HHS Public Access

Author manuscript

J Am Geriatr Soc. Author manuscript; available in PMC 2019 April 01.

Published in final edited form as:

J Am Geriatr Soc. 2018 April ; 66(4): 789–803. doi:10.1111/jgs.15248.

Infectious Diseases in Older Adults of Long-term Care Facilities: Update on Approach to Diagnosis and Management

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Author Contributions: All authors contributed equally to the concept, organization, preparation, and writing of this manuscript.

The opinions expressed by the authors are not necessarily those of the Department of Veterans Affairs or the affiliated universities and medical centers of the authors.

Sponsor's Role: None.

Conflict of Interest Checklist:

Elements of Financial/Personal Conflicts	RLPJ		CJC		LM		SFB	
	Yes	No	Yes	No	Yes	No	Yes	No
Employment or Affiliation		X		X		X		X
Grants/Funds		X		X		X		X
Honoraria		X		X		X		X
Speaker Forum		X		X		X		X
Consultant		X		X		X		X
Stocks		X		X		X		X
Royalties		X		X		X		X
Expert Testimony		X		X		X		X
Board Member		X		X		X		X
Patents		X		X		X		X
Personal Relationship		X		X		X		X

Elements of Financial/Personal Conflicts	LEN		TTY					
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Honoraria		X		X				
Speaker Forum		X		X				
Consultant		X		X				
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Expert Testimony		X		X				
Board Member		X		X				
Patents		X		X				
Personal Relationship		X		X				

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Abstract

The diagnosis, treatment and prevention of infectious diseases in older adults in long-term care facilities (LTCFs), particularly nursing facilities, remain a challenge for all health providers who care for this population. In this review, the authors provide updated information on the currently most important issues of infectious diseases in LTCFs. With the increasing prescribing of antibiotics in older adults, particularly in LTCFs, the topic of antibiotic stewardship is presented “front and center” in this review. Following this discussion salient points on the clinical relevance, clinical presentation, diagnostic approach, therapy, and prevention are discussed for skin and soft tissue infections, infectious diarrhea (*Clostridium difficile* and norovirus infections), bacterial pneumonia, and urinary tract infection as well as some of the newer approaches to preventive interventions in the LTCF setting.

Keywords

Infections; infectious diseases; long-term care facilities; nursing facilities; nursing homes; geriatrics

INTRODUCTION

Many of the clinical challenges and differences in epidemiology, pathogenesis, diagnostic approach, treating, and preventing infections in the older adult population have been recently described. (1) However, among older adults, there is a subset of individuals who add another dimension of complexity, difficulties and challenges in managing infections, i.e., those who reside in long-term care facilities (LTCFs), or more specifically, nursing homes, which are

now more commonly referred to as nursing facilities (NFs). The 15,600 NFs in the United States provide medical and residential care for 1.4 million persons on a daily basis. Each year, 3.2 million persons reside in one of these facilities for some period of time. (2,3) Although LTCFs may also refer to rehabilitation centers, assisted living facilities and other forms of residential care, in this paper the term LTCF will be referring to NF and thus both terms may be used interchangeably. The authors will focus on providing an update on the approach to the most important infectious diseases as well as the challenges clinicians encounter in diagnosing, treating and preventing infections in older adults residing in an LTCF/NF. A brief summary on managing infection outbreaks in LTCFs can be found in a recent publication (1) and thus will not be discussed in this review.

Hospitalized patients include a wide spectrum of age groups and diseases/disorders needing acute (immediate) diagnosis and management, and generally have a short stay of less than a week. In contrast, the population in LTCFs/NFs is almost exclusively those beyond age 65 (average age about 80–85 years); suffer from multiple chronic diseases/disorders (with occasional acute exacerbations), physical disability, cognitive impairment, and functional incapacity, and lengths of stay that most often are beyond 30–60 days with many remaining in the LTCF/NF for the rest of their lives. Consequently, the goals of care, approach, resources, environment and staffing in an LTCF/NF may be very dissimilar to those of an acute care facility. Standard hospital care in a ward setting generally requires a registered nurse (RN) to patient ratio of 1:5; however, the LTCF: patient/resident ratio is 1:25. Acute care hospitals have physicians making daily rounds on their patients with onsite availability of laboratory and imaging studies, whereas LTCFs/NFs usually have no immediate access to such tests and physicians generally see the resident once a month (more often if the resident is not clinically well). It is also well known that infection is a major health issue in residents of LTCF/NFs and that the diagnosis of an infection may be challenging in this population, given the atypical presentation commonly seen in older adults with infection, which sometimes includes a lack of a febrile response. (1) With these major differences between a patient in an acute hospital setting versus a resident in an LTCF/NF, there is a substantial challenge in the approach to the clinical and laboratory diagnosis, treatment, and prevention of serious infections in this setting.

ANTIBIOTIC STEWARDSHIP

Introduction

Approximately 75% of residents who stay in a NF for 6 months or longer will receive at least one course of antibiotics. (4–6) Over half of the antibiotic courses initiated in NFs are unnecessary and, even when necessary, the antibiotics prescribed are often excessively broad-spectrum or administered for a duration longer than necessary for treatment of the underlying infection. The overuse and misuse of antibiotics in NFs are major causes of adverse drug events and future infections such as those caused by *Clostridium difficile* and antibiotic-resistant bacteria. Once acquired by a resident, *C. difficile* and/or antibiotic-resistant bacteria may then be spread to other residents and to patients in hospitals when resident illness requires a higher level of care.

Improving the quality of antibiotic prescribing in healthcare settings increasingly relies on development and expansion of antibiotic stewardship programs (ASPs) which are characterized by coordinated efforts: 1) to monitor patterns of antibiotic use and antibiotic-related outcomes and 2) to oversee identification and implementation of strategies to improve these measures. (6,7) Implementation of ASPs in hospitals has been associated with significant reductions in use of targeted antibiotics, reductions in *C. difficile* and certain types of multidrug-resistant organisms (MDROs), and significant cost savings. (8) Expansion of ASPs into other healthcare settings has been recommended by policy stakeholders (9) but their uptake in NFs remains limited. (6,7) Nevertheless, this situation is poised to change rapidly with the recent release of regulations that will require NFs to have ASPs in place by November of 2017. (10)

Barriers to Antibiotic Stewardship

ASPs in hospitals and NFs share common goals although their structure and process are quite different. (7) ASPs in hospitals are typically organized around a team of individuals with expertise in infectious diseases, pharmacodynamics/pharmacokinetics and informatics. (9) Stewardship programs in NFs are most commonly directed by the facility infection preventionists or director of nursing. The medical director and pharmacist are actively engaged in ASPs in less than 50% of NFs and involvement of individuals with formal infectious disease training is present in less than 15% of facilities. (7) Most hospitals employ mature and sophisticated electronic record systems that permit efficient tracking and reporting of antibiotic utilization and antibiotic-related outcomes. However, adoption of electronic health record systems has been slow in NFs, and most still rely on cumbersome manual methods to track and report process and outcome measures. The most effective antibiotic improvement methods in hospitals, including prior authorization and post-prescriptive review and feedback, can be quite effort-intensive. (9) While similar strategies have proven effective in NFs, (11) most facilities lack the resources and expertise to sustain these types of efforts. Consequently, efforts to improve the quality of antibiotic prescribing in NFs have primarily relied upon education, dissemination of guidelines and introduction of decision-support tools. (6)

Implementing an ASP

While implementing an ASP in a NF can be a daunting task, tools developed by the Centers for Disease Control and Prevention (CDC) (12,13) can help facilities structure their initial planning and implementation efforts (Table 1). Support from facility leadership, assembly of a team, and identification of a leader with overall accountability for the program are key structural resources that NFs should have in place when first embarking on development of an ASP. While it is unlikely that most NFs will have access to an ASP leader with specific antibiotic stewardship expertise, individuals with an understanding of facility clinical operations and data systems as well as experience with quality improvement activities should be accessible in most facilities. In most NFs, the infection preventionist or director of nursing are the individuals in the best position to assume this key leadership role although other individuals, such as the NF pharmacist, may also be appropriate. The medical director and director of nursing, even if they are not the designated ASP leaders, can assume a

critical role in growing the facility ASP by publicly affirming its importance and supporting improvement efforts.

Tracking and reporting antibiotic utilization and antibiotic-related outcomes (e.g., *C. difficile* and MDROs) is a core activity recommended by the CDC (12) and will be required under new regulations. (10) NFs currently perform infection surveillance and tracking residents that experience a change-in-condition, particularly those receiving antibiotics, as a routine practice in NFs. (14) Adapting these existing processes to track antibiotic utilization and related outcomes should, therefore, be feasible in most NFs. At a minimum, facilities should periodically assess antibiotic utilization in the facility cross-sectionally (e.g., the number of residents on antibiotics during a given day, week, or month). In order to monitor the effects of improvement interventions and detect aberrant prescribing patterns, NFs should ideally track antibiotic starts and/or antibiotic days of therapy prospectively. Stratifying tracking measures by indication (e.g., urinary tract infection [UTI]) and antibiotic class (e.g., fluoroquinolones) can help facilities better ascertain conditions in need of focused attention and follow the effects of condition-specific interventions. Supplementing utilization measures with assessments of appropriateness (e.g., proportion of monthly antibiotic courses meeting explicit criteria or proportion of monthly antibiotic courses exceeding 7 days (15)) can provide additional insights into opportunities for improvement.

Once an ASP team and a system for monitoring antibiotic utilization are in place, NFs should focus on developing policies and procedures that encompass prescribing etiquette (e.g., providing the indication, drug, dose and duration with every antibiotic order), clinical indications for diagnostic testing, and clinical indications for initiating antibiotic therapy and preferred agents for treating commonly encountered infections. Education of facility staff and providers as well as resident families (16) is another foundational antibiotic stewardship strategy that has been shown to be effective in reducing inappropriate antibiotic use in NFs. Introduction of training and tools focused on improving resident assessments and interdisciplinary communication of resident change-in-condition have been associated with significant reductions in antibiotic utilization in several studies (16) and may have benefits in other areas such as reducing hospital admissions. Given the outsized role that suspected UTI plays in antibiotic prescribing in NFs, (6,17) implementation of protocols that restrict urine testing to residents with a high probability of having a UTI and similarly designed protocols to limit antibiotic therapy in residents without clear symptoms and signs of UTI (18,19) would appear to offer a good return on investment. Strategies focused on promotion of self-directed stewardship, in which prescribers are trained and/or prompted to engage in review of empirically initiated antibiotics and modify the therapeutic dose, spectrum and/or duration when appropriate (“antibiotic timeout”), has been implemented successfully in hospitals (20) and implementation of a checklist tool to promote this practice in NFs was associated with a significant reduction in systemic antibiotic use in intervention facilities in one study. (21) Other improvement strategies, such as introduction of a facility-specific antibiogram and a pharmacist-led post-prescriptive audit and feedback, can be very effective but may require expertise and resources that are not widely available in most NFs. (6,7)

Future Directions

The emerging crisis in antibiotic resistance will require a concerted effort to improve antibiotic stewardship across all healthcare settings. Considerable progress has been made in our understanding of the extent and determinants of inappropriate antibiotic use in NFs. While there is accumulating evidence that interventions focused on processes (e.g., urine testing) associated with the initial antibiotic decision can reduce unnecessary antibiotic use, there remains a critical need to identify the effectiveness of interventions that target post-prescribing decision-making (e.g., review and de-escalation) and how these interventions can be delivered in a cost-effective manner. There is also a need for more research on how to implement stewardship interventions with fidelity and sustain them over time, particularly in NFs with limited quality improvement resources. Finally, there is a need for studies that evaluate the effects of stewardship interventions on facility and resident outcomes, including healthcare costs as well as rates of infections caused by *C. difficile* and multidrug-resistant bacteria.

SKIN AND SOFT TISSUE INFECTION (SSTI)

Clinical Relevance

SSTIs are the third most common infection diagnosed in LTCF residents. In surveys of European and US Veterans Affairs LTCFs, it is suggested that ~ 22% of infections are due to SSTI. (22,23) Routine infection surveillance in LTCF does not require the monitoring of all SSTI, so the prevalence of less severe infections may not be known. (24) However, in Europe, it has been estimated that bacterial infections such as cellulitis, soft tissue and wound infections account for 87.4% of SSTI. (22) Fungal infections (8.3%) followed by herpes simplex or herpes zoster infections (2.4%) and scabies (1.9%) account for the remainder. (22)

Risk Factors for SSTI in Older adults

Increased exposure to pathogens and conditions that promote changes in patient normal flora contribute to risk of SSTIs. Shared living space exposes residents to various pathogens. Use of antibiotics and corticosteroids contribute to the overgrowth of bacteria and fungi. Waning immunity is associated with reactivation of latent herpes infections in LTCF residents; 10,000–20,000 cases of herpes zoster occur annually. (25,26)

Primary bacterial infections are frequently due to bacteria that asymptomatically colonize human skin and mucosa, such as *Staphylococcus aureus* and group A beta-hemolytic streptococci (GABHS). These bacteria can be easily spread to other residents and staff; outbreaks have been reported with high attack and fatality rates. Outbreaks of acute bacterial conjunctivitis may occur due to these pathogens as well. Epidemics of viral conjunctivitis due to adenovirus are also reported; spread is facilitated by contamination of ophthalmologic equipment and medications. (25,26)

Pre-existing wounds can become secondarily infected by bacteria transferral from other patients via the hands of healthcare personnel or from the environment. (25,26) Breaks in skin can occur as a consequence of thinning of skin with age, pressure due to decreased

mobility, maceration associated with incontinence, ischemia due to reduced blood flow, edema, and device use. Pressure ulcer risk increases with length of stay; it is estimated that one-fifth of LTCF residents will acquire an ulcer within 2 years. Almost 6% of pressure ulcers in LTCF residents will become infected. (25,26) These infections are typically polymicrobial involving aerobic and anaerobic flora including *Escherichia coli, Proteus* species*, Pseudomonas* species, staphylococci, enterococci, anaerobic streptococci, *Bacteroides* species*,* and *Clostridium* species. (25,26)

Clinical Presentation

Primary bacterial SSTIs can be categorized as erythematous without purulence or with purulence (Table 2). Infections that involve deeper structures such as fascia occur less often and are typically more severe. (25–27) Non-bacterial superficial mucocutaneous infections also occur in LTCF due to *Candida* and tinea species and dermatophyte (tinea) infections (Table 2). Tinea ungiuum has been reported to occur in 10–57% and tinea pedis in 10–34% of residents. Rashes due to scabies [*Sarcoptes scabiei],* lice [*Pediculus humanus capitus, P. humanus corporis, Phthirus pubis*] and bedbugs [*Cimex lectularius*] and reactivation of herpesvirus infections [herpes simplex and herpes zoster] also occur. Scabies has been reported in 3.3% of LTCF residents with an attack rate of ~70%. (25,26)

Diagnostic Approach

Initial evaluation of possible SSTI should focus on the acuity of onset of the SSTI and whether symptoms and signs of systemic illness are present (27,29,Table 2). Pain out of proportion to clinical findings might suggest herpetic infection or necrotizing fasciitis. Distribution or location of skin lesions may suggest a diagnosis such as involvement of intertriginous areas (*Candida* or tinea infection), dermatomes (herpes zoster), nape of the neck (carbuncles), and webs of the fingers (scabies). Characteristics of the skin lesions such as erythema, pustules, blisters, ulcerations, size, depth and rate of spread should be described.

If the skin lesions have a characteristic appearance, then further diagnostic testing may not be necessary. Painful or pruritic vesicles or ulcerations involving nasolabial, genital, or rectal skin and mucosa suggests herpes simplex, while a dermatomal distribution that does not cross the midline is diagnostic for herpes zoster. (25,26) Typical scabies presents with pruritis, intertrigenous rashes, and burrows; these features may be absent in older patients. Crusted scabies can be more typical in this population, and the diagnosis is made only when usual features are seen in visitors or healthcare workers. (25,26) Head and pubic lice may be found crawling in their respective hair bearing areas; their eggs (nits) may be found at the base of hair follicles. In the case of body lice, the louse or nits are found in the seams of clothing. Acquisition of bed bugs in the healthcare setting is rare as furniture in this setting is easily cleaned and disinfected. Red pruritic nodules may be noted in a linear distribution. Bed bugs are rarely found on the patient; they infest clothing, mattresses, and overstuffed furniture. When they are seen, adult bed bugs run rapidly and have a flat, red brown apple seed appearance. (25,26,29)

If the clinical appearance is atypical, the patient is severely ill, or is not responding to empirical therapy then further diagnostic studies are appropriate. Scrapings for fungal potassium hydroxide (KOH) smear, Tzanck smear and viral polymerase chain reaction (PCR) for herpesviruses, or for ectoparasites, eggs, and feces can be done. (25–27,29) Deep cultures of pus, aspirates, or tissue are recommended to confirm the cause of the infection and antimicrobial susceptibilities. Swabs of superficial ulcers likely reflect colonization and not the true cause of infection. MDROs frequently colonize or infect LTCF residents and can influence treatment choices. (22) In the US, LTCF residents, overall rates of colonization have varied for methicillin-resistant *S. aureus* (MRSA) (11–59%), 1–19% for vancomycin-resistant enterococci (VRE), and 23–51% for multidrug resistant gram-negative organisms. (5) Many residents are colonized with more than one organism, and new acquisitions may be frequent. (5)

Therapy

Residents with possible bacterial infections who do not have symptoms or signs of systemic illness may be managed in the LTCF. If the patient is systemically ill and advance directives warrant aggressive care then transfer to hospital is appropriate for more intensive monitoring, urgent imaging and surgical intervention.

One important consideration for SSTI is when to begin antibacterial therapy. For SSTI, minimum criteria have been established to initiate an antibiotic including at least one of the following: 1) pus present at a wound, skin, or soft tissue site or 2) at least two of the following: fever or new or worsening redness, tenderness, warmth, or swelling at the suspected site. These criteria do not apply to non-bacterial infections or deep tissue or bone infection. Non-infectious causes such as burns, thromboembolic disease, and gout should be considered. (29) If a decision is made to begin treatment, the most likely underlying etiologies of the skin lesions, the clinical stability of the patient, and the route of antimicrobial administration should be considered in addition to risks for MDRO (Table 2).

Prevention

Prevention of SSTI should focus on prevention of wounds by alleviating their underlying cause and using good technique to keep wounds clean. Screening for neuropathy and use of appropriate footwear in diabetics is essential. Patients who are immobile should have optimal pressure relief with appropriate bedding and wheelchair cushions. Macrovascular disease should be evaluated and blockages relieved when feasible. Edema should be controlled with medications and compression wraps if venous insufficiency is present. Adherence to infection control procedures, such as hand hygiene and glove use, to prevent the spread of pathogens is essential. Limiting the use unnecessary and overly broad antibiotics may limit overgrowth of *Candida* species. Vaccination may also reduce herpes zoster infection. (25,26)

INFECTIOUS DIARRHEA

Clinical Relevance

Bacteria, viruses and, occasionally, protozoa may all cause outbreaks of infectious diarrhea in LTCFs. Discussed in detail below, *C. difficile* is the most important and most common bacterial cause of nosocomial diarrhea in this setting. Other bacterial pathogens include *Shigella*, *Salmonella* and *Campylobacter* spp. as well as toxigenic enterohemorrhagic *Escherichia coli*. (29) Additionally, ingestion of food contaminated with enterotoxins produced by *S. aureus, C. perfringens* and *Bacillus cereus* may also lead to outbreaks of nausea and vomiting. A wide array of viruses from the families *Caliciviridae* and *Adenoviridae* as well as enterovirus and rotavirus may cause gastroenteritis among nursing home residents. Of these, norovirus, a member of the family *Caliciviridae*, is globally the leading cause of acute gastroenteritis and merits further discussion below. Finally, protozoa such as *Giardia*, *Cryptosporidium* and *Cyclospora* may cause diarrheal outbreaks in institutional settings, including those that care for older adults.

C. difficile

Older adults are at increased risk for infections caused by *C. difficile,* a gram-positive spore-forming bacillus. (30–31) In 2010, over 90% of deaths due to *C. difficile* infection (CDI) were in adults aged ≥ 65 years. Age-specific risk factors for CDI include changes to the gut microbiome and immunosenescence. Both aging and residence in an LTCF correlate with a less diverse gut microbiome at baseline. Subsequent exposure to antibiotics causes further disruption to the gut microbiome, rendering people exposed to *C. difficile* spores vulnerable to infection for up to 90 days following completion of their antibiotic. (32) Once ingested by a vulnerable host, *C. difficile* spores germinate in the intestine to become toxin-producing vegetative bacteria. Robust antibody production against *C. difficile* toxins correlates with a decreased risk for CDI and for recurrent disease. Older adults unable to mount a robust immune response may have diminished capacity to neutralize the effects of *C. difficile* toxins, correlating with both increased disease severity and risk of recurrent disease. Moreover, CDI among LTCF residents is more severe and associated with more recurrent infection compared to older adults living in a community setting with CDI. (33)

Clinical Presentation

CDI presents as watery diarrhea, sometimes accompanied by abdominal cramping and discomfort. While some patients may mount a fever, nausea and vomiting are not typical features of CDI. Disease manifestations may be mild to moderate, characterized by a white blood count of 15,000 cells/μL and a creatinine level less than 1.5 fold of the premorbid level. Severe disease, with a white blood cell count of >15,000 cells/μL or serum creatinine 1.5 times greater than the premorbid level, is best managed in acute care settings that can offer fluid resuscitation, electrolyte replacement and, for severe cases, parental therapy and possible colectomy. (32) Severe disease may occasionally present with an ileus, leading to a clinical presentation of abdominal pain and distention without diarrhea. These individuals appear toxic, with hemodynamic instability.

Following an initial episode of CDI, 20–30% of adults develop recurrent disease, most often within 1–2 weeks of completing therapy. Recurrent CDI is not due to resistance but rather to reexposure of a vulnerable host to *C. difficile* spores. These may be the same strain causing the initial infection (relapse) or a new strain of *C. difficile* (reinfection). In 2000, one study reported that among 93 people with recurrent CDI, relapse with the same strain caused approximately 50% of cases while reinfection with new strains caused the remainder of cases. (31) The risk for recurrence increases with age and, not surprisingly, with antibiotic exposure. Medications that suppress gastric acid production represent a potentially modifiable risk factor for recurrent disease. (34) In a retrospective study of 754 hospitalized patients with CDI, the authors found a hazard ratio of 1.5 (95% confidence interval (CI), 1.1 to 2.0) for recurrent CDI among those receiving proton pump inhibitor therapy; less than 50% of those patients had an indication for taking a proton pump inhibitor. (34)

Diagnostic Approach

Clinical criteria for CDI are 3 or more unformed stools within 24 hours and a stool test positive for toxigenic *C. difficile* or demonstration of pseudomembranous colitis. (32,35) The approach and selection of specific tests to support a laboratory diagnosis of CDI remains an area of controversy. A guidance document from the European Society of Clinical Microbiology and Infectious Diseases recommends a 2-step algorithm as no single commercial test has a sufficient positive predicative value when the prevalence of CDI is low. (36) Regardless of the diagnostic tests used, only unformed stools should be sent for clinical testing. Because *C. difficile* colonizes up to 50% of long-term care residents, (31) testing stools from asymptomatic individuals diminishes the specificity of diagnosing CDI. Similarly, as people may remain colonized with *C. difficile* for several weeks following resolution of clinical disease, tests of cure are not indicated. (32,35) Finally, for individuals who may have an ileus, clinicians may consider sending a rectal swab, recognizing this may lead to a false-negative result.

Therapy

In addition to supportive care, a key step to managing CDI is, whenever possible, to stop the inciting antibiotic and avoid subsequent antibiotic exposure. Metronidazole or oral vancomycin remain the mainstays of treatment for mild to moderate disease, including recurrent episodes. (35) For people with severe CDI, treatment with oral vancomycin significantly reduced the risk of 30-day mortality (adjusted relative risk (RR), 0.79; 95% CI, 0.65 to 0.97). (37) Additionally, oral vancomycin is the first-line agent for people taking warfarin. The risk of recurrent disease following treatment with metronidazole and oral vancomycin is similar. (37) While fidaxomicin appears to reduce the risk of recurrent disease, (31) the cost of this agent is several fold higher than metronidazole and oral vancomycin, the latter prepared by compounding the intravenous preparation. (35)

Prevention

Reducing exposure to antibiotics and to *C. difficile* spores are the cornerstones of CDI prevention. While any antibiotic may predispose individuals to CDI, a meta-analysis found the following agents to be high-risk: clindamycin, fluoroquinolones, cephalosporins, monobactams and carbapenems. (38) In acute and long-term care settings, ASPs reduce the

incidence of CDI. (31) (See also earlier section on “Antibiotic Stewardship.) Infection prevention and control measures, discussed more extensively elsewhere, (31) seek to reduce the contamination of healthcare providers hands and the environment with *C. difficile* spores. While symptomatic, people with CDI should remain on contact precautions, with healthcare providers removing their gown and gloves prior to exiting the room, followed by hand washing with soap and water (alcohol gel is not sufficient to kill or remove spores). (32,35) Following resolution of symptoms, patients continue to shed spores into their environment for several weeks, (31) which suggests consideration of extending contact precautions. Finally, to reduce the burden of *C. difficile* spores sporicidal agents approved by the environmental protective agency (EPA) should be used to clean and disinfect the equipment and environment of people with current or recent CDI.

When administered concurrently with standard-of-care antibiotics, bezoltoxumab, a recently approved monoclonal antibody against *C. difficile* toxin B, reduced the rate of recurrent disease by 10% more than placebo. (39) Fecal microbiota transplant (FMT) has proven to be an effective and safe intervention for recurrent CDI, including among older adults. (31,35) While clinical trials are underway, vaccines against *C. difficile* are not yet commercially available. A systematic review of randomized controlled trials investigating probiotics found moderate quality evidence that probiotics prevent *C. difficile*-associated diarrhea (RR 0.36; 95% CI: 0.26, 0.51) but do not reduce the incidence of CDI (RR 0.89; 95% CI: 0.64, 1.24). While subgroup analysis to examine older adults or residents of LTCFs or to evaluate specific species or combinations of microorganisms was not feasible, the authors do conclude that probiotics are safe. (40)

Norovirus

Norovirus is also a common cause of gastroenteritis among long-term care residents. A recent article reviewed this topic extensively; this section will only highlight the key issues. (41) The majority of norovirus outbreaks occur in LTCFs, with 90% of norovirus-associated deaths occurring in adults ≥65 years of age. (42) Unlike CDI, norovirus infections present with acute onset nausea, vomiting and watery diarrhea. As few as 100 virions may lead to disease. Given that infected individuals may shed billions of virions in their stool and vomitus, norovirus spreads rapidly among long-term care residents and their healthcare providers. The incubation period for norovirus is 12 to 48 hours, followed by a self-limited illness that lasts 12 to 60 hours.

Early recognition and prompt implementation of infection prevention and control measures are central to limiting the severity of a norovirus outbreak. Some state public health laboratories will use reverse-transcription PCR (RT-PCR) to confirm norovirus. More often, however, LTCFs will recognize a norovirus outbreak when 2 or more cases fulfill the Kaplan Criteria:

- **a.** vomiting in more than half of affected persons;
- **b.** a mean (or median) incubation period of 24–48 hours;
- **c.** a mean (or median) duration of illness of 12–60 hours; and
- **d.** no bacterial pathogen is identified in stool culture.

In LTCFs, infection prevention and control measures must address both residents and healthcare providers. Affected residents should be placed on contact precautions for at least 48 hours following symptom resolution. For norovirus, contact precautions entail gowns, gloves, hand hygiene with soap and water as well as a mask when around vomitus or fecal material as norovirus may become airborne and cause infection. Additionally, the facility should minimize resident movements, suspend group activities and consider restricting access to an affected ward. Healthcare providers with symptoms consistent with norovirus infection should be excluded from work and be encouraged to stay home for 48 hours following symptom resolution. Upon returning to work, recently ill healthcare workers should care for symptomatic residents. A general framework to group residents and staff into 3 clinical categories is the following: symptomatic; asymptomatic and potentially exposed; and asymptomatic and unexposed. This framework can help with staff assignments that avoid having asymptomatic and potentially-exposed staff interact with asymptomatic and unexposed residents.

BACTERIAL PNEUMONIA

Clinical Relevance

Infections of the lower respiratory tract, which include pneumonia and bronchitis, are leading causes of morbidity and mortality among older adults. Pneumonia, in particular, affects 1.4 to 2.5% of nursing home residents in the United States and is among the most common causes for hospitalization. (43) Age-related changes to the respiratory system, including diminished cough and gag reflexes, impaired mucocilary clearance, reduced respiratory muscle strength, and decreased chest wall compliance and elastic recoil, all serve to impair host defense mechanisms and allow pathogens to penetrate and infect the respiratory tract. This section will focus on only bacterial pneumonia.

Recognition, diagnosis and treatment of acute infections of the lower respiratory tract among LTCF residents present significant challenges. Co-morbid conditions including congestive heart failure and chronic respiratory diseases may confound the clinical presentation. Additionally, aspiration of oral contents into the respiratory tract may lead to chemical pneumonitis or bacterial pneumonia or both. Furthermore, while the vast majority of people with acute bronchitis have a viral infection, some of them may go on to develop secondary bacterial pneumonia. Recent evidence implicates a viral pathogen in at least 25% of older adults presenting with community-acquired pneumonia. (44) While the implications on the treatment of older adults with pneumonia, particularly those who are LTCF residents, are not yet known, these data help to explain the similarity in clinical predictors for pneumonia due to bacterial, viral and mixed etiologies. (45) Finally, the high rate of colonization with MDROs among LTCF residents in general, coupled with a paucity of microbiological data from the individual resident in whom there is a concern for bacterial pneumonia, render selection of appropriate empirical antimicrobial therapy challenging.

Clinical Presentation

Clinical indicators of bacterial pneumonia include fever, pleuritic chest pain, respiratory rate of >25 breaths per minute, a decline in functional status, new or increased cough, sputum

production, shortness of breath, or physical findings upon examination of the chest. A retrospective review of nearly 300 nursing home residents admitted through the emergency room with a diagnosis of pneumonia described dyspnea as the most common presenting symptom (67%), followed by mental status change (51%), cough (49%) and fever (45%). (46) In another study, the authors reported on an attempt to develop a consensus of characteristics for the diagnosis of pneumonia among nursing home residents. Of the pulmonologists and geriatricians queried, 57% agreed that dyspnea, fever, decline in functional status, tachypnea, and crackles or rales on auscultation were important characteristics; they further agreed that at least two of these characteristics should be present to diagnose nursing-home-acquired pneumonia. For aspiration pneumonia, 80% of the clinicians reached a consensus of the following as risk indicators for aspiration pneumonia: dysphagia, choking incident, tube feeding, neurological disease and cognitive impairment. (47) However, with advanced age and decline in functional capacity the presence of typical pneumonia symptoms decreases. Accordingly, atypical symptoms (e.g., change in mental status, loss of appetite) or an exacerbation of chronic illnesses (e.g., congestive heart failure, chronic respiratory illness, diabetes mellitus) may be early clinical indicators of an acute infection, including pneumonia.

Diagnostic Approach

In addition to assessing clinical changes, the diagnostic evaluation of an LTCF resident with suspected bacterial pneumonia should include measuring pulse oximetry and obtaining a chest radiograph. Among LTCF residents, demonstration of deceased oxygen saturation using a bedside pulse oximeter may suggest pneumonia. A case-control study of residents in a veteran's nursing home found that a decrease in oxygen saturation of >3% from baseline or <94% suggested pneumonia. (48) Chest radiographs revealing a new infiltrate also indicate pneumonia. Obtaining a chest radiograph of sufficient quality to make this determination, however, may be challenging in LTCF settings due to the limitations of portable films, inability of an ill resident to maintain a suitable position, and interpretation including delays or lack of comparative radiographs. Interestingly, in the study of patients hospitalized for nursing home-acquired pneumonia, the authors found that fewer than 20% of chest radiographs obtained in the emergency department indicated possible pneumonia. (46) These data suggest during the initial phase of illness, a "negative" chest radiograph is not sufficient to exclude a lower respiratory tract infection.

While consistently challenging to obtain and, sometimes to interpret, sputum culture results, the findings can help direct appropriate antibiotic therapy. A study found that among 56 patients hospitalized with nursing home-acquired pneumonia, microbiological culture results were available for just 12% of cases. (49) This unfortunate paucity of sputum cultures increases the necessity of using rapid diagnostic tests. Positive tests for *Streptococcus pneumoniae* antigen in urine or for influenza in nasopharyngeal swabs can inform both the choice of therapeutic agent and length of therapy used to treat LTCF residents. Similarly, multiplex panels that test for several respiratory pathogens may help improve the diagnosis of bacterial pneumonia though their cost makes routine use of these impractical for most LTCF settings. Finally, while procalcitonin holds the potential to identify bacterial

infections, further studies are needed to understand if this test has a role in the clinical evaluation of frail older adults or LTCFs residents with suspected pneumonia.

Therapy

The Loeb Minimum Criteria offer a concise set of recommendations for starting antibiotic treatment in LTCF residents in whom there is a concern for bacterial pneumonia. (28) Evidence-based recommendations for empirical agents and length of therapy are less clear. Despite the prevalence of MDROs colonizing LTCF residents, recent literature suggests that using antibiotics recommend for community-acquired pneumonia are sufficient to treat most cases of nursing-home acquired pneumonia (Table 3). (46,50) While few data specifically address older adults or LTCF residents with bacterial pneumonia, recommendations for treating community-acquired and hospital-acquired pneumonia indicate that in most instances the length of antibiotic therapy should be 5–7 days. (51,52) In general, short, fixed course of antibiotics reduce adverse events related to antibiotics, including CDI, the emergence of resistant bacteria and costs, without reducing the benefits of antibiotic therapy. For residents with immunocompromising conditions, structural lung disease or a delayed response to empirical therapy, a longer course of antibiotics (i.e., 7 to 10 days) may be warranted. Hospitalization should be considered in those residents with respiratory compromise, cardiovascular instability, worsening of pre-existing non-infectious comorbidities or poor oral intake or inadequate nutrition.

Prevention

Vaccination against *S. pneumoniae* and influenza remain central to reducing the risk of lower respiratory tract infection among LTCF residents. While dysphagia is clearly a risk factor for developing nursing home-acquired pneumonia, efforts directed at minimizing the risk of aspiration have not reduced the incidence of respiratory illness. (53) (See section on Preventative Interventions for a more detailed discussion.)

URINARY TRACT INFECTION

Clinical Relevance

UTI is one of the most common infections diagnosed in residents of LTCFs. (54) The high frequency of infection is largely attributable to comorbidities which affect normal voiding, such as urologic abnormalities and chronic neurologic diseases. A very high prevalence of asymptomatic bacteriuria, i.e., 35–50% of residents without indwelling urethral catheters, also occurs in this population. While asymptomatic bacteriuria is benign, the common finding of a positive urine culture leads to frequent overdiagnosis of symptomatic UTI. As many as 75% of prescriptions for UTI in LTCF residents are given to individuals who do not meet criteria for UTI. (55) This is a major contributor to inappropriate antimicrobial use in long-term care, and promotes antimicrobial resistance and CDI in residents. (55,56) The important clinical issues for optimizing management of UTI are the ascertainment of symptomatic infection and non-treatment of asymptomatic bacteriuria.

From 5–10% of residents in LTCFs have bladder emptying managed with a chronic indwelling catheter. (57) Bacterial biofilm formation along the internal and external catheter

surfaces is universal, so polymicrobial bacteriuria is the norm for residents with chronic catheters. The presence of a catheter is associated with an increased incidence of symptomatic UTI, and catheter-associated UTI (CAUTI) is the most frequent source of bacteremia in LTCFs. (54,57)

Clinical Presentation

Residents with UTI may present with typical clinical symptoms. (54) Bladder infection is manifested by an acute onset of lower tract irritative symptoms of frequency, urgency, slow and painful urination (stranguria), dysuria or new or increased incontinence. Upper tract (kidney) infection presents as pyelonephritis with costovertebral angle pain or tenderness, usually with fever, and variable accompanying lower tract symptoms. Ascertainment of symptoms in many residents, however, is problematic because of impaired communication, functional disability, and chronic genitourinary symptoms attributed to comorbidities. (24,54) Residents without acute localizing genitourinary findings but with clinical deterioration and nonspecific symptoms or signs are frequently diagnosed and treated as UTI, often because a urine culture is positive. (24,54–56) However, evidence does not support attributing nonlocalizing and nonspecific symptoms to UTI, even with a positive urine culture. (24,58) Mental deterioration (e.g., delirium) (59) or falls (60), by themselves, are generally not presentations of UTI.

Residents with CAUTI usually present with fever alone, although localizing symptoms including catheter obstruction, acute hematuria, or suprapubic or costovertebral tenderness may occasionally be present. (57) Determinants of symptomatic infection are not well described, but catheter obstruction or catheter trauma are potential antecedents of symptomatic infection.

Diagnostic Approach

Guidelines for diagnosing symptomatic UTI in residents without indwelling catheters require the presence of localizing genitourinary symptoms or signs (24,28,29,54) (Table 4). An evidence-based diagnostic approach to UTI was recommended in the 2009 Infectious Diseases Society of America (IDSA) guidelines for evaluation of fever and infection in older adult residents of LTCFs. (29) For residents in whom a diagnosis of UTI is considered, a urine specimen for determination of pyuria should be obtained. If a voided urine specimen cannot be collected, an in-and-out catheter specimen should be collected, whenever possible. A urine culture is requested only if the urinalysis is positive. A screening test for pyuria has a negative predictive value of over 95% for UTI, so UTI is excluded if pyuria is not present. (29) However, pyuria accompanies asymptomatic bacteriuria, and is also found in as many as 30% of residents without bacteriuria. Thus, pyuria, by itself, does not diagnose bacteriuria or differentiate symptomatic from asymptomatic infection. (54)

The most common clinical presentation of CAUTI is fever alone (Table 4). When fever is the only sign, infection at other sites must always be considered and excluded. Replacement of the catheter is recommended if it has been present for 2 weeks or more, as the biofilm contaminates a urine specimen collected through the catheter. Obtaining a urine specimen through a freshly inserted catheter provides a more valid specimen to identify bladder

bacteriuria and infecting organisms and susceptibilities. (57) Blood cultures are indicated for patients with or without catheters who are severely ill. Residents with indwelling catheters are more likely to experience urosepsis.

Some residents present with a clinical syndrome consistent with severe sepsis, including one or more of the following signs: fever or hypothermia, hemodynamic instability, acute delirium, and respiratory distress. If no source for infection is apparent, these patients should be managed appropriately as sepsis syndrome, considering urinary infection as one potential site, pending results of cultures and other investigations.

Therapy

When the presenting symptoms are mild, initiation of antimicrobial therapy should await urine culture results. If the urine culture is subsequently positive, antimicrobial therapy should only be initiated if symptoms have persisted. When fever alone is present in residents with chronic indwelling catheters, clinical monitoring without initiation of antimicrobial therapy may also be appropriate. As many as two-thirds of febrile episodes in residents with long-term catheters are attributed to urinary infection, but most resolve in less than 24 hours without intervention. (61) In patients with severe symptoms including sepsis, immediate empirical therapy is indicated. Asymptomatic bacteriuria should be treated only prior to an invasive urologic procedure which is likely to be associated with mucosal bleeding. A single dose of an effective antimicrobial given immediately prior to the procedure is usually effective for prophylaxis. (54)

The choice of antimicrobial regimen, including oral or intravenous therapy and duration, is determined by consideration of the clinical presentation, resident tolerance, and known or suspected susceptibilities of the infecting organism. (54) Susceptibility of organisms isolated in prior urine cultures from the resident and the resistance prevalence of uropathogens in the facility should guide selection of initial empirical therapy. The specific antimicrobial choice is similar to other populations with UTI and may include, nitrofurantoin (for cystitis only), trimethoprim/sulfamethoxazole, ampicillin, cephalexin and, when indicated, fluoroquinolones, oral extended-spectrum cephalosporins, or amoxicillin/clavulanic acid. (54) Where resistant organisms are isolated, antimicrobial selection is directed by susceptibility, and aminoglycosides, carbapenems and beta- lactam/beta-lactamase inhibitor combinations may be appropriate. For residents requiring parenteral therapy, transfer to an acute care facility may be necessary.

Prevention

For residents with frequent recurrent symptomatic infection, especially when the clinical presentation is severe, urologic abnormalities, which are potentially correctable, such as obstruction, should be excluded. Prophylactic antimicrobial therapy for women or men with recurrent infection should be avoided, as this promotes emergence of resistant organisms without decreasing the frequency of symptomatic infection. Cranberry products do not decrease the frequency of infection. (62) The most effective means of preventing CAUTI is to remove the catheter, whenever possible. When this is not possible, resident care practices

to identify catheter obstruction early and to avoid trauma to the catheter should be implemented and followed.

PREVENTIVE INTERVENTIONS

Clinical Relevance

Similar to cardiovascular disease and cancer prevention is key to reducing the risk of infection, particularly in LTCFs, which have a high prevalence of MDROs. Administration of influenza vaccine to older adults as well as healthcare personnel lowers infection rates, saves lives, and reduces complications. (63) Recommended vaccinations in older adults include yearly influenza vaccine, 1 dose of pneumococcal conjugate vaccine (PCV13) and at least one dose of pneumococcal polysaccharide vaccine (PCV23), herpes zoster vaccine, and tetanus-diphtheria and acellular pertussis (Tdap) vaccine if there is anticipated contact with a child less than 12 months of age. Tdap can be replaced by Td if there is no anticipated child contact. Optimal management of chronic diseases; prevention of pressure ulcers; attention to infection prevention practices, such as hand hygiene for healthcare professionals, caregivers, patients and families; appropriate gown and glove use; and judicious antibiotic usage, are all key preventive measures to reduce infections and enhance quality of care among older adults in NFs.

Emerging Evidence

Several recent randomized controlled trials identify preventive interventions that are shown to be of benefit and help discard those that are not. Next, we provide a brief overview of some recent studies.

UTIs

Use of Cranberry to Prevent UTIs—In a recent randomized controlled study, investigators asked the question: Do two oral cranberry caps/day lead to lower bacteriuria plus pyuria among non-catheterized older women in NFs? (62) In a double blind, placebo-controlled randomized controlled trial focused on older long-term female residents, consenting participants were randomized to two cranberry capsules per day (equivalent to 72mg of proanthocyanidins) versus placebo for 360 days. Surrogate consent was required in 94% of the instances highlighting challenges in conducting research in these settings. Twenty-six percent of urine specimens in the treatment group and 30% of urine specimens in the control group had pyuria with bacteriuria. In other words, cranberry capsules did not have any effect on the primary outcome. Furthermore, cranberry capsules had no impact on secondary outcomes. This study helped discard long-held pervasive practice of using cranberry capsules to prevent UTI. (64)

Bundled Approach to Preventing CAUTI—In a recent cluster-randomized interventional study, investigators evaluated the effect of a Targeted Infection Prevention (TIP) multi-modal intervention program in reducing MDRO prevalence and device-associated infections in a group of southeast Michigan NFs. (65) The intervention included a structured interactive educational program for frontline healthcare personnel, hand hygiene promotion, preemptive barrier precautions when assisting with high-risk activities of daily

living (e.g., bathing, dressing, grooming, toileting, feeding, and ambulation), and active surveillance for MDROs and infections with monthly data feedback. Interactive educational modules, incorporating Adult Learning Theory, were presented to healthcare personnel at intervention sites through 10 in-services on a broad range of topics, including overview of infection prevention practices, hand hygiene, barrier precautions, infection recognition, and care of indwelling devices, with content following evidence-based guidelines. This approach was shown to reduce overall MDRO prevalence by 23%, new MRSA acquisition by 22% and clinician-diagnosed CAUTIs by 31%. (65)

Lessons learned from the TIP study as well as the "Agency for Healthcare Research and Quality (AHRQ) Safety Program for Reducing Catheter-associated UTI in Hospitals" (66) were then implemented in nearly 500 NHs in 48 states through the "ARHQ Safety Program in Long-Term Care: HAI/CAUTI" project. (67) Using a combination of technical and socio-adaptive interventions, the program emphasized professional development in urinary catheter utilization, catheter care and maintenance, and antimicrobial stewardship, as well as promoting NF resident safety culture, team building, and leadership engagement. CAUTI rates decreased by 54% (incidence rate ratio (IRR), 0.46; 95% CI, 0.36–0.58; P<.001) during the project. The number of urine cultures ordered for all residents decreased by 15%. (67)

Respiratory Tract Infections

Use of High-Dose Vitamin D in Pneumonia Prevention—In another recent randomized controlled study, investigators conducted a major randomized controlled trial to determine the efficacy and safety of high-dose vitamin D to prevent acute respiratory tract infections in NHs. (68) The study involved 25 Colorado-based NFs and residents over the age of 60. Participants were randomized to a high-dose group that received 100,000 international units (IU) of vitamin D monthly and a standard dose group that received either placebo if already on supplementation of 400–1,000 IU/d of vitamin D or 12,000 IU of vitamin D if taking anything less than 400 IU/day. High-dose group experienced 0.67 acute respiratory tract infections/year, standard-dose group experienced 0.6 infections/year and the difference being clinically insignificant. Furthermore, falls were more common in high-dose group at 1.47/person-year versus standard-dose group at 0.63/person-year. However, fractures were uncommon. Thus, the role of high-dose Vitamin D in preventing infections remains unclear.

Chlorhexidine-based Oral Care in Aspiration Pneumonia—Several preliminary studies suggest that adequate oral hygiene using mouth rinses, toothpaste, brushing along with feeding in an upright position, would mitigate the risk of pneumonias attributed to aspiration. (53) In another major cluster-randomized study involving 36 NFs in Connecticut, the study involved older NF residents with at least one of the two following modifiable risk factors: impaired oral hygiene or swallowing difficulty by clinical assessment. The intervention comprised of manual tooth/gum brushing along with a chlorhexidine rinse twice a day along with upright positioning. Primary and secondary outcomes included time to first chest radiograph confirmed pneumonia and development of first lower respiratory tract infections, respectively. However, with the adjusted hazard ratio of 1.12 (95% CI 0.84, 1.5, p 0.44) for the primary outcome of time to first pneumonia, the study was terminated for

futility and ineffectiveness, since this chlorhexidine-based intervention was not effective in reducing lower respiratory infections and thus questioning the utility of this particular enhanced oral care protocol in long-term populations.

Acknowledgments

RLPJ is the Principal Investigator on a research grant from Steris corporation and participated in a Pfizer advisory board.

CJC is supported by research grants the Agency for Healthcare Research and Quality (R18HS022465, R18 HS022465-01 A1) and the Veterans Health Services Research & Development (RFA# HX-16-006, CRE-12-291 (CJC) and PPO 16-118-1).

This work was supported in part by funds and facilities provided by the Cleveland Department of Veterans Affairs (VA), the Cleveland Geriatric Research Education and Clinical Center (GRECC) and VA Merit Review Program (PPO 16-118-1; RJ). This work was also supported in part by the Agency for Healthcare Research and Quality (AHRQ; HHSP2332015000201; RJ) and the National Institute on Aging (K24AG050685; LM). The findings and conclusions in this document are those of the authors, who are responsible for its content, and do not necessarily represent the views of the VA, AHRQ or of the United States Government.

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Table 1

Core Elements of Antibiotic Stewardship in Nursing Facilities (12).

Component	Description	Comments
1. Leadership Commitment	Dedicate support and commitment to safe and appropriate antibiotic use in the facility.	• Medical director and nursing leadership should provide visible support for the facility antibiotic stewardship program (ASP). • Leader of ASP should have dedicated time to perform their stewardship duties. • Structure, roles and responsibilities of facility ASP should be clearly delineated in a policy that is reviewed and approved by facility leadership. • The facility ASP should periodically report to the facility Quality Assurance and Performance Improvement (QAPI) committee
2. Accountability	Identify which members of the facility will be part of the stewardship team and clearly delineate their role and responsibilities. Assign administrative leadership of the stewardship team to a single individual.	• Antibiotic stewardship is a team-based process that requires involvement and collaboration between leadership, providers, nursing staff and pharmacy. • While responsibility for completing various ASP tasks may be delegated to different members of the team, administrative oversight should be assigned to a single individual. • The ASP team leader should have a clinical background plus a demonstrated capacity to work and communicate well with stakeholders in other disciplines who operate in the facility.
3. Drug Expertise	Ensure access to individuals with experience and/or training in antibiotic stewardship.	• Ideally, the individual selected to lead the facility stewardship team will have prior training/expertise in infectious diseases and/or antibiotic stewardship but this will be unusual in most nursing facilities. • In the absence of local expertise, the facility should: ⇒Provide support for the stewardship team to attend stewardship training opportunities and pursue formal certification, if available. ⇒Identify and collaborate with experts in the region (e.g., referring acute care hospital) who can help develop facility policies/guidelines and provide input on selection and implementation of different stewardship interventions.
4. Action	Implement at least one policy or practice to improve antibiotic use in the facility.	• Specific strategies should be chosen based on facility resources and needs identified through tracking measures. • Strategies that focus on reducing unnecessary testing of urine samples and treatment of asymptomatic bacteriuria appear to have the greatest potential for immediate impact (see text).
5. Tracking	Monitor at least one antibiotic utilization outcome and one clinical outcome measure of antibiotic use in the facility.	• At a minimum, track facility-initiated antibiotic starts on a monthly basis (ideally, denominate by resident-days). Other utilization measures to consider include, proportion of antibiotic starts prescribed for >7 days and proportion of antibiotic starts that meet appropriateness criteria. • Clinical outcomes that should be considered include the monthly number of residents colonized or infected with different multidrug-resistant organisms (e.g., methicillin-resistant *Staphylococcus aureus*), *Clostridium difficil*e, and the facility antibiogram.
6. Reporting	Provide regular feedback of antibiotic use and antibiotic resistance to staff and providers in the facility.	• Antibiotic utilization and clinical outcomes data should be presented at least quarterly at the facility QAPI meeting.

Component	Description	Comments
		• Providing individual feedback to providers on their prescribing patterns relative to their peers may have a beneficial normative influence on outliers.
7. Education	Provide resources to staff, providers and patients/ residents about the risks of antibiotics and opportunities for improving antibiotic use.	• Education on the importance of antibiotic stewardship and the strategies the facility is using to promote better antibiotic stewardship should be delivered at hire and periodically thereafter. • Education should target both nursing staff and prescribers.

Table 2

Empirical Treatment for Skin and Soft Tissue Infections in Long-Term Care Residents.

PRIMARY BACTERIAL INFECTIONS

Impetigo (non-bullous and bullous)					
Severity	**Route**	**Antimicrobials**	**Minimum Duration**	**Typical Organisms**	**Comments**
Mild	oral	dicloxacillin or cephalexin	7 days	*Staphylococcus aureus* MSSA most common	if many lesions empiric Rx
		doxycycline or clindamycin or TMP/SMX		MRSA	culture known
		penicillin		GABHS	culture known
	topical	mupirocin	5 days	streptococci, *S. aureus*	empirical Rx
Non-purulent infections (cellulitis, erysipelas, necrotizing infection)					
Mild*	oral	penicillin or dicloxacillin or cephalosporins or clindamycin	5 days	streptococci	cultures; aspirates not routinely recommended
Moderate**	IV	penicillin or ceftriaxone or cefazolin or clindamycin		streptococci	consider MSSA Rx; consider MRSA Rx if prior infection
Severe***	IV	vancomycin piperacillin/tazobactam		GABHS polymicrobial	transfer to hospital; emergent surgery; deep tissue culture
Purulent infections (furuncle, carbuncle, abscess)					
Mild+	N/A	none	N/A	*S. aureus* MSSA, MRSA	incision & drainage; antibiotics if fails
Moderate++	oral	TMP/SMX or doxycycline	minimum 5 days	*S. aureus* MSSA, MRSA	incision & drainage; culture & susceptibility
	IV/oral	glycopeptides or daptomycin or ceftaroline or linezolid			
Severe+++	IV	as above	N/A	*S. aureus* MSSA/MRSA	transfer to hospital; emergent surgery; deep tissue culture

PRIMARY BACTERIAL INFECTIONS

Impetigo (non-bullous and bullous)

Severity	Route	Antimicrobials	Minimum Duration	Typical Organisms	Comments
Necrotizing fasciitis/gangrene					
Severe	IV	vancomycin & piperacillin/tazobactam vancomycin & carbapenem or vancomycin & metronidazole & ceftriaxone	N/A	polymicrobial *S. pyogenes* *S. aureus*	transfer to hospital; emergent surgery; deep tissue culture
Pyomyositis					
Severe	IV	vancomycin	N/A	*S. aureus* MSSA/MRSA	transfer to hospital; emergent imaging; deep tissue & blood culture

SECONDARY BACTERIAL INFECTIONS

Surgical Site Infection > 4 days post-operatively					
Clean Site head, neck trunk, extremity	IV	vancomycin or cefazolin	N/A	*S. aureus* MSSA/MRSA	erythema > 5 cm from incision; T > 38°C; elevated WBC; begin dressing changes
Perineal wound or GI/GU surgery	IV	cephalosporin & metronidazole or levofloxacin & metronidazole or carbapenem		polymicrobial	
Pressure Ulcer Infection: Stage III or IV					
	PO	ciprofloxacin or levofloxacin & metronidazole or clindamycin		polymicrobial aerobes & anaerobes	optimize local care; debride necrotic tissue; deep tissue for culture; osteomyelitis evaluation
	IV	piperacillin-tazobactam or carbapenem or cephalosporin & metronidazole or clindamycin quinolone & metronidazole or clindamycin if MRSA suspected, add vancomycin			
Superficial fungal infections					

PRIMARY BACTERIAL INFECTIONS

Impetigo (non-bullous and bullous)

Severity	Route	Antimicrobials	Minimum Duration	Typical Organisms	Comments
intertrigo, vaginitis thrush paronychia denture stomatitis	topical or oral	clotrimazole, nystatin fluconazole, itraconazole		*Candida albicans*	culture if no response; drug interactions are common with azoles; monitor hepatotoxicity
tinea pedis tinea capitis tinea ungiuum tinea cruris	topical or oral	clotrimazole, terbinafine itraconazole, terbinafine		dermatophytes	drug interactions are common with azoles; monitor hepatotoxicity
Herpesviruses					
Shingles	IV oral	acyclovir acyclovir, famciclovir valaciclovir		varicella zoster virus (VZV)	VZV higher doses than HSV IV for disseminated infection adjust for renal function treat VZV-related PHN
Genitorectal herpes	oral	acyclovir, famciclovir valacyclovir		herpes simplex virus (HSV 1&2)	adjust for renal function
Ectoparasites					
Scabies	topical oral	permethrin 5% ivermectin	12 hours		cover hairline to feet crusted scabies
Lice	topical	permethrin %	12 hours		retreat one week later
Bedbugs	N/A	N/A	NA		contact precautions launder clothing contact isolation disinfect mattress seek expert guidance

Adapted from (25–27)

MSSA = Methicillin-susceptible *S. aureus*

MRSA = Methicillin-resistant *S. aureus*

GABHS = group A beta-hemolytic streptococci

TMP-SMX = trimethoprim-sulfamethoxazole

IV = intravenous

WBC = white cell count

J Am Geriatr Soc. Author manuscript; available in PMC 2019 April 01.

GI/GU = gastrointestinal/genitourinary

Systemic signs of infection = (T> 38°C, heart rate > 90 beats/minute, respiratory rate > 24 breaths per minute, WBC > 12,000 or < 400 cells/mm3.

Non-purulent Severity Index	
Mild*	typical cellulitis /erysipelas without focus of purulence
Moderate**	typical cellulitis/erysipelas with systemic signs of infection
Severe***	residents who have failed oral therapy with systemic signs of infection, who are immunocompromised, or have signs of deeper infection such as bullae, skin sloughing, hypotension, or organ dysfunction

Purulent Severity Index	
Mild+	purulent infection
Moderate++	purulent infection with systemic signs of infection
Severe+++	residents who have failed incision & drainage with oral antibiotics or have systemic signs of infection, or who are immunocompromised

Table 3

Suggested Empirical Antibiotic Therapy for Nursing Home-Acquired Bacterial Pneumonia.

Clinical Context	First-line	Second-Line
Mild to moderate pneumonia symptoms	• cefpodoxime or • amoxicillin/clavulanic acid (first choice if aspiration suspected)	• doxycycline or • levofloxacin
Severe pneumonia symptoms or failure to improve with appropriate empirical therapy	• ceftriaxone and azithromycin	• ertapenem or • levofloxacin
Severe pneumonia symptoms and concern for MRSA in respiratory tract	• consider adding vancomycin or doxycycline	• consider adding linezolid
Known history or strong suspicion of Pseudomonas or resistant Gram-negative bacteria in respiratory tract	• cefepime or • piperacillin/tazobactam	• levofloxacin or • carbapenem (other than ertapenam) or • aztreonam

MRSA, methicillin-resistant *Staphylococcus aureus*

Table 4

Guidelines Providing Criteria for the Clinical Diagnosis of Urinary Tract Infection (UTI) in Residents of Long-Term Care Facilities (LTCFs).

Reference	Proposed Use	Residents without indwelling catheters	Residents with indwelling catheters
Loeb et al, (28)	Minimum criteria for the initiation of antibiotic therapy for urinary infection	Acute dysuria alone, or fever [> 37.9°C (100°c) or 1.5°C (2.4°F) above baseline] and one or more of: new or worsening urgency, frequency, suprapubic pain, gross hematuria, costovertebral angle tenderness, or urinary continence.	Presence of at least one of the following: • Fever (>37.9°C or 1.5°C above baseline) • New costovertebral angle tenderness, rigors (shaking, chills) with or without identified cause, • New onset delirium
High et al, (29)	Evaluation of fever and infection in older residents of LTCFs.	Acute onset of UTI associated symptoms and signs (e.g., fever, dysuria, gross hematuria, new or worsening urinary incontinence, and/or suspected bacteremia).	Suspected urosepsis (i.e., fever, shaking, chills, hypotension or delirium), especially in the context of recent catheter obstruction or change.
Stone et al, (24)	Surveillance definitions for infection in long term care.	At least one of the following symptoms or signs: **a.** acute dysuria or acute pain, swelling or tenderness of the testes, epididymis or prostate. **b.** Fever or leukocytosis [single oral temperature > 37.8°C (>100°F), or repeated oral temperature >37.2°C (99°F) or rectal temperatures >37.5°C (99.5°F or single temperature ≥1.1°C (2°F) over baseline from any site]; leukocytosis, neutrophila (>14,000 leukocytes/cubic mm) or left shift (>6% bands or 1,500 bands/cubic mm)] and at least one of the following localizing subcriteria: **1.** Acute costovertebral angle pain or tenderness; 2. Suprapubic pain; 3. Gross hematuria; 4. New or marked increasing incontinence or urgency or frequency; 5. Urgency **c.** In the absence of fever or leukocytosis, then two or more of the above localizing urinary tract sub-criteria.	At least one of the following signs or symptoms: **a.** Fever, rigors, or new onset of hypotension with no alternate source of infection **b.** Either acute change in mental status or acute functional decline, with no alternate diagnosis and leukocytosis **c.** New onset suprapubic pain or costovertebral angle pain or tenderness **d.** Purulent discharge from around the catheter or acute pain, swelling or tenderness of the testes, epididymis or prostate