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IMPROVING STUDENTS' KNOWLEDGE ON SURGICAL SKIN PREPARATION AND DISINFECTION TO PREVENT SURGICAL SITE IN-FECTIONS

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Abstract

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Abstract

Surgical site infection is the contamination of the wound that is acquired through a surgical procedure. Surgical Skin Disinfection is crucial when speaking of surgically acquired infection prevention, therefore it is essential for the students to be able to learn how it is done step-by-step.

The purpose of the literature review was to research the principles of Surgical Skin Disinfection methods, compare them, and find the most effective procedure patterns, when it comes to the prevention and control of Surgical Site Infections. The thesis work was commissioned by Savonia university of applied science teachers of perioperative course. The findings can be used by nursing students studying in the perioperative nursing course.

Databases such as PubMed and Cinahl Ultimate were assessed, and 600 articles were found. After filtering and excluding articles that are irrelevant to our research question, 12 articles have been chosen for review that complied with the criteria. According to the analysis of the literature, was retrieved from the selected articles, four findings that answer the research question were identified: Clipping instead of shaving should be used when removing hair from the incision site, preoperative showers could reduce risk of Surgical Site Infection, chlorhexidine-alcohol as the antiseptic is the most effective, antiseptic should be allowed to dry for it be effective against microorganisms on the skin.

The nursing students who are studying on the Perioperative nursing course can benefit from the research by broadening their knowledge on the topic of Surgical Skin Disinfection and using this knowledge during the exams and nursing practice skills test. Furthermore, by expanding their knowledge and revising the topic through our research, students can reduce the risk of inducing SSI in the surgical environment during the internship and future work.

Keywords

Surgical, Skin, Disinfection, Infection, Prevention, Control

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1 INTRODUCTION

Surgical site infection is the contamination of the wound that is acquired through a surgical procedure. Surgical site infection is the third most common infection that is obtained from a hospital environment, which increases the risk of post-surgical mortality, as well as increases hospital expenses (Pryme 2019). Following the modern operating room guidelines, in order to prevent surgical site infections, a disinfection of the site prior to the procedure is to be implemented. The skin flora is the most common cause of surgically acquired infections, due to it containing pathogenic microorganisms (Jolivet 2019). Therefore, it is essential that Surgical Skin Disinfection is conducted in accordance with the principles and none of the procedure's steps are missed.

Surgical skin disinfection is a critical component of preventing Surgical Site Infections (SSIs), which can lead to significant morbidity and mortality, increase cost of care and patients' length of stay in the hospital. The types of surgical site disinfection used can vary across different countries and even between different surgical specialties. The two most used disinfectants are based chlorhexidine and iodine. These disinfectants are used for hand hygiene, surface disinfection, and preoperative skin preparation. (Pryme 2019.)

Being able to disinfect the site prior to the surgical procedure is one of the key points of working as a circulating nurse in the operating room. The knowledge will be useful during nursing studies, internships, and in future career life. Surgical Skin Disinfection is crucial when speaking of surgically acquired infection prevention, therefore it is essential for the students to be able to learn how it is done step-by-step. We have come to the decision to compare different methods and approaches used in Surgical Site Disinfection and find the steps that are scientifically proven to be more effective in reducing Surgical Site Infections.

While we were preparing for the perioperative nursing skills test during the perioperative nursing course in Savonia UAS, we faced difficulties in finding the direct steps for implementing Surgical Skin Disinfection. We failed to find enough step-by-step material for the procedure, which would have significantly improved our understanding of how it is done and therefore would be sufficient during our independent revision. The material that we could find, aside from those provided by our teachers, lacked a few detailed instructions, or did not follow the new principles of perioperative nursing. Overall, the primary problem that emerged out of this situation is that it was challenging to find a guide with a clear explanation of how Surgical Skin Disinfection is done and it resulted in us doubting the sufficiency of our knowledge and skills needed for the exam.

The aim of our literature review is to research the principles of Surgical Skin Disinfection methods, compare them, and find the most effective procedure patterns, when it comes to prevention of Surgical Site Infections. Our findings can be used by nursing students studying on the perioperative nursing course. The thesis work was commissioned by Savonia university of applied science teachers of perioperative course.

2 THE CONCEPT OF STERILE AND CLEAN

2.1 Sterile surgical environment

Sterile refers to an environment, object, or substance that is free from living microorganisms, including bacteria, viruses, and fungi, or incapable of reproducing. This can be achieved through various methods of sterilization, such as heat, radiation, chemical treatment, or filtration. (Rutala 2008.)

Sterilization involves the destruction of all microorganisms in fluid or on surfaces in order to halt disease spread and may involve inadequately sterilized critical items posing risks of pathogen transmission. However, documented cases showing pathogen transference through such items are uncommon due to the large margins of safety found with sterilization procedures used by healthcare facilities. This probability is determined by how likely each item will become sterile (Rutala 2008).

Medical and surgical equipment used in healthcare typically consists of heat-resistant materials like metal, which is then sterilized using heat (usually steam). Since 1950, however, an increase has occurred in medical instruments made from materials like plastic that require low-temperature sterilization to function as intended. Ethylene dioxide gas has long been employed as a sterilizing method. Several low-temperature systems, such as hydroperoxide plasmas, peracetic, and ozone immersions that use heat sterilization processes, have recently come to use. (Rutala 2008.)

2.2 Cleaning in the surgical environment

Cleaning refers to the process of removing dirt, dust, stains, and other unwanted substances from surfaces or objects, often using water and cleaning agents such as soap, detergent, or bleach. The goal of cleaning is to create a hygienic and visually appealing environment, as well as to prevent the spread of germs and infectious diseases. (Rutala 2008.)

Cleaning involves the process of eliminating soil, organic material, or bioburden from an item using various means such as water, detergents, or enzymes. Prior to high-level sterilization and disinfection of instruments, it is vitally important that they have been adequately cleansed as organic substances on surfaces interfere with these processes. Any soiled substance left dry on instruments makes removal harder while disinfection or sterilization will also become less or ineffective. If this happens surgical tools should also be presoaked, rinsed, or softened prior to sterilization. (Rutala 2008.)

3 SURGICAL SKIN DISINFECTION

3.1 Different types of disinfection

"Disinfection" refers to any method for eliminating pathogenic microorganisms from objects other than living beings (excluding bacteria spores). Healthcare environments tend to use liquid chemicals or wet pasteurization processes in disinfection whereas various factors could reduce or negate their efficacy. (Rutala 2008.) Beyond prior cleaning and the presence of microorganisms, elements that influence efficacy include physical characteristics of lumens and hinges as well as biofilm formation; pH, temperature, and humidity in disinfection as well as relative humidity control measures (using ethylene dioxide for example). (Rutala 2008.)

Disinfection differs from sterilization or sporicidal treatments in that it does not eliminate bacteria spores completely, although certain disinfectants have proven successful at killing some strains if exposed for extended periods (between 3-12 hours), known as chemical sterilants. With similar concentrations used over shorter exposure times (20 minutes for glutaraldehyde 2% for instance), all bacteria except large numbers are killed, such products are called high-level disinfectants. (Rutala 2008.)

Low-level disinfectants have the capability of killing most vegetative bacteria, some fungi, and viruses within a short period (= 10 minutes), whereas intermediate-level disinfectants have greater effectiveness against mycobacteria as well as vegetative bacteria; they kill most viruses and fungi but may fail to eliminate spores completely; individual germicides vary considerably in both their antimicrobial properties as well as speed of effectiveness. (Rutala 2008.)

3.2 General Types of disinfectants for surgical skin preparation

Antiseptics contain various chemical components. When it comes to disinfectants, many of the same ingredients used are usually present (with slight variance in amounts used); however, due to their aggressive nature disinfectants are generally inadvisable when used on mammalian skin (Sandle 2016). A summary of the different types of disinfectants can be obtained from the Table 1 below. A more detailed description of the chemicals used in the SSD listed in Table 1 below have been explained herein. The primary types are:

Chlorine-based disinfectants: Chlorine-based disinfectants, such as sodium hypochlorite (bleach), are commonly used in healthcare settings and for water treatment due to their effectiveness against a wide range of microorganisms, including bacteria, viruses, and fungi (National Center for Biotechnology Information 2023). Quaternary ammonium compounds (QACs): QACs are commonly used as disinfectants for hard surfaces, medical equipment, and food surfaces due to their broad-spectrum effectiveness against bacteria, viruses, and fungi (National Pesticide Information Center 2023).

Alcohols: Ethanol and isopropyl alcohol are commonly used as disinfectants and antiseptics due to their broad-spectrum effectiveness against bacteria, viruses, and fungi. They are commonly used in healthcare settings for hand sanitizing. (National Center for Biotechnology Information 2023.)
Hydrogen peroxide: Hydrogen peroxide is an effective disinfectant against bacteria, viruses, and spores. It is commonly used in healthcare settings for surface disinfection and sterilization of medical equipment. (National Center for Biotechnology Information 2023.)

Phenolic disinfectants: Phenolic disinfectants, such as orthophenylphenol, are commonly used for surface disinfection in healthcare settings and public areas due to their broad-spectrum effectiveness against bacteria, viruses, and fungi (National Center for Biotechnology Information 2023.).
Peroxyacetic acid: Peroxyacetic acid is a strong oxidizing agent that is effective against bacteria, viruses, and spores. It is commonly used in the food industry for disinfecting equipment and surfaces. (National Center for Biotechnology Information 2023.)

Glutaraldehyde: Glutaraldehyde is a powerful disinfectant and sterilizing agent that is effective against bacteria, viruses, and spores. It is commonly used in healthcare settings for sterilizing medical equipment. (National Center for Biotechnology Information 2023.)
Chlorhexidine: Chlorhexidine is a broad-spectrum disinfectant that is effective against bacteria, viruses, and fungi. It is commonly used as an antiseptic and skin disinfectant in healthcare settings. (National Center for Biotechnology Information 2023.) It is important to note that different disinfectants may have different levels of effectiveness against different types of microorganisms, and it is important to follow the manufacturer's instructions for use and safety precautions (Sandle 2016).

Table 1 below illustrates that, although there are multiple forms of applicable skin disinfectants, chlorhexidine remains the first choice due to its prevalence across a wide variety of brands (Chlorhexidine-gluconate or Acetate at 2% weight-to-volume in 70 percent isopropyl alcohol. Digluconate variant is often utilized during wound care (Sandle 2016). Moreover, studies suggest that alcohol-based chlorhexidine is more effective than povidone iodine aqueous solutions during abdominal surgical procedures (Peristeri 2023).

TABLE 1. The common types of disinfectants (Sandle 2016).

Type	Example of disinfectants
Alcohol	Ethyl alcohol 70% concentration Isopropyl alcohol 70% concentration
Quaternary ammonium compounds	Benzalkonium chloride Cetrimide Methylbenzethonium chloride Benzethonium chloride Cetalkonium chloride Cetylpyridinium chloride Dofanium chloride Domiphen bromide
Chlorhexidine and other diguanides	Chlorhexidine gluconate Chlorhexidine acetate
Antibacterial dyes	Proflavine hemisulphate Triphenylmethane Brilliant green Crystal violet Gentian violet
Peroxides and permanganates	Hydrogen peroxide solution Potassium permanganate solution Benzoyl peroxide
Halogenated phenol derivatives	Chlorocresol Chloroxylenol Chlorophene Hexachlorophane/hexachlorphene Triclosan
Quinolone derivatives	Hydroxyquinoline sulphate Potassium hydroxyquinoline sulphate Chlorquinaldol Dequalinium chloride Di-iodohydroxyquinoline

3.3 Surgical site disinfectants used in Finland

Surgical disinfection is an important aspect of preventing surgical site infections (SSIs) in Finland. The use of disinfectants for skin preparation is regulated by the National Institute for Health and Welfare (THL). The guidelines and recommendations for healthcare professionals regarding the use of disinfectants for skin disinfection in Savonia UAS are based on the above-mentioned regulations as well. (Aura & Kinnunen 2022.)

Ethyl alcohol, i.e. ethanol, is used as a disinfectant in hospital environments only in denatured form (A12t). It is a commonly used disinfectant in Finland. It reliably destroys bacteria and viruses. Its effect on fungi, on the other hand, is unreliable. Ethanol penetrates poorly through dirt, so the surface to be disinfected must be clean. Ethanol evaporates from the surface of the skin quite quickly, so its use does not prolong the start of surgery. Surgical units in Finland generally use 70-80% A12t denatured ethanol. (National Center for Biotechnology Information 2023).

Chlorhexidine is an antiseptic that effectively kills bacteria and fungi, but its effect on viruses varies. The duration of action of chlorhexidine is longer than that of ethanol because it attaches to surfaces and tissues more strongly. For this reason, its drying time is also longer than that of ethanol. The effectiveness of chlorhexidine is weakened by, among other things, blood and moisture, so the surface to be disinfected must be dry and clean of blood before disinfection. (National Center for Biotechnology Information 2023).

Surgery units can also use a chlorhexidine-alcohol solution that contains denatured 80% alcohol (A12t) and chlorhexidine. It destroys harmful bacteria, yeasts, and most viruses in a span of 30 minutes, so it is suitable for disinfecting the surgical area due to its safety and rapid effectiveness. (Aura & Kinnunen 2022.)

In addition, chlorhexidine gluconate (20 mg/ml) and isopropyl alcohol (0.70 ml/ml) solutions can be used (Chlora-Prep). The solution is inside the stem in a container that is broken by squeezing the stem and applied through the sponge-like applicator. When the disinfectant has wetted the sponge completely, the disinfection of the surgical area is started. With a damp sponge, the nurse spreads the solution on the cut area by gently rubbing the area back and forth for 30 seconds. After this, the area is allowed to dry before attaching the surgical dressings. Spreaders come in different sizes, and if necessary, several can be used to thoroughly disinfect the surgical area. (Aura & Kinnunen 2022.)

In some cases, for disinfection of the surgical area povidone iodine can be used. It affects bacteria and several viruses but is weakly effective against fungi and spores. Povidone-iodine is used quite rarely in Finland these days. (Aura & Kinnunen 2022.)

3.4 Methods and Principles of Surgical Disinfection in Finland:

Skin hair does not need to be removed for surgery, but if there is too much of it in the surgical area, it can prevent the dressing from being attached or remaining inside the surgical wound when the wound is closed. Hair can be cut with scissors or an electric machine that uses a disposable blade. However, the hair should only be trimmed as close as possible to the time of surgery and the cut hair should be removed from the surgery area. The skin must not be damaged while shaving as skin cuts increase the risk of infection. (Aura & Kinnunen 2022.)

Any jewelry and piercings must be removed from the patient before entering the operating room to prevent infections. The substances used in the disinfection of the surgical area affect the most common protozoa, bacteria, and fungi. The purpose of disinfection is to remove or kill pathogenic, i.e. disease-causing microbes, or to weaken their ability to cause disease. Disinfectants destroy proteins, causing the permeability of the microbial walls to increase or the enzyme system to suffer. The effectiveness of disinfection is affected by the number of microbes in the surgical area, organic dirt, pH, humidity, temperature, and treatment time of the area. In a successful disinfection, the concentration of the disinfectant used must be sufficient so that it can directly affect the microbe, and its duration of action is long enough. The optimal concentration of the disinfectant is 60-90%. (Aura & Kinnunen 2022.)

Either colored or colorless disinfectant can be used to disinfect the surgical area. The benefit of the colored disinfectant is that the disinfected area stands out clearly. Color can be used to differentiate also disinfection times because an area that has been disinfected several times stands out darker. However, a colored disinfectant is not used during surgery it is important to monitor and evaluate the blood circulation in the surgical area and the color of the skin, for example in the limbs or extreme parts of the body. A colorless disinfectant could be used in surgeries on the face. It is also important to tell the patient about the use of a colored disinfectant, as the color remains on the skin for a few washings. (Aura & Kinnunen 2022)

Before disinfection of the surgical area, the condition of the patient's skin is checked. Any skin defects, ulcers, or other skin reactions must be reported to the operating surgeon. In addition, the place of the assumed surgical incision, which the surgeon has usually marked on the patient's skin in advance, is checked. The nurse starts the disinfection of the surgical area when the patient is anesthetized and the surgical position is prepared. Disinfection should also take into account the hypothermia of the patient: only those areas that are necessary for the operation are exposed, and any heating blankets and fans that may be used are placed on the patient before disinfection. It is recommended to heat the disinfectant in use to a temperature of 36 °C, as it also reduces heat evaporation. Heating the disinfectant does not weaken its effectiveness. (Aura & Kinnunen 2022)

If necessary, the environment of the area to be disinfected can also be protected with wool blankets. In this way, wetting of the operating table and the blankets in use due to the leakage of the disinfectant is prevented and the disinfectant is prevented from running under the patient (Aura & Kinnunen 2022).

The duty of the nurse is to reserve the supplies used in the disinfection of the surgical area. A separate table with wheels is often used, which can be moved close to the patient. The surface of the table is disinfected before opening the supplies. The supervising nurse opens the factory-clean washing package and places it on the table. After this, the disinfectant in use is poured over the folds or cotton buds in the washing kit, following the aseptic technique. The disinfectant bottle must not hit the washing package or the folds or creases in it. When pouring the substance, the nurse tries not to spill it outside the washing package. Disinfection of the surgical area can be started when the anesthesia team gives permission. After this, the surgical area is revealed and at the same time, the light can be connected to the surgical lamp and aimed at the surgical area. (Aura & Kinnunen 2022.)

Disinfection of the surgical area is carried out from clean to dirty area. For this reason, it starts at the supposed surgical incision and the nurse disinfects the area away from herself first. This ensures that the last area to be disinfected is the area over which the nurse may have been bent over. When disinfecting, the direction of the disinfectant flow must be taken into account. The substance must not flow from the edges of the disinfection area in the direction of the surgical wound. In addition, it must be taken into account that the fold or the cotton bud in use does not touch the outside of the disinfection area, for example, the blankets on top of the patient. If this happens and the fold or cotton bud becomes contaminated, it is immediately replaced with a new one. (Aura & Kinnunen 2022.)

The surgical area is disinfected at least twice, but in practice, the disinfection is done several times. With each disinfection, the area is reduced by about one fold or cotton bud. A sufficiently large area must be disinfected during the first disinfection. When the surgical area has been disinfected at least twice, the last thing to do is wipe only the area of the presumed surgical incision. (Aura & Kinnunen 2022)

4 SURGICAL SITE INFECTION AND THE CONSEQUENCES OF INCORRECT IMPLEMENTATION OF DISINFECTION

More than 15% of infections acquired in hospital settings are reported as Surgical Site Infections (SSI) and at least 5% of surgical patients are affected by it. The most common cause of SSI are microorganisms introduced through surgery into an incision wound site and multiplying afterward to cause signs such as pus or inflammation, wound breakdown, or fever. Symptoms may take several days after leaving the hospital to appear; most SSIs tend to affect superficial tissues while some can penetrate deep layers. (Pryme 2019.)

Human skin contains its own resident or resident flora of microorganisms that live deep within its folds including hair follicles and sebaceous glands, while surface contamination from body excretions/secretions, dirt, or items (transient flora) could contaminate its surfaces as well. Seemingly harmless on the surface level, such microorganisms could potentially introduce infections into surgical incisions so cleansing must take place prior to any surgeries in order to rid as many microorganisms as possible from surfaces (Pryme 2019).

In a surgical team, the surgeon, anesthesiologist, scrub nurse, and circulating nurse work together to ensure a safe and sterile environment. The circulating nurse plays a key role in disinfecting the surgical site before the operation. Therefore, nursing students and professional nurses must understand and follow the basic principles of disinfection in surgeries. Nurses are responsible for ensuring that they follow guidelines and that the patient is fully prepared for surgery. Proper disinfection methods and preventing damage to the patient's skin are essential in preventing infections.

Clinical guidelines and research studies support the role of nurses in preventing surgical infections through skin disinfection. For example, the Centers for Disease Control and Prevention CDC provides guidelines to prevent surgical site infections, including skin preparation and disinfection preferences. These guidelines emphasize the importance of properly preparing the skin, selecting an appropriate antiseptic solution, and following established protocols for skin disinfection. (Berríos-Torres 2017.)

Proper skin disinfection is crucial in preventing infections, as shown by various research studies. Recently, The New England Journal of Medicine conducted research showing that residents living in nursing homes who use antiseptic solutions available to cleanse their skin and nose are less likely to contract serious infections (Miller 2023). Additionally, a study published in the Journal of Perioperative Practice found that a comprehensive educational program for perioperative nurses on skin preparation and disinfection led to improved adherence to established protocols and a reduction in surgical site infections (Paskins 2017).

Therefore, nurses play a crucial role in preventing surgical infections through skin disinfection by following established guidelines, using appropriate antiseptic solutions, and monitoring for adverse reactions. Through their diligent efforts, nurses can help improve patient outcomes and reduce healthcare costs associated with surgical site infections (Paskins 2017).

5 OBJECTIVE OF THE STUDY AND THE RESEARCH QUESTION

The aim of this literature review was to explore and compare the principles of Surgical Skin Disinfection methods and find the most effective procedure to reduce Surgical Site Infection risk. The findings can be used by nursing students studying on the perioperative nursing course to prepare independently for perioperative nursing skills practice test.

The research question for our study was as follows: What are the most effective Surgical Skin Disinfection and preparation methods for reducing Surgical Site Infection risk?

6 LITERATURE REVIEW

6.1 Literature review

A literature review can be broadly described as a methodical process of collecting and summarizing existing research. The importance of conducting a literature review as a research technique is particularly noteworthy considering the current situation. An effective and well-conducted review as a research method creates a firm foundation for advancing knowledge and facilitating theory development. (Webster & Watson 2002.)

The literature review provided us with a great opportunity to enhance the content of our research work. We deemed that literature review tends to be a useful tool that progressively and purposely leads in the healthcare education field assuring the following studies in the nursing field to an already valuable expertise. A literature review serves to offer a comprehensive understanding of diverse and interdisciplinary topics within the research field. Moreover, it aids in integrating research outcomes to establish a meta-level evidence base and identify gaps requiring further investigation. These aspects play a vital role in constructing theoretical frameworks and conceptual models.

In addition, selecting appropriate terms for an all-inclusive search strategy was a demanding and challenging task to perform in the case of our literature review since materials were impending and not widely known. Mak (2022) states that one of the main obstacles to creating an efficient search strategy lies within its inability to effectively define individual subjects, leading to multiple definitions for similar concepts and terminology for one topic. In our research subject highlights were difficult to search since not all terms may be included and reported.

For instance, Surgical Skin Disinfection was indeed a wide topic for which various terms and high points were utilized. Most of them were related to surgical infections, risk factors, and surgical site scrubbing. To overcome the challenges mentioned previously, it is imperative to clearly define the topic and extensively familiarize oneself with the relevant literature. To overcome the challenges mentioned previously, it is imperative to clearly define the topic and extensively familiarize oneself with the relevant literature. In order to conduct a comprehensive literature review our plan was to spend a significant amount of time reflecting, analyzing, discussing, and iteratively reviewing data as a team to ensure the process was rigorous and significant results contributed to our research.

Frequently reviews consist of 6 steps which Arksey and O'Malley (2005) described as a six-step model framework. We have adopted those model structure steps for creating our own research. We performed a literature review in order to improve students' knowledge on surgical skin preparation and disinfection which could be utilized by Savonia UAS nursing students in preparation for the Practical Nursing Skills Test. These 4 steps are: Step A Identifying the research question, Step B Identifying relevant studies, Step C Selecting the studies and Step D Charting data.

6.2 Identifying the research question

Reviews are useful when the researcher wants to evaluate theory or evidence in a certain area or to examine the validity or accuracy of a certain theory or competing theories (Tranfield 2003). As it piloted and assisted in developing the system of search strategies. In fact, it was supreme to

acknowledge and analyze different parts of the aim: to investigate and evaluate the principles of various Surgical Skin Disinfection methods, purposing to identify the most efficient procedure in minimizing the risk of Surgical Site Infections. When we were preparing for the perioperative nursing skills practice test we encountered an issue that the written and video materials that were available did not correspond with Finnish and Savonia UAS recommendations.

6.3 Identifying relevant studies

As mentioned above, the literature review gave an opportunity to improve the content of the research paper which held the purpose of identifying the most scientifically proven methods for Surgical Site Disinfection. In expectation of pursuing this strategy, we have searched for evidenced-based literature via different sources: Electronic databases such as Cinahl ultimate, Pubmed, Science Direct; Key research journals: The new England Journal of Medicine, Lancet Microbe; Verified organizations: EMVO Medicines.

Prior to the search of any articles or written materials particular settings were set with the aim to get the most valid and applicable records. Search words: Preoperative Skin Disinfection We selected the articles which matched the following criteria: Material available in English language; Accessible and available free full texts; Guidelines and materials years 2012-2023; Article type: clinical study, classical article, guideline; Species: Humans.

Non-English language articles were not included in the review due to concerns about the time-consuming task of translating the information, potential inaccuracies in translation, and difficulties in comprehending the content. Only free accessible full texts were considered in terms of costs. We have advanced and operated articles that were published starting from the year 2012 till 2023 inclusive. We have chosen these particular years because it felt relatively recent and since guidelines were constantly being updated up to 2023. Only clinical studies, articles, or guidelines specifically verified for the human species were considered relevant for our research, while others were not deemed applicable to our research. For practical reasons, we had to set these limits. However, it's worth noting that some relevant papers may have been overlooked.

6.4 Selecting the studies to be included

When we were building a mechanism that would assist us in eliminating the articles that did not convey our research question, we were looking for certain filters. Apart from this, inclusion and exclusion criteria have played integral parts in every review.

We have found 600 records from Pubmed, Cinahl, Research Journals. The exclusion criteria we have applied are as follows: are not preoperative skin disinfection methods, antiseptics not in use in Finland, articles focused on properties of antiseptics, and unfinished studies. Such terms were applicable with the purpose of reaching the most apposite clinical studies. After using these tools, we had 503 records to screen. Due to the narrow focus of the topic, it proved to be challenging to locate appropriate full-text articles that directly addressed the subject matter.

The screening part was ordered. The next stage required us to study and read full clinical studies with the purpose of excluding 85 non-compliant records (exclusion criteria mentioned above). From

full-texted 12 screened records related texts were assessed for eligibility and then selected those which would be included in a review. Additionally, it should be noted that abstracts should not be considered as representative of the entire article or as fully encompassing the breadth of its content.

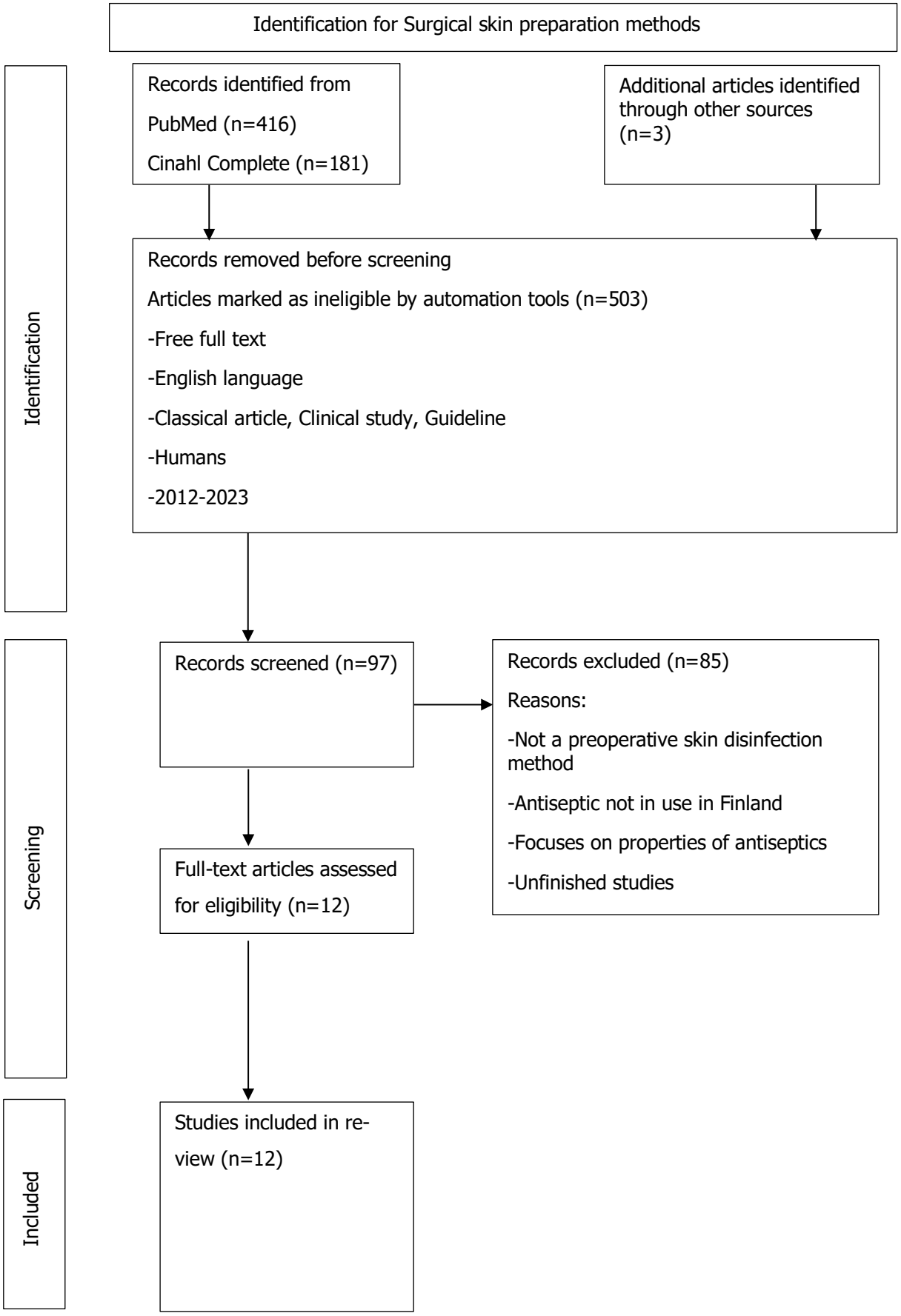

FIGURE 1: Prisma. Identification for surgical skin preparation methods

6.5 Thematic analysis

The following part involved organizing key information obtained from primary research records. We decided to represent and organize obtained data in a systemized charting form, where guidelines from some of the 12 contrasting studies were taken. The Table 2 below includes extracts from the literature, coding sentences and phrases, narrow-focused subthemes/outcome measures, and important/final results. The data in the chart is placed going from general to specific information and guidelines.

The evidence-based guidelines and forthcoming findings were organized in a sequential manner, typically referred to as "data extraction" in a literature review. In the context of a meta-analysis, this process may also involve the use of specific statistical methods.

Thematic analysis is an approach used to recognize, investigate, and present themes or patterns found within the data. According to Braun & Clarke (2006), data is merely organized and described in (rich depth) using this method.

Step 1: Become familiar with the data

The work had begun by assessing the information that was collected earlier. Learning its sources, arrangement, and settings was an initial part. This step helped to comprehend the chosen data and assured guarantees which contained careful and precise analyzed information.

Step 2: Generate initial codes

Studying through the information and recognizing key words, expressions, or ideas that are noticeable. These initials could be straightforward names or categories that restrain most thoughts or themes inside the article. This very step assisted in organizing and categorizing essence.

Step 3: Search for themes

Utilize the codes created within the past step as a direct to explore for repeating designs or topics within the information. Search for something in common, contrasts, or any curious designs that rise. This step includes perusing and analyzing the substance in profundity.

Step 4: Review themes

After finding and highlighting those themes which suit the most, they were surveyed. Searching for consistency and recurrence inside each topic and put together part topics based on their likenesses or contrasts was the main goal.

Step 5: Define themes

Succeeding in arranging the subthemes, which involved providing definitions of themes and research's findings from data.

Step 6: Writing results

At last, recorded findings in data analysis were ready . Results and findings were put together from the evidence-based records. Information was documented in this way: Intervention type (in yellow), author(s) name and surname, year of publication, and article title. Altogether, details and data were shaped by the premise of analysis. We have tried to find a universal approach in 12 studies included in the review. Some of which can be seen in Table 2. There are those extracted results and steps which correspond with our initial request and study.

TABLE 2. Charting table

Extract from the literature	Coding	Subtheme	Theme Results
Jolivet, S., & Lucet, J. C. (2019). Surgical field and skin preparation. Spruce L. (2015). "Back to basics: implementing evidence-based practice"	"Shaving incurs risk of micro-trauma and hence of infection. Clipping, incurs less risk of microtrauma, cutting the hair without skin abrasion. Recommendations do not favor routine hair removal . If it is to be performed, 1)clipping with a single-use blade, rather than mechanical shaving 2) the area should so far as possible be restricted to the incision site." "The evidence for preoperative hair removal is insufficient to draw conclusions about its effects on SSIs"	"Shaving incurs risk" "Clipping incurs less risk of micro-trauma." "Do not favor hair removal"	"Routine hair removal is not recommended "Clipping should be preferred and shaving avoided"
Jolivet, S., & Lucet, J. C. (2019). "Surgical field and skin preparation"	"The aim is to keep the skin as free of bacteria as possible for as long as possible, thus an antiseptic with a longer persistent effect will be more effective, which may be why chlorhexidine shows superiority in lengthy procedures"	"The use of 2·0–2·5% chlorhexidine in alcohol is recommended for preoperative skin preparation in any type of surgery"	It is recommended to use an alcohol-based solution of povidone-iodine or chlorhexidine Use of chlorhexidine in alcohol Is recom-

Jalalzadeh, Hasti.,&Groenen Hannah (2022) "Efficacy of different preoperative skin antiseptics on the incidence of surgical site infections: a systematic review, GRADE assessment, and network meta-analysis" Hsieh, C. S., Cheng, H. C., (2014) "Effect of 4% chlorhexidine gluconate predisinfection skin scrub prior to hepatectomy: a double-blinded, randomized control study" Uri P Dior, 2020, "Effect of Surgical Skin Antisepsis on Surgical Site infections in Patients Undergoing Gynecological Laparoscopic Surgery: A Double-Blind Randomized Clinical Trial" Athokpam Lenin Luwang, 2021, Chlorhexidine-alcohol versus povidone-iodine as preoperative skin antisepsis for prevention of surgical site infection in cesarean delivery-a pilot randomized control trial Methodius G Tuuli, 2016, A Randomized Trial Comparing Skin Antiseptic Agents at Cesarean Delivery	"Skin preparation using high concentration of chlorhexidine in alcohol is effective prevention of SSIs" "Chlorhexidine in alcohol is a non-significant benefit when compared with iodine in alcohol" "(1)A sterile washcloth was saturated with a solution of either CHG (4%) (2) the saturated cloth was applied to the presumptive surgical site for 3 minutes of vigorous scrubbing, verified by electronic timer; and (3) a standard 3-step disinfection was done (after patting dry with sterile towel) using iodine-alcohol solution" "Surgical skin preparation, each patient was draped in a sterile fashion with the abdomen exposed, allowing full air drying of skin before incision" "CHG is a biguanide effective against a wide range of Gram-positive and Gram-negative bacteria" "No skin preparation solution provides an advantage by reducing infection" "the patients who received chlorhexidine-alcohol as skin antiseptic had less chance of developing SSI than those	"The difference in incidence of SSI is not significant when comparing chlorhexidine-alcohol and povidone-iodine." "Use of Chlorhexidine-alcohol showed less risk of SSI"	mended for preoperative Surgical Skin Disinfection

Safia Bibi, 2015, Is chlorhexidine-gluconate superior than Povidone-Iodine in preventing surgical site infections? A multicenter study A Charehbili, 2019, Cluster-randomized crossover trial of chlorhexidine-alcohol versus iodine-alcohol for prevention of surgical-site infection (SKINFECT trial) NIHR Global Research Health Unit on global Surgery, 2021, Reducing surgical site infections in low-income and middle-income countries (FALCON): a pragmatic, multicentre, stratified, randomized controlled trial T N Peel, 2019, Chlorhexidine-alcohol versus iodine-alcohol for surgical site skin preparation in an elective arthroplasty (ACAISA) study: a cluster randomized controlled trial	who received povidone-iodine" "The use of chlorhexidine-alcohol for preoperative skin antisepsis resulted in a significantly lower risk of surgical-site infection" "Chlorhexidine gluconate was associated with lower infection rates compared to povidone-iodine" "The overall incidence of SSI was 3·8 percent among patients in the chlorhexidine–alcohol group and 4·0 percent among those in the iodine–alcohol group" "The trial did not show benefit from 2% alcoholic chlorhexidine skin preparation compared with povidone-iodine" "There was an increased odds of surgical site infection in the chlorhexidine-alcohol group compared to iodine-alcohol"		
Spruce L. (2015). "Back to basics: implementing evidence-based practice"	"Research has shown no clear evidence of benefit for preoperative showering or bathing with chlorhexidine gluconate (CHG) compared with other	"Preparation of the surgical site should occur as close to surgery as possible prior to draping"	

	products to reduce SSIs.”		
Sandra Pryme, Sophie Singh, Lindsay Keeley, Deborah Pike, 2019, Surgical Skin Preparation, OneTogether UK	“The direction of cleansing should be away from the incision site” “The solution must be allowed to dry on the skin before drapes are fixed” “Skin antiseptics should be removed from the sterile field immediately after use” “Either gauze swabs or commercially available applicators are effective”		

7 RESULTS OF THE REVIEW

The research question for our study was as follows: What are the most effective Surgical Skin Disinfection and preparation methods for reducing Surgical Site Infection risk? As the aim of our research was to explore and compare Surgical Skin Disinfection methods and find the most effective procedures, we have compared methods listed in different articles. According to the analysis of the literature, that we have retrieved from the selected articles, four findings that answer the research question were identified:

7.1 Shaving or clipping

Shaving is the act of removing hair from the body using a razor or other sharp instrument. Clipping refers to the act of cutting or trimming hair using scissors or clippers. This method is commonly used for shortening the hair on different parts of the body. In preparation of the surgical site shaving and clipping are used to remove the hair from the incision site. According to the studies, shaving incurs the risk of SSI and should be avoided. If hair removal is necessary, clipping should be used instead. (Joliver 2019; Spruce 2015.)

7.2 Chlorhexidine or povidone-iodine

Seven articles out of 10 agree that Chlorhexidine shows less risk of Surgical Site Infection, while 2 articles found no difference between chlorhexidine and povidone-iodine, and 1 states that povidone-iodine there were increased odds of SSI. The majority of the articles assessed agree that chlorhexidine has a reduced risk of SSI. (Jolivet 2019; Jalalzadeh 2022; Hsieh 2014; Dior 2020; Luwang 2021; Tuuli 2016; Bibi 2015; Charehbili 2019; NIHR Global Research Health Unit on global Surgery 2021; Peel 2019.)

7.3 Preoperative showers

The research that has been done on the topic of preoperative bathing showed no clear evidence of benefit while comparing different products used for the procedure when it comes to reducing the risk of SSI (Spruce 2016).

7.4 The method of application of the antiseptic:

One of the studies lists the following methods of antiseptic application on the surgical site. While there is a lack of studies that support this statement, it is supposedly better to cleanse in the direction away from the incision site. In order to ensure that microorganisms on the skin are killed, the antiseptic should be allowed to dry. To avoid confusing antiseptic bottles with medications that could be used during surgery, the antiseptic equipment should be removed from the sterile field as soon as the disinfection is complete. (Pryme 2019.)

8 DISCUSSION

In this section, we compared the various surgical skin disinfection and preparation methods. By understanding the differences and similarities between these methods, nursing students can gain insights into their efficacy and determine the most effective approach to reduce the risk of surgical site infections.

8.1 Differences:

Antiseptic solutions

The literature review identified several different antiseptic solutions used for surgical skin disinfection, including chlorhexidine gluconate and povidone-iodine. Each of these solutions has distinct properties, such as broad-spectrum antimicrobial activity and persistence on the skin. Some articles stated that "Chlorhexidine gluconate was associated with lower infection rates compared to povidone-iodine" or that "It is recommended to use an alcohol-based solution of povidone-iodine". Understanding the differences in these solutions can help students make informed decisions about which one to use in different clinical scenarios. One notable difference that we have highlighted was observed in the use of chlorhexidine-alcohol solution, which showed a lower risk of surgical site infections (SSIs) compared to other methods.

Application technique

The manner in which antiseptic solutions are applied to the skin can vary across different methods. Some methods employ a back-and-forth motion, while others use a concentric circular pattern (Pryme 2019). These variations may have implications for the effectiveness of the disinfection process and should be considered by nursing students when choosing a technique.

Contact time

The duration for which the antiseptic solution needs to remain in contact with the skin before surgical incision can also differ between methods. Some studies suggest that longer contact times result in better disinfection outcomes. Understanding these discrepancies in contact time requirements can assist nursing students in ensuring thorough skin disinfection before surgery. It is essential to wait for the solution to dry on the skin before securing drapes.

Shaving and clipping

Based on the read and studied material it is obligatory to minimize the risk of surgical system infections, so it is recommended that routine hair removal be avoided, and instead, clipping should be preferred while shaving should be avoided.

8.2 Similarities:

Key components

Despite the differences, all the surgical skin disinfection methods discussed in the literature review share some common elements. They all involve preoperative skin preparation using antiseptic solutions, followed by a rigorous scrubbing or application technique. This emphasizes the importance of these foundational elements in effective surgical skin disinfection.

Importance of skin integrity

Another noteworthy similarity is the emphasis on maintaining skin integrity during the disinfection process. All methods acknowledged the importance of avoiding prolonged or excessive application of antiseptic solutions, as it can potentially damage the skin barrier. This shared concern highlights the need for nursing students to balance effectiveness and safety when implementing these methods.

Role of healthcare professionals

The literature review consistently highlighted that proper surgical skin disinfection is a responsibility shared by healthcare professionals, including perioperative nurses, surgeons, and scrub practitioners. This serves as a reminder to nursing students that effective disinfection requires collaboration and adherence to standardized practices in the operating room.

While there are differences in antiseptic solutions, application techniques, and contact times, various surgical skin disinfection methods also have important similarities. Understanding these differences and similarities can equip nursing students with the knowledge and skills needed to make informed decisions and choose the most effective procedure to reduce the risk of surgical site infections in a perioperative setting.

9 CONCLUSION

9.1 Limitations and recommendations

Working as a group of three students, we have certainly faced challenges in organizing our research process, which could have resulted in minor shortcomings in the structure of our writing. However, in our opinion, as our work has been checked by all three of us, it was beneficial for the thesis' level of reliability.

Although the number of articles that had structured methods described in them was limited, we still managed to find the most relevant steps of the Surgical Skin Disinfection procedure. We have reviewed literature covering the topic of Surgical Skin Disinfection. Our goal was to compare different methods and recommendations in order to find the most scientifically accurate steps for preoperative skin antisepsis. Most articles that we found focused on the effectiveness of the disinfectants that are used in SSD or covered the topic of disinfection methods and Surgical Site Infection in postoperative settings.

We have explored the topic of disinfection through articles, nursing study guides, and books. The opinions on such steps of the procedure as preoperative showers, hair removal, and recommended antiseptic varied in the articles that we have selected for our literature review. We have found what common conclusions these articles had and chosen the steps that are scientifically proven to be most effective against Surgical Site Infection.

While literature review is a flexible type, there are certain limitations that need to be mentioned. We should practice reflexivity. A literature review includes a wide range of literature and, therefore, requires a lot of time resources, and management skills as well as efficient communication between the members of the research team.
While conducting our review, we needed to be able to filter large numbers of articles and capture those that were the most relevant to our topic. Although there were automatic filter tools at our disposal, there is still a human factor to be considered, that could have played a role in relevant articles being excluded from our research. Furthermore, we had to be aware of our own point of view on the topic, which could have affected our judging and selecting of material while searching for review material. (Mak 2022.)

While searching for articles by using filters on databases such as PubMed and Cinahl Ultimate, we have struggled to find articles that are relevant to our research question. Therefore, the number of articles assessed is poor, which decreases the level of depth and reliability of our thesis.
As stated earlier, literature review is time-consuming, and we must bring to the attention that the quality of the assessment of the chosen articles might be flawed.
As we have excluded articles in languages other than English from our review, there are limitations regarding the background theoretical information we could have used as a source for our research in general.

According to the results of research conducted in 2022: using an interactive video as a self-study method is as beneficial as learning by in-class demonstration. (Natarajan 2022.) In our own experience, video materials are beneficial for students who need to revise a topic independently, especially when it comes to medical procedures. There is a limited amount of visual as well as written step-by-step guides that are easy to comprehend and access. Most of the video guides found online contain methods that do not correspond with the text guides provided to us during our nursing studies.

In our opinion, short and comprehensive video materials should be more used as a self-study or self-revision tool when it comes to such topics as Perioperative nursing, where most procedures are done manually and, therefore, require visual learning. Therefore, we suggest that in the future a video with clear steps is made on the topic of Surgical Skin Disinfection.

9.2 Reliability and ethics

We had a list of steps to follow for retrieving relevant to our research question literature and for its further assessment. We have used such databases as PubMed and Cinahl Ultimate to search for the articles. We have searched for the articles in these databases with the keywords "Surgical Skin Disinfection". Our next step was to filter out irrelevant to our topic articles through automation tools and then manually assess the articles that were left after it. Therefore, after a thorough assessment, the articles that we chose were retrieved from reliable databases and written by professionals. (Arksey 2005.) While reporting we followed Savonia UAS reporting guidelines: we have cited all the references that we have used during our research in accordance with the guidelines, as well as used the Turnitin internet plagiarism surveillance system.

9.3 Conclusion

As we have conducted the research to find the most effective Surgical Skin Disinfection methods in the prevention of Surgical Site Infection, found the following findings emerged as the most effective Surgical Skin Disinfection methods and practices in reduction of SSI risk. Clipping instead of shaving should be used when removing hair from the incision site, preoperative showers could reduce risk of SSI, chlorhexidine-alcohol as the antiseptic is the most effective, antiseptic should be allowed to dry for it be effective against microorganisms on the skin.

The nursing students who are studying on the Perioperative nursing course can benefit from our research by broadening their knowledge on the topic of Surgical Skin Disinfection and using this knowledge during the exams and nursing practice skills test. Furthermore, by expanding their knowledge and revising the topic through our research, students can reduce the risk of inducing SSI in the surgical environment during the internship and future work.

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