We face an apocalypse of antibiotic resistance; in many facilities our favorite antibiotics, the quinolones, are becoming unreliable. For example, O’Fallon et al.1 analyzed 1661 clinical cultures obtained in a 750-bed nursing home (NH) over 2 years. The prevalence of ciprofloxacin-resistant gram-negative bacteria increased from approximately 7% in 2003 to 13% in 2005. These isolates were more common than methicillin-resistant Staphylococcus aureus (MRSA).1 Lautenbach et al2 identified 1805 gram-negative organisms in urine cultures obtained from residents of 63 long-term care facilities over a 10-month period in 2008. The prevalence of fluoroquinolone resistance in Escherichia coli was 51% (446 of 874 isolates). The prevalence of ceftazidime and imipenem resistance in Klebsiella species was 26% and 6% (84 and 19 of 323 isolates respectively). Ceftazidime resistance is a marker of extended spectrum beta-lactamase (ESBL) production and imipenem resistance is a marker of carbapenemase production. The prevalence of resistance varied significantly by facility type, size, and geographic location. One should not assume that your facilities’ rates of resistance are the same as those reported in medical journals.2 This fact underscores the need for each facility to maintain its own bacteriology database.

Finally, clinicians reported a retrospective series of 121 patients with nursing home–acquired pneumonia with illness severe enough to require admission to an urban teaching hospital (2003–2005). The results were restricted to the subset of patients in which a bacterial pathogen was identified. Many of these residents had additional risk factors for multidrug-resistant organisms (MDROs) such as recent hospitalization and critical illness. MRSA, Pseudomonas, or ESBL-producing bacteria were isolated in 72%.3,4 It is unclear which residents with “pneumonia” require empiric treatment to “cover” MRSA and/or Pseudomonas. Universal application of such “coverage” would drive the system toward greater levels of resistance.

**HOW CAN A FACILITY ASSESS ITS BURDEN OF MDRO?**

The facility should maintain a bacteriology database sorted by nursing unit, organism, antibiotic sensitivity, and date. In some cases the reference laboratory may have software to construct and maintain the database. Facilities often fail to capture isolates obtained following transfer to the emergency room or during the first 2–3 days following hospital transfer. These isolates are considered to be NH acquired if there is no past medical history of isolation.5,6 However, it may not be possible to determine the location of initial colonization in a hospital or NH. The database may identify clustering of facility-acquired MDRO in time/space (evidence of transmission). Genetic testing could be utilized to verify strain relatedness. Evidence of transmission on a nursing unit may not become apparent for months. MRSA nasal colonization may not be detected until a culture is obtained following a subsequent aspiration event or development of a necrotic infected wound.

The database can also be used to determine the facilities’ burden of MDROs such as the percentage of quinolone resistance in urinary isolates.6 Only one isolate of a given type from the same resident should be included.2 This information will assist clinicians selecting empiric antibiotic therapy especially in the face of serious illness. MDRO possibilities include MRSA, Pseudomonas, vancomycin-resistant Enterococcus, ESBL-producing and carbapenem-resistant Enterobacteriaceae. Numerous studies have demonstrated that failure to initially “cover” a resistant pathogen is associated with excess mortality in the face of critical illness.4,7,8 This fact underscores the need to focus or de-escalate antibiotic choice based on individual bacteriology.

**WHAT APPROACHES SHOULD BE IMPLEMENTED TO PREVENT TRANSMISSION?**

The cornerstone of any program to prevent transmission is standard precautions. A review of the 2007 Centers for Disease Control and Prevention (CDC) Isolation Guideline indicates that standard precautions are extensive. For example, standard precautions include the use of gloves and gowns during care of a resident with incontinence or uncontained secretions when contact with potentially contaminated intact skin is anticipated. Universal respiratory hygiene/cough etiquette is also included in standard precautions. All respiratory secretions should be contained with spatial separation, tissues, or masks. Standard precautions therefore include aspects of contact and droplet precautions based on a clinical assessment of secretion containment rather than culture results.9 The intensity of standard precautions should be driven by the realization that any resident may be an MRSA carrier.5 The fact that many facilities do not apply contact precautions to residents infected or colonized with gram-negative MDRO underscores the need to emphasize good standard precautions.
for all residents. Never say “only” standard precautions. Standard precautions are extensive.

The facility must also determine the role of contact precautions, which are usually applied during active infection (versus colonization) with MDROs and more broadly during outbreaks of MDRO transmission. NHs may modify contact precautions for MDRO-colonized or -infected residents to allow participation in group activities. Body fluids and/or wound drainage from the colonized or infected site must be contained and the resident must perform good hand hygiene. Clinicians should review the 2006 CDC MDRO Guideline and consult state public health publications/officials for guidance.10

WHAT APPROACHES SHOULD BE IMPLEMENTED TO PREVENT COLONIZING BACTERIA FROM CAUSING INFECTION?

Residents often have “fertile ground” for colonization/infection such as chronic wounds, catheters, and invasive devices.11 Dental plaque also supports the growth of pathogens that can produce pneumonia following aspiration.12 Facilities should strive to limit the existence of “fertile ground” to limit the impact of MDROs. An example includes the prevention and healing of wounds by avoiding ischemia (pressure), excess exudates, and necrotic tissue by maintenance debridement. Pneumonia may be prevented by vaccination, oral hygiene, and the selective application of measures to prevent the regurgitation and aspiration of gastric contents.12 Finally, urinary catheters are a frequent cause of urosepsis. Proper care of the urinary catheter (with removal if indicated) is an excellent focus for quality improvement efforts.11,13

HOW COMMON IS THE EMERGENCE OF RESISTANCE FOLLOWING A COURSE OF ANTIBIOTICS? IF COMMON, THIS SHOULD MOTIVATE US TO USE ANTIBIOTICS ONLY FOR SPECIFIC INDICATIONS

I am not aware of data from NHs, however there are data from other sources. Thomas et al14 studied the pharmacodynamic factors associated with the development of antibiotic resistance in 107 patients with ventilator-associated pneumonia. Twenty-five percent of 128 targeted bacterial pathogens developed antibiotic resistance during therapy.14 Fish et al15 reviewed 173 clinical studies of antibiotic administration (14,000 patients, 1970 to 1992) that included all sites of infection. Resistance to previously sensitive pathogens developed during 5.6% of infections. This percentage did not include overgrowth of small numbers of preexisting resistant pathogens that were not targeted. Because of colonization pressure and transmission, many residents are colonized with small numbers of resistant pathogens.16–18 We recently reported cross-sectional data from 4 rural Wisconsin NHs indicating that 22% of 282 residents were colonized with MRSA and 33% were colonized with fluoroquinolone-resistant gram-negative bacteria.18 Colonization persisted for months.17,19,20 Other investigators have reported similar results as well as clonal or plasmid spread/transmission of these pathogens within facilities.16,17,21

HOW COMMON IS OVERGROWTH/NEW COLONIZATION WITH RESISTANT BACTERIA?

Cancer patients were treated with oral ciprofloxacin prophylaxis for 9 days. Ciprofloxacin-resistant *Escherichia coli* was isolated from the stool in 32%.22 Cirrhotic patients received oral norfloxacin prophylaxis for 25 days. Resistant bacteria were isolated from the stool in 52%; some developed lethal MRSA infections.23 Clinicians should anticipate the overgrowth of antibiotic-resistant pathogens when antibiotics are prescribed to NH residents. An unnecessary antibiotic prescription is an “antibiotic-resistant time bomb” set to explode 1 to 2 months later if the individual develops a serious infection. Prior antibiotic therapy is a powerful risk factor for infection or colonization with MDROs.16,17,21 This is not a trivial risk in residents with frequent and/or serious infections.

WHAT STEPS CAN A FACILITY TAKE TO PREVENT THE UNNECESSARY USE OF ANTIBIOTICS?

1. Nursing Protocols for ASSESSMENT and Physician Notification of Status Change

Infection is difficult to detect in residents with low baseline functional status who are unable to communicate. Presentation may be atypical and include confusion, falls, or functional decline. The differential diagnosis is vast. We don't want to miss serious infection; however, we do not want to give unnecessary antibiotics. Protocols to assess change in status are available from the American Medical Directors Association (AMDA).24 The 2008 Infectious Disease Society of America (ISDA) Guideline for Evaluation of Infection in NH Residents recommends that if infection is suspected, the on-site assessment should include a review by systems, vital signs, and oximetry; an assessment of mental status and hydration; and an examination of the throat, conjunctiva, chest, heart, abdomen, indwelling devices, and skin including perineal, perirectal, and pressure-sensitive areas on the back. In addition, the IDSA recommends performing a complete blood count (CBC) and a differential (preferably manual). Bacterial infection is not likely if there is no fever, leukocytosis/left shift, or signs/symptoms of focal infection. Fever is defined as higher than 100°F orally, higher than 2°F baseline, or repeated values higher than 99°F.25

If infection is the cause of confusion or functional decline, what is the mechanism? Possibilities include hypoxia, dehydration, or a systemic inflammatory reaction that includes cytokines.26,27 The readily available way to assess the existence of an acute inflammatory reaction is to look for fever, leukocytes, and/or left shift. In the future, procalcitonin may be available as a marker of acute bacterial infection. Procalcitonin is not usually elevated by viral infection or surgery.25

2. Specific Indications for Initiating Antibiotics: Instead of Prescribing Antibiotics for Vague Indications

The Loeb/Society for Healthcare Epidemiology of America Consensus Criteria are available for starting antibiotics in
NHS. If urinary tract infection (UTI) is the indication for antibiotic treatment (in the absence of a catheter) the resident should have localizing signs or symptoms.\textsuperscript{29} Admittedly failure to meet these criteria does not completely rule out symptomatic UTI, however as stated previously, an unnecessary course of antibiotics increases the risk of serious infection with MDROs. Continued effort will be needed to maximize the sensitivity and specificity of criteria for starting antibiotics in NHS. A cluster randomized controlled trial of modified Loeb Criteria for the treatment of UTI demonstrated a 31.0% reduction in prescriptions for UTI and a 9.4% reduction in total antibiotic prescriptions. No adverse events were detected.\textsuperscript{30}

3. Nursing Protocols for MONITORING Residents’ Status, as an Alternative to Antibiotics, If There Is No Specific Indication for Antibiotics

Face it; we often don’t know the diagnosis after the first visit. Observation is a standard medical procedure. Monitoring protocols should include a specific order to observe for an evolving condition, vital signs (upright blood pressure), serial weights, attention to hydration, and a repeat physical assessment with practitioner update.

We should replace casual quinolone prescriptions with: ASSESSMENT protocols to identify the true cause of deterioration, SPECIFIC CRITERIA for starting antibiotics, and MONITORING protocols to detect an emerging infection. These steps require a significant institutional commitment.

REFERENCES