Chapter 4

PERIPHERAL INTRAVENOUS CATHETERIZATION PRACTICES AND A NEW APPROACH TO SKIN ANTISEPSIS: 5% $NAHCO_3$[1]

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INTRODUCTION

Intravenous therapies are one of the mainstays of modern healthcare and are one of the most popular approaches in nursing practices (O'Grady et al., 2017; Rai et al., 2019). In healthcare centers, peripheral intravenous catheters (PICs) are used for diagnosis and therapy (Özyazıcıoğlu & Arıkan 2007). PIC is commonly used in procedures such as patient hemodynamic monitoring and intravenous treatment (antibiotics, chemotherapy, administration of blood and blood products, fluid, or nutritional therapy) (Özyazıcıoğlu & Arıkan, 2007; Camacho-Ortiz & Roman-Mancha, 2016; Rai et al., 2019; Choudhury et al., 2019). PIC offers several advantages in these typical usage regions. The use of the catheter may encounter problems, much like any other interventional procedure, depending on the patient, treatment, or catheter-related factors (Aktaş & Giray, 2010; Camacho-Ortiz & Roman-Mancha, 2016; Indarwati et al., 2020). Catheter-related infections (CRIs) are likely the most significant of these problems. Local inflammation findings such as redness and temperature increase around the catheter are classified as CRIs, as are systemic findings such as fever and chills (Aygün et al., 2017). According to reports, the incidence of CRIs ranges from 0.2% to 0.5%, and this situation increases with decreasing age (Aygün, 2006; Ersöz, 2006; Newman, 2006; Turken et al., 2019). In a medical context, it was shown that, over a one-year pe-

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riod, 13.9% (n=201) of the patients had a catheter-related bloodstream infection, 6.4% had a catheter site infection, and 27.3% had colonization (Aktaş et al., 2014).

Children are not included in any of the numerous research studies on infections related to the use of PIC in adult patients (Serane & Kothendaraman, 2016). Children's CRIs require a particular discussion because they differ from adults in terms of body weight, current chronic disease, catheter characteristics, drug administration, and the presence of a connector in pediatric patients (Newman, 2006; Timsit et al., 2011).

Cleaning the site where the catheter will be inserted carefully and quickly with a safe antiseptic is the main procedure for preventing infections. An effective antiseptic solution is one that benefits the patient and the procedure in every aspect (Ersöz, 2016). In the literature, 70% Alcohol, 2% Chlorhexidine Gluconate (CHG), 1% Octenidine Dihydrochloride, and 10% Povidone Iodine are the antiseptic solutions most often used to clean the PIC insertion site (Eser Mete et al., 2009; Karpanen et al., 2016, Wu et al., 2017).

According to research on antiseptics, a 2% CHG solution is the most effective antiseptic (Karpanen et al., 2016). Inadequacies in research in infants and children, as well as concerns about CHG's strong binding to skin proteins and long-lasting (48-hour) antibacterial activity on the skin, have led to reports of concerns in recent years over its usage in children, especially newborns under 2 months (Aygün et al., 2017; Newman, 2006; O'Grady et al., 2017; Serane & Kothendaraman, 2016). Like how 70% of Alcohol dries out children's skin and causes skin problems, it has been reported that povidone-iodine skin absorption may cause a variety of problems, particularly thyroid functions, and skin problems (Kieran et al., 2018). In view of this information, the need for a child-safe antiseptic solution is emphasized (Şenol, 2015).

In the world and in our country, sodium bicarbonate ($NaHCO_3$) solutions are used in a wide range of conditions, including oral hygiene and dental care, with no adverse effects observed (Letscher-Bru et al., 2013). There is little information in the literature on it being used as a skin antiseptic, and what there is seems to be for adults only (Farha et al., 2018; Letscher-Bru et al., 2013; Wu et al., 2017). There is no information on its use in children as a skin antiseptic.

PERIPHERAL INTRAVENOUS CATHETER

When a patient needs medication or nutrition, a peripheral intravenous catheter is inserted directly into the peripheral vein to provide continuous IV Access

(McCallum & Higgins, 2012; Suliman et al., 2020). Successful intravenous catheterization is an important step in patient care and requires accurate technical knowledge (Avşar et al., 2013; Ersöz, 2016).

History of Peripheral Intravenous Catheter

In the fourteenth century, Pope Innocent VIII took blood from two healthy people at the Vatican, resulting in the first IV procedure recorded in history. The discovery of blood circulation happened in the seventeenth century. Two doctors then used a hollow feather to inject opium intravenously into a dog after that (Biçer, 2017; Cozantis & Makela, 2018; Erdoğan, 2014; Karpanen et al., 2016). In the late 1700s, the first venous cannula was developed. Following the successful implementation of the first animal-to-human blood transfusion in France, human-to-human blood transfusions were attempted to prevent deaths from postpartum hemorrhage. The first fluid infusion in recorded history was saline water given to a patient by Thomas Latta in 1832 (Biçer, 2017; Cozantis & Makela, 2008; Erdoğan 2014).

Peripheral Intravenous Catheter Types

IV applications for support and treatment are extremely complicated procedures used in healthcare centers. Nurses play a role in the successful maintenance of this complicated process for children. The characteristics of the patient, length of the treatment, type and size of the catheter, length, site of insertion, and potential complications should all be taken into consideration by the nurse when choosing the catheter (Cihan Erdoğan & Denat, 2016).

Since the first plastic catheter was used in 1945, it has played a significant role in patient care and is the material that is most frequently used when administering fluids and medications intravenously (Cozantis & Makela, 2008; Helm et al., 2015; Indarwati et al., 2020) The peripheral IV cannula is compensated by a steel or silicone-tipped needle, radiopaque lines for radiological detection, a port for extra dose distribution, and flexible detection wings. This cannula is in a sterile packet and is ready for use. The length, diameter, and application areas of peripheral cannulas that have been wrapped in plastic differ.

Peripheral Intravenous Catheter Indications

In the literature, there is no standard guideline regarding which PICs should be applied to which patients and in which situations. PICs are often used for temporary intravenous access (Brooks, 2016; McCallum & Higgins, 2012). The status and requirements of the patient should be taken into consideration while deciding where to implant the catheter. The list that follows includes the catheters' indications for use:

- Maintaining fluid and electrolyte balance
- IV drug therapy
- When a long-term IV line is desired to remain open
- For total parenteral nutrition in children who cannot be fed orally
- It is used in blood and blood product transfusions (Albayrak, 2012; Brooks, 2016; Camacho-Ortiz & Roman-Mancha, 2016; McCallum & Higgins, 2012).

Peripheral Intravenous Catheter Application

One of the most used invasive procedures is PIC insertion. The success of PIC is increased by the nurse's expertise in interventions and knowledge of vascular anatomy (Avşar et al, 2013). Catheter insertion shouldn't be done without the necessary training and theoretical knowledge (Özyazıcıoğlu & Arıkan, 2007). In accordance with the guidelines, the catheter should be inserted using appropriate materials (Yasuda et al., 2017).

Preparing for processing: Identity must be verified before placing the catheter, and patient consent must be obtained by describing the procedure to be performed. For the child, PIC insertion is a traumatic and stressful procedure. The process should be carried out by the nurse patiently and with the child's support. During the PIC insertion, newborns and toddlers may lie down on the treatment table while big children can sit. It is ensured that the parent is present for the children's comfort. Making sure the child behaves in a controlled way increases the procedure's chances of success (Özyazıcıoğlu & Arıkan, 2007). Before the procedure begins, the materials needed for PIC insertion should be prepared and kept readily available.

Selecting the catheterization site: Depending on the patient and the treatment, a different catheter and location are used (Brooks, 2016; Özyazıcıoğlu & Arıkan, 2007). According to where the catheter is inserted, infections and complications related to PICs increase or decrease (Albayrak, 2012). These should be taken into consideration while selecting the site, and care should be taken to choose an area that won't restrict the patient's comfort and mobility (Brooks, 2016; Choudhury et al., 2019). When choosing a vein, go from distal to proximal using examination and palpation techniques, and give preference to the veins in the hand and arm first (Choudhury et al., 2019; Cihan Erdoğan & Denat, 2016; McCallum & Higgins, 2012). For children of all ages, the hand veins are the ideal site (Özyazıcıoğlu & Arıkan, 2007). The vein for catheter insertion should be assessed for visibility, length, continuity, and use (Mee-Marquet, 2007; O'Grady et al., 2017).

Hand hygiene: The activity of hand washing was first recorded in literature in 1847. It is one of the various strategies created to protect against microorganisms (Cozantis & Makela, 2008). Hand hygiene can eliminate contamination and decrease hospitalization, mortality, and morbidity (McCallum & Higgins, 2012; Rundjan, 2011).

Skin antisepsis: Studies have shown that inadequate and inefficient skin antisepsis causes to the increase in CRI rates (Rundjan, 2011). As a result, before PIC, skin antisepsis and site preparation for catheter insertion are essential for avoiding CRIs. A variety of antiseptic agents are recommended for skin antisepsis. However, it is important to be aware of any side effects the recommended antiseptics may have on the patient, especially if they are used locally. Data on its usage are limited, especially for children, infants, and premature neonates. As a result, it should only be used with care (Elçi, 2016; Hastane enfeksiyonları Derneği, 2019; Rundjan, 2011).

Intravascular access and fixation: Beforehand, materials should be prepared in the intervention room (Özyazıcıoğlu & Arıkan, 2007). An appropriate antiseptic solution should be used to clean the site where the catheter will be inserted. After cleaning the area with a wet, sterile gauze in circular movements from the inside out, let it dry naturally Huang et al. (2011); Casey et al. (2017). It is recommended to use the number 22 and 24 children's catheters (Brooks (2016; Paioni et al., 2020). After the catheter has been correctly fixed using fixation tape, it is then inserted into the vein (McCallum & Higgins, 2012; O'Grady et al., 2017; Timsit et al., 2011; Zhang et al., 2016). The cannula insertion site should be kept dry and clean (Zhang et al, 2016). Transparent sterile tapes are a useful tool in the fight against CRIs (O'Grady et al., 2017; Zhang et. al, 2016). These tapes have the benefits of protecting the catheter, allowing visibility of the catheter site, and requiring less frequent replacement. (Brooks, 2016; O'Grady et al., 2017, Timsit et al., 2011; Zhang et al., 2016).

Medication Characteristics Used in Peripheral Intravenous Catheter Administration: Intravenous medications that are basic or acidic can damage the vein (O'Grady et al., 2017). As a result, the characteristics of the medication to be supplied as well as the method, rate, and infusion duration are evaluated. Venous damage can also be brought on by intermittent or continuous infusion. The catheter's characteristics, the vein's qualities, and the patient's characteristics should all be taken into consideration when determining the infusion rate. The right concentration should be used while administering the medications via the PIC.

Considering the irritant state, the drug is given not as a bolus or push but as an infusion and for a certain period (O'Grady et al., 2017; McCallum & Higgins, 2012).

The length of stay the Peripheral Intravenous Catheter: An important aspect in the development of infection is the length of the PIC stay. The infection rate increases with the length of stay (Newman, 2006; Rickard et al., 2012). In pediatric patients, the PIC should not be changed unless clinically necessary. It is, however, regularly monitored in terms of local and systemic infection findings (Infusion Nursing Society, 2016; O'Grady et al., 2017).

PERIPHERAL INTRAVENOUS CATHETER RELATED INFECTIONS

About 75% of hospital-acquired infections are CRIs (O'Grady et al., 2017). In PIC-related infections, microorganisms enter the body in two ways (extraluminal and intraluminal colonization) (Timsit et al., 2011).

Extraluminal colonization, which occurs when skin asepsis and catheter fixation bands are inadequate prior to the PIC insertion, is the introduction of microorganisms into the inner layers of the skin by adhering to the catheter from the outside (Timsit et al., 2011). Extraluminal biofilm forms if the catheter stay is less than 10 days (Centers for Disease Control and Prevention, 2020; Cozantis & Makela, 2008). Mistakes in the aseptic technique during the insertion and care of PIC catheters result in **intraluminal colonization** (washing, closure, fixation, etc.) (Helm et al., 2015; Martín-Rabadán et al., 2017; Timsit et al., 2011). An intraluminal biofilm forms if the catheter is left in place for more than 10 days (Cozantis & Makela, 2008; Rai et al., 2019; Serane & Kothendaraman, 2016; Zhang et al., 2016).

Colonization: Both extraluminal and intraluminal routes are used to form it. The patient's characteristics, the type of microorganism, and the characteristics of the catheter being used all play a role in this (Ersöz, 2016). The host reacts to the catheter like a foreign body, and thrombin forms around the catheter, forming a biofilm (Choudhury et al., 2019). The existence of biofilm, which not only adheres to surfaces but also ensures that it stays there, serves as a barrier that prevents infections and harmful substances from reaching the body deeper (Donlan, 2011; Timsit et al., 2011). The microorganism can enter the bloodstream and cause an infection if it gets through this biofilm (Cozantis & Makela, 2008; Serane & Kothendaraman, 2016). CRI is divided into systemic (blood circulation) and local (catheter entry site) infections (Biçer, 2017; Elçi, 2016; Ersöz, 2016; Helm et al., 2015; Huang et al., 2011; O'Grady et al., 2017; Rai et al., 2019; Yasuda et al., 2017).

Etiology and Epidemiology

It is difficult to determine the proportion of all catheter-related infections. The use of IV catheters is related to most bloodstream infections in both adults and children (Newman, 2006; O'Grady et al., 2017). In studies conducted with children, it has been reported that the rates of complications related to PIC range from 35%–56% (Ben Abdelaziz et al., 2017; Unbeck et al., 2015; Vinograd et al., 2017). Most of the responsible factors are caused by the skin flora, and the main factors are gram-positive and gram-negative bacteria (Centers for Disease Control and Prevention, 2020). CRIs are caused by catheter point colonization in treatments lasting more than 10 days and skin contamination in treatments lasting less than 10 days. According to studies, catheter point colonization causes 30% of CRI and skin contamination causes 65% (Elçi, 2016). Although the incidence of catheter-related infections is low, they have the potential to be life-threatening and preventable. Therefore, it is important not only to identify and treat PIC and CRI but also to prevent them.

Clinical and Microbiology

The majority of CIE in children is caused by coagulase-negative staphylococci, just like in adults (Zhang et al., 2016). Infection is characterized by an increase in microorganisms throughout the catheter (Huang et al., 2011; O'Grady et al., 2017; Zhang et al., 2016). Thirty percent of catheter infections are caused by *Staphylococcus epidermidis.* This bacteria forms a biofilm around the catheter to protect it from antibodies and antibiotic treatment (Cozantis & Makela, 2008). Therefore, removing the catheter is the first step in treating catheter infections (O'Grady et al., 2017).

Diagnosis

Evaluation of clinical findings (local and systemic) and microbiological studies are important in diagnosis (Ersöz, 2016). The patient should be observed for signs of CRI systemically and locally. Vital signs should be measured at regular intervals. However, microbiological techniques are used to make the final diagnosis. A swab culture obtained from the catheter insertion site is analyzed in microbiological diagnostics (Ersöz, 2016). In addition, venous blood analysis is also performed (Elçi, 2016; Helm et al., 2015; Zhang et al., 2016). In the presence or suspicion of a systemic infection, blood is cultured, and the catheter is withdrawn (Huang et al., 2011; Ersöz, 2016). The catheter is removed if there are any signs of local infection (swelling, redness, elevation of fever, and discomfort). If there is purulent discharge, a sample of the discharge is taken for culture and analysis (O'Grady et al., 2017).

Risk Factors and Complications

Although peripheral catheters are one of the most important tools in medicine, they are also an important cause of morbidity and mortality due to complications (Indarwati et al., 2020; Rai et al., 2019). Many factors related to the patient, catheter, and team play a role in the development of PIC-related complications (McCallum & Higgins, 2012). These complications can drastically damage a patient's health and quality of life. It can also increase healthcare costs due to long-term treatment and hospitalization (McCallum & Higgins, 2012; Sarı et al., 2016).

Treatment

The treatment varies according to the type of infection (local or systemic), the type of microorganism, the catheter, and the condition of the host (immune status, underlying disease, etc.) (Öztürk, 2000). In patients with CRI who have a short-term catheter, the catheter and infusion set are changed, and cultures are collected from the catheter. If antibiotics are to be used based on the results of the culture, they should be targeted against the pathogen; routine antibiotic therapy should not be applied (Ersöz, 2016; O'Grady et al., 2017; Öztürk, 2000). When the catheter is the source of local infection, removing the catheter is all that is required (O'Grady et al., 2017). In cases of high fever, antipyretics are also included in the therapy. The patient is observed for infection parameters, and vital signs are measured and recorded at regular intervals.

Nursing Approach

Precautions taken when the catheter is inserted and at the site can significantly lower CRI (Ersöz et al., 2016). These risk factors determine which preventative strategies should be used.

Education: The primary healthcare professional in charge of managing and inserting PICs is the nurse. The management, insertion, and follow-up of PIC are all issues that should be included in nursing education (Özyazıcıoğlu & Arıkan, 2007; Miles et al., 2015). Today, theoretical PIC management knowledge is given to students as part of their undergraduate nursing education, and this knowledge is supported by laboratory and clinical practices (Sarı et al., 2016). Their knowledge should be maintained and updated with in-hospital training after graduation (Elkhunovich et al., 2017; O'Grady et al., 2017; Zhang et al., 2016).

Peripheral Intravenous Catheterization Teams: Since PIC management is important to the development and prevention of CRI, the establishment of “PIC teams” in hospitals is an appropriate strategy (Hartman et al., 2020). In the literature, it is claimed that the concept of PIC teams decreases the growth of CRIs in hospitals (Zhang et al., 2016). It is well known that the PIC teams’ experience and knowledge are the reasons for this (O’Grady et al., 2017). According to studies, using PIC teams and supportive techniques (such as imaging, palpation, infrared light, ultrasound, and translumination during the procedure) increases PIC management success to 84.3% from 59.4% Elkhunovich et al., 2017, Hartman et al., 2020). The establishment of these teams is predicted to decrease costs, CRI incidence, and complications (Ersöz, 2016; Paioni et al., 2020).

Number of attempts: Health professionals shouldn’t attempt the PIC procedure more than twice. A different health professional should assess the patient’s veins after two unsuccessful attempts. (Cihan Erdoğan & Denat, 2016; Centers for Disease Control and Prevention, 2020; O’Grady et al., 2017).

Bundles for PIC insertion and CRI prevention: To prevent CRI, it is recommended to use catheterization bundles containing standardized maximum barriers and asepsis measures in the management of the catheterization process. (Deshpande et al., 2016; Hartman et al., 2020, O’Grady et al., 2017; Timsit et al., 2011). In these packages for the prevention of infections, five basic rules are reported: hand washing, personnel training, skin antisepsis, provision of barrier methods, daily evaluation of the catheters, and removal of the catheter when no longer needed (Aygün et al., 2017; Centers for Disease Control and Prevention, 2020; O’Grady et al., 2017). The PIC installation place should be in a well-lit, comfortably cooled room with enough noise and personal privacy. Catheters, tourniquets, stabilizers, gloves, a box for medical waste, sterile distilled water, an injector, sterile gauze, a connector, and a tray are among the items that must be used (O’Grady et al., 2017, Özyazıcıoğlu & Arıkan, 2007; Timsit et al., 2011). To prevent any potential problems from occurring later, the steps of the PIC procedure should be included in these bundles, along with any necessary instructions (Boyd et al., 2011; Newman, 2006).

Care and monitoring: The patient with a PIC should be evaluated every 6 to 8 hours for signs and symptoms of local and systemic infection (McCallum & Higgins, 2012; O’Grady et al., 2017; Timsit et al., 2011). The dressing is changed if it is dirty and wet (Ersöz, 2016). The catheter sites are routinely checked by observation or palpation, depending on the clinical state of the patient (Simsek, 2020; Cihan Erdoğan & Denat, 2016). The dressing is removed, and the catheter entry site is observed so that the site may be thoroughly checked if there is pain at the PIC site, a temperature increase, or other symptoms of local or systemic infection (Centers for Disease Control and Prevention, 2020; O'Grady et al., 2017).

Patient education: Nurses should inform patients and their families about PIC and possible complications and should encourage them to promptly report the presence of such conditions. (Centers for Disease Control and Prevention, 2020; O'Grady et al., 2017).

Length of the stay: The PIC is kept in place until the procedure has been completed, unless there is a complication, such as phlebitis in pediatric patients. The catheter dressing is changed if it becomes contaminated (Özyazıcıoğlu & Arıkan, 2007; Centers for Disease Control and Prevention, 2020; O'Grady et al., 2017).

Insertion site: A major risk factor for CRI is the density of the skin flora at the site of catheter insertion (O'Grady et al., 2017). When selecting a cannula site for a child, the scalp, hand, and foot veins are preferred over the leg, arm, and antecubital regions (Cihan Erdoğan & Denat, 2016; Centers for Disease Control and Prevention, 2020; O'Grady et al., 2017).

Material type selection: Permanent or polyurethane, single-lumen catheters, which cause fewer complications, should be preferred in material selection for PICs to be inserted into patients (Cihan Erdoğan & Denat, 2016; Gorski, 2017). Unnecessary capping of catheter systems should be avoided. Entry into the closed system due to procedures such as venous blood collection is kept to a minimum (Cihan Erdoğan & Denat, 2016; O'Grady et al., 2017).

Hand Hygiene and Aseptic Technique: Catheter-related infections can be prevented with hand hygiene, the use of antiseptic techniques, and adequate skin preparation (Paioni et al., 2020; Palece et al., 2013; Centers for Disease Control and Prevention, 2020). Most of the factors responsible for CRIs originate from the skin flora, and adherence to asepsis and antisepsis (hands, skin, materials, etc.) is important (Gorski, 2017; O'Grady et al., 2017; Zhang et al., 2016; Wu et al., 2017).

Using sterile gloves is not always necessary for an aseptic technique. For PIC, a "non-touch" method and disposable, clean gloves are sufficient to prevent CRI (Choudhury et al., 2019; O'Grady et al., 2017; Zhang et al., 2016). Prior to the PIC, the insertion site should be disinfected with a strong antiseptic solution (Rickard et al., 2012). Clean or sterile gloves should be worn when dressing intravascular catheters (O'Grady et al., 2017; Zhang et al., 2016).

SKIN FLORA

The largest organ in the human body, the skin, functions as the body's primary barrier of protection (Zhang et al., 2016). Normal human skin contains aerobic microorganisms at different rates depending on the region. About 80% of the permanent and temporary microorganisms on the skin live in the first 5 layers of the skin's stratum corneum. The epidermal and dermal layers, hair follicles, and sebaceous glands contain the remaining 20% (O'Grady et al., 2017).

In addition to typical and non-pathogenic microorganisms, the skin is the primary source of microorganisms that cause infections in the bloodstream. Normal skin flora acts as protection for the body by preventing the entry of pathogenic microorganisms into the body (Wu et al., 2017). Additionally, it's important for the short-term colonization and infection of catheters (Zhang et al., 2016). Skin flora can be either persistent or temporary.

Persistent flora: Most of the microorganisms that make up the persistent flora, also known as the permanent flora, are found in the top layers of the skin (Albay, 2005; Ding et al., 2014). After mechanical hand washing with soap and water, the bacterial community does not decrease. Surgical handwashing is required. The microorganisms found in this flora are *coagulase-negative staphylococci*, *Micrococcus spp*., *Propioni bacterium spp*., and *Coryne bacterium spp*. and are not pathogenic (Albay, 2005; Wu et al., 2017).

Temporary Flora: Microorganisms on the skin, are transmitted from the patient's body fluids and secretions and contaminated tools and equipment (Ding et al., 2014). They settle in the superficial part of the skin, where they cannot live and reproduce for a long time. However, because they are spread from patient to patient, they are an issue in terms of infection. *Pseudomonas*, *methicillin-resistant Staphylococci*, and *coliform bacteria* from the *Enterobacteriaceae* family are the most frequent pathogens of this flora (Wu et al., 2017).

ASEPSIS AND ANTISEPSIS

Sterilization is called asepsis, while applying an antimicrobial agent to a patient's skin is known as antisepsis (Centers for Disease Control and Prevention, 2020; Ersöz, 2016). The most important step in avoiding cannula infections is antisepsis of the cannula site (Boyce, 2019). Most pathogens that cause cannula infections are the result of insufficient antisepsis (Albayrak, 2012). The skin should be cleansed with an antibacterial solution before the procedure to avoid these problems

(Infusion Nursing Society, 2016; O'Grady et al., 2017; Centers for Disease Control and Prevention, 2020).

The three antiseptics that are most frequently used to sterilize peripheral venous catheter insertion sites are 10% Povidone Iodine, 2% CHG, and 70% Alcohol (Cihan Erdoğan & Denat, 2016; Ersöz, 2016; Karpanen et al., 2016; O'Grady et al., 2017). Recent studies on 1% Octenidine Dihydrochloride solution have also increased the findings showing a decrease in bloodstream infections, so it has been added to the usage (Dettenkofer et al., 2009; O'Grady et al., 2017).

For skin cleansing, the most suitable and efficient skin antiseptic should be used. It should also be applied to clean skin, as antiseptic agents can be inactivated in the presence of organic matter. As a result, before beginning antisepsis, the insertion site should be carefully washed with soap and water and dried (O'Grady et al., 2017). The cannula insertion site is then cleaned with an antiseptic solution, and the site is allowed to dry (Centers for Disease Control and Prevention, 2020; O'Grady et al., 2017; Zhang et al., 2016).

ANTISEPTICS

Antiseptics are germicides used on skin and live tissue (Ersöz et al., 2016). Since they might harm the skin and other tissues, disinfectants are often only used on artificial objects and are not used in skin antisepsis (McGrath & McCrory, 2005). An antiseptic is a chemical that prevents bacteria from proliferating and growing. Bacteriostatic or bactericidal effects are possible. When performing oral hygiene before invasive treatments (such as injections or surgery) and for cleansing the skin and wound area after wounds, these solutions are used (Ersöz, 2016; Palece & Cescon, 2013). Depending on the type of microorganism, antiseptics have different durations of action (Avcı, 2015; Donlan, 2011; Kieran et al., 2018).

Antiseptics' use and number have increased dramatically in recent years. Antiseptics provide an effective barrier for infection prevention and decrease the incidence of nosocomial infections when used correctly (Karpanen et al., 2016; O'Grady et al., 2017; Zhang et al., 2016; Yasuda et al., 2017).

An ideal antiseptic solution should have fast and lasting effects, be non-irritating or only mildly irritating, not be toxic or cause allergies, not damage immune function, not lose strength in the presence of organic substances, and be economical and simple to use (Şenol, 2015; Ersöz et al., 2016; O'Grady et al., 2017). For this, there are antiseptics such as alcohols, chlorhexidine, iodine compounds, and octenidine dihydrochloride, in addition to soaps with additional softener and moisturizer (O'Grady et al., 2017). The most used ones among these are 70% Alcohol, 2% CHG, 10% Povidone Iodine, 1% Octenidine Dydrochloride, and 5% Sodium Bicarbonate ($NaHCO_3$), which have been used recently (Centers for Disease Control and Prevention; Cihan Erdoğan & Denat, 2016; O'Grady et al., 2017) (Figure 1).

70% Alcohol

Alcohol, which has been used in different fields since the dawn of history, was used in the scientific field at the end of the nineteenth century (Albay, 2005, Ersöz, 2016). The first and most popular antiseptics for the skin are those based on alcohol. The most popular chemical compound among them as a colorless, combustible, and distinctive-smelling substance is 70% alcohol (Ersöz, 2016, Wu et al., 2017). Alcohol has an excellent antibacterial effect (Avcı, 2015). It is effective against gram-positive and gram-negative bacteria, tuberculosis bacillus, many fungi, and viruses, but it is not sporicidal (Chiari et al., 2014; Wu et al., 2017). Alcohols are suggested for disinfecting surfaces but not for sterilization because of their non-sporicidal activity. Because of its volatility and speedy disinfection time, it is often used in skin antisepsis (Mee-Marguet, 2007, Wu et al., 2017). Alcohol does not penetrate organic matter well, so it should only be used to superficially clean skin. If used on patients with open wounds or skin problems, it may irritate and pain them (Wu et al., 2017).

Bacterial mortality is its primary mechanism of activity (Albay, 2005; Biasucci et al., 2018). Cells dissolve under its influence, and metabolism is disturbed (Albay, 2005; O'Grady et al., 2017). When combined with water, alcohol concentrations between 60% and 95% provide the most antibacterial effects. Because proteins cannot easily be denatured without water, concentrations below 30% have minimal impact (Ersöz, 2016).

2% Chlorhexidine Gluconate

The most common biocide and antiseptic is CHG, which is insoluble in water and has a colorless, odorless solution (Boyce, 2019; Ersöz, 2016). Because of its limited systemic absorption, it provides long-lasting antibacterial effects. It adheres to the bacterial cell walls and destroys them. Low doses cause damage to the cytoplasm, whereas higher concentrations cause the microorganism to perish by crossing the cytoplasm and entering the cell nucleus (Boyce, 2019).

While CHG is more effective against gram-positive bacteria in low concentrations, like 2%, it is also used as a bactericidal agent for most bacteria, including gram-negative bacteria, in long-term or high concentrations (Camacho-Ortiz & Roman-Mancha, 2016; Dalgleish et al., 2015; Ersöz, 2016). CHG has a minor effect on bacteria that are resistant to heat or acid (Simsek, 2020).

In the late 1940s, CHG, a powerful base, was produced in research laboratories for use as an antiseptic cream. Since 1957, it has been used for both general disinfection and the treatment of infections (skin, eye, mouth, and throat) (Adıgüzel, 2015; Berry, 2013; Lim & Kam, 2008). Additionally, it is used in the sterilization of catheters, bladder irrigation, topical antiseptic creams, mouthwashes, dental gels, and medical wound products (bandages, powder, spray, cream, etc.) (Boyce, 2019; Cabrera-Jaime et al., 2018; Karpanen et al., 2016). Due to its broad spectrum of effects and low irritation ratio, national and international guidelines recommend skin sterilization with CHG prior to intravenous catheterization (Camacho-Ortiz & Roman-Mancha, 2016; Cihan Erdoğan & Denat, 2016; Elçi, 2016; Karpanen et al., 2016; Lim & Kam, 2008; O'Grady et al., 2017; McGrath & McCrory, 2005).

Five to six hours after application, its effects are still there (Albayrak, 2015; Ersöz, 2016). Despite being a secure method, CHG has adverse effects (contact dermatitis, local skin reactions, drug rash, urticaria, photosensitivity, anaphylactic reactions, and shock) (Huang et al., 2011). Localized skin reactions are based on the dermis and epidermis' incompatibility and immaturity (Adıgüzel, 2015; Choudhury et al., 2019; Lim & Kam, 2008).

Alcohol-prepared CHG solutions have a stronger effect than iodinated compounds (Centers for Disease Control and Prevention, 2020; Zhang et al., 2016). It is also not recommended for use in children under the age of two due to a lack of understanding about its mechanism of action (Jacob & Gaynes, 2019; O'Grady et al., 2017). CHG solutions should not be closed with cork-like materials and should be kept in opaque, dark-colored bottles Aktaş & Giray, 2010; Ersöz, 2016). The mouth is stored in dry, cool environments, with the mouth securely closed to prevent moisture damage (Simsek, 2020; Adıgüzel, 2015; Aktaş & Giray, 2010).

10% Povidone Iodine

Over 150 years ago, iodine was first used to heal wounds and prevent infections (Simsek, 2020; (Albay, 2005; Avcı, 2015; O'Grady et al., 2017). A broad-spectrum disinfectant with a microbicide and bactericidal activity is 10% Povidone-iodine solution (gram-negative and gram-positive bacteria, some spore-forming bacteria, mycobacteria, molds, yeasts, viruses, and fungi) (Ersöz, 2016; Eser Mete et al., 2009). It is brown and gives the skin color (Albayrak, 2012; Eser Mete et al., 2009). Iodine is more accessible and has a longer-lasting effect when used in the form of an iodophor solution, which combines iodine with a carrier molecule (Lim & Kam, 2008). Its effect starts with the wound forming a film layer. Then it lasts for a long period, like 3–4 hours, due to the microbicide effect of the iodine released from the film layer (Simsek, 2020). Iodine molecules damage cell walls and kill pathogenic microorganisms during this period (Ersöz, 2016). Povidone iodine eliminates spores in 15 minutes and all bacteria in one minute (Albayrak, 2012).

Nurses differ regarding the realization of drying after application in their daily practice. These are ventilation, drying using gauze, and blowing, which is not recommended due to the increased risk of infection (Albayrak, 2012; Palece & Cescon, 2013; Wu et al., 2017). Despite being used for a long time, iodine solutions have drawbacks that include thyroid dysfunction, irritation, excessive staining, contact dermatitis, and burns (Ersöz, 2016, Eser Mete et al., 2009; McGrath & McCrory, 2005).

1% Octenidine Dihydrochloride

Most gram-positive and gram-negative bacteria are resistant to Octenidine, also known as bispiridinamine Octenidine Dihydrochloride, an antibacterial agent (Albay, 2005; Ersöz, 2016). It has excellent bactericidal, fungicidal, and moderate virucidal activity at low concentrations (0.1%) (Simsek, 2020; Ersöz, 2016). Due to its low absorption via the skin and mucous membranes, it does not cause systemic toxicity (Dettenkofer et al., 2009).

It is known that skin maturation lasts from birth through infancy. At this age, an antiseptic that has components that won't cause systemic toxicity is needed (Şenol, 2015). According to studies, aqueous solutions containing octenidine and phenoxyethanol can be used safely for skin disinfection in children and even preterm newborns (Dettenkofer et al., 2009; Simsek, 2020; Ersöz, 2016). Following skin antisepsis with octenidine and alcohol and after catheterization for 387 adult patients, CRI rates were evaluated. In the study, it was shown that the alcohol group (8.3%) showed higher growth than the octenidine group (4.1%; $p=0.081$) (Dettenkofer et al., 2009). Similar findings were made in different research, and it is said that comparative studies with CHG are required because it is an effective antiseptic when compared to alcohol (Timsit et al., 2011).

5% Distilled water with Sodium Bicarbonate

Sodium bicarbonate is an acidic substance that can be neutralized with a strong base or a weak acid (Simsek, 2020). According to studies, the alkaline property of 5% $NaHCO_3$ makes it an efficient solution for use as a skin and surface disinfectant (Ding et al., 2014, Farha et al., 2018; Letscher-Bru et al., 2013; Wu et al., 2017). By controlling microbial adhesion, it prevents the growth of aciduric bacteria (Sousa ce ark, 2009). Additionally, sodium bicarbonate has the power to remove greasy skin secretions during routine skin cleansing (Ding et al., 2014; Farha et al., 2018; Wu et al., 2017).

Although sodium bicarbonate has a variety of uses in research, medicine, and other fields, there aren't many scientific materials available to support this usage (Letscher-Bru et al., 2013). Compared to 2% CHG, a 5% $NaHCO_3$ solution in distilled water is more inexpensive. It is non-volatile and non-flammable, unlike 70% alcohol (Karpanen et al., 2016). It is non-toxic to children and newborn infants and has a lower risk of being activated by blood or serum proteins than 10% povidone-iodine. Additionally, antiseptic contamination has never been related to distilled water with 5% $NaHCO_3$ (Ding et al., 2014; Wu et al., 2014). Only one study examined its use in children (Simsek, 2020), despite research showing the use of a 5% $NaHCO_3$ distilled water solution in adults before PIC insertion (Ding et al., 2014, Farha et al., 2018; Wu et al., 2017). In this 62-child study, skin antisepsis was provided with sodium bicarbonate, alcohol, and CHG solutions before PIC insertion, and their comparative efficacy was evaluated. The study's results suggested that $NaHCO_3$ is an effective skin antiseptic (Simsek, 2020). Given the efficacy of bicarbonate in treating skin conditions and oral hygiene in children, there is no risk in addressing the insertion site with intravascular catheters (Berry, 2013; Cabrera-Jamie et al., 2018; Ding et al., 2014, Farha et al., 2018, Letscher-Bru et al., 2013). However, more studies are needed to determine its true effects.

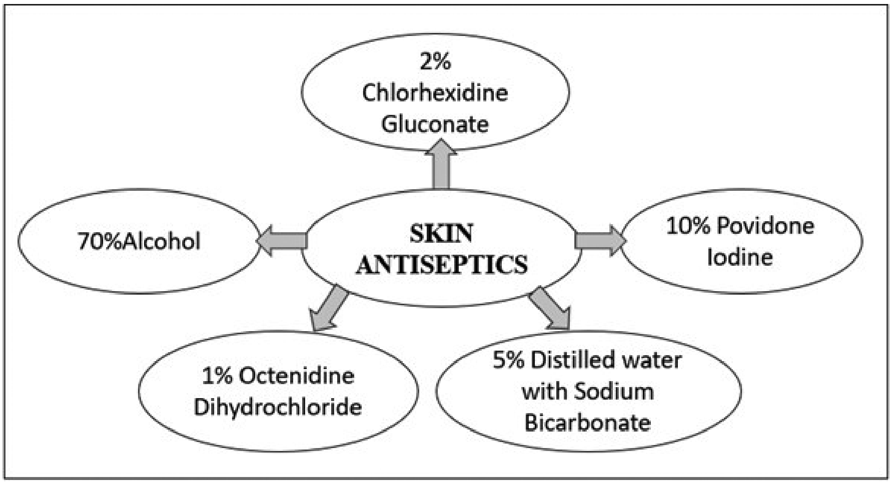

Figure 1. Commonly used skin antiseptics

CONCLUSION

One of the most common nursing interventions today is IV therapy. IV therapy is mostly the responsibility of nurses in the healthcare profession. Intravenous treatment is delivered via PICs. These CRIs impact the healing process and prolong hospital stays. The guidelines for PICs give advice on CRI prevention, and these recommendations should be taken into consideration up to the removal of the PIC. These suggestions include cleansing the skin with an appropriate and effective antiseptic. Even though many skin antiseptics are recommended in the literature, there are only a few common uses.

The search for suitable skin antiseptics for children continues. Recently, it has been reported that 5% $NaHCO_3$ distilled water antiseptic has been used. For improved PIC management, nurses should use the most appropriate antiseptic agent according to the guidelines. It is recommended that they conduct more evidence-based research in keeping with the literature on this condition.

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