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Catheter-Related Bloodstream Infections (CR-BSI) in Geriatric Patients in Intensive Care Units

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Catheter-related bloodstream infections (CR-BSIs) are bloodstream infections that, through specific laboratory testing, identify the intravascular catheter as the source of the bloodstream infection. By 2015, the rate of elderly patients 80 years of age and older admitted to the intensive care unit (ICU) will represent 1 in 4 admissions. Approximately 80 000 CR-BSIs occur in ICUs annually, potentially resulting in as many as 56 000 CR-BSIs occurring in the geriatric ICU patient, with 20% of these cases resulting in death. To minimize the occurrence of CR-BSIs in these patients, specific knowledge about the geriatric patient will have to be factored into the ICU health care professional's practice, including the development of a vascular access plan, which includes selection of the correct device and proper insertion of that device along with an evidence-based care and maintenance program. Intensive care unit health care professionals may be at a loss when it comes to navigating the vast array of vascular access medical devices available today. The Healthcare and Technology Synergy framework can assist the ICU health care professional to logically review each vascular access device and select those devices that best meet patient needs. **Key words:** *catheter-related bloodstream infection*, *geriatrics*, *HATS framework*, *intensive care patient*

CATHETER-RELATED bloodstream infections (CR-BSIs) are bloodstream infections (BSIs) that, through specific laboratory testing, identify the intravascular catheter as the source of the BSI.[1] Elderly patients (aged >65 years) currently account for 42% to 52% of intensive care unit (ICU) admissions and for almost 60% of all ICU days.[2] Bagshaw et al[3] predicted that, by 2015, the rate of elderly patients 80 years of age and older admitted to the ICU will increase by 72%, representing roughly 1 in 4 admissions to the ICU.[3] With 80 000 CR-BSIs occurring in ICUs yearly,[4] as many as 56 000 CR-BSIs occur in the geriatric ICU population. Conservatively, 20% (11 200 geriatric patients) of these infections will result in death.[5] The current goal is to eliminate CR-BSI occurrence. To achieve this goal, specific knowledge about the geriatric patient will have to be factored into the ICU health care professional's practice, including the development of vascular access care and its maintenance plan.

Since a central venous catheter (CVC) lies in a vessel, it is not surprising that the common skin bacteria, *Staphylococcus epidermidis*, which adheres only to fibronectin,

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Staphylococcus aureus, which adheres to fibronectin, fibrinogen, laminin, and gram-negative bacteria, and *Pseudomonas aeruginosa*, *Klebsiella* spp, *and Enterobacter* spp, which adheres to fibrin, are the primary causes of CR-BSI.[6] These microorganisms anchor to fibrin on the catheter wall, multiply, adhere to each other, and encase themselves in a matrix of primarily polysaccharide material, which is often referred to as slime or a biofilm colony.[7] Detachment of either individual cells or clusters of cells can reattach to new sites in the body such as cardiac valves.

Preventing CR-BSI requires critical thinking of numerous variables. The Healthcare and Technology Synergy framework includes 3 main variables—patient, product, and practice.[8] Either alone or in combination, these variables effect CR-BSI prevention outcomes. The relationships among these 3 variables are an essential component of nursing care to geriatric patients in the ICU who are at risk for CR-BSI.[9] The purpose of this article was to use the Healthcare and Technology Synergy framework to examine each of these 3 variables in relation to the geriatric patient, CR-BSIs, and the ICU.

PATIENT

The geriatric patient is at an increased risk for CR-BSIs for a number of reasons (see Table 1). For example, after the age of 30 years, there is a 1% loss of immunity for each year.[10] This loss places the geriatric patient who has lost a minimum of 35% immunity (aged 65 years) at a significant risk for infection. Cardiac and renal deficiencies impact antibiotic circulation and filtration, further impacting infection care. The elderly usually have several comorbidities (eg, chronic obstructive pulmonary disease, diabetes, hypertension, cardiac disease, and renal compromise) in addition to their primary diagnosis. They take numerous medications of which some (eg, steroids, aspirin, and nonsteroidal

Table 1. Reasons Geriatric Patients in ICU Are at Increased Risk for CR-BSIs

Geriatric Characteristic	Geriatric Response
Increased age	Decreased immunity
Renal compromise	Delays antibiotic filtration or effects amount of antibiotic prescribed
Decreased cardiac output	Lower antibiotic effectiveness
Vascular problems	Inhibit antibiotics from getting to needed areas of the body
Comorbid diseases (COPD, diabetes, hypertension, and pneumonia)	Can affect vasculature and immunity. Multiple lines increase potential CR-BSI
Multiple concurrent medications (steroids, ASA, and NSAIDs)	Can mask signs/symptoms of infections
Increased INR[12]	Enhances blood and fluid around CVC insertion site aiding the environment for CR-BSI
Emergently placed CVC (ED, ICU)	Increased risk of infection
Thin skin/fragile veins	Limit access points and/or lead to vein disruption, infiltration, extravasation
Confusion, dementia, Alzheimer disease	Aids in body movement and pistoning at catheter insertion site
Coughing, vomiting, and/or ventilator support	Blood movement in catheter tip and fibrin formation at the tail of the catheter

Abbreviations: ASA, acetylsalicylic acid or aspirin; COPD, chronic obstructive pulmonary disease; CR-BSI, catheter-related bloodstream infections; CVC, central venous catheter; ED, emergency department; ICU, intensive care unit; INR, international normalized ratio; NSAIDs, nonsteroidal anti-inflammatory drugs.

anti-inflammatory drugs) are known to mask infection symptoms. The elderly's skin has thinned and lost turgor, and the veins have become fragile. Increased international normalized ratio[11] values in the geriatric patient increases bleeding around the vascular access site, and this increases potential for insertion site bacterial colonization and infection.

The geriatric ICU patient with a vascular insertion site or multiple sites has a direct catheter/vein link to skin surface bacteria. The body responds to a skin puncture (vascular catheter insertion) with an inflammatory response resulting in edema and serosanguinous fluid secretion at the puncture site. The vein's intimal layer promotes platelet adherence followed by thrombus formation. The "healing" thrombus just inside the puncture site and the increased bleeding at the site provide the ideal site for bacteria to colonize and form biofilm. The puncture site and the proximal catheter end have the highest level of colonization of bacteria. Colonization of short-term vascular access devices (<15-20 days) typically occurs at the catheter exit site.[13]

The ICU patient usually experiences diaphoretic episodes. Moisture enhances bacterial migration down the extraluminal pathway.[14] An elderly patient is often confused and moving, which aids in pistoning movements of the vascular access catheter or intravenous (IV) catheter in and out of the puncture site. This catheter movement at the insertion site and frequent pistoning movements further damage the vein and the insertion site. Intraluminally, coughing, vomiting, and mechanical ventilation cause blood movement at the catheter tip. This catheter tip blood movement can result in fibrin tail formation and thrombus formation. To review, the geriatric patient has many factors that increase the risk of forming an environment conducive to biofilm formation and decreasing treatment success.

PRODUCT

Vascular access care includes the use of products including disinfectants, catheters, securement devices, dressings, and needleless access devices. Each of these devices includes many different manufactured products. It is important to understand some basic information about these products and their potential impact on CR-BSI prevention to select the most appropriate product for the geriatric ICU patient.

Disinfectants

Common disinfectants include 70% alcohol, tincture of iodine, or alcoholic chlorhexidine gluconate (CHG) solution. Alcohol basically bursts the bacteria cell. Chlorhexidine gluconate enters the cell and disrupts the cell contents. Povidone-iodine is nonstaining solution (unlike iodine) but retains the germicidal activity of iodine. Iodine, like CHG, enters the cell and disrupts it; thus, it too requires dry time. Povidone-iodine formulations have been reported to be able to become contaminated. It is unclear why, but it is thought that this might be related to the dilution of the iodine. Since CHG binds with skin proteins (persistence), it is effective with repetitive applications over time. Chlorhexidine gluconate does not bond with products the same way. All CHG disinfectants in the United States are combined with alcohol. It is a point of controversy whether it is the alcohol instead of the CHG that disinfects nonskin surfaces. A pivotal study by Maki et al[15] demonstrated CHG and alcohol to be more effective than povidone-iodine aqueous solution. Today, the use of some form of CHG for skin disinfection is accepted practice. Resistance arises as microbe mutation occurs. To that end, it is important to consider all available antiseptic solutions.[16] There is a relatively new skin antiseptic available in many areas of the world—alcoholic povidone-iodine. This product has been shown to have superior efficacy over aqueous povidone-iodine.[17] In fact, it performed similarly to antiseptics containing CHG and alcohol.[17] Antiseptics have both pros and cons, and these considerations (eg, patient condition, patient allergies, time, and cost) should be considered prior to selecting the antiseptic of choice.

Catheters

Catheter properties can be divided into 3 major categories—material, structure, and coatings. Polyurethane and silicone are the polymers that make up the material category. Polymers are materials made up of smaller molecules that are chemically linked into long chains. These long chains vary in the number and type of molecules used to formulate a specific polymer. Polyurethane CVCs are available in many different configurations. These devices, while biocompatible, can be stiff or soft, depending on the molecules that make up the polyurethane chain. Silicone elastomers are made from long linear dimethylsiloxane-type molecules, which are then reinforced with silica filler and crosslinked. Silicone catheters are soft and flexible; however, because silicone is softer, these catheters are generally thicker. In summary, catheter material must be considered when assessing the risk of the vascular access device to the patient. Polyurethane catheters are stronger and will generally last longer; however, due to their structure, they may be harsher on the vein lining, which can lead to increased rates of thrombosis. Silicone catheters are softer and may be more vein-friendly. However, since the material is softer, the wall thickness must be even thicker to provide strength. This means that the inner diameter is smaller when compared with the same gauge polyurethane catheter. Internal diameter impacts flow rate dramatically. For example, a 20 gauge peripherally inserted central catheter (PICC) made of silicone may not infuse without a pump, whereas a 20 gauge polyurethane PICC will infuse on gravity. The gauge size directly impacts vein-catheter ratio. There needs to be a sufficient flow of blood around a catheter to minimize vein wall damage. One size does not fit everyone or every vein.

The second major catheter category is structure. Central venous catheters may be either open-ended or valved. Valved CVCs may have a proximal or distal valve. Distally valved CVCs were created with the idea that the distal valve would be located in the bloodstream and would remain closed when not in use. This design is purported to prevent blood reflux and thus catheter occlusion. The proximally valved CVC was created with a similar goal, preventing blood reflux when the catheter is not in use. Both were designed to eliminate the use of heparin, which has been implicated in CR-BSI due to increased biofilm formation.[18] A recent study concluded that there is no significant advantage related to the presence of a proximal valve.[19] This category can be further divided into a number of catheter lumens, stepped tip versus all lumens ending at the same point, and special tip configurations that are designed to minimize thrombosis formation at the catheter tip. No studies exist that conclusively validate the efficacy of these design features. To that end, clinicians need to study available literature and talk to others using the products and make their product decision based on the design that seems to support their patient's needs to the greatest degree.

Finally, catheter category 3 is composed of catheter coatings. Coatings have been available for a number of years. Major players in this category include antibiotics (eg, minocycline and rifampin), antiseptics (eg, chlorhexidine), and antithrombotic coatings (eg, heparin). Although these coatings have demonstrated efficacy in decreasing infections and thrombus formation, each carries risks as well, such as antibiotic resistance and heparin-induced thrombocytopenia. Studies vary in their reliability regarding the efficacy of catheter coatings; therefore, the clinician should carefully study published outcomes to determine which coatings are viable for a particular patient situation. It has been postulated that their use should be considered on the basis of the infection risk.[20] For example, a patient who has a history of several CR-BSIs would be a good candidate for a coated catheter.

Securement devices

Securement devices are used to ensure that the catheter stays where it was placed, with the tip in the proper location. Over

the years, several catheter securement strategies have been used. These strategies can be divided into 3 categories—transdermal (eg, sutures/staples), cutaneous (eg, adhesives and adhesive devices), and subcutaneous (eg, subcutaneous securement anchors). Transdermal devices such as sutures have been used for many years and are often considered the gold standard for catheter securement. When applied correctly, sutures prevent gross catheter accidental dislodgement; however, sutures may lead to several complications. The first complication is associated with the suture skin puncture wounds. These wounds provide additional openings in the skin, which may allow bacteria to migrate from the surface into the dermis and subcutaneous tissue, which provide rich food sources for these microbes. The microbes are then able to grow and proliferate, which may lead to an infected insertion site. In addition, as each suture is being drawn through the epidermis and back to the surface, the suture material is effectively pulled through various transient flora living in the lower layers of the epidermis, thus contaminating the suture material.[21-23] These sutures are under the dressing, which may act as an incubator, promoting bacterial growth. Over time sutures may loosen or erode through the patient's skin, allowing the CVC to become loose and less stable. The risk of a needlestick injury for the placing clinician is relatively high. Overall, there are 384 000 needlestick injuries in the United States each year, with 24% of these injuries directly related to suture needles.[24] Sutures may also prevent thorough cleaning of the catheter insertion site, as the catheter is initially secured tightly to the skin.

Cutaneous securement devices, such as manufactured adhesive devices, prevent needlestick injuries, minimize gross dislodgement of the CVC while in place, and promote thorough catheter insertion site cleaning. The adhesive may degrade over time and loosen, allowing the catheter to piston in and out of the insertion site. In addition, adhesive devices must be completely removed and replaced during each dressing change process, which may exacerbate existing skin issues such as allergic reactions and skin maceration and may lead to catheter migration. These devices have also been implicated in causing skin damage in some patients.

The final securement category is subcutaneous securement. This technology uses nitinol anchors, which are inserted through the catheter dermatotomy, reaching into the subcutaneous tissue where they are anchored and heal into place within 48 to 72 hours. This healing process promotes a nonmoving catheter, rather than attempting to secure the catheter to the constantly moving skin. The lack of movement promotes healing of the insertion site, allowing the remodeled tissue to act as a barrier to surface bacteria. A review of several case studies has been published indicating a dramatic decrease in catheter dislodgement/malposition rates.[25] Just as with the previously mentioned devices, securement devices must be evaluated for the pros and cons they bring to an individual patient situation.

Needless access devices

Following catheter securement, the Centers for Disease Control and Prevention (CDC) recommends the use of a needleless system to access IV tubing or catheters.[1] As with any medical device, needleless access devices are available in various styles and formats. A needleless connector allows needleless connection of an administration set to a catheter or allows direct connection of a syringe to a catheter without the use of a needle. These devices automatically seal when the IV administration set or syringe is detached. There is no standard methodology used to designate the different types of needleless access devices. In general, they can be divided into several categories—blunt cannula or split septum devices (requires a blunt cannula to access a prepierced septum) and Luer-activated devices that incorporate a valve or membrane to prevent fluid flow through the device until an IV tubing administration set or

syringe is attached to the device. This class of needleless connector is much more common today. Luer-activated devices can be further divided into 3 major categories—negative pressure (results in blood reflux upon tubing or syringe disconnection), positive pressure (results in saline bolus upon disconnection), and neutral (prevents blood reflux and fluid bolus upon disconnection). There are also a variety of coatings that have been used to provide additional antimicrobial activity with these devices. A paucity of literature exists regarding the antimicrobial efficacy. After detailed research, William R. Jarvis, MD, a respected infection control specialist, provided the most concise method for evaluating the efficacy of a needleless connector. Dr Jarvis suggested 9 characteristics that the "ideal" needleless connector would embody (See Table 2).[26] The astute clinician should closely examine the needleless connector choices, making a device decision on the basis of these recommended characteristics. The same examination should occur with intravenous lines that have Y-sites where bacteria can also enter.

Dressings

In their 2011 guidelines, the CDC recommends the use of sterile gauze or sterile, transparent, semipermeable dressings to cover the catheter site.[1] These dressings require different change routines from every 24 hours to 7 days.[1] Dressing choice should be tied to the specific needs of the patient. There are a number of new adhesives that can be used for patients who traditionally have allergic reactions to adhesives. Most of these are silicone-based and can be used with gauze. Gauze dressings must be changed every 2 days.[1] Transparent semipermeable membrane (TSM) dressings make up the majority of the dressing materials available for CVCs, although there are also some hydrocolloidal dressings available. When evaluating a dressing, it is important to understand the qualities of the dressing, such as size, permeability, durability, ease of application and removal, patient comfort, type of adhesives used and adhesion, and moisture barrier. The TSM is permeable to air, allows visualization of the catheter site, and allows moisture to evaporate away from the insertion site (moisture vapor transmission rate

Table 2. Ideal Needleless Connector Design Features[27]

Feature	Description
Septum surface	Smooth external septum surface with few if any gaps that can be thoroughly cleaned
Septum seal	Tight seal between septum and the connector housing to reduce or eliminate space for contamination to occur and biofilm to develop
Dead space	Little or no dead space in the fluid pathway to minimize the surfaces that infusates can contaminate and where biofilm can develop
Internal mechanism	The most direct and least tortuous fluid pathway, with preferably no moving parts
Clamping sequence	A connector that does not require a specific clamping sequence
Visibility	A transparent connector is preferable to one that is opaque
Blood reflux	Little to no blood reflux
Flushing solution	Can be flushed with saline only rather than heparin-containing solutions to avoid potential risk of heparin-induced side effects

[MVTR]), leaving an environment less conducive to bacterial growth. These dressings are typically changed every 7 days, although a more frequent change may be required on the basis of patient condition (eg, diaphoresis). There is no evidence to support a specific TSM change protocol. Transparent semipermeable membranes have also begun to evolve as antiseptics have been added. The use of a CHG-impregnated disk has become a popular CR-BSI reduction strategy. One study reported significant reductions in the rate of CR-BSIs with this product.[28] Silver ion dressing products have been reported to provide some CR-BSI reduction activity, although there are no conclusive studies to support their use neither in ICUs or geriatric populations.[29] A recent addition to the CVC dressing armamentarium is the TSM with integrated CHG gel pad. These dressings have been reported to maintain bacterial suppression to a greater extent than the CHG disk during a 7-day dressing period.[29]

Practice

Once a biofilm colony is formed, it is extremely difficult to eradicate, so the best plan is prevention. This requires minimizing both extraluminal and intraluminal bacterial entry into the system (eg, connector sites and Y-sites of IV lines) and fibrin buildup on the catheter walls. The role of the nurse and associated high-priority actions (see Table 3) is the keys to preventing extraluminal and intraluminal ingress of bacteria.

Table 3. High Priority Activities in Vascular Access Nursing in ICU Geriatric Patients

1. Handwashing
2. Surface disinfection and scrub the hub (eg, Y-sites and connector sites)
3. Flushing
4. Minimizing catheter manipulations
5. Dressing management
6. Minimizing number of lines and discontinue lines when not needed.

Much research has been completed related to CVC insertion. It is widely accepted that a bundle approach be used that includes a CVC insertion checklist,[30] with a nurse observer who is empowered to stop the procedure at any time based on a break in protocol.[27] Other research stipulates the need for barrier precautions.[31] Additional measures, such as proper hand hygiene, maximum barrier precautions (eg, drape from head to toe, gown snap and tie, sterile gloves, mask, and cap), CHG skin antisepsis, ultrasound for placement, dressing applied prior to undraping, and hubs capped prior to undraping,[32] aid in getting to zero occurrences of CR-BSI in acute care.[33] Using the Institute of Healthcare Improvement central line bundle reduces the rate of catheter-associated BSIs in hospitals as shown by the success of the Institute of Healthcare Improvement initiatives. The nurse's role during insertion cannot be understated. This is a period of active observation and intervention to promote an optimal insertion.

Placing the catheter represents less than 5% of the catheter life. The remaining life of the catheter falls into the care and maintenance period. The care provided during this time is entirely the nurse's responsibility. First and foremost to prevent CR-BSIs, handwashing is the primary critical practice intervention within vascular access care. Much has been written about the importance of this single act, but it cannot be overstated. One-third of CR-BSIs are due to isolates found on health care workers' hands.[34] One should note that, during handwashing, the thumbs are most often missed,[35] and using foam requires a minimum of 2 dollops of foam and 20 seconds of friction.[36] The major tasks that need to be addressed when developing a vascular care and maintenance plan are catheter manipulations including entry point disinfection and flushing, blood sampling, and dressing management, including catheter securement and insertion site care. Much of vascular care today is implemented based on the calendar and not on the patient condition. For example, dressings are changed weekly, flushing with

normal saline is completed once a shift, caps are changed every 3 to 4 days, and swabbing the hub is implemented for 15 to 60 seconds. This approach makes standardizing practice simpler but misses the issues raised by special need patients such as geriatric, trauma, cancer, and intensive care patient. These patient groups require special thought and potentially an individualized plan of care.

Catheter manipulations

Catheter manipulations are the primary cause of bacterial migration into the intraluminal pathway. Entry site disinfection is extremely important. This step should never be overlooked or done quickly. This activity is a good example of where product impacts outcome. For best results, one should have a connector with a smooth, tight surface that is easily swabbed.[26] One must know what type of connector you are using. If the connector is positive (reflux on connection), the clamp must be opened before access. With a negative connector (reflux with disconnection), connect first and then open the clamp. Some medications such as norepinephrine, dopamine, and dobutamine promote biofilm formation of *S. epidermidis*.[37] After medication administration, you must reverse the actions with disconnection. With positive connectors, disconnect and close the clamp; with negative connectors, close the clamp and then disconnect. These actions done correctly with the correct cap minimize blood reflux associated with usage and help minimize the internal fibrin buildup on the distal tip. Flushing is another critical phase. Using the correct access sequence and flushing the catheter with at least 10 mL of normal saline (20 mL after blood draw) with a steady flush are imperative. Steady flush is best because it minimizes catheter wall adhesion.[7] Heparin should be avoided since it stimulates *S. aureus* biofilm formation.[38] If accessing an implanted port directly with a Huber needle, place the needle bevel up. When accessing a port on a patient in ICU, placing the needle tip up toward the shoulder (bevel up) will increase removal of debris when flushing.[39] This takes active attention since the common access is with the bevel pointed down.

Not only is medication administration important but also important is blood sampling for laboratory analysis. Blood sampling from CVCs is often a primary ICU nursing responsibility. It is important when drawing blood samples that the clinician achieves success the first time. Repeated sampling due to erroneous results or contaminated samples increases catheter manipulations. This exposes the intraluminal pathway with numerous blood episodes, which increases both the potential for habitat growth and microorganism anchoring. With CVCs, the syringe method is the MOST consistently successful method of blood specimen collection because the withdrawal pressure can be more easily controlled. Blood is aspirated into a syringe, which is then attached to a transfer device. The preset vacuum in each tube will withdraw the blood from the syringe. Tubes will fill with the correct volume. The vacuum pressure is exerted on the syringe and not on the soft catheter. It is important to note that less pressure is exerted during withdrawal (the opposite of flushing). For example, if using a 10 mL syringe and having difficulty withdrawing an adequate volume, switch to the next smaller syringe (5 mL) for increased success.[39] The order of which color tubes to draw (see Table 4) is crucial to preventing erroneous results due to additive crossover and/or dilution potential. For citrate tube draws (eg, coagulation tests) as the first or only tube the clinician draws, the clinician MUST get a discard tube (with no additives) to remove air and tissue fluid from the blood collection set. Otherwise, the process invalidates the blood-to-additive ratio.

Dressing management

Dressing management is dependent on securement. This is really evident when catheters are placed in the jugular veins. Considering the geriatric patient's skin quality, this site should be avoided. The subclavian location or a PICC may provide a more optimal site. The CDC recommends avoiding

Table 4. Order of Blood Draw Tubes for Common ICU Laboratory Tests[a]

Tube Top Color (Contents)	Uses
Yellow	Blood cultures
Light blue (buffered sodium citrate)	Coagulation studies like PT, PTT, fibrinogen, and D-dimer
Royal blue (EDTA)	Toxicology, metals, nutrition, antibody screen, copper, zinc, trace elements
Red or pink	Serology, blood bank, type and screen, crossmatch
Gold/Tiger top/SST (gel separator tube)	Chemistry panels, hepatitis
Bright green (sodium heparin)	AFP blood cultures, HLA-B27, chromosome studies
Light green (lithium heparin)	Troponin, metabolic panel, lipids, liver panel, ammonia (ice), HIV rapid antibody
Dark green (lithium)	Ionized calcium (not part of blood gas), ammonia (ice)
Lavender (EDTA)	Hematology, CBC, platelets, sedimentation rate, G6PD, HgbA1C, CD4
White (PPT gel)	Antibody screening, copper, zinc, trace elements
Gray (Na+ fluoride or K+ oxylate)	Glucose, lactate (lactic acid)

Abbreviations: AFB, acid-fast bacilli; CBC, complete blood count; CD4, cluster of differentiation 4; G6PD, glucose-6-phosphate dehydrogenase; Hgb AIC, hemoglobin AlC; HLA B27, human leukocyte antigen B27; ICU, intensive care unit; PT, prothrombin time; PTT, partial thromboplastin time; SST, serum separator tubes.
[a]As a general rule, after the tube is filled, invert each tube 5 to 8 times slowly, do not shake.

the use of the femoral vein for central venous access in adult patients as a category 1A recommendation—the strongest recommendation backed by clinical evidence.[1] If the femoral site must be used, then dressing management can be extremely difficult and will often require special attention and products.

Sterile technique must be maintained throughout the dressing change procedure. Meticulous attention to each step is very important. Exudate or dry blood should be thoroughly cleaned before using the antiseptic. If dried blood is present on the catheter, it can be removed with an alcohol wipe. The effect of CHG/isopropyl alcohol skin preparations is negated in the presence of blood. The disinfection activity of CHG requires a dry time. This may take 2 minutes or more. The skin is cleaned either in an up-and-down motion or across using friction. Fanning, blowing, or blotting the area decrease bacterial kill. The CDC strongly advises against routinely applying antimicrobial ointment to any insertion site because this practice can cause insertion site maceration and promote fungal growth.[1]

Assessing the skin is paramount to dressing selection. Catheter manipulation should be done very carefully during the cleaning process. Damage to the insertion site increases the habitat for bacterial anchoring. Using a skin protectant prior to dressing application is important. This protectant must be allowed to completely dry prior to dressing application. Apply to a wide enough area to include any window pane taping of the dressing. The moisture accumulation under different types of transparent dressings can vary greatly from patient to patient and brand to brand depending on its MVTR rating. Diaphoresis may be a common problem for ICU patients. A high MVTR dressing will enhance dressing adhesion.

Dressing removal is another important care phase. This can be time consuming, but skin damage can be disastrous to long-term CVC needs. Adhesive removal pads may be the

Table 5. Complete Nursing Assessment for CR-BSI in Geriatric ICU Patients Using the HATS Framework[8]

Patient	Product	Practice
Age ≥65 y	Evaluate research on CR-BSIs and products.	Effective handwashing
Immune function (WBC and Diff)	Does connector and Y-sites require alcohol cap to increase its effectiveness?	Use proven bundles[30,32,33] or research your own bundle
Renal function (BUN/creatinine)	How should invasive products (eg, urine catheters, and IVs) and add-ons (eg, short lines and connectors) be used (specific "how to" instructions) including research on time frames (eg, how long is product good for before it should be changed out?) and clinical use (eg, under what circumstances do you change out the product?)?	Catheter securement
INR	Are there any adverse event reports, warnings or recalls published?	Insertion site care
Cardiac output	Research shows increased colonization with the use of betadine alcoolique (PVP-IA) compared with CHG.[43]	Dressing change and management
Vascular and skin	Are policies, procedures, and education materials reviewed and/or updated related to CR-BSIs?	Swabbing the hub. Suppress regrowth of normal skin flora with a CHG gluconate dressing applied over CHG-prepped skin
Comorbid diseases		IV caps necessary?
Medications	Know if medications are acid or alkaline	Flushing, note the connector type used
Department where CVC was placed, ED or ICU?	Were CDC and manufacturer's instructions followed?	Ongoing skin and temperature assessment
Is CVC in groin/femoral area?	Were CDC and manufacturer's instructions followed?	Ongoing skin and temperature assessment
Confused, dementia, Alzheimer disease	Is product placed and anchored so patient is not able to pull it out easily?	Ongoing assessment for cognitive and behavioral changes from baseline
Coughing, vomiting, or ventilation support	Is insertion site secured and covered to decrease contact with sputum or vomit.	Ongoing assessment for suctioning, tracheostomy care, oral care, and need for cough suppressant.

Abbreviations: BUN, blood urea nitrogen; CHG, chlorhexidine gluconate; CR-BSIs, catheter-related bloodstream infections; CVC, central venous catheter; ED, emergency department; HATS, Healthcare and Technology Synergy; ICU, intensive care unit; INR, international normalized ratio; IV, intravenous; PVP-IA, alcohol-based povidone iodine or Betadine alcoolique (registered); WBC and Diff, white blood cell differential count (Diff).

best solution. Here, prevention is paramount. Apply CHG impregnated disks[40,41] or CHG gel dressing. This will maintain significantly lower counts than skin prepped with CHG-containing skin antiseptic alone, but remember micro-flora cannot be totally eradicated.[42] Suppression of regrowth of normal skin flora will be enhanced when a CHG dressing is applied over CHG-prepped skin.

CONCLUSIONS

Eliminating CR-BSIs is difficult and requires that attention be given to assessment of the patient, products, and practices (see Table 5). The geriatric patient in the ICU is extremely vulnerable to infection and requires diligent and individualized care. Often vascular access care is not seen as important as other practice activities. Yet, the patient's CVC is their lifeline. Bloodstream infection is a high risk. Meticulous care with no shortcuts does not alone ensure success, but without it, a poor outcome is almost certain. Products are central to vascular access care. Yet too often, a "one-size-fits-all" approach is used for all patients. Some products are not used due to expense or lack of ease to use. Nursing practice is the focus of poor outcomes, yet the wrong product may make the positive outcome impossible to achieve. We now know how a biofilm colony develops. By eliminating or minimizing habitat and microorganism migration, CR-BSIs can be eliminated. High-priority activities (see Table 3) must always be implemented meticulously. Stabilization and dressing management offer unique challenges in the geriatric population and require special critical thinking actions to achieve success. Today, practitioners must constantly read current research and become active in the research process to determine what products should and should not be used in their patients. Nurses know that change is part of the job and must be open to changing practice based on new discoveries, products, and research. Compliance with evidence-based prevention policies should be followed consistently. This should start with patient assessment and consent, followed by insertion, and then continuing on to include all phases of care and maintenance. A comprehensive approach to caring for the geriatric patient using up-to-date research findings is effective care that all patients deserve.

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