OBJECTIVES:

To provide clinicians with the most reliable, updated evidence to support clinical decision-making and improve outcomes for patients with cancer who are at increased risk for infection.

DATA SOURCES:

Review of two evidence-based summaries of prevention of infection interventions published by the Oncology Nursing Society; MEDLINE and guidelines.gov literature review.

CONCLUSION:

Handwashing is the most important intervention to prevent infection in patients with cancer. Guidelines-based intravascular catheter care and preventive activities can reduce infection incidence in this vulnerable patient population. Understanding risk factors for aggressive pathogens can help identify patients for rapid surveillance and isolation procedures. Additional multi-site research is required in oncology settings to recommend recent interventions for practice.

IMPLICATIONS FOR NURSING PRACTICE:

Oncology nurses should assess their adherence to evidence-based guidelines on infection prevention. Outcomes are optimized when clinicians identify high-risk patients and provide scientifically supported interventions.

KEYWORDS:

Infection, outcomes, cancer, interventions

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0749-2081/07/2303-$30.00/0
doi:10.1016/j.soncn.2007.05.002

PREVENTION OF INFECTION IN PATIENTS WITH CANCER

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INFECTION refers to the symptoms caused by the multiplication of microscopic organisms and subsequent invasion of the body's natural barriers.[1,2] These organisms may be of bacterial, fungal, viral, or parasitic origin. Patients with cancer, compared with other clinical conditions, are at increased risk for infectious complications. The factors that predispose patients with cancer to infection include decreased supply and/or function of lymphocytes or granulocytes, wounds following invasive surgery, the placement of vascular catheters, nutritional deficiencies, and pre-existing or newly acquired comorbidities.[3] In many cases, patients present with many or all of these factors at once. Prevention of infection occurs through activities by patients, nurses, physicians, and public health professionals to reduce the likelihood of microbial multiplication and invasion.[1] Despite the recognition that patients with cancer are at increased risk for infection, preventive interventions often vary by setting and lack an evidence base.

The white paper on nursing-sensitive patient outcomes published by the Oncology Nursing Society (ONS) recognized prevention of infection as an important safety outcome that is sensitive to nursing interventions.[4] Four of the 15 outcomes endorsed by the National Quality Forum as nursing-sensitive performance measures are related to infection.[5] Reimbursement strategies for health care services based on quality measures, termed "pay for performance," are anticipated to increase widely. Moreover, oncology nurses have an interest in preventing infection in patients with cancer to facilitate timely anti-cancer therapies, promote quality of life, and improve patient satisfaction. It is with these motivations that this article discusses the recent evidence base for interventions to prevent infection. The goal of this review is to provide clinicians with the most reliable, updated evidence to support clinical decision-making and improve outcomes for patients with cancer who are at increased risk for infection.

Two principal documents were used to frame this review. The first was a review completed by the author in 2004[1] as part of the initial ONS effort to measure nursing-sensitive patient outcomes. The second document is a summary of the 2005 ONS Putting Evidence Into Practice (PEP) project team to categorize interventions based on the quality of the available evidence.[6,7] Finally, common clinical problems, such as infections related to vascular catheters, pneumonia, and aggressive organisms (*Clostridium difficile,* vancomycin-resistant *Enterococcus* [VRE], and methicillin-resistant *Staphylococcus aureus* [MRSA]) were addressed specifically because of their high prevalence and potential for poor outcomes in the oncology patient population. This review concludes with knowledge gaps and suggestions for future research.

Evidence-Based Summary of Nursing-Sensitive Outcomes: Prevention of Infection

The first review conducted for the ONS focused on: (1) available measures, and (2) effective interventions with a high level of evidence for the prevention of infection in patients with cancer.[1] A computerized search of the Cumulative Index to Nursing & Allied Health Literature (CINAHL) and the United States' National Library of Medicine bibliographic database (MEDLINE) was conducted using the search terms "registered nurses" and "infection" or "infection control." Searches were limited to papers published between 2000 to 2003, and classified as systematic reviews or meta-analyses. Meta-analyses are quantitative syntheses of separate but related research studies. In addition, the Agency for Healthcare Research and Quality's online database of clinical practice guidelines (www.guidelines.gov) was searched using similar terms.

The findings showed scant attention to measurement techniques of infection. While this is partly because of the heterogeneity of infection, very little empirical research is available on how clinicians or researchers should measure infection from the quality of care perspective. One paper addressed the concept of time to positivity to infection as a tool to discern vascular catheter-related blood stream infection.[8] In this approach, paired blood cultures are obtained; one from the distal port of the vascular catheter, and a second from phlebotomy. If the culture from the catheter source is positive first, the difference in time to positive result is compared between the catheter and the phlebotomy sample. When the difference exceeds 120 minutes, catheter-related infection is more certain. Clinicians continue to debate the frequency, number, and source(s) of blood cultures required in the febrile patient with cancer. Although no published studies answer the question empirically, a sound protocol was developed by Penwarden and Montgomery.[9] The steps include: (1) obtaining the cultures within 30 minutes of fever; (2) obtaining one peripheral set of cultures with the initial fever, with cultures obtained only via the vascular catheter during subsequent febrile episodes; and (3) cultures obtained from each lumen of the catheter, with no blood discarded. While individual scenarios may dictate a different response by clinicians, a standardized approach to blood cultures improves the validity and reliability of the diagnostic test.

Catheter-related blood stream infections have been measured using standardized terminology endorsed by the Centers for Disease Control and Prevention (CDC), among other groups.[10] The number of infections per 1,000 catheter days is a widely used metric in the literature. For example, assume in 1 month a clinic cared for 100 patients who had their catheters for 3 days each (300 catheter days/month). In that month, 4 patients acquired a blood stream infection. The catheter-related blood stream infection rate would be $4/300 \times 1{,}000 = 13.33$. While the calculation may not be intuitive it accounts for the fact that different clinics vary in their patient volumes and the length of time catheters are used.

The reviewed literature was then categorized into five domains of infection prevention interventions: (1) hygiene, (2) intravenous therapy, (3) nutrition/gastrointestinal, (4) environment, and (5) chemoprevention. Readers are referred to the source document for a complete discussion of the review findings. However, important findings are presented in Table 1.

The 2004 review concluded that several interventions had strong support to recommend widespread adoption, but many common practices, such as diet modifications and "protective isolation" of patients with neutropenia, lacked strong evidence. Measurement of infection was varied and few clear approaches were available for clinical use. Specific gaps in the infection prevention literature were noted in the outpatient oncology

TABLE 1.
Major Findings from the 2004 Prevention of Infection Review[1]

Domain and Intervention	Findings	Discussion
Hygiene		
Handwashing	The single most important nursing intervention to prevent infection	Antimicrobial soap and water, or the use of alcohol-based hand gel have equal efficacy
Oral care	Frequent oral care, including gentle toothbrushing and flossing (as tolerated) are effective	The frequency of oral care and the ideal oral cleansing agent are unknown
Intravenous therapy		
Catheter placement	Avoid placement of catheters when patient is functionally or quantitatively neutropenic	Not always possible in certain clinical circumstances. Aseptic practice and full barrier precautions during placement are recommended
Injection port cleansing	Injection ports on intravenous tubing or vascular catheters should be cleansed with 70% alcohol before access	Sufficient time between swabbing and access should be maintained to assure the alcohol has dried
Nutrition/gastrointestinal		
Nutritional route	Enteral nutrition is preferred to the parental route	Increased risk of blood stream infections has been observed for patients receiving parenteral nutrition
Diet modifications	There is little evidence for the "neutropenic diet"	Historical anecdotes have led to restriction of fresh fruits, vegetables, and other food sources. Two randomized trials are currently investigating this question
Environment		
Protective isolation	No rigorous data exist to support protective isolation practices for patients with cancer and neutropenia	These data differ from the CDC-endorsed approach of isolating patients with active infections to protect other immunocompromised patients
Chemoprevention		
Prophylactic therapy for patients with acute leukemia	Patients receiving induction therapy for acute leukemia should receive routine prophylaxis for fungus and herpes simplex. Patients with acute lymphocytic leukemia should also receive *Pneumocystis carinii* prophylaxis	Several agents are available to achieve anti-fungal and anti-viral prophylaxis

setting, and for infections outside the bloodstream. These findings were shared with advanced practice nurses (APNs) at the ONS-sponsored APN retreat in 2004. While reviewers found the document helpful, they requested additional detail for interventions commonly used in practice with varying levels of evidence. These comments stimulated the ONS's PEP initiative.

The Putting Evidence into Practice (PEP) Process

A series of manuscripts and documents are now available to describe the process and findings of the PEP initiative and specifically for the prevention of infection project team.[1,6,7,11] Briefly summarized, a panel of staff nurses, APNs, and a doctorally prepared researcher conducted a literature search of a broader scope than the 2004 review. Reviewed manuscripts were not restricted to systematic reviews or meta-analyses; lower levels of evidence were included. To discriminate the evidentiary support for particular interventions, each manuscript was assigned a level of evidence (highest reflecting randomized controlled clinical trials with 100 or more patients; lowest evidence level referring to clinical observation or editorial).[12] Papers describing the outcomes of a specific intervention were then aggregated by the team to assign an overall level of evidence for the inter-

vention to prevent infection. As a practical example, the prevention of infection team reviewed five separate studies of varying levels of evidence to conclude that chlorhexidine was not recommended to prevent mucositis in patients with cancer.

Although the 2005 PEP Prevention of Infection document reviews a more comprehensive array of interventions, significant gaps remain. Controversies remain in oral care (frequency, choice of agent), isolation practices, and the use of fluoroquinolone prophylaxis. The literature is lacking in evaluation of standardized patient and provider education on prevention of infection for patients with cancer. While frequently hypothesized, there is no evidence that detailed infection prevention educational content improves outcomes. This is a high priority area for future nursing research.

Research Findings on Selected Topics

The reviews described above provide a general approach to the prevention of infection in the patient with cancer. Additional specific areas are worthy of attention. Infections related to vascular catheters and pneumonia are highly prevalent and are the source of significant morbidity and mortality in the oncology patient population. In addition, the increase in incidence of aggressive organisms places current and future patients at risk for poor outcomes. These specific topics were reviewed in MEDLINE and guidelines.gov for the years 2000 through 2006. Restrictions were placed on manuscripts in English and focused on adult patients. When 300 or more manuscripts were retrieved, the search was combined with neoplasm as a search term to restrict to the oncology patient population.

Vascular Catheters

Standardized, evidence-based interventions for the patient with vascular access are vital to infection control efforts. When providers deliver these interventions consistently, outcomes are easier to track and measure. Many oncology nurses are aware of the Access Device Guidelines published by the ONS.[13] This guideline summarizes pertinent issues related to the insertion, care, and maintenance of vascular access devices. The guidelines summarize available evidence surrounding controversial issues, including dressing type, cleansing agents, flushing agents, occlusion, infection control, and catheter removal. However, more recent standards have been made available. Oncology nurses are advised to consult with their subspecialty colleagues, the Infusion Nurses Society (INS), for recent updated evidence-based standards on a variety of vascular access devices. In 2006, the INS published standards of practice on a wide variety of relevant topics to oncology nurses, including catheter site selection, skin preparation, dressing application and changes, flushing, and stabilization procedures.[14] Both the ONS guidelines and the INS standards are supported by published sources, however, they lack a level of evidence weighting assignment. Thus, randomized trials, as well as observational studies, support the guidelines and standards as currently published. Selected INS standards are presented in Table 2. However, the reader is strongly encouraged to review the entire issue of the journal for complete details and considerations for special patient populations. Important teaching points from the standards include frequent observation of the junction between the access device and the patient's skin. Daily inspection and palpation is required, and dressings should avoid covering the junction to permit inspection. Clinical practice varies in the schedule of catheter and dressing changes. Basic principles include reducing the number of "breaks" to the intravenous system where infectious agents could be introduced inadvertently.

In addition to the published standards, the INS's journal, *Journal of Infusion Nursing*, has numerous nurse-led, data-based research articles documenting outcomes following changes related to infusion nursing interventions. These articles are an excellent model for oncology nurses to emulate in making changes to their own practices, as it not only increases nursing scholarship, but informs the community about novel, effective interventions for the patient population.

One recent nurse-led study in a large homecare infusion service reported 7 years of data on 551 patients.[15] Using the standardized metric in catheter-related outcomes, 20,879 catheter days were observed. This prospective, observational study reported 0.77 infections per 1,000 catheter-at-home days. In addition to the outcome data, factors associated with the infected catheters were reported; total parenteral nutrition was associated with 6 of the 16 documented infections in the study period (χ^2 28.14, $P < .001$). Other risk factors included neutropenia, immunosuppressive agents, multi-lumen catheters, history of catheter

TABLE 2.
Selected Standards of Practice from the Infusion Nurses Society[14]

Topic	Standard
Placement	1. Maximal barrier precautions (sterile gown, sterile gloves, cap, mask, eyewear, sterile drapes/towels) used for central, midline, and peripherally inserted central catheters 2. Accepted antiseptic solutions include alcohol, chlorhexidine gluconate, povidone-iodine, and tincture of iodine. A combination of alcohol followed by chlorhexidine gluconate or povidone-iodine (after the alcohol dries) are preferred
Catheter site care	1. The catheter dressing change procedure should include cleaning the junction of the catheter and skin with antiseptic agents (detailed above) using aseptic technique 2. Sterile gloves and mask should be used for catheters with extended dwelling times, are placed centrally, or in immunocompromised patients 3. Sterile dressings should be applied to vascular access devices. Options include gauze that prohibits direct observation of the entry site (change every 48 hours); gauze with a transparent semipermeable (TSM) dressing (change every 48 hours), or TSM dressing alone (at least every 7 days) 4. The junction of the skin and catheter should be inspected and palpated for tenderness daily 5. Catheters should be stabilized to restrict movement. Manufactured stabilization devices are preferred to sterile tape or surgical strips. If the latter are used, they should not be placed on the catheter-skin junction 6. Implantable ports: safety non-coring needles should be changed every 7 days. If a TSM dressing is used with gauze to anchor the needle and the catheter-skin junction is visible, dressings should be changed every 7 days. Needle and dressing changes should be timed simultaneously
Intravenous administration sets	1. Sets should be changed every 72 to 96 hours, or whenever contamination or compromised integrity of the system is suspected 2. Aseptic technique should be used for set changes 3. Changes should coincide with new catheter placements, extension sets, filters, stopcocks, and/or initiation of new containers of solution 4. All sets should use luer-lock design 5. Sets used for parenteral nutrition should be changed every 72 hours or immediately after suspected contamination or compromised integrity 6. Sets for intravenous fat emulsions should be changed every 24 hours 7. Sets used for blood products should be changed after each unit or after four hours, whichever comes first 8. Hemodynamic monitoring sets should be changed every 96 hours

infection, and serum albumin ≤ 3.5. This study sheds important light on the possible explanations for catheter-related infection, and allowed the home care agency to target surveillance activities to high-risk patients. The infrastructure of prospective data collection allows the agency to track outcomes data and respond promptly to changes.

Another practice inconsistent with the evidence surrounds the techniques used to secure catheters. Historically, catheters have been sutured immediately after placement, and nurses have relied on mounds of tape to reduce the risk of dislodgment. A trial of 170 peripherally inserted central catheter (PICC) line recipients, randomized subjects to standard securing procedures with sutures and tape versus a sutureless securement device.[16] The infection rate per 1,000 catheter days was 3.4/1,000 in the suture arms versus 0.7/1,000 in the sutureless securement device arm ($P < .03$). A meta-analysis of two trials (including the one above) compared stabilization devices with traditional catheter securement procedures with tape or surgical strips and reported a statistically significant decrease in catheter-related blood stream infection rates with the use of stabilization devices.[17] Hypothetically, the differences are because of the skin disruption caused by suture placement, as well as use of unclean tape applied to non-intact skin.[18]

One institution reported 6-year outcome data following the implementation of a midline catheter placement program for high-risk patients.[19] Midline catheters have longer cannulas than peripheral catheters (7 to 8 inches ʊ 1 inch, respec-

tively), yet are indicated for shorter infusion time than PICCs. The vascular team reviewed the scant literature and, in accordance with expert opinions, developed explicit criteria for midline placement. The program reports increased rates of infusion completions for patients with midline catheter placement, with low phlebitis and infection rates. An important implication of this study is that in the absence of strong evidence, expert opinion was consulted to drive interventions. Subsequently, the change in practice was studied systematically and published in the peer-reviewed literature.

For decades, the standard of care for the patient requiring bone marrow or stem cell transplantation for hematologic malignancy was placement of a tunneled Hickman catheter. However, other devices have documented efficacy in this high-risk population. In a single-site, retrospective chart review of 120 autologous marrow/stem cell recipients, the outcomes for those who received Hickman catheters versus PICCs were compared.[20] While all Hickman catheters were placed by surgeons, the PICCs were placed by nurses and radiologists. Cellulitis, phlebitis, and bacteremia were less frequent in the PICC group. Although the groups were relatively well balanced in terms of age, gender, and presenting diagnosis, comorbidity and other uncaptured indicators of illness severity were not available. The data, however, do point to encouraging results in terms of reducing infection in a vulnerable patient population.

A recent study examined whether patients with tunneled catheters required dressings once cuff adherence had occurred.[21] The rationale supporting dressing-free catheters include the observation that dressings may place and contain pathogens closer to the catheter site. Second, the Dacron cuff in the tunneled portion of the catheter adheres to tissues along the tunnel, preventing displacement. This randomized, single-site study followed 78 patients with cancer who received Quinton or Cook catheters with two or three lumens. At day 21, afebrile patients with low bacterial counts on exit site culture were randomized to skin cleansing with chlorhexidine and scheduled gauze dressings or skin cleansing without dressing. While sepsis rates were lower in the no-dressing arm, the result did not reach statistical significance. However, the average days until blood stream infection were significantly longer in the no-dressing arm versus scheduled gauze dressing arm (145 υ 90 days, $P < .03$).

Antibiotic locks are a more recent, controversial intervention in vascular catheter care. Solutions of varying antibiotics and concentrations are instilled in the catheter for up to 12 hours. Six randomized trials were pooled in meta-analysis to examine the effect of antibiotic locks on catheter-related blood stream infection. The relative risk of catheter-related blood stream infection was significantly decreased in the antibiotic lock arm, compared with usual care ($P < .01$).[22] However, the Healthcare Infection Control Practices Advisory Committee (HICPAC) does not recommend antibiotic locks in routine practice because of resistance concerns.[23] Studies using standardized drug and concentration, in immunocompromised patient populations, with detailed antimicrobial resistance data are required before adoption of this practice can be widely supported for oncology nursing practice.

Pneumonia

Health care-associated pneumonia is a frequent and severe problem for patients. The matrix of immunosuppression, surgery, nutritional deficiencies, and activity intolerance makes pneumonia particularly problematic for patients with cancer. The CDC has published exhaustive, evidence-based guidelines for pneumonia prevention in health care facilities.[24] To date, this guideline has been slowly adopted. However, a single institution has reported recent improvement in nosocomial pneumonia rates after the implementation of a performance improvement project to adhere to the CDC guidelines.[25]

The ONS prevention of infection PEP team summarized the 2003 recommendations by the CDC on the PEP card,[6] with additional detail at the website (www.ons.org/outcomes).[7] Important pearls from this review for the oncology population include:

1. Clean, disinfect, rinse, and dry nebulizers between doses. Use sterile medication (single doses are preferred) and administer aseptically.
2. Oxygen tubing, humidification circuits and masks should be changed after malfunction or visible signs of contamination.
3. Glove use by providers when handling respiratory secretions; Single-use gowns when respiratory secretions are anticipated.
4. 23-valent pneumococcal polysaccharide vaccination to adults with cancer.

TABLE 3.
Interventions to Prevent Transmission of Drug-Resistant Organisms[32]

Category	Specific Interventions
Administrative	Organizational priority on infection control. Tracking system of patients colonized with resistant organisms. Use of coalitions to track and compare data. At least annual feedback to health care providers on infection rates and outcomes
Education	Annual, updated training to health care providers on pathogen incidence, risk factors, and evidence-based control efforts
Antimicrobial use	Strongly implicated in resistant organisms. Frequent updates of facility-specific resistance information, formulary restrictions, interdisciplinary review of anti-infective use
Surveillance	Standardized laboratory methods to test for resistant organisms. Rapid notification system to health care providers. Unit-specific resistance reports to target interventions and increased surveillance
Infection control	Standard precautions in all health care settings. Contact precautions for patients with resistant organisms in acute care settings. Consider increased efforts in long-term care. Standard precautions appropriate for home care/ambulatory settings. For patients with resistant organisms, providers wear masks when splashing is anticipated, open tracheostomy care, care of open, heavily colonized sources
Environment	Specific cleaning, disinfection, and sterilization procedures. Focus on frequently touched surfaces

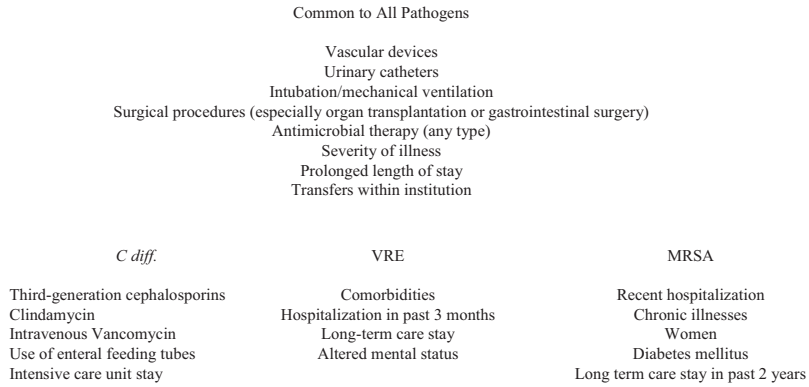
5. Restrictions on visitors when respiratory symptoms are present.

While not addressed by the CDC guideline, a recent contribution to the literature was the examination of formal dysphagia screening for patients at risk for pneumonia.[26] The Stroke Practice Improvement Network conducted chart review in 15 institutions, and tracked adherence to formal dysphagia screening protocols. Patients who received formal dysphagia evaluation after cerebrovascular event but before the re-initiation of oral intake were deemed successfully screened. Rates of pneumonia were significantly higher in hospitals that lacked formal dysphagia screening protocols, even after adjustment for stroke severity. Applied to oncology practice, clinicians should identify patients at higher risk for dysphagia and arrange for screening. Head, neck, and esophageal patients are candidates, but additional patients may be considered based on comorbidities, and history of surgery and radiotherapy.

Aggressive Organisms

Three organisms are responsible for the large proportion of infectious diseases difficult to eradicate with standard therapy: *Clostridium difficile*-associated disease (CDAD), VRE, and MRSA. While clinically heterogeneous diseases, several principles of care are relevant to all three in terms of prevention. First, the influence on hand hygiene cannot be understated. Clear instructions based on empirical science are provided by the CDC's Healthcare Infection Control Practices Advisory Committee[27] and are summarized in the ONS PEP website.[7] Whereas the CDC guideline details instructions for both water-based and water-less scenarios, it provides the caveat that most alcohol hand rubs are not effective against spore-based organisms, such as CDAD. While some contradictory evidence suggests that use of alcohol rubs decreases CDAD rates in hospitals, it is clear that handwashing alone is not sufficient to combat these aggressive pathogens.[28,29] Additional interventions, such as isolation procedures, are required to prevent transmission of these organisms to patients.

The CDC has articulated isolation procedures to prevent the transmission of resistant pathogens to other patients. These procedures are published by the evidence-based document endorsed by the HICPAC, and were most recently revised online in April 2005.[30,31] The baseline approach, standard precautions, provides the initial framework for interactions between health care providers and patients; the goal is to reduce the transmission of microorganisms between recognized and unrecognized sources in hospitals. The second approach, termed "transmission-based precautions," focuses on interrupting the spread of highly virulent pathogens throughout health care facilities. An example is the use of contact precautions to reduce the risk of CDAD, VRE, and MRSA transmission from colonized patients to other patients. A parallel intervention, empiric precautions, is used to identify patients with clinical characteristics who should be isolated (using contact precau-



C diff: Clostridium dificile; VRE: Vancomycin-resistant *Enterococcus*; MRSA: Methicillin-resistant *Staphylococcus aureus*

FIGURE 1. Risk factors for increased risk of resistant pathogens.[28,36-45]

tions) before definitive microbiological culture. For example, diarrhea in patients with incontinence or diaper use, or diarrhea in an adult with recent antibiotic use, would raise suspicion for CDAD and warrant empiric precautions until after CDAD toxins return negative. Patients with active, infected wounds that cannot be covered completely are also candidates for empiric precautions.

The recent CDC guideline on the prevention of multi-drug-resistant organisms in health care settings outlines six initiatives to prevent the transmission of organisms such as VRE and MRSA (see Table 3).[32] These initiatives support clinicians in their infection control efforts. When prevalence of resistant organisms fails to decrease after these initiatives, or a clinically important pathogen is isolated in a facility, the guideline suggests more aggressive efforts. The evidence base is strongest for acute care facilities, and weaker in long-term care, ambulatory, home care, and infusion settings. Research in this area is strengthened when outcomes are compared before and after interventions, baseline infection control measures are clearly described, changes in practice in addition to infection control procedures is documented, and data are collected across several health care facilities.

The establishment of a surveillance program has been implicated in the reduced incidence of CDAD, VRE, and MRSA. Clinical active surveillance has been defined as prospective screening for VRE via rectal swabs on admission. This approach, contrasted with laboratory screening (additional culture performed for VRE from stools sent for *Clostridium difficile* toxin assays) is more sensitive and cost effective.[33] To assist in surveillance activities, recent studies that identify risk factors for the colonization of resistant organisms were reviewed and are presented in Figure 1. Many risk factors are shared across pathogens, such as vascular catheters, urinary catheters, prolonged hospital stay, and transfers within hospitals. Concurrent antibiotics are also common factors for all three pathogens, but are most strongly implicated in *Clostridium difficile* incidence; cephalosporins and clindamycin are recognized culprits. Oncology nurses can identify patients at risk for resistant organisms, conduct active surveillance in the form of querying for symptoms and surveillance culture, and isolate patients at high suspicion for resistant pathogens. Although such a targeted approach has not been published in the oncology literature, it applies the research findings from active surveillance and risk factor analysis. Further, it promotes consistency across providers and allows for straightforward outcomes assessment.

The use of intranasal mupirocin has been investigated as a strategy to reduce both MRSA and VRE. While data are more supportive for prevention of MRSA in the surgical patient,[34] data on non-surgical patients to prevent MRSA are equivocal.[35] In addition, valid concerns regarding promoting resistance restrict the prophylactic use of intranasal mupirocin to high-risk surgical populations.

CONCLUSION

While this review highlights many interventions oncology nurses can implement to reduce the burden of infection in patients with can-

cer, additional studies are needed to confirm current findings and effects of interventions. Nursing research in this area would be strengthened by standardized measures, in multiple sites, and focused on the oncology population. Much of the work reviewed here was performed in general hospital or community settings. The unique clinical characteristics of patients with cancer and their response to nursing interventions to prevent infection are of special priority.

Clearly, the problem of infection in the patient with cancer affects not only immediate clinical outcomes, but quality of life and adverse outcomes to providers and institutions. For these reasons, prevention of infection, whenever possible, is an important part of oncology nursing practice. Several evidence-based interventions have been discussed here. The role of handwashing is central; providers, patients, and caregivers require frequent instruction and observation of handwashing practices to assure technical accuracy. Across the spectrum of pathogens, recognition of high-risk pathogens, consistent application of guideline recommendations, and collection of outcome data, can all help optimize outcomes for this vulnerable patient population.[31]

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