSA as a problem, and 69% with MRSA cases had sought outside help or consultation for its control. In eight counties of western New York surveyed in 1991, 81% of 75 responding facilities had identified one or more MRSA cases in the preceding year, and 21% indicated an infection control problem with MRSA.²⁶ Larger facilities reported more cases. Lastly, of 109 nursing homes in Oregon surveyed in 1990, only one facility had MRSA cases in 1985 and 1986, whereas 34 (31%) acknowledged MRSA cases in 1989.²⁷ The number of MRSA cases in the involved facilities also increased substantially during the period from 1985 to 1989. These three surveys, dispersed in time and geography, depict widespread MRSA colonization and infection in LTCFs.

The potential of MRSA strains to acquire additional forms of resistance in LTCFs also has been reported. Ciprofloxacin resistance was noted in MRSA strains isolated in 1988 from residents of eight nursing homes in metropolitan New York within 3 months of the drug becoming commercially available.²¹ During an MRSA outbreak at a VA NHCU in Washington, MRSA strains uniformly were ciprofloxacin resistant within a year of initial ciprofloxacin use.²⁵

Other pathogens. The prevalence of enterococci with HLR to gentamicin and other aminoglycoside antibiotics in Ann Arbor, Michigan, in 1986 was 4.3% in urine specimens and rectal swabs from residents of a community nursing home and 47.4% in those from residents of the VA NHCU.³² The higher rate of colonization in the VA NHCU residents probably reflected the high rate of colonization (36.1%) in the acute-care division of the Ann Arbor VA Medical Center. More recently, VRE have been detected in nursing home residents. In the *in vitro* susceptibility study of isolates from residents of Oklahoma nursing homes, vancomycin resistance was detected in 3% of *Enterococcus faecalis* strains and 22% of *Enterococcus faecium* strains.¹⁶

An outbreak caused by an ampicillin-resistant strain of *H influenzae* involving six patients in a nursing

home and adjoining hospital during a 1-month period has been reported.³³ All patients had personal contact with at least one other case-patient, suggesting person-to-person spread; two patients were bacteremic, and one died. Sturm et al reported a similar type of outbreak involving 15 patients in a pulmonary rehabilitation center in The Netherlands.³⁴ The outbreak strain of *H influenzae* was resistant to amoxicillin, trimethoprim-sulfamethoxazole, chloramphenicol, and tetracycline. Finally, Choi et al described a 1988 nursing home outbreak caused by *Salmonella heidelberg*, a serotype frequently displaying multiple antimicrobial resistance.³⁵

Origin of Antimicrobial-Resistant Pathogens in LTCFs

Antimicrobial-resistant pathogens in LTCFs have three possible origins. First, they may arrive with a colonized or infected patient. This has been documented for MRSA²⁵ and gentamicin-resistant strains of *Enterobacteriaceae*.³⁶ Second, resistant pathogens may be selected for or, more rarely, may arise via mutation as a consequence of antimicrobial use for a given patient or for the facility as a whole. In their study of 10 patients with chronic indwelling urinary catheters at a VA NHCU in North Dakota, Bjork and colleagues observed that 70% of 63 antibiotic courses prescribed for these patients over a 2.5-year period were followed by bacteriuria with organisms resistant to the antibiotics administered.¹¹ Lastly, antimicrobial-resistant pathogens may arise from the transfer of genetic material from one species or genus of bacteria to another within the facility. An outbreak of ceftazidime resistance caused by an extended-spectrum β -lactamase in a chronic-care facility in Massachusetts arose from plasmid transmission among different strains of the family *Enterobacteriaceae* and not from dissemination of a single resistant isolate following the introduction of ceftazidime into the facility.¹⁸ Similarly, in a study of gentamicin-resistant gram-negative bacterial colonization in a VA NHCU, an *E coli* plasmid, which conferred resistance to ampicillin, carbenicillin, tetracycline, and sulfonamides, was identical to two *C freundii* plasmids and a *P stuartii* plasmid isolated from three different patients.¹⁵ Thus, all three mechanisms play a role in generating resistant bacteria in LTCFs; the relative importance of the three mechanisms has not been delineated.

Natural History and Epidemiology of Antimicrobial-Resistant Pathogens in LTCFs

Once antimicrobial-resistant pathogens are introduced into LTCFs, they tend to persist and become endemic. Widespread dissemination

throughout some facilities has been documented. For example, 15 months after the introduction of MRSA into a VA NHCU in Washington, a prevalence study identified 34% of the residents and 7% of the staff to be colonized with MRSA.²⁵ Outbreaks of clinical disease have been observed in other LTCFs.¹⁹ Several studies have documented large percentages of residents colonized by MRSA over extended periods of time. The mean monthly colonization rate over a 2-year period for MRSA at any site in a VA NHCU in Ann Arbor was $23 \pm 1\%$.²³ For 65% of the 60 patients who were evaluated for at least 3 months after initial detection of MRSA colonization, persistent or probable persistent colonization was documented. Similar observations are reported in other studies.²⁴ MRSA persistence also has been reported from studies in community LTCFs but at lower frequencies—5% to 16%.^{20,22}

The persistence of antimicrobial-resistant bacteria in LTCFs has been attributed to a number of factors. The presence of large numbers of residents with significant underlying diseases and indwelling foreign bodies (urinary catheters, feeding tubes, tracheostomies, etc) who frequently receive antimicrobial therapy (see companion position paper by SHEA Long-Term-Care Committee³⁷) and who generally stay for months to years appears to be most important.^{37,38} Additional institutional factors that may increase the likelihood of person-to-person transmission include resident interaction in two- or four-bed rooms and communal activities such as meals and various types of therapy; high patient-to-staff ratios, staffing by nonprofessional personnel, frequent turnover of staff, meager emphasis on infection control, and limited facilities for hand-washing may facilitate cross-infection.^{4,38,39} Increased frequencies of residents colonized with resistant pathogens in large facilities with more skilled beds further support the importance of these factors.³⁸ Surveys repeatedly have documented deficiencies in the infection control programs of US and Canadian LTCFs.⁴⁰⁻⁴³ Finally, antibiotic use likely contributes to the persistence of resistant strains in LTCFs.

Few MRSA or other LTCF studies have focused specifically on the sources, reservoirs, and means of transmission. Nevertheless, it seems likely that the same factors responsible for the spread and maintenance of MRSA and other resistant pathogens in hospitals are operative.⁴⁴ MRSA-infected and MRSA-colonized residents are thought to constitute the major reservoir and source of resistant

strains. Of note, however, in the 1-year study reported by Bradley and coworkers at the Ann Arbor VA, only 3% of the 258 residents at risk appeared to acquire their MRSA strain from a roommate. These findings suggest that other sources may be present. Although several studies have documented MRSA nasal carriage in healthcare workers in LTCFs, none have implicated them directly in strain transmission.^{19,20,25} Several studies from LTCFs also have reported the recovery of MRSA and enterococci with HLR to aminoglycoside antibiotics from environmental surfaces,^{23,32,45} but the potential role of the inanimate environment as a reservoir or source is otherwise unexplored.

As in the hospital, person-to-person spread via direct contact, especially that between a resident and the transiently colonized hands of a healthcare worker, is thought to be the principal mode of transmission. Isolation of resistant pathogens from the hands of healthcare workers and observations on the timing of new cases have provided some evidence to support this theory for MRSA,^{46,47} resistant gram-negative uropathogens,^{15,17} and *H influenzae*.^{33,34} As judged from one VA study, cross-colonization is a common occurrence.¹⁷ Although not well studied, no evidence published to date has strongly implicated indirect contact via environmental sources, droplet or aerosol generation by colonized patients with tracheostomies, or contaminated common vehicles as important means of spread for antimicrobial-resistant pathogens in LTCFs.

Risk Factors for Infection and Colonization With Resistant Pathogens in LTCFs

For infection. Only two studies have identified risk factors for infection with antimicrobial-resistant pathogens in LTCFs. In a VA intermediate care ward and an NHCU, persistent MRSA colonization and dialysis were independent risk factors for MRSA infection.²⁴ In another VA NHCU study, diabetes mellitus and peripheral vascular disease were significant independent risk factors for MRSA infection²; intermittent urinary catheterization and presence of an indwelling urinary catheter were significant independent risk factors for infection caused by resistant gram-negative bacilli.²

For colonization. A number of studies have reported risk factors for colonization with antimicrobial-resistant pathogens in LTCFs.^{2,15,17,20,22,23,28,38,48} These indicate that poor functional status, presence of wounds such as pressure sores, presence of invasive devices such as urinary catheters or feeding tubes, and recent

TABLE 1
RISK FACTORS FOR COLONIZATION BY ANTIMICROBIAL-RESISTANT BACTERIA IN LONG-TERM-CARE FACILITIES*

Category of Risk Factor	Risk Factor for Colonization With:		
	Resistant Gram-Negative Uropathogens	Methicillin-Resistant <i>Staphylococcus aureus</i>	Enterococci With High-Level Aminoglycoside Resistance
Patient characteristic	Inflammatory bowel or chronic renal disease and prior pneumonia ² ; nonambulatory status and increased length of stay ¹⁴ ; decreased functional status and increased length of stay ¹⁷ ; bladder dysfunction and advanced age ³⁸	Bedridden or chair/bed confined status ²² ; poor functional status ²³ ; male gender and urinary incontinence ²⁸	Renal failure, poor functional status (Katz), and low serum albumin ² ; need for advanced nursing care and bedridden/wheelchair-bound status ³²
Skin condition	Presence of wounds ²	Presence of wounds and decubitus ulcers ^{20,22} ; decubitus ulcers ² ; pressure sore present ²⁸	Presence of wounds ²
Invasive devices	Intermittent urinary catheterization ² ; urinary catheter ¹⁵	Nasogastric intubation or intravenous catheter ²⁰ ; feeding tube or urinary catheter ²²	Intermittent urinary catheterization ² ; urinary or intravenous catheterization ³²
Prior antimicrobial therapy	Antimicrobial therapy in previous 2 weeks ³⁸	Current antibiotic therapy ²⁰	Antimicrobial therapy in previous 3 months ³²
Prior colonization	Prior perineal or rectal colonization (a risk factor for urinary tract colonization) ¹⁵	Positive MRSA culture prior to prevalence survey ²⁸	
Facility feature	Residence in large facilities (219 to 330 skilled beds) ³⁸		

*For studies using stepwise logistic regression or multivariate discriminant analysis techniques, putative risk factors that were identified only by univariate analysis are not listed.

antimicrobial therapy identify LTCF residents who are likely to be colonized with resistant microbes. Specific risk factors identified for the major resistant pathogen groups are listed in Table 1. Other putative risk factors that were identified only by univariate analysis also are described in several studies that employed stepwise logistic regression analysis.^{2,15,17,28,38}

Consequences Resulting From Presence of Antimicrobial-Resistant Pathogens in LTCFs

Antimicrobial-resistant pathogens in a LTCF have important consequences for the patients and for the facility. Facility-acquired infections with resistant organisms are the direct cause of considerable morbidity. There may be excess morbidity or mortality if initial empiric therapy is ineffective. Control strategies may limit the movement of infected or colonized residents, and, hence, their opportunities to socialize or participate in various forms of group therapy.

There are additional costs associated with more expensive antimicrobials or a need for parenteral therapy.⁴⁸ Moreover, a small proportion of resistant isolates often begets overuse of new broader-spectrum antimicrobial agents, which, in turn, increases the selective pressure for resistant strains. Recent examples of this phenomenon include the emergence of quinolone resistance in pseudomonads and MRSA following increased use of ciprofloxacin for the empiric therapy of urinary tract infections possibly caused by bacteria resistant to trimethoprim-sulfamethoxazole; outbreaks caused by *Enterobacter* strains resistant to third-generation cephalosporin antibiotics following overuse of ceftazidime or aztreonam; and, finally, clusters of VRE infections following overuse of vancomycin empirically in anticipation of possible MRSA infection or for *Clostridium difficile* colitis.

The presence of antimicrobial-resistant pathogens in an LTCF has additional consequences for the facility itself. As the facility recognizes increasing cases,

efforts to control transmission usually bring additional costs, eg, for staff training, gloves, gowns, consultation, etc. If the infection control program necessitates the use of single rooms for some patients, the facility may lose beds and the associated revenue. If the frequency of antimicrobial-resistant cases becomes sufficiently high, the facility may find its reputation and its ability to market its services threatened.

The presence of antimicrobial-resistant pathogens in LTCFs has additional consequences for the entire healthcare system. Resistance emerging in the facility due to selective antimicrobial pressure, or resistance arriving with hospitalized patients suffering from severe underlying disease or needing invasive devices, often spreads widely within LTCFs, greatly expanding the numbers of patients colonized with resistant pathogens. From the acute-care hospital perspective, LTCFs can be viewed as both amplifiers and reservoirs of resistant pathogens.⁴⁹ Several reports in the literature have linked hospital outbreaks to an infected or colonized LTCF patient's admission^{1,13,29}; and other studies have identified large numbers of LTCF residents colonized or infected with antimicrobial-resistant pathogens at the time of their admission to the hospital.^{12,19,50,51} Patients frequently shuttle back and forth between the two institutions.⁵¹ As a breeding ground, amplifier, reservoir, and distribution center, LTCFs contribute substantially to the overall societal burden of antimicrobial resistance.

CONTROL STRATEGIES

Special Considerations for LTCFs

Many control measures used in hospitals cannot be extrapolated to LTCFs. For example, few LTCFs have the laboratory resources to screen their residents for colonization with antimicrobial-resistant pathogens, a practice often employed in hospital outbreaks to define the reservoir. Similarly, the number of private rooms in which to accommodate colonized or infected residents who need segregation is limited. In facilities that use a common dining hall or that sponsor rehabilitation programs for large groups, isolating patients with resistant microbes may deprive them of important opportunities for socialization and rehabilitation. Lastly, the rapid discharge of residents who are colonized or infected with antimicrobial-resistant pathogens seldom is possible in LTCFs, because the residents often have nowhere to go.

Published Reports From LTCFs

Only a few studies, all targeting MRSA, have examined control measures for dealing with

antimicrobial-resistant pathogens in LTCFs (Table 2). Of note, Storch and colleagues¹⁹ responded to an acute MRSA outbreak that developed during the influenza season in which 17 residents developed "clinically significant infections," while the other three studies arose in response to high colonization rates in the affected facilities. This likely explains the more draconian measures employed by Storch et al and emphasizes the role of context in the formulation of goals and strategies for control efforts. An outbreak with morbidity and mortality arising from cross-infection within the institution may justify a number of actions that might seem inappropriate in situations where antimicrobial-resistant pathogens have become endemic, yet account for only a small proportion of the infectious morbidity.

Because more than one control measure was used in each of the MRSA studies, it is difficult to assess the utility of any specific action. It does appear that the overall approach of Storch and colleagues to their epidemic, which obviously was patterned on programs used in hospitals, was successful in terminating the outbreak of cross-infections. However, the end of the influenza season also may have been an important factor in terminating the outbreak, and, because the duration of follow-up was short, the long-term outcome of their approach is unknown. The results of the other three studies are even less clear. Although MRSA colonization rates decreased in response to mupirocin therapy in the study reported by Kauffman and colleagues, there was no discernible effect on infection rates; and mupirocin resistance subsequently was noted.⁵² Because of these limitations and uncertainties, these studies provide little guidance on generally applicable approaches to MRSA or other resistant pathogens in LTCFs.

Published Recommendations for Control of Antimicrobial Resistance in LTCFs

A number of reports have made recommendations for managing the problem of antimicrobial resistance in LTCFs. The Association for Professionals in Infection Control and Epidemiology, Inc (APIC) guideline for infection prevention and control in the LTCF suggests that the infection control practitioner be involved in antibiotic education and control programs and that barrier precautions be used to prevent cross-infection with known resistant microorganisms.⁵³ Similarly, Johns and Ribner³⁹ suggest general strategies for the control of antimicrobial-resistant bacteria, which include antimicrobial restriction, surveillance, nontreatment of asymptomatic bacteri-

TABLE 2
STUDIES REPORTING CONTROL MEASURES USED AGAINST MRSA IN LONG-TERM-CARE FACILITIES

Facility	Interventions	Outcome	Comment
182-bed skilled nursing facility (near St Louis, MO) ¹⁹	(1) Residents and staff cohorted; (2) gowns and gloves for direct contact with cases; (3) separate handling of linens and trash of cases; (4) decolonization of staff; (5) staff education; (6) cultures of selected residents and staff	MRSA cases (colonizations and infections) reduced from 16 to five over 6 months	Outbreak recognized in wake of influenza A epidemic when five MRSA pneumonia cases occurred; other cases detected by prevalence survey, which was not repeated
170-bed skilled nursing facility (near Los Angeles, CA) ²⁰	(1) Residents and staff cohorted; (2) staff education; (3) cultures of new admissions, residents, and staff; (4) unspecified isolation procedures	9.1% of residents and 3.4% of staff MRSA-positive at outset of study; 28% reduction in resident and 32% reduction in staff colonization rates 3 months later (not statistically significant)	Two cross-sectional culture surveys performed 3 months apart; only one infected resident in first survey; one in second survey
120-bed VA skilled nursing facility (near Portland, OR) ⁴⁵	1) Residents cohorted; (2) staff education; (3) cultures of new admissions, staff, and residents; (4) decolonization therapy for residents and staff; (5) chlorhexidine handwashing preparations	56% of residents persistently colonized or recolonized within 30 days of decolonization therapy; increased frequency of rifampin resistance after decolonization campaign	Focus on decolonization, which was judged ineffective and potentially hazardous because of emerging resistance
120-bed VA skilled nursing facility (in Ann Arbor, MI) ⁵²	(1) Routine resident surveillance cultures; (2) cultures of new admissions; (3) mupirocin therapy for colonized wounds and nares	Facility colonization rates decreased from 22% to 11% in 1 year; 10.8% of treated patients later found to have mupirocin-resistant isolates	No effect on infection rates, which were small throughout study; other control measures, eg, barrier precautions, not specified

uria, minimizing topical antibiotics, promoting handwashing, and optimal use of urinary drainage systems. While these strategies seem reasonable, the difficulties in applying these principles to real-life situations need to be addressed, and it must be acknowledged that there is no specific evidence to demonstrate their efficacy. Outbreaks in which cross-infection is conspicuous undoubtedly would require additional strategies.

A number of reports, including those of the American Hospital Association's (AHA) MRSA task force⁴⁴ and the VA consensus panel,⁵⁴ have made specific suggestions regarding the control of MRSA in LTCFs.⁵⁵⁻⁶³ There is general agreement that MRSA cases should not be excluded from LTCFs, that surveillance of culture and susceptibility testing results should be maintained, that good handwashing practices should be emphasized, and that

barrier precautions should be used for wound care. Other control measures are warranted only in the context of an outbreak generated by cross-infection within the institution. Here again, there is a paucity of supporting data, but enough common sense to generate some agreement. Some measures, eg, decolonization, remain highly controversial.

Components of a Control Program

The list of potential control measures to prevent the spread of antimicrobial-resistant pathogens in LTCFs derives from the acute-care experience (Table 3). The value of any particular measure is unproven, and what combinations are appropriate in any given situation is unknown. The specific goals to be achieved determine the measures needed. Such goals could include (a) control of an outbreak; (b) keeping out all resistant pathogens; (c) eradication

of all resistant pathogens from a facility; or, (d) keeping cross-infection rates within an acceptably low range. Different combinations of measures would be needed for each of these differing goals, and they will be influenced by the resources available. The challenge for those interested in preventing the spread of antimicrobial resistance is the formulation of realistic goals that can be accomplished with available methods and resources.

Recommendations for Control Strategies

Because antimicrobial use patterns often affect prevalence of antimicrobial resistance in LTCFs, strategies for controlling resistant pathogens need to deal with antibiotic use. Specific recommendations regarding these issues are contained in the companion position paper³⁷ from the SHEA Long-Term-Care Committee, entitled "Antimicrobial Use in Long-Term-Care Facilities," and will not be repeated here. Other recommended strategies for control and additional commentary follow below. Using the quality standards developed by the Infectious Diseases Society of America,⁶⁴ all of the recommendations below are categorized BIII; that is, the strength of each recommendation is B ("moderate evidence to support a recommendation for use") and the quality of evidence on which the recommendation is based is III ("evidence from opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees"). Antimicrobial pathogens of concern include MRSA; VRE; gram-negative uropathogens resistant to all aminoglycoside, all β -lactam, or all fluoroquinolone antibiotics; and any human pathogen that is susceptible to two or fewer effective antimicrobial agents.

(1) *Residents who are colonized with antimicrobial-resistant pathogens should not be denied entry into LTCFs.*

Comment: Repeatedly, LTCFs have sought to deal with the potential problem of residents colonized with selected antimicrobial-resistant pathogens, such as MRSA, by restricting their entrance into the facility.³¹ There is no evidence to indicate that this strategy is effective and, more importantly, it leads to overuse of hospital resources for colonized patients who must remain in the acute-care facility indefinitely while awaiting placement. This policy may lead not only to an adversarial or dishonest relationship between the referring hospital and LTCF, as they contend over the placement of colonized patients, but also to a false sense of security on the part of the LTCF management, who may think this strategy keeps their facility free of resistant organ-

isms. Additional basic precepts that support nonexclusion of colonized patients include antimicrobial-resistant pathogens are *not* more virulent than their less-resistant counterparts; entry of resistant microbes into LTCFs does *not* appear to increase facility infection rates or necessarily lead to excess morbidity or mortality⁶⁵; and presence of colonization frequently is difficult to detect. The AHA Task Force⁴⁴ and VA Consensus⁵⁴ documents both oppose restricting the access of MRSA-colonized residents to LTCFs, and there is no reason to restrict those colonized with other antimicrobial-resistant pathogens.

(2) *Decolonization therapy should not be required for residents colonized with antimicrobial-resistant pathogens prior to their admittance to an LTCF.*

Comment: The failure rates reported with rifampin or mupirocin, together with the emergence of resistance, suggest that decolonization efforts be limited to highly selected situations.^{45,52} Even if apparently effective, decolonization often is a temporary phenomenon with recolonization occurring within days or weeks of therapy.

(3) *LTCF residents colonized with antimicrobial-resistant pathogens should not be restricted from participation in social or therapeutic group activities within the facility unless there is reason to think that they are shedding large numbers of bacteria and have been implicated in the development of infection in other residents.*

Comment: Strict isolation, or restriction of residents from dining rooms and rehabilitation group activities, occasionally are suggested to control transmission of antimicrobial-resistant pathogens in LTCFs.⁶³ There is no evidence that this approach is effective, and the deprivation of social contact and rehabilitation opportunities may impair the convalescence or quality of life in affected residents. Strict isolation and other restrictions of movement should be reserved for instances where residents may be shedding large numbers of organisms into the environment (eg, large wounds not contained with dressings or tracheostomies with frequent coughing), *and* who also have been linked epidemiologically with other residents who acquired infections with similar microbes. Residents with acute contagious illnesses, rather than colonization, should be isolated appropriately.

(4) *LTCFs should obtain information on colonization or infection with antimicrobial-resistant pathogens of concern prior to receiving new admissions.*

Comment: This information alerts infection control practitioners at the receiving institution to potential problems and may provide added incentive

TABLE 3
POSSIBLE CONTROL MEASURES FOR PREVENTING SPREAD OF ANTIMICROBIAL-RESISTANT PATHOGENS
IN LONG-TERM-CARE FACILITIES

Category and Control Measure	Comment
Surveillance	
Review microbiology data	Data usually available
Maintain line listing of cases	Provides rough dimensions of facility case load
Prevalence surveys of residents, staff, or new admissions	Expensive, time consuming; used to define extent of problem and to identify candidates for cohort schemes, isolation or precaution strategies, or decolonization therapy
Identify readmission cases	Rapidly identifies possible sources
Precautions	
Handwashing	Universally recommended
Antimicrobial soaps	Questionable added benefit to handwashing
Environmental decontamination	Major questions about significance of environmental reservoir
Private room for C/I* residents	Usually in short supply in many LTCFs [†] ; may decrease resident socialization and participation in therapeutic activities
Barrier precautions for C/I residents	Gloves for handling infectious material; gowns if soiling is likely; masks are of questionable benefit
Strict isolation for C/I residents	Private rooms in short supply; adverse effect on socialization and participation in group activities
Isolation of new admissions	Private room shortage; implies commitment to screening cultures and subsequent commitment to cohorting, extraordinary precautions, or decolonization
Special placement C/I residents	Identified cases kept away from residents at high risk of infection
Cohort C/I residents	Many LTCFs not set up for this; requires screening to identify all candidates; impractical when 20% to 30% of residents are colonized
Cohort C personnel	Difficult; requires screening of staff
Establish isolation ward	Impractical for most nursing homes; requires space and screening; adverse effect on socialization and participation in activities
Reduction of reservoir	
Exclusion of C/I residents from facility	Universally decried; places significant burden on hospitals; creates hardship for patients
Rapid discharge of C/I residents	Impractical for residents requiring long-term care
Decolonization therapy of residents, personnel, or new admissions	Not 100% effective and development of resistance to agents used inevitable; logic of use often would dictate screening

Abbreviation: *C/I, colonized/infected; [†]LTCF, long-term-care facilities.

to maintain optimal infection control practices. The intent of this recommendation is to use laboratory information that is already available and *not* to promote additional culturing of asymptomatic individuals. Surveillance cultures should *not* be performed routinely on patients awaiting transfer to LTCFs, nor should such screening be required for transfer.

(5) *Routine surveillance for selected antimicrobial-resistant pathogens should be performed in LTCFs and should include regular review (weekly, biweekly, or monthly, depending on the frequency of resistance within the facility) of all microbiological data*

obtained in association with patient care; maintenance of a line listing of antimicrobial-resistant pathogens identified; differentiation of colonization and infection status, calculation of infection rates for resistant pathogens; and identification of threshold infection rates that would prompt additional actions.

Comment: These recommendations are consistent with the “APIC Guideline for Infection Prevention and Control in Long-Term-Care Facilities”⁵³ and with recommendations for MRSA control in LTCFs.^{44,54,63} Facilities need to know the status of antimicrobial-resistant pathogens.

Such data should be used in educational reinforcement of infection control procedures and to prioritize problems to be addressed. Clinicians will use information about resistant pathogens in the facility in selecting empiric therapy for infected residents.

(6) *Routine precautions in all LTCFs should include adequate sinks, education, and incentives to ensure good handwashing practices throughout the facility at all times; adequate supplies, incentives, education, and personnel to minimize the use of invasive devices such as urinary catheters, feeding tubes, tracheostomies, etc; and adequate supplies and education to ensure that appropriate barrier precautions are used in the management of all wounds and invasive devices.*

Comment: This recommendation also is consistent with the APIC guideline and with recommendations for MRSA control in LTCFs.^{44,53,54,58,59} It places emphasis on those measures that are most likely to disrupt cross-colonization and cross-infection by healthcare workers.

(a) *For LTCFs without infections caused by antimicrobial-resistant pathogens in the preceding year and few, if any, colonized patients, no additional control measures are advocated.*

Comment: Surveillance to detect the appearance of resistant pathogens and basic infection control practices remain important. No additional efforts would appear to have a favorable cost-benefit ratio.

(b) *For LTCFs with a low-level endemic infection rate caused by antimicrobial-resistant pathogens of concern (eg, <1 case per 1,000 resident-care days), the following additional control measures are recommended: surveillance data should be analyzed monthly to identify cross-infection or cross-colonization; residents colonized or infected with antimicrobial-resistant pathogens should not be placed in rooms with the debilitated, nonambulatory resident at greatest risk of becoming colonized or infected; and single rooms (if available) and cohorting strategies should be used judiciously to minimize dissemination of resistant organisms from residents shedding large numbers of bacteria into the environment, eg, residents with colonized wounds not covered fully with dressings, incontinent residents with urinary or fecal carriage, or colonized residents with tracheostomies and difficulty handling respiratory secretions.*

(c) *For LTCFs with high rates of endemic infection (eg, >1 per 1,000 resident-care days) or an outbreak (eg, greater than three infections in a week or twice the number of infections in a month than had been observed in each of the 3 preceding months), consultation with an experienced epidemiologist is recommended.*

Comment: Recognizing the varied factors that may be responsible for high endemic rates or outbreaks, members of the SHEA Long-Term-Care Committee judge that the approach to problems of this nature must be individualized, with input from an experienced epidemiologist. Any combination of the control measures listed in Table 3 may be appropriate. Several approaches may be tested before the optimum control strategy is identified.

RESEARCH CONSIDERATIONS

Limitations of Published Studies

The magnitude of the problem of antimicrobial resistance in LTCFs is not defined. Much of the data in the literature has been generated in VA facilities, whose experience may not parallel that observed in community facilities. Large, urban facilities also are overrepresented in the published experience. Nationally or regionally, there have been no systematic, culture-based surveys that use reference laboratories to confirm and identify resistance mechanisms and distinguish colonized from infected residents, to document the qualitative and quantitative aspects of the problem in the diverse spectrum of facilities classified under the heading of LTCFs. Similarly, quantitative estimates of the problem, including patient morbidity, mortality, and expense, which is information required for prioritization of resources, are not available. The role of transposons in facilitating the acquisition and dissemination of new antibiotic resistance genes, the dynamics of transmission of resistant strains, and the pathogenesis of colonization and infection must be determined. Expansion of the knowledge base in these basic areas seems essential for the development of innovative control strategies. The efficacy of individual control measures or their combinations have not been substantiated in controlled trials in LTCFs. Innovative strategies that have been suggested, such as rotation of agents on the LTCF formulary or use of vaccines to alter colonization of specific bacteria, have not been studied in LTCFs.³⁹

Priorities for Future Research

The limited knowledge about antimicrobial-resistant pathogens in LTCFs generates a number of research questions. The list provided below is not exhaustive, but identifies broad areas that are viewed as important for the identification of appropriate management approaches. The order of priority was established by consensus of the SHEA Long-Term-Care Committee and reflects a strong desire to determine the magnitude of the problem and appropriate responses.

(1) Observational studies to assess the effects of antimicrobial-resistant pathogens in LTCFs on patterns of infection-related morbidity and mortality; resident and facility expense; and consequences for hospitals and other sectors of the healthcare system. Such information constitutes an important baseline for evaluating the potential impact of control strategies.

(2) Controlled trials to evaluate the impact of various strategies on prevalence of infection caused by antimicrobial-resistant pathogens. The focus would be prevalence of infection and associated morbidity. Several different control measures may be incorporated into any given strategy.

(3) National and regional surveys to delineate the extent of the problem in residents of LTCFs. Optimally, such surveys should collect and distinguish isolates from colonized and infected residents, use reference laboratories for confirmation of strain identity and resistance patterns, and incorporate appropriate epidemiological principles in sampling from the diverse array of LTCFs.

(4) Expansion of basic knowledge about behavior of resistant pathogens in LTCFs. Attention might focus on microbial factors, eg, transposons or other promoters of resistance and its dissemination; host factors resisting or permitting colonization and infection; quantitative aspects of transmission and spread; and additional considerations that arise from investigations at the molecular level. New knowledge in this area is considered crucial for the development of innovative control strategies.

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