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Infection Control Issues in Older Adults

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Health care delivery in the United States changed significantly during the latter part of the twentieth century. In the past, health care delivery occurred mainly in acute care facilities. Today, health care is delivered in hospital, subacute care, long-term care or nursing home (NH), rehabilitation, assisted living, home, and outpatient settings. Measures to reduce health care costs have led to a reduced number of hospitalizations and shorter lengths of stay (with an increase in severity of illness and ICU admissions), along with increased outpatient, home care, and NH stays for older adults [1].

There are approximately 36.57 million (projected to be 63.5 million by 2025) adults over 65 years of age in the United States; of these, 4.9 million are over 85 years of age (projected to be 8 million by 2025). Approximately 1.43 million older adults reside in NHs certified by the Centers for Medicare and Medicaid [2]. About 3%–15% of such patients acquire an infection in these facilities. In 1 year, approximately 2.1 million patients are discharged from NHs with the primary reasons of death or transfers to hospitals. These numbers are expected to grow as the population ages [2].

Infections in NHs increase the mortality and morbidity of residents and generate additional costs for the facilities and hospitals. This article focuses on infection control issues pertaining to older adults in various health care settings. It also discusses the elements of infection control programs with a focus on the NH setting.

Infection control challenges in older adults

Older adults in the United States have many different options on where to reside, ranging from independent single-family homes to senior apartments, assisted living, group homes, and traditional NHs or long-term care facilities. Older adults also undergo several care transitions—home to acute care hospital, acute care hospital to rehabilitation facility, acute care hospital to NH, NH to home, and acute care hospital to home [3]. This section focuses on infection control issues pertaining to older adults in various health care settings.

Acute care hospitals

Traditionally, acute care hospitals have been the major center for infection control research and activities, since most health care has been delivered in the acute care setting. However, during the 1990s, there was a reduction in the number of acute care hospital beds, along with reduced length of stay and greater severity of illness in the hospitalized population. Hospitals are downsizing their infection control operations, compelling the infection control departments to focus surveillance activities on those at highest risk of infection, and antimicrobial resistance. Older adults, particularly those admitted from NHs, with multi-morbid conditions and poor functional status, form one such high-risk group.

There are several issues pertaining to infection control in older adults admitted to acute care. It is common for acute care facilities to receive frail older adults from NHs without a patient assessment from a physician before the transfer, with poor documentation of their comorbidities and medications, with resistant pathogens. Older adults typically present with atypical clinical findings of infection [4]. For example, a NH resident with pneumonia is more likely to present with confusion and deteriorating functional status than shortness of breath or new cough. This can lead to delayed diagnosis resulting in delayed administration of appropriate treatment.

Recently, several investigations have shown the value of surveillance cultures in controlling hospital acquired methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant enterococci (VRE) colonization and infection. The Society for Healthcare Epidemiology of America (SHEA) recommends active surveillance culture programs for these resistant pathogens [5]. Patients colonized with these pathogens are to be placed under surveillance conditions to prevent the spread of these organisms to other susceptible patients. Whether all new admissions should be subjected to a surveillance program or only those at high risk, such as ICU admissions or NH transfers, is a matter of active debate. Several recent investigations also have challenged the quality of care provided to patients in isolation. One study found that isolated patients were twice as likely as control patients to experience adverse events during hospitalization [6,7]. Isolated patients also were more likely to complain about their care, not having their vital signs recorded as ordered, and have days with no physician progress notes [6]. The effects of isolation practices in older adults (in terms of depression, delirium, and functional decline) has not been evaluated, but they are likely to be deleterious. These debates and controversies highlight the need for further data on infection control and isolation practices in older adults admitted to acute care hospitals.

Nursing homes

Older adults, especially those in NHs, have unique characteristics that create special challenges to implementing an effective infection control program. These characteristics include diagnostic uncertainty, time and resource limitations, rapid staff turnover, high staff/patient ratios, limited and intermittent physician coverage, increasing acuity of care, and frequent care transitions. These characteristics can be divided into in three categories: host factors, structural concerns, and process factors.

Host factors

NH residents are susceptible to infections because of an increased prevalence of chronic diseases, increasing severity of illness, medications that affect resistance to infection (eg, steroids and frequent antibiotic usage), level of debility, impaired mental status (predisposing to aspiration and pressure ulcers), incontinence and resultant indwelling catheter usage, and the institutional environment in which they live [8]. Most infections found in NH residents are thought to be endogenous in nature and often result from the resident's flora.

NH residents also may serve as host reservoirs for antimicrobial-resistant pathogens, such as MRSA and VRE. With a reduction in the length of hospital stay, the severity of illness among residents of the subacute care nursing unit has increased with resultant inherent rapid transfers to a hospital and increased polypharmacy. All of these factors combine to create a vulnerable resident who is prone to develop infections and transmit resistant pathogens.

Structural concerns

Structural concerns affecting infection control relate to a facility's capacity to provide care, whereas an assessment of the process of care is an evaluation of the actual delivery of service. Structural factors of concern in implementing an effective infection control program within a NH include suboptimal full-time equivalents for registered nurses, nursing aides and therapists; high staff turnover; a changing case mix; limited availability of information systems; and variable availability of laboratory and radiologic services.

The number of staff per resident varies considerably among facilities [9]. Hospital based NHs and skilled NHs for residents covered by Medicare have almost twice the nursing staff of other community nursing facilities. The relationship between nursing care intensity and health outcomes for NH patients has been examined for years, and associations between increased nursing hours per patient and improved health outcomes have been reported [10]. For example, in a sample of Maryland NHs, registered nurse turnover has been associated with increased risk of infection and a higher risk of hospitalization caused by infection [11]. Potential explanations for these findings include difficulties in establishing and maintaining effective infection control practices, reduced familiarity between staff and residents to detect minor changes in residents' health, and inconsistent supervision and training.

To reduce the length of acute hospital stay, NHs now are accepting patients who are sicker and have more severe illnesses. This change in case mix has led to increased care transitions between hospitals and NHs, which has led to increased lapses in information exchange. These care transitions also lead to increased risk of pathogen transmission between the hospital and NHs.

Process factors

The processes of care in NHs pertain to health care service delivery. Process factors affecting infection control in NHs include variable staff education, availability and use of diagnostic specimens, and use of quality improvement tools, such as regional databases, quality indicators, and minimum datasets.

Whereas the effectiveness of staff education alone is controversial, the value of education as part of a comprehensive quality control program has been recognized in all health care settings for a long time. The importance of staff education is accentuated further by considerable turnover in NH personnel. However, there are currently no standard guidelines regarding curriculum or frequency of staff education in NHs, which includes education in infection control measures. Nursing aides, who are the frontline personnel in recognizing any change in clinical status of NH residents, may receive little or no formal educational training in various infection control issues, such as hand hygiene, antimicrobial resistance, early signs and symptoms of common infections, and infection control measures to reduce infections related to indwelling devices. However, NHs can overcome these barriers by scheduling monthly in-service training for staff members. However, the content, frequency, and attendance of these in-services will vary among facilities.

Diagnostic specimens have limited usefulness in the NH setting for two reasons (1) they cannot be or are not obtained, or (2) if they are obtained, the results may not be communicated to the appropriate health care provider in a timely fashion, or in the case of radiologic investigations, may not be interpreted accurately. The onsite availability of diagnostic or radiologic services is lacking in many NHs. In addition, patients may not be able or willing to cooperate in the collection of valid specimens. Thus, diagnostic tests may be requested infrequently, resulting in initiation of therapy without appropriate clinical information. On the other hand, whereas urine specimens are obtained more frequently than other types of specimens, the prevalence of bacteriuria in 30%–50% of urine specimens

means that without an assessment of symptoms, a positive culture has a low predictive value for appropriate diagnosis of infection. Often, these specimens are not collected or handled appropriately before delivery to the laboratory. These diagnostic dilemmas can lead to further delay in initiation of care, inappropriate or unnecessary use of antibiotics, and delayed transfers for sicker patients to acute care.

Home health care

With a move toward reduced hospital stay, home health care delivery remains the fastest growing segment in health care. Established in the 1880s, the home care industry grew from 1,100 home health care organizations in 1963 to over 20,000 in 2004 [12]. Per the 2000 Home and Hospice Care Survey, about 7.2 million individuals received home health care (5 million or 69% over 65 years of age) [12]. This number represents an increase of nearly 90% in 15 years. Home health care agencies, home care aide organizations, and hospices are known collectively as *home health care organizations*. Durable medical equipment and supply companies, while not included under the traditional home health care umbrella, are ancillary to home health care and provide products ranging from respirators and sleep apnea machines to walkers, catheters, and wound care supplies.

These home health care organizations provide care for elderly adults, who frequently have multiple medical problems including diabetes, congestive heart failure, cancer, chronic obstructive pulmonary disease, and chronic wounds. Coupled with the use of indwelling devices, such as urinary catheters, intravascular catheters, and feeding tubes, their infection risk increases tremendously. Data on the epidemiology of infections in this group are limited, albeit several outbreaks of bloodstream infections have been documented [13,14].

Although attempts have been made to standardize surveillance definitions, several challenges remain [15,16]. These include the fact that few dedicated infection control personnel are employed by home health care agencies, the role of informal caregiving in the spread of infections and adherence to infection control recommendations, and the paucity of data to understand the epidemiology of infections among patients receiving home health care.

Infection control and care transitions

Transitional health care is defined as “a set of actions designed to ensure the coordination and continuity of health care as patients transfer between different locations or different levels of care in the same location” [3]. These locations can include acute care hospitals, NHs, skilled nursing facilities, rehabilitation units, home care, and outpatient primary and specialty clinics. During care transitions, older adults are susceptible to care fragmentation, which may lead to medical errors and poor quality care. These transitions also provide an opportunity for pathogens to be transferred from one setting to another. Different financing and contractual agreements with pharmaceutical companies also may impede these transitions. For example, as patients are transferred across settings, each facility has incentives to substitute medications according to their own formulary.

Thus, these care transitions have implications for the spread of pathogens and the appropriateness of antimicrobial usage, including choice of antibiotics, dosage, and duration. In addition, care transitions can cause confusion for the patient, caregiver, and clinicians providing care at different settings. These care transitions also can cause confusion in exercising isolation practices. A patient with MRSA colonization could be confined to his/her room during the acute care stay, but he/she may not be isolated in the skilled nursing facility to undergo rehabilitation, which leads to confusion among health care workers (HCWs), patients, and families.

In summary, infection control issues in older adults vary as they move through various health care settings caused by the type of care provided, patient characteristics, the unique need for social and personal contact, and staff and facility resources.

Infection control and prevention: functions and elements

Infection prevention and control is important for continuum of care across various health care settings. The main functions are (1) to obtain and manage critical data, including surveillance information for endemic and epidemic infections; (2) to develop and recommend policies and procedures; (3) to intervene directly to prevent infections; and (4) to educate and train HCWs, patients, and nonmedical caregivers [1]. The next section focuses on the requirements and scope of infection control committees with specific focus on the NH setting.

Elements of infection control

Infection control program

An effective infection control program includes a method of surveillance for infections and antimicrobial-resistant pathogens, an outbreak control plan for epidemics, isolation and standard precautions, hand hygiene, staff education, an employee health program, a resident health program, policy formation and periodic review with audits, and a policy to communicate reportable diseases to public health authorities (Fig. 1).

Surveillance

Infection surveillance in NHs involves collection of data on NH acquired infections. Surveillance is defined as “ongoing, systematic collection, analysis, and interpretation of health data essential to the planning, implementation, and evaluation of public health practice, closely integrated with timely dissemination of these data to those who need to know” [13]. Surveillance can be limited to a particular objective or may be a facility-wide goal. Surveillance often is based on individual patient risk factors, focused on a unit, or based on a particular pathogen or infection type.

Surveillance can be either passive or active. In passive surveillance, also known as routine surveillance, an infection control professional uses data collected for routine patient care. Although less costly in terms of resources, passive surveillance is inherently biased. It may also underestimate the magnitude of the outcomes measured and delay detection of outbreaks. The feasibility of passive surveillance has been demonstrated and has led to continuing education opportunities. On the other hand, active surveillance uses multiple data sources to detect infections and antimicrobial resistance early. It requires routine infection control practitioner (ICP) rounds to detect infections early and may involve patient screening for resistant pathogens. Active surveillance for antimicrobial-resistant pathogens in acute care has created significant debate in recent years, but data in NHs are lacking.

For surveillance to be conducted correctly, objective valid definitions of infections are crucial. Hospital surveillance definitions are based on the National Nosocomial Infection Surveillance (NNIS) criteria, which depend rather extensively on laboratory investigations. Radiology and microbiology data are less available, and if available, are delayed; therefore, these criteria may not be applicable in NH settings. Modified NH specific criteria were developed by a Canadian consensus conference, which took into account the unique limitations of the NH setting [17]. The criteria have been used widely, but not uniformly [14].

In addition to using valid surveillance definitions, a facility must have clear goals and aims for setting up a surveillance program. These goals, like other elements of an infection control program, have to be reviewed periodically to reflect changes in the facility's population, pathogens of interest, and changing antimicrobial resistance patterns. In addition, plans to analyze the data and use them to design and implement proven preventive measures must be made in advance.

The analysis and reporting of infection rates in NHs typically are conducted monthly, quarterly, and annually to detect trends. Because the length of stay at a NH is typically long, and each resident is at risk for a prolonged duration, an analysis of absolute numbers of infections can be misleading. Infection rates (preferably reported as infections/1,000 resident days) can be calculated by using resident days or average resident census for the surveillance period as the denominator.

These data can be used to establish endemic baseline rates and recognize variations from the baseline that could represent an outbreak. Feedback to the nursing staff, physicians, and appropriate quality control and review committees is critical to the success of any surveillance program. This information eventually should lead to specific, targeted infection control initiatives and follow-up surveillance to evaluate the success of the changes.

Furthermore, surveillance data can be combined at a regional or a national level, and individual facility rates can be compared with an aggregate of other facilities using visual and simplified statistical methods (Table 1). The success in the reduction of nosocomial infection rates in acute care hospitals that participate in an NNIS system has been demonstrated. While one study among 17 NHs has demonstrated the feasibility of using interfacility comparisons, it needs to be studied further at other sites [18].

Outbreak control

An illness in a community or region is considered an outbreak when it clearly exceeds the normal rate of expectancy. Thus the existence of an outbreak is always relative to the number of cases that are expected to occur in a specific population in a specific time period.

The main objectives of an outbreak investigation are control and elimination of the source, prevention of new cases, prevention of future outbreaks, research to gain additional knowledge about the infectious agent and its mode of transmission, program evaluation and strategies for improvement, and epidemiologic training to conduct outbreak investigations.

It is vital that the ICP know the following (1) appropriate data collection methods; (2) methods of interpreting the data using simple epidemiologic measures; (3) effective study designs to conduct an effective and efficient outbreak investigation; and (4) effective and appropriate infection control measures. Local health departments are available for counsel, but it also may be beneficial for the ICP to have access to a hospital epidemiologist for consultation.

Antibiotic resistance

Infection and colonization with antimicrobial-resistant pathogens are important concerns in NHs and develop primarily because of widespread use of empiric antibiotics, functional impairment, use of indwelling devices, mediocre adherence to hand hygiene programs among HCWs, and cross-transmission during group activities. A NH can reduce infections and colonization with resistant pathogens by emphasizing hand hygiene compliance, developing an antimicrobial use program, encouraging evidence-based clinical evaluation and management of infections, and ensuring that the facility has a well established

individualized infection control program. Guidelines to control MRSA and VRE have been published by SHEA and provide a good base for developing facility specific policies [19].

Isolation precautions

The Centers for Disease Control and Prevention's Healthcare Infection Control and Prevention Advisory Committee (HICPAC) has proposed a two-tiered structure for isolation precautions. In the first tier, HICPAC proposes use of "Standard Precautions," which have been designed for the care of all patients in hospitals, regardless of the diagnosis, infectious or otherwise. In the second tier are "Transmission-based Precautions," which have been designed for the care of patients suspected of or known to be infected with epidemiologically important pathogens that have been acquired by physical contact or airborne or droplet transmission [20].

Standard precautions apply to blood, all body fluids, secretions and excretions regardless of whether they contain visible blood, skin that is not intact, or mucous membrane material. Designed to reduce the risk of transmission of pathogens from apparent and ambiguous sources of infection, these precautions include hand hygiene compliance, glove use, masks, eye protection, gowns, and avoidance of injuries from sharp materials. Transmission-based precautions are intended for use with patients who may be infected with highly transmissible or epidemiologically significant pathogens. These include airborne precautions (eg, for tuberculosis), droplet precautions (eg, for influenza), and contact precautions (eg, for *Clostridium difficile*). Although these guidelines were designed for acute care settings, several of them, especially the universal precautions, apply to NHs as well. These recommendations have to be adapted to the needs of the individual facility.

There has been some debate on the role of active surveillance cultures and their impact on isolation policies in acute care hospitals. The SHEA guideline for preventing nosocomial transmission of multidrug resistant organisms advocates for aggressive active surveillance cultures [5], whereas the recent draft of HICPAC guidelines calls for individual facilities to assess their own needs and conduct surveillance cultures as necessary [20]. These guidelines refer to studies from acute care hospitals serving a sicker, shorter stay population. Facilities should evaluate these guidelines and individualize the plan to obtain active surveillance cultures based on the population it serves, baseline rates of MRSA and VRE, and any recent outbreaks.

Hand hygiene compliance

Contamination of the hands of HCWs has been recognized as playing a role in the transmission of pathogenic bacteria to patients since the observations of Holmes, Semmelweis, and others more than 100 years ago [21]. Hand antisepsis remains the most effective and least expensive measure to prevent transmission of nosocomial infections. However, compliance with hand washing recommendations among HCWs averages only 30%–50% and improves only modestly following educational interventions [22]. HCWs frequently reported poor compliance with hand hygiene measures because of skin irritation from frequent washing, too little time because of a heavy workload, and simply forgetting.

The use of waterless, alcohol-based hand rub in addition to washing hands with soap and water has become a routine practice by HCWs in many acute care facilities. Introduction of alcohol-based hand rubs has been shown to significantly improve hand hygiene compliance among HCWs in acute care hospitals and to decrease overall nosocomial infection rates and transmission of MRSA infections. Alcohol-based hand rubs also have been shown to enhance compliance with hand hygiene in the NH setting and should be used to complement educational initiatives [22]. While the cost of introducing alcohol-based hand rubs could be

a concern of NHs, recent data in acute care have shown that the total costs of a hand hygiene promotion campaign, including alcohol-based hand rubs, corresponded to less than 1% of costs that could be attributed to nosocomial infections [23].

Although introducing the alcohol-based hand rub in health care settings is a prudent, cost-effective measure, several issues need to be considered. Alcohol-based hand rubs should not be used if hands are visibly soiled, in which case hand hygiene with antimicrobial soap and water is recommended. Alcohol-based hand rubs can cause dry skin; however, recent data on rubs containing emollients have shown to cause significantly less skin irritation and dryness [24]. Facilities should be aware that alcohols are flammable. Facilities have reported difficulties in implementing the current hand hygiene guidelines and use of alcohol-based hand rubs because of fire safety concerns. Existing national fire codes permit use of alcohol-based hand rub dispensers in patient rooms, but they cannot be used in egress or exit corridors. Because state and local fire codes may differ from national codes, facilities should work with their local fire marshals to ensure that installation of alcohol-based hand rub containers is consistent with local fire codes.

Staff education

Ongoing staff education is critical in health care settings because of the plethora of literature published every year, advancements in technology, and regulatory demands. The Joint Commission on Accreditation of Healthcare Organizations expects new employee orientation to include the facility's infection control program and the employee's responsibility to prevent infections. In addition, the Occupational Safety and Health Administration (OSHA) requires training for bloodborne pathogens and tuberculosis for any employee expected to come into contact with potentially infectious agents.

The ICP plays a vital role in meeting these requirements and educating NH personnel on various infection control measures, particularly in view of rapid staff turnover. Informal education during infection control and quality improvement meetings and during infection control walking rounds should be complemented with in-service education on various topics including hand hygiene compliance, antimicrobial usage and antimicrobial resistance, appropriate and early diagnosis of infections, infection control and prevention measures, and isolation precautions and policies.

Resident health program

The resident health program should focus on immunizations, tuberculin testing, and infection control policies to prevent specific infections, include areas such as skin care, oral hygiene, prevention of aspiration, and catheter care to prevent urinary tract infections. Adults over the age of 65 should receive pneumococcal vaccination at least once, influenza vaccination every year, and a tetanus booster every 10 years. Despite proven effectiveness, compliance with these measures remains low. Average influenza and pneumococcal vaccination rates among NH residents are 60% and 40%, respectively [25]. In addition to poor documentation, reasons for lower immunization rates include lack of physician emphasis, patient concerns about the side effects of vaccinations, and the inability to obtain consent [26]. Adopting a standing order policy for immunization could eliminate implementation delays caused by the consent process.

Employee health program

The employee health program mainly applies to employees with potentially communicable diseases, policies for sick leave, immunizations, and OSHA regulations to protect them from blood-borne pathogens. NH bar employees who have known communicable diseases or infected skin lesions from direct contact with the residents, and who have infected skin

lesions or infectious diarrhea are prevented from having direct contact with residents' food. Moreover, when hiring new employees, an initial medical history and a physical examination and screening for tuberculosis must be obtained. Infection control education also must be provided to staff members.

Infection control policies and measures in NHs must be in place to address postexposure prophylaxis for infections such as HIV and hepatitis B. Varicella vaccine should be given to employees who are not immune to the virus. Employees are expected to be up-to-date with their tetanus boosters and to receive influenza vaccinations every year. The vaccine is effective not only in preventing influenza and reducing absenteeism in HCWs, but it also has been associated with a decrease in influenza mortality in patients [26]. Annual influenza vaccination campaigns play a central role in deterring and preventing nosocomial transmission of the influenza virus and should be promoted by ICP and NH leadership.

Rehabilitation services

NHs increasingly are responsible for postacute care rehabilitation, including physical therapy (PT), occupational therapy (OT), and wound care with or without hydrotherapy. These therapists, like other clinical staff such as nurses and nurses' aides, provide many opportunities for the transmission of pathogens. In an NH, PT and OT services can be provided either at the bedside or in a central therapy unit. For bedside therapy, therapists move between rooms and units and do not routinely wear gloves and gowns. For care at a central therapy unit, residents are transported to an open unit, where hand washing sinks may not be readily available. While these therapists have not been implicated in any major outbreaks, hydro-therapy for wounds has been shown to facilitate outbreaks with resistant pathogens [27].

A detailed infection control program for rehabilitation services should be prepared and should focus on facility design to promote hand hygiene compliance, which includes convenient and easy access to sinks and the use of alcohol based hand rubs. Patients who are infectious should not be treated at the central facility. Facilities providing hydrotherapy should consider providing the service in a separate room with a separate resident entrance.

Infection control practitioner

An ICP, usually a staff nurse, is assigned the responsibility of directing infection control activities in an NH. The ICP is responsible for implementing, monitoring, and evaluating the infection control program. Because of financial constraints, an ICP usually functions as an assistant director of nursing, or is involved in staff recruitment and education. Need for a full time ICP usually depends on the number of beds, the acuity level of residents, and the level of care provided at the facility. Nonetheless, for an infection control program to succeed, the ICP should be guaranteed sufficient time and resources to carry out infection control activities. A basic background is advisable in infectious disease, microbiology, geriatrics, and educational methods. The ICP also should be familiar with the federal, state, and local regulations regarding infection control.

Additionally, an alliance with and access to an infectious disease epidemiologist should be encouraged. Such collaborations also could provide assistance with outbreak investigations, emergency preparedness in the events of bioterrorism and vaccine shortages, and the use of microbiologic and molecular methods for infection control.

Oversight committee

The Federal Nursing Home Reform Act from the Omnibus Budget Reconciliation Act (OBRA) of 1987 mandated the formation of a formal infection control committee to

evaluate infection rates, implement infection control programs, and review policies and procedures. However, this mandate has been dropped by OBRA at the federal level, although some states still may require them. A small subcommittee or a working group comprised of a physician/medical director, an administrator, and an ICP should evaluate the NH infection rates on a regular basis, present the data at quality control meetings, review policies and any research in the area, and make decisions to implement infection control changes. This subcommittee can review and analyze the surveillance data, assure this data is presented to the nursing and physician staff, and approve targeted recommendations to reduce infections. Records pertaining to these activities and infection data should be kept and filed for future reference.

Principles guiding infection control practices also provide a model for enhancing quality of care and patient safety for other noninfectious adverse outcomes such as falls, delirium, inappropriate medication usage, and adverse drug events.

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Appendix: Resources for infection control practitioners

1. Society for Healthcare Epidemiology of America (SHEA) and the Association for Professionals in Infection Control (APIC) have long-term care committees that publish and approve NH infection guidelines and publish periodic position papers related to pertinent infection control issues. Their websites have several educational resources for staff education and in-services. In addition, APIC also publishes a quarterly long-term care newsletter.
2. Local APIC chapters provide a network for ICPs to socialize, discuss infection control challenges and practical solutions to overcome them, and provide access to educational resources and services. ICPs should become members of APIC at the local and national level to remain up-to-date with practice guidelines, position statements, information technology resources, and changes in policies and regulations.
3. Mayhall CG. Hospital Epidemiology and Infection Control. 3rd edition. Philadelphia: Lippincott Williams & Wilkins; 2004.
4. Selected internet websites:
 - a. Centers for Disease Control and Prevention: <http://www.cdc.gov>.
 - b. Society for Healthcare Epidemiology of America: <http://www.shea-online.org/>.
 - c. Association for Professionals in Infection Control: <http://www.apic.org>.
 - d. Occupational Health and Safety Administration: <http://www.osha.gov>.
 - e. Joint Commission on Accreditation of Healthcare Organizations-Infection Control Initiatives: <http://www.jcaho.org/accredited±organizations/patient±safety/infection±control/ic±index.htm>.

References

1. Friedman C, Barnette M, Buck AS, et al. Requirement for infrastructure and essential activities of infection control and epidemiology in out-of-hospital settings: a consensus panel report. *Infect Control Hosp Epidemiol*. 1999; 20:695–705. [PubMed: 10530650]
2. Jarvis WR. Infection control and changing health-care delivery systems. *Emerg Infect Dis*. 2001; 7:170–3. [PubMed: 11294699]
3. Coleman EA. Falling through cracks: challenges and opportunities for improving transitional care for persons with continuous complex care needs. *J Am Geriatr Soc*. 2003; 51:549–55. [PubMed: 12657078]
4. Marrie TJ. Community-acquired pneumonia in the elderly. *Clin Infect Dis*. 2000; 31:1066–78. [PubMed: 11049791]
5. Muto CA, Jernigan JA, Ostrowsky BE, et al. SHEA guideline for preventing nosocomial transmission of multidrug-resistant strains of staphylococcus aureus and enterococcus. *Infect Control Hosp Epidemiol*. 2003; 24:362–86. [PubMed: 12785411]
6. Stelfox HT, Bates DW, Redelmeier DA. Safety of patients isolated for infection control. *JAMA*. 2003; 289:1899–905. [PubMed: 14532319]
7. Kirkland K, Weinstein J. Adverse effects of contact isolation. *Lancet*. 1999; 354:1177–8. [PubMed: 10513715]
8. Nicolle LE. Infection control in long-term care facilities. *Clin Infect Dis*. 2000; 31:752–6. [PubMed: 11017825]
9. Mody L, Langa KM, Saint S, et al. Preventing infections in nursing homes: A survey of infection control practices in Southeast Michigan. *Am J Infect Control*. 2005; 33:489–92. [PubMed: 16216667]
10. Loeb MB, Craven S, McGeer AJ, et al. Risk factors for resistance to antimicrobial agents among nursing home residents. *Am J Epidemiol*. 2003; 157:40–7. [PubMed: 12505889]
11. Zimmerman S, Gruber-baldini AL, Hebel JR, et al. Nursing home facility risk factors for infection and hospitalization: importance of registered nurse turnover, administration and social factors. *J Am Geriatr Soc*. 2002; 50:1987–9. [PubMed: 12473010]
12. National Association for Home Care and Hospice. Basic statistics about home care. Available at: www.nahc.org. Accessed January 25, 2007
13. Do AN, Ray BJ, Banerjee SN, et al. Bloodstream infection associated with needleless device use and importance of infection control practices in the home health setting. *J Infect Dis*. 1999; 179:442–8. [PubMed: 9878029]
14. Danzig LE, Short LJ, Collins K, et al. Bloodstream infections associated with a needleless intravenous infusion system in patients receiving home infusion therapy. *JAMA*. 1995; 273:1862–4. [PubMed: 7776503]
15. Schantz M. Infection control comes home. *Home Healthcare Management & Practice*. 2001; 13:126–33.
16. Horan, TC.; Gaynes, RP. Surveillance of nosocomial infections. In: Glen Mayhall, C., editor. *Hospital epidemiology and infection control*. 3rd edition. Lippincott Williams & Wilkins; Philadelphia: 2004. p. 1661-702.
17. McGeer A, Campbell B, Emori TG, et al. Definitions of infection for surveillance in long-term care facilities. *Am J Infect Control*. 1991; 19:1–7. [PubMed: 1902352]
18. Stevenson KB, Moore J, Colwell H, et al. Standardized infection surveillance in long-term care: interfacility comparisons from a regional cohort of facilities. *Infect Control Hosp Epidemiol*. 2005; 26:231–8. [PubMed: 15796273]
19. Strausbaugh LJ, Crossley KB, Nurse BA, et al. Antimicrobial resistance in long-term care facilities. *Infect Control Hosp Epidemiol*. 1996; 17:129–40. [PubMed: 8835450]
20. Garner JS. The Hospital Infection Control Practices Advisory Committee, guideline for isolation precautions in hospitals. *Infect Control Hosp Epidemiol*. 1996; 17:53–80. [PubMed: 8789689]
21. Otherson MJ, Otherson HB. A history of handwashing: seven hundred years at a snail's pace. *The Pharos*. 1987; 50:23–7.

22. Mody L, McNeil SA, Sun R, et al. Introduction of a waterless alcohol-based hand rub in a long-term care facility. *Infect Control Hosp Epidemiol.* 2003; 24:165–71. [PubMed: 12683506]
23. Pittet D, Sax H, Hugonnet S, et al. Cost implications of successful hand hygiene promotion. *Infect Control Hosp Epidemiol.* 2004; 25:264–6. [PubMed: 15061421]
24. Centers for Disease Control and Prevention. Guideline for hand hygiene in healthcare settings: recommendations of the healthcare infection control practices advisory committee and the HICPAC/SHEA/APIC/IDSA hand hygiene task force. *MMWR Recomm Rep.* 2002; 51:S3–40.
25. Mody L, Langa K, Malani P. Impact of the 2004-05 influenza vaccine shortage on immunization practices in long-term care facilities. *Infect Control Hosp Epidemiol.* 2006; 27:383–7. [PubMed: 16622817]
26. Carman WF, Elder AG, Wallace LA, et al. Effects of influenza vaccination of health-care workers on mortality of elderly people in long-term care: a randomised controlled trial. *Lancet.* 2000; 355:93–7. [PubMed: 10675165]
27. Embril JM, McLeod JA, AL-Barrak AM, et al. An outbreak of methicillin-resistant *Staphylococcus aureus* on a burn unit: potential role of contaminated hydrotherapy equipment. *Burns.* 2001; 27:681–8. [PubMed: 11600247]

Fig. 1.
Components of infection control program in long-term care facilities.

Table 1

Summary of results from surveillance for infection from 17 regional nursing homes

Facility	Infection rates ^a						
	Total UTIs ^b	Catheter UTIs ^c	Respiratory	GI	Skin	Bloodstream	Febrile
A	0.61	0.00	2.55	0.12	2.67	0.00	0.00
B	0.69	3.70	1.56	0.09	1.26	0.00	0.00
C	0.63	3.70	1.77	0.14	1.12	0.00	0.03
D	0.66	3.15	1.12	0.03	0.66	0.03	0.00
E	0.53	5.14	0.23	0.00	0.69	0.00	0.00
F	0.30	2.92	2.11	0.08	0.83	0.00	0.00
G	0.40	1.80	1.76	0.09	0.97	0.00	0.00
H	0.68	4.56	2.02	0.09	0.68	0.02	0.00
I	0.21	1.33	1.65	0.15	0.72	0.00	0.05
J	0.27	1.66	1.06	0.64	0.77	0.00	0.00
K	0.69	4.74	2.36	0.25	1.16	0.04	0.00
L	2.28	6.90	2.88	0.22	1.54	0.00	0.04
M	0.00	0.00	1.90	0.38	1.43	0.10	0.10
N	0.28	7.43	2.24	0.09	0.75	0.00	0.00
O	0.29	2.99	0.79	0.13	2.30	0.00	0.00
P	0.67	1.32	2.88	0.15	1.83	0.00	0.04
Q	0.44	3.04	1.54	0.00	0.83	0.00	0.00
Mean infection rates ^d	0.57	3.20	1.79	0.16	1.19	0.01	0.01
SD	0.49	2.12	0.72	0.16	0.60	0.02	0.03
Total infections	282	130	828	77	520	4	6

Abbreviations: GI, gastrointestinal; SD, standard deviation; UTIs, urinary tract infections.

^aExpressed as number of infections per 1000 resident or device days.^bCatheter-associated and non-catheter-associated UTIs combined.^cCatheter-associated UTIs.^dInterfacility mean of the number of infections per 1000 resident days.

Data from Stevenson KB, Moore J, Colwell H, et al. Standardized infection surveillance in long-term care: interfacility comparisons from a regional cohort of facilities. *Infect Control Hosp Epidemiol* 2005;26(3):234.

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