Intraoperative aseptic practices in orthopaedic operations

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Laurea University of Applied Sciences **Abstract**

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The objectives of the research were to monitor the aseptic practices carried out by operating room nurses and doctors in orthopaedic operations focusing on aseptic behaviour and preparations of the personnel during sterile field establishment and maintenance phases of the surgeries, and to evaluate the practices carried out compared to existing international and national guidelines and evidence-based recommendations.

Previous study findings indicate that existing recommendations on aseptic and sterile technique are always not fully adhered to and that there are improvement areas in the aseptic practices of operating room personnel during surgery. The adherence to aseptic practices in intraoperative settings is essential within all team members to minimize and control microbes from contaminating the surgical field and its surroundings, but also to protect the personnel from being transmitted with antibiotic resistant microbes. Surgical site infections after orthopaedic operations where foreign body fixation materials are used have long-term effects and high costs. This study evaluated the actualized aseptic practices during sterile field establishment and maintenance phases in five operating room units within one organization in Finland. The study was implemented as a local small-scale observational clinical aseptic practice quality improvement study with statistical data analysis. The research aimed to compare the practices in action to existing evidence-based guidelines and recommendations using criteria-based evaluation. Data collection was done with the constructed tool in which foci of observation were divided to seven main themes: Availability of hand hygiene products, hand hygiene realisation, preparations of the patient, establishment of sterile field, preparations of sterile personnel, aseptic behaviour and maintenance of sterile field. A descriptive analysis of the research data was conducted using SPSS-software.

Results show high adherence to most evaluated categories, but also that there are areas of improvement in sterile field establishment and maintenance, and aseptic behaviour during surgery. The hand hygiene enabling products were properly available in 74.7% of observed operations and hand hygiene realisation of the team was 91% of operations. Timely antibiotic prophylaxis of 60 minutes before incision or tourniquet inflation was managed in 97.7% of operations. Establishment of sterile field was adherent in 89.5% of operations. Preparations of the sterile team members were highly adhered to: Sterile surgical attire was used according to guideline in all operations, and double gloves and protective eyewear were used adherently in 95.5% of operations. Aseptic behaviour during surgery was adherent in most of the operations (90.7%), but it appeared that doors were often open during surgery: The average number of door openings during surgery was six. The number of door openings and joint replacement surgeries were noticed to have a statistically significant association. Surgery duration did not seem to have a statistically significant association with aseptic behaviour or sterile field maintenance, but an operation with a duration of more than 45 minutes was noticed to require more door openings than a surgery with shorter duration: The average number of door openings in longer operations was eight. Maintenance of sterile areas was adherent in 76.9% of all operations, where eye contact and visible distance to sterile fields were kept in 79.6% of operations when moving near sterile fields, and back was not turned to sterile areas by sterile team members in 69.4% of observed cases.

Aseptic practices are teamwork that are affected by actions of all individuals in the operating room. Previous research findings indicate that aseptic practice training and implementation of guidelines are considered insufficient by OR staff and lack of adherence was discovered in some observed criteria. Based on study results, to enable adequate infection control and prevention in intraoperative settings, implementation of regular multidisciplinary education, policy development and monitoring of aseptic practices were recommended.

Keywords: infection prevention and control, aseptic practice, aseptic technique, sterile technique, operating room

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1 Introduction

The role of aseptic practices (AP) is highlighted in healthcare settings: Healthcare-associated infections (HCAI) and surgical site infections (SSI) are the second highest medical safety risks after medicine related threats (ECDC 2019), with increase of post-surgery morbidity and healthcare expenses (Puhto 2018). Specific aseptic knowledge and behaviour, hygienic clothing and use of personal protective equipment is required from personnel working in the operating room (OR) to prevent the incidence of a procedure-related infection. There are several existing guidelines created by The Association of Perioperative Registered Nurses AORN, the World Health Organization WHO and Centres for Disease Control and Prevention CDC on aseptic behaviour and practices in OR environments. Based on international guidelines Finland has welfare-area-centered instructions on infection prevention and control (IPC) for hospital staff, which are also followed by private health care providers (Anttila et.al. 2010; Kurvinen et.al. 2018; Similä 2020; Tays 2021; HUCH 2022). Leaning to the WHO Global patient safety action plan 2021-2030, the Finnish Ministry of Social Affairs and Health updated The Client and Patient Safety Strategy and Implementation Plan 2022–2026 on June 8th, 2022, that as a new addition includes requirements on IPC and states that every healthcare service provider is obliged to regularly monitor and report HCAI's and use of hand disinfectants in their organization by 2024.

In 2019, the second leading cause of death globally was bacterial infection related, which is found to be a significant threat to healthcare settings (GBD 2022). The main responsibility of hospital infection prevention and control (IPC) is based on the compliance with aseptic practice recommendations of healthcare staff. Hand hygiene aligned with other aseptic practices are the most efficient actions to prevent the emergence of SSI and antimicrobial resistance (AMR), but healthcare staff compliance with appropriate practices remains low in several settings (Allegranzi et.al. 2018; Aholaakko 2018; Zucco et.al. 2019). The risk of SSI varies between conditions and surgeries, but in average an SSI doubles the healthcare costs for a patient (Allegranzi et.al. 2018): According to research of Puhto (2018), in Finland the cost of a non-infected procedure is 7000 euros, treatment of a prosthetic joint infection (PJI) is approximately 25 000 euros and two-stage revision treatment 53 400 euros. Minimizing the risk of SSI is a significant part of patient safety and needs to be acknowledged in all healthcare related procedures worldwide (Allegranzi & Pittet 2009).

Previous study findings indicate that hand hygiene compliance is in correlation with the incidence of HCAI's (WHO 2009a, 9; Ojanperä, Kanste & Syrjälä 2020; Ojanperä et.al. 2022). According to international and national regulations (Mangram et.al. 1999; WHO 2016), aseptic practices are subjects of quality control and monitored in healthcare environments

worldwide. Hand hygiene is monitored by regular observation in several Finnish welfare areas and university hospitals. According to the research of Ojanperä, Kanste and Syrjälä (2020) and Ojanperä et.al. (2022), improving healthcare personnel's adherence to hand hygiene has a decreasing effect on the incidence of healthcare-associated infections in hospital facilities.

In their academic dissertation research Aholaakko (2018) studied the AP of OR staff and created baseline criteria to evaluate the adherence to AP recommendations. In this study the criteria of Aholaakko (2018) are used as a framework in co-operation with the author to be used in AP observation in orthopaedic OR units. The aim of the study was to monitor and evaluate the AP of OR nurses and doctors based on the modified criteria. The study was conducted in five OR units within one organization in Finland. Comparison material for the study are international and national guidelines and evidence-based recommendations, and research findings of DeOliveira and Gama (2015), Aholaakko (2018; 2020), Parnikh et.al. (2022) and study results collected through literature search for observation tool construction.

2 Intraoperative aseptic practices in orthopaedic operations

Patients going through a surgical procedure are at risk of attaining a surgical site infection (SSI), which leads to prolonged hospitalization and costs (Badia et.al. 2017). Study findings of Badia et.al. (2017) noted that orthopaedic or trauma surgery patients had the highest number of hospital days after SSI diagnosis. SSI rates are globally monitored by various, more or less realistic and real-time information offering systems (WHO 2018). The estimated SSI rate of the organization in question was 1.54% among all 12 055 operated patients in 2022 between January 1st and October 31st, according to diagnosis-based data offered by the used patient record system.

The purpose of AP is to minimize contact, air, droplet and vector borne microbe contamination of the OR facility and surgical site during surgery, and prevent the development of a potential SSI afterwards (Aholaakko 2018). Factors affecting SSI development in intraoperative settings include surgical attire, hand hygiene, wound classification (clean-contaminated-dirty/infected), duration, technique and procedure of the surgical operation, the use of antimicrobial sutures and the type of anaesthesia (Bashaw & Keister 2019). According to article by Tarabichi and Parvizi (2023), the prevention of SSI-risk factors in perioperative settings are usually divided in two groups between patient-specific and environmental features, but they state that the most important steps in SSI and PJI prevention can be summarized in ten effective measures of both groups: Host risk factor optimization, bioburden reduction, perioperative antibiotic prophylaxis (PAP), respect for soft tissues, expeditious surgery, minimization of blood loss, OR traffic reduction, antiseptic irrigation solution use, sterilization of implants and instruments and wound management. The

intraoperative risk factors of the summary are recognized when creating the observation tool for OR AP evaluation in sterile field establishment and maintenance phases.

To protect healthcare patients, standard precautions offer guidance on hand hygiene, use of personal protective equipment (PPE), respiratory hygiene etiquette, patient placement, adequate handling and disinfection of patient care equipment, proper handling of textiles and healthcare worker safety (CDC 2016). To minimize the risk of SSI, international and national recommendations have been created based on research-based evidence both in medical and nursing practices starting from the late 1800's (Aholaakko 2018). Cochrane-reviews on OR AP present low or very low certainty, because of ethical reasons practices cannot be dissembled. The CDC Guideline for the prevention of SSI focuses on patient preparations before surgery, glycaemic control, oxygen sufficiency, body temperature maintenance, antibiotic prophylaxis and surgical site disinfection, but do not offer guidance on intraoperative AP (Berrios-Torres et.al. 2017). The existing guidelines of infection preventive measures are created by the AORN (2005; 2007; 2010; 2017) and the WHO (2009a; 2009b; 2016), and are individually adapted by hospital facilities worldwide. The AP of operating room personnel are taught mainly in practice as a part of job-specific education during orientation to the OR settings (CDC 2022).

Adherence to AP is the basis of IPC, and dependable on individual knowledge and know-how. Based on previous research, staff feedback (Pitko 2022) and experiences, there are differences and weaknesses in the AP of OR personnel in intraoperative settings. In Finland, the education of hospital staff is regulated by the Health Care Professionals Act Chapter 2 (1200/2007); Right to practise as a health care professional; and includes the basic information of IPC. However, little training is included to the curriculum about the intraoperative AP (Finlex 1994; Laurea University of Applied Sciences 2022), and the methods and reasons of certain APs are considered challenging to understand especially among fresh nurses (Pitko 2022). The expected outcome of the study was to create an instrument for measuring the AP of OR personnel, to achieve information on staff adherence to AP in the OR and to provide need analyses for future development. The expectation of the organization was to be able to compare results between units which was possible by separating the observation events by unit. Each of these expected outcomes was a possibility to develop the AP of the personnel, because observation itself is an effective tool to influence on behaviour of the participants (Polit & Beck 2004, 320; Ojanperä et.al. 2022).

The adherence to AP in Finnish public hospital facilities is considered high referring to low SSI incidence and antimicrobial resistance rates comparing to other European countries (Allegranzi 2014). However, the adherence to recommendations is generally not controlled, supervised or evaluated in hospital facilities, except for regular hand hygiene observation performed in certain Finnish university hospitals. The circulating nurses' aseptic practice

assessment-tool (Aholaakko & Metsälä 2015), Baseline principles for development of intraoperative AP (Aholaakko 2018) and surgical hand rub observation tool eLeikkaus (Flowmedik 2022), are the only existing measuring instruments in use to evaluate the adherence to IPC methods or quality of AP in OR settings in Finland. The tool created for the research can be used as a measuring instrument for future evaluation and development of AP.

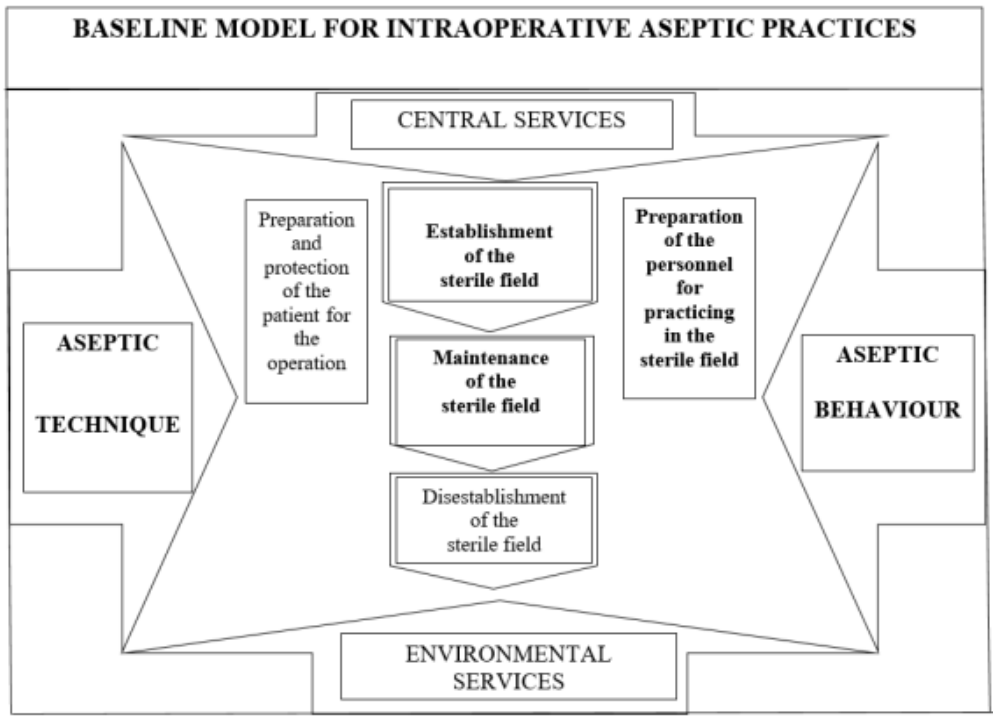

Figure 1: Baseline model for intraoperative aseptic practices (Aholaakko 2018©, published with the permission of the copyright holder)

The adherence to AP in OR settings and complying with aseptic technique (AT) during surgical operation are essential within all team members to minimize and control microbes from contaminating the surgical field and its surroundings, but also to protect the OR personnel from being transmitted with antimicrobial resistant microbes (Phillips & Hornacky 2021, 252). Aholaakko (2018) studied the acceptance of the intraoperative AP recommendations for the establishment, maintenance and disestablishment of the sterile field among OR staff with observational research and a self-reported assessment.

The role of the circulating nurse is highlighted in perioperative settings; Because acting as supervisors of AP, the circulating nurses should be highly aware of AP recommendations, comply them with high adherence and possess a rigorous aseptic know-how (Aholaakko & Metsälä 2015). This study evaluates the AP of all perioperative team members: Nurses, anaesthetics and surgeons. Ayukekbong (2019, 102-103) points that research of healthcare related problems focused on patient care quality is necessary, and favourable topics of monitoring IPC can be for example adherence to precautions, hand hygiene and processes of quality assurance.

Aholaakko and Metsälä (2015) and Aholaakko (2018) have created criteria on evaluating the know-how of AP among operating room staff. The criteria are based on international guidelines on AB in sterile and clean healthcare environments. Aholaakko (2018) discovered that there were significant differences in adherence to aseptic recommendations between professions, genders and hospitals before and after the project of co-creating recommendations. Measures were made in relation to establishment, maintenance and disestablishment of the sterile fields (Aholaakko & Metsälä 2015; Aholaakko 2018). In conclusion, Aholaakko (2108) stated that the differences in compliance to intraoperative AP recommendations among Finnish operating room staff require improvement.

1. Use of sterile multi or single use equipment to prevent cross contamination.
2. Preparing the sterile field as near to the time of performance as possible to reduce the risk of contact, droplet and airborne microbe contamination.
3. Preparing the sterile field inside the clean air zone in the OR to prevent and reduce contact, droplet and airborne microbe contamination.
4. Covering all the skin and hair of the team members and patient when working in the sterile field to reduce the risk of person-to-person contact microbe contamination.
5. Avoiding unnecessary movements in the sterile field and respecting air-current models to reduce the risk of contact, droplet and airborne microbe contamination.
6. The “aseptic working order” is followed during the practices by moving from clean area to unclean area to reduce the risk of direct and indirect microbe contamination.
7. Avoiding traffic in and out of the OR
8. Avoiding unnecessary touching of sterile items, drapes and sponges to reduce the risk of direct and indirect contamination.
9. Avoiding touching sharp items and using hands-free-technique to reduce the risk of bloodborne contamination.
10. Implementing clean and dirty techniques by keeping the used (“dirty”) and sterile equipment separated during the procedure to reduce the risk of contact, vector borne and bloodborne contamination.

Table 1: Baseline principles for development of intraoperative AP modified according to Aholaakko© (2018; 2020)

According to Parnikh et. al. (2022), the assessment of OR AP helps revealing circulating nurses’ strengths and weaknesses in applying AP recommendations. When observing the SSI preventive measures of surgical teams in Brazil, including the number of people in the OR, door openings, ventilation system, antimicrobial prophylaxis use, scrub prepping and adequately preparing the surgical site and hands of the surgical team, DeOliveira and Gama

(2015) discovered that some recommended practices for SSI prevention were not fully adhered to by the personnel under observation. The study results of Handaya and Werdana (2019) did not show significant differences between perioperative consultant surgeons, surgical residents and nurses in compliance to hand hygiene and sterile gowning procedure performance. CDC (2016) standard precautions and Baseline AP Principles (Aholaakko 2018) were used as framework in the tool construction (Table 2), 45 research articles and 34 national and international recommendations were used as basis in each evaluated criteria.

CDC standard precautions (2016)	**Baseline AP principles (Aholaakko 2018©)**
Hand hygiene	Aseptic behaviour (AB)
Personal protective equipment (PPE) use in exposure to blood, body fluids or surgical wound	AB
Handling sterile equipment + Handling, cleaning and disinfection of patient care equipment	Aseptic technique (AT) + Central services (CS)
Safe handling of sharps	AT
Use of mask	AB

Table 2: Comparison of criteria of CDC's (2016) Standard precautions and Aholaakko's© (2018) Baseline AP Principles

2.1 Hand hygiene as intraoperative aseptic behaviour and aseptic technique

This chapter describes hand hygiene as part of aseptic behaviour (AB) and AT in OR settings. Hand hygiene consists of microbe contamination minimizing actions between healthcare staff, patient and patient's surroundings and is based on hand washing and disinfectant use (WHO 2009b; WHO 2022). Insufficient hand hygiene provides potential risk of microorganism transmission to patients, risk of healthcare worker (HCW) colonization or infection caused by microbes originating from the patient and risk of increase in expenses, morbidity and mortality rates (CDC 2002, 27). Based on research evidence, the correlation between hand hygiene compliance of healthcare staff and SSI incidence is reported significant, and AP are the most effective measures to prevent HCAI's (CDC 2002; WHO 2009; Allegranzi & Pittet 2009; Ojanperä et.al. 2020).

Hand hygiene compliance is challenging to measure because contacts between patients, their environment and healthcare staff take place simultaneously in many locations within the organization and situations requiring aseptic conscience emerge at all times, monitoring requires resources while the staff is burdened by care work and when using staff members in observation instead of external researchers, bias are difficult to eliminate (Joint Commission International 2009, xxiii). The WHO Your Five Moments of Hand Hygiene (WHO 2009b) is a simple guideline presenting the aseptic actions to be followed as an effective IPC measure. Results in hand hygiene observational studies (Allegranzi & Pittet 2009; Ojanperä et.al. 2020;

Ojanperä et.al. 2022) show that healthcare staff hand hygiene compliance can be improved from 61% up to 81% with observation and topic-centred interventions.

According to Allegranzi, Sax and Pittet (2013), the most important selection criteria of alcohol-based rub to healthcare staff are availability, convenience and functioning of the hand disinfectant dispensers. OR settings should be maintained clinically clean by preventing the access and reproduction of microorganisms, therefore regular hand disinfection inside the area, and when entering and leaving the room is justifiable. Your Five Moments for Hand hygiene by WHO (2009b) instructs HCWs to use hand disinfectant before touching a patient, before clean/aseptic procedure, after body fluid exposure risk, and after touching a patient and their surroundings. For easy access, hand rub dispensers should be placed in several locations in the OR. According to research by O'Hara et.al. (2019), gloves and gowns are the parts of attire that most often contaminated with antibiotic resistant microbes among ICU personnel. To ensure accurate and infection safe use of gloves, hand disinfectant should be used before reaching to the glove box (THL 2022).

Observation of hand hygiene events (WHO 2009) requires incessant attention from the observer and cannot be performed simultaneously for more than one individual. Observation on hand disinfection events was not included in this study due to resource reasons and measurement difficulties. There are existing tools for the observation of surgical hand rub (eLeikkaus) and hand disinfection (eHuuhde), which focus on the hand hygiene-observation events (Ojanperä et.al. 2022; Flowmedik 2022). (Flowmedik 2022; Ojanperä et.al. 2022) and to ensure reliable results, it should be performed as a separate action of AP or by a second observer focusing only on hand disinfection events. The adherence to not wear nail polish, jewellery and watches during surgery was however observed. Also surgical hand rub of sterile team members was included in observation.

It is mentioned in several Finnish welfare-area guidelines, that the use of nail polish and artificial nails are forbidden in healthcare work (Kurvinen et.al. 2018; HUCH 2019; TYKS 2020; HUCH 2022). Nail polish and artificial nails enable microbes to contact in cracked surfaces and are worn out quickly from constant disinfectant use (TYKS 2020). CDC Guideline for Hand Hygiene in Health-Care Settings (2002, 29) states that long natural nails and artificial nails worn by healthcare workers (HCW) have been associated with HCAI's and recommends healthcare staff not wearing artificial fingernails or nail extenders when in direct contact with patients at high-risk care, such as intensive-care units (ICU) and OR. AORN (2017) suggests that the use of nail polish and gel nails in the perioperative settings should be determined by a multidisciplinary team inside the organization.

Jewellery and watches prevent successful hand hygiene by leaving moist and bacteria between skin and item, which can cause inflammation or be transmitted from person to

another (WHO 2009; CDC 2002). Efficient rubbing is impossible when wearing jewels or watches, and an item underneath a sterile glove is a significant safety risk for the patient under operation. According to research of Boucherabine et.al. (2022), the microbial load of smart watches showed significant contamination of 40% (N=159) microbes, virulence factor genes and antibiotic resistance genes.

CDC (2002, 30) notes that skin underneath rings is significantly more colonized than other areas of skin on fingers without rings, which proved by multiple studies. However, a Cochrane-review by Arrowsmith and Taylor (2014) notes that there is currently insufficient trial evidence of the impact of nail polish and finger ring wearing on microbe density and SSI incidence based on studies conducted between 1982-1997. DeKay (2022) has introduced updates on the AORN Guideline for Hand Hygiene with Five New Hand Hygiene Practices to Reduce Infection, which include prohibitions and limitations of nail lacquer use, reducing the risk of waterborne contamination, ensuring the accessibility of surgical hand rub and scrub, evaluation of hand hygiene product quality and implementation of hand hygiene improvement interventions. The hand hygiene guidelines of Finnish university hospitals' (Kurvinen et.al. 2018; HUCH 2019; TYKS 2020; HUCH 2022) prohibit the use of jewellery, watches and nail polish in all care work, and referring to WHO (2009a) Hand hygiene guideline, the Finnish Institute for Health and Welfare THL (2022) recommends removing hand jewellery while performing hand disinfection. According to the hand hygiene guidelines of the organization under observation the use of rings, watches and nail polish and artificial nails is forbidden in all patient care work.

2.2 Preparations of the patient in surgery

There are existing guidelines on patient preparations before surgery e. g. regarding preoperative antisepsis, but actions before entering the OR were not evaluated in this study. In perioperative settings, an antibiotic treatment is recommended especially in high SSI risk surgeries as an IPC-procedure (Mangram et.al. 1999). According to CDC guidelines (Mangram et.al. 1999), an antimicrobial prophylaxis should be used in operations in which its presence has been shown to reduce SSI rates based on clinical evidence.

Based on ECDC (2013) publication of Perioperative antibiotic prophylaxis (PAP) review, the adequate timing of PAP administration is 30–60 minutes before incision or tourniquet inflation and ideally during anaesthetic induction (except for vancomycin and fluoroquinolones). WHO (2016) recommends that PAP is administrated within 120 minutes pre-incision regarding the half-life of the used medicine. With short half-life antibiotics, such as commonly used cefuroxime, cefazolin and penicillin, the pre-incision time should be considered within 60 minutes (WHO 2016, 71). Referring to research by Weber et.al. (2008), ECDC (2013) notes that when evaluating cefuroxime use as PAP, the administration of cefuroxime between 30-

and 60-minutes pre-incision was more effective in preventing SSI than administration within 30 minutes. Evidence also shows that repeated doses of PAP should be given during the procedure, depending on the duration of the operation, the antibiotic used and significant blood loss of the patient (Mangram et.al. 1999; ECDC 2013).

According to national guidelines (HUCH 2021), PAP should be designated by the surgeon and regarding the medicament used, administrated within 60 min or 120 min pre-incision or before inflation of tourniquet, and is repeated after three hours if the procedure is prolonged when using cefuroxime. If the patient is carrying an antibiotic resistant microbe, the prophylaxis should be evaluated by the surgeon and an infectious diseases specialist or microbiologist (Mangram et.al. 1999; ECDC 2013; HUCH 2021).

The Cochrane-reviews of Gosselin, Roberts and Gillespie (2004) and Gillespie and Walenkamp (2010) indicate strong evidence supporting PAP use in orthopaedic operations especially in open fracture surgeries. According to Gillespie and Walenkamp (2010), a single dose of PAP significantly reduces both deep and superficial SSIs, but also other HCAIs (urinary and respiratory). ECDC (2013) recommends that a safe and effective PAP should be selected based the best agent depending on patient and procedure related features. The correct dose of PAP should be administered at adequate time to achieve antibiotic concentration in blood serum and tissue, to minimize the microbe load in the surgical site at the time of the incision (ECDC 2013). This study observed if PAP was administered according to guidelines within 60 minutes before incision or tourniquet inflation.

2.3 Preparations of sterile personnel

The risk of contamination of surgical site and sterile areas is minimized by sterile gowning of the operating team. The attire and personal protective equipment (PPE) suitable for clean and sterile OR settings are defined by CDC (Mangram et.al. 1999) WHO (2016, 131-134) and AORN (1998; 2005), and are published in global guidelines. The risk of cross-contamination is reduced by wearing clean clothes suitable for OR settings, covering head and facial hair to prevent hair, dandruff and skin cells from falling to surgical site and using sterile gowns and gloves in sterile field work (AORN 1998; AORN 2005; Phillips & Hornacky 2021, 267-276; Aholaakko 2018). A surgical mask is required from all team members working in the OR to prevent droplet and airborne contamination. When using face and head covering sterile helmet, e. g. in joint replacement surgery, mask is not required to be used underneath.

CDC (2002, 17), AORN (2017) and WHO (2018) guidelines strongly recommend that surgical hand antisepsis is performed by scrubbing with either soap and water or using an alcohol-based hand rub before donning sterile gloves. According to latest instructions by AORN (2017), WHO (2015) and Finnish University hospitals (HUCH 2019; TYKS 2020), the primary action of surgical hand antisepsis is using an alcohol-based hand disinfectant for three minutes, which

is also instructed by alcohol-based hand disinfectant manufacturers in Finland (KiiltoClean 2022). Hands should be washed with soap before the first operation of the day and when they are visibly dirty or layered by disinfectant, jewellery is removed from the hands and wrists before surgical hand wash and rub (AORN 2017; HUCH 2019; TYKS 2020). This study observes if surgical hand rub with alcohol-based disinfectant product is performed before donning sterile gloves by sterile team members. The quality and durance of surgical hand rub were not assessed during observation.

Based on research evidence, sterile gloves should be changed after draping, before implant handling and after macroscopic perforation risk of gloves has occurred (AORN 2007). Research suggest that gloves should also be changed at least once every 60 to 90 minutes, as risk of contamination and glove perforation increase with duration of surgery (Harnoss et.al. 2010; Autorino et.al. 2019). Padhye et.al. (2011) noticed that sterile gloves were often broken after 90 minutes use and recommended changing gloves after 90-150 minutes.

During surgery a single glove offers low protection to operating team members against needle stick injury, and to patient against microbe contamination through broken glove. According to Padhye et.al. (2011), sterile gloves are typically perforated after 90 minutes of use depending on the procedure and surgery technique. Tanner (2006) notes, that the Cochrane review in 2002 found that wearing double gloves offers more protection against perforations that single gloving even during surgeries with low risk of perforation, but also that each surgical procedure should be evaluated individually. Wearing two pairs of gloves is a preventive and ensuring action which is widely used especially in orthopaedic procedures (Aarnio & Laine 2001). Based on research results by Aarnio & Laine (2001) and Laine & Aarnio (2004), it is important to use double gloving at least in operations where high risk of glove perforation appears on the grounds of worker and patient safety. Korniewicz and El-Masri (2012) state, that the use of double gloves does not necessarily fully protect against perforations, but that the correctly used colour-indicator glove system may increase safety during surgery due to its premonitory feature. Study findings of Laine and Aarnio (2004) suggested that perforations in orthopaedic surgery are often caused by sharp bone edges and have occurred in 18,5% to 48% of the operations reviewed. However, a Cochrane-review on intraoperative interventions for the prevention of surgical site infection by Liu et.al. (2018) reported no significant correlation between double-gloving and SSI incidence.

The risk of a contamination from falling body hair should be minimized during the procedure. If a sterile team member has eyelash extensions, they should wear goggles to protect the operation area and prevent surgical site contamination from falling eye lashes by using protective eye wear (Meriö-Hietaniemi & Palosara 2019). The use of eye shield is not otherwise required from sterile team members, but as a protective measure against blood and body fluid exposure it is highly recommended especially in operations with risk of splatter

(Neo et.al. 2013; HUCH 2017). Meriö-Hietaniemi and Palosara (2019) also remind, that eyeglasses should not be considered as protective eyewear, although they protect the eyes from splatter. There are also existing welfare-area and hospital centered guidelines that may prohibit the use of false eye lashes in the OR (TYKS 2020).

2.4 Aseptic behaviour

Sanitation, maintenance and HVAC (heating, ventilation and air-conditioning) of healthcare facilities are significant sectors of IPC. The importance of cleaning and disinfection is highlighted in institutions with a high risk of infection because some microbes are able to survive on surfaces from hours two weeks. Operating room is classified as a clinically clean area with high risk of infection due to its feature as an invasive procedure environment. (Teirilä & Pekkala 2010, 584-586.)

Body fluids and blood cause a risk of cross contamination for the OR environment and team members, and bloodstains should be appropriately removed with a washing disinfectant immediately after they are noticed. Environmental cleaning is an essential measure to prevent the spread of pathogens. (Mangram et.al. 1999; Allegranzi & Pittet 2009; Aholaakko 2018.)

To prevent airborne microbe contamination during surgery, operating rooms have strict airflow standards maintaining highly accurate, excess pressured laminar airflow to steer clean air towards the sterile area and unclean air away from the surgical site (Rantala 2010, 238-239). According to Dharan and Pittet (2002), ultra-clean air of OR during surgery has been shown to reduce SSI rates in orthopaedic implant operations. High-efficiency particulate air (HEPA) filters are recommended to be used in OR settings, which filter at least 99,97% of particles over 0,3Чm size (Anttila & Asikainen 2010, 138; Dharan & Pittet 2002). There are no standardized methods or guidelines for OR air bacterial measurement, but in most countries laminar OR airflow is recommended 20 air changes per hour (Dharan & Pittet 2002). The selection between vertical and horizontal airflow systems in OR is dependent on obstacle layout, work practices and airflow rates, but regardless of the chosen airflow method, door openings, excess number of personnel and improper positioning of OR team members or equipment can affect the efficiency of the ventilation (Rantala 2010, 238-239; Sadrizadeh, Holmberg & Tammelin 2014). The airflow systems of the observed units are based on vertical laminar airflow ventilation, starting from the ceiling above the operating table and moving out from one or two outputs in the ceiling and/or floor level. With every door opening of the OR the clean, filtered air of the surgery room is mixed with the unfiltered air from the hallways, which allows the air particles and microbe load in the air in the OR increase during surgery (Teter et.al. 2017; Aholaakko 2018). Change in air quality and disturbance in the airflow may have an effect on SSI incidence (Sadrizadeh et.al. 2014). Mostly traffic in OR is

nonessential to the functions of the surgery (DeOliveira & Gama 2015) and exposes the surgical site to risk of airborne microbe contact (Bashaw & Keiter 2019). The efficiency of OR ventilation as an IPC technique is achieved only with appropriately worn surgical attire by the team and if OR doors are remained unopened during procedures (Rantala 2010, 240). Controlling traffic in the OR is a significant measure to prevent SSI and PJI in orthopaedic operations (Tarabichi & Parvizi 2023).

Personnel entering the OR should wear a mask when sterile items and equipment are present (AORN 2005; Phillips & Hornacky 2021, 267-276). Surgical attire guidelines include clean scrub attire, shoes, head coverings and masks (Mangram et.al. 1999; AORN 2005; AORN 2018). To protect the personnel and other patients from being transmitted harmful microbes during healthcare treatment, standard precautions are performed in all patient care (CDC 2016; Moralejo et.al. 2018). According to a Cochrane-review by Moralejo et.al. (2018), standard precaution adherence among healthcare personnel could be improved by peer-evaluation. They discovered in a comprehensive literature search that observed adherence to standard precautions was increased, but also noticed significant variation in baseline adherence, in changes between and within studies and in the practices evaluated (Moralejo et.al. 2018).

The risk of vector borne contamination should be minimized by wearing clean clothes suitable for OR settings (Mangram et.al. 1999; AORN 2005; Phillips & Hornacky 2021, 252-265) and avoiding contact to personal items and clothing brought from outside the aseptic area, such as backpacks and doctor's jackets (AORN 2007). Personal items are exposed to blood and body fluids in perioperative settings and should not be stored in OR (AORN 2007), but they also offer a risk of vector borne contamination of the OR setting and patient from the surfaces of the belongings, such as personal mobile phones brought outside the OR (Boucherabine et.al. 2022). Touching face and mouth the personnel expose patient and staff to vector borne risk of contamination (Aholaakko 2018). Because hand-to-hand, hand-to-skin, hand-to-nose, hand-to-mouth or hand-to-eye actions can lead to direct or indirect transmission of microbes, food and drink should not be present in perioperative settings (AORN 2007; Girard 2008).

A patient carrying a contagious and possibly SSI causing antimicrobial resistant (AMR) microbe such as *Methicillin-Resistant Staphylococcus aureus* (MRSA), *Vancomycin-resistant Enterococci* (VRE) and *Carbapenem-Resistant Enterobacteriaceae* (CPE) should be treated with contact precautions and isolated from other patients during their hospital stay (AORN 2007; WHO 2015, 9; CDC 2022). Contact, droplet and airborne precautions are used in addition to standard precautions as a safety measure to prevent the transmission of infectious agents (CDC 2022). Ayukekbong (2019, 158-161) states, that healthcare facilities should have an existing environmental cleaning, antibiotic stewardship and contact precaution practice guideline for the perioperative process of an AMR microbe carrying patient. According to guidelines of Finnish University hospitals, AMR laboratory tests are also required from a

patient treated in a hospital abroad in the past year and from a patient using iv-drugs, to prevent the transmission of HCAI's (CDC 2022; Kurvinen et.al. 2018; Similä 2020, 6-9; TAYS 2021; HUCH 2021). The participating organisation of the study has a guideline for the perioperative care of patients who are or may be infected or colonized with HCAI agents, which includes preoperative laboratory tests to examine a possible colonization, PAP evaluation by the surgeon and contact precaution guideline for possible and confirmed carriers of an AMR microbe.

2.5 Aseptic technique in the establishment and maintenance of the sterile fields

The establishment and maintenance of the sterile fields require rigorous AT to prevent SSI risk increasing sterile equipment contamination (Mangram et.al. 1999). The establishment phase includes creating the sterile table, opening of sterile packages, and disinfection and covering of the surgical field (Aholaakko 2018). The maintenance phase includes actions in sterile areas during surgery (Aholaakko 2018).

The handling of sterile equipment should be done according to sterile practices without compromising the sterility of the settings. Sterile fields should be prepared as near as possibly of the starting time of the surgery to avoid unnecessary air contact and risk of contamination (AORN 2006; Bussieres et.al. 2017; Aholaakko 2018; Bashaw & Keister 2019; Phillips & Hornacky 2021, 252-265.) According to review of Bussieres et.al. (2017), it is not possible to define the specific time frame for optimal sterile table establishment when referring to existing data. The recommendations of sterile field establishment are unclear regarding the time of instrument tray sterility and referring to a single study, it was noted that there is low risk of instrument contamination within the first 30 minutes of exposure in an unoccupied OR (Bussieres et.al. 2017). Several recommendations (AORN 2006; Mangram et.al. 1999) lean on the practice of sterile field establishment as near incision time as possible, but it is impossible to know the exact the starting time of the surgery due to unpredictable circumstances. There is very little research regarding the optimal moment of opening sterile trays and Bussieres et.al. (2017) note that it is a significant area of AT to be developed for exact recommendation creation.

When establishing a sterile table, tossing sterile items on includes a risk of contamination for the item and a risk of breakage of the sterile drape (AORN 2006; Aholaakko 2018; TYKS 2020). Unsterile personnel should keep distance to sterile areas and not lean over a sterile table because of risk of contamination from personnel's attire (AORN 2006; Brower 1868 in Phillips & Hornacky 2021, 261). The sterile table needs to be under surveillance at all times (AORN 2006; 2010, 94-95).

During the disinfection of the surgical site the circulating nurse needs to comply with AT principles by avoiding contact of unsterile clothing and body parts with the established sterile

field (Phillips & Hornacky 2021, 259) and conduct the preparation of the surgical site in a manner that follows the guidelines of AT and the manufacturer of the product used (AORN 2010, 260-261). Although research by Markel et.al. (2018) suggests that use of long sleeves as part of surgical attire would decrease bacterial bioburden during prepping surgical site, long sleeves easily expose the sterile site to unintended contact with unsterile clothing. Use of long sleeves when preparing sterile field is recommended by AORN (2005) to prevent skin cells and hair falling to sterile area but is not commonly recommended by Finnish national healthcare authorities because of the contamination risk of unsterile clothing and cloth dust (Kurvinen et.al. 2018; HUCH 2017). The significant factor of AT is that regardless of the attire worn by circulating nurse, the sterile areas are kept sterile at all times during establishment and maintenance phases.

According to AORN (2010, 260-261) guidelines, surgical site asepsis should be performed as instructed by the product manufacturer, starting the performance from the incision site proceeding to periphery depending on the operated area, taking account the direction from clean to dirty areas and the flowing direction of the used fluid. Internationally recognized skin disinfection and antiseptic agents are chlorhexidine gluconate, iodophors, triclosan and chloroxylenol (para-chlorometaxylenol) and octenidine (WHO 2009, 52-53). In Finland the commonly used disinfectants are 77-80% percent denaturized ethanol alcohol and chlorhexidine products. The product-specific instructions should be followed due to different impact mechanisms and applying techniques of the disinfectants: When using alcohol based fluid the disinfection is instructed to be done with long solid sweeps (Finntensid 2023), with a chlorhexidine-isopropyl alcohol applicator the disinfection is done with rubbing back and forth for three minutes (BD 2023) and with povidone iodine paint the disinfection is usually done with rubbing in circle motions (Dumville et.al. 2013).

Physical movements near the surgical site cause airflow with particles and create a risk of unintentional airborne contact (Phillips & Hornacky 2021, 254-255). Movements of unsterile personnel near the sterile sites expose the equipment and tables for falling microorganisms from unsterile clothing (Friberg & Friberg 2005; Phillips & Hornacky 2021, 261). An unsterile person should never lean over sterile area or approach it without informing sterile team members (AORN 2006; Phillips & Hornacky 2021, 261). Sterile areas should be monitored at all times and unsterile personnel should keep a visible distance when moving near sterile sites (AORN 2006). Sterile personnel should not turn their back to sterile fields especially after contamination of their back side when sitting in a stool. The back side of the gown is considered unsterile: Microbe growth of the sterile gown is highest above the chest (33%–42%) and below the operating room table (17%–22%) (Bible et.al. 2009). Bible et.al. (2009) state that based on research evidence, the front of the gown between the operative table and the chest are areas of greatest sterility (contamination rates 6%–9%).

3 Research aims

The aim of the study was to observe and evaluate the AP carried out by the OR personnel during orthopaedic operations and provide need analysis for future development based on results. CDC (Mangram et.al. 1999), WHO (2018) and AORN (2021) have published guidelines on SSI preventive measures and AP in operating room, which were used as requirements in the tool and the Baseline Model for Intraoperative AP originally created by Aholaakko (2018) was acting as a framework in the process. PICOT-model of the research is presented in Figure 2.

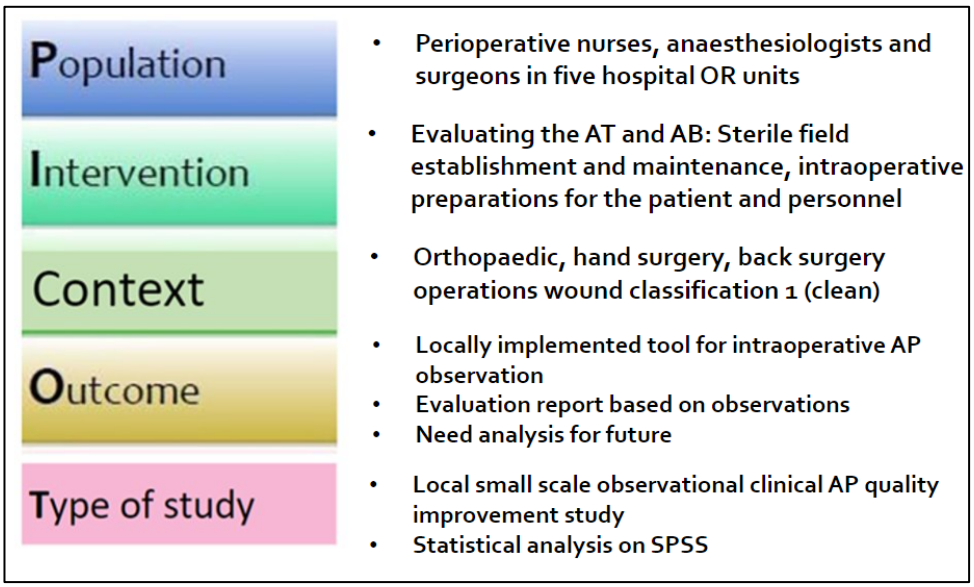

Figure 2: PICOT-model of the research

The objectives of the research were the following:

1) To observe the AP of OR personnel in orthopaedic operations
2) To analyse the AP of the personnel
3) To improve the aseptic practices of operating room personnel during the project and based on the research results
4) To provide need analysis for future development

Research questions examined based on previous literature results were:

1) Are hand hygiene enabling products available for staff members?
2) Is hand hygiene realized among staff members regarding hand jewellery and watches?
3) Was PAP administered according to guidelines?
4) Is the use of indicator gloves adherent?
5) Is the use of protective eyewear adherent?
6) Are there differences in preparations for practicing in the sterile field among personnel?

7) Are there differences in adherence between aseptic behaviour, sterile field establishment and maintenance in implant surgeries and non-implant surgeries?
8) Is there association between number of door openings and duration of the surgery?

4 Research methods

This chapter introduces the planning process, used methods and foci of observation of the study.

4.1 Project timeline

Project plan was presented for audience on November 16th, 2022. After permission of research implementation, a tentative timetable of the research and information letter was sent to directors of the units in December 2022. Field research was conducted between January 16th, 2023, and February 28th, 2023. One week (five working days) was preserved for each unit. The targeted publish date of thesis and result analysis of research project report were end of May 2023. Unit-specific results are planned to be presented for each participating unit by autumn 2023. Flow chart of research timeline is presented in Figure 3, which included literature search, tool construction, research planning, research implementation, result analysis and recommendations.

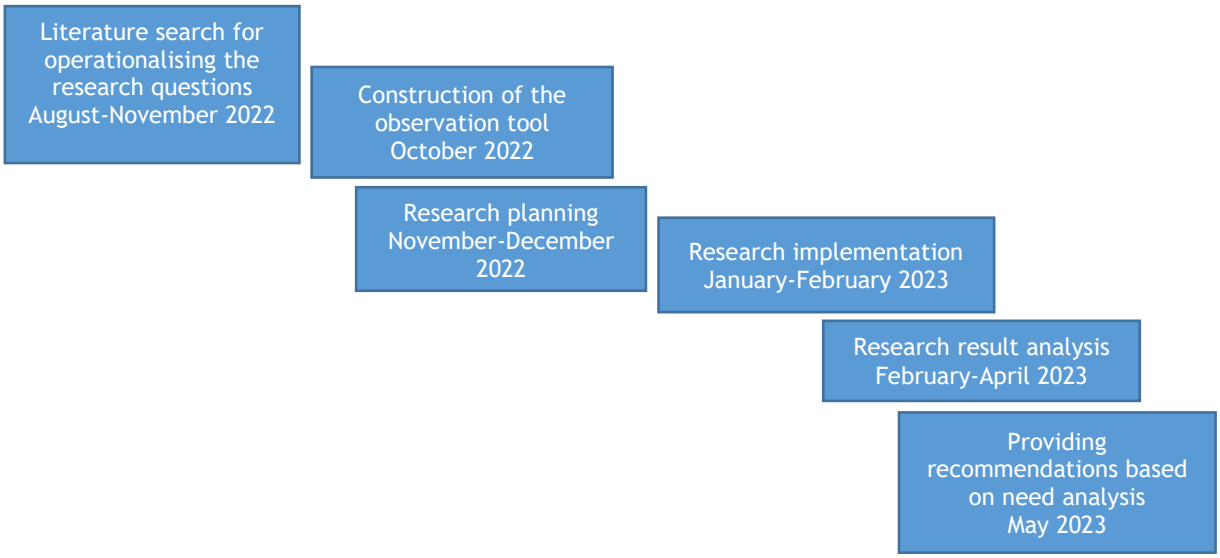

Figure 3: Research flow chart

4.2 Observation tool construction

Aholaakko's (2018) Baseline model for intraoperative aseptic practices (Figure 1) focuses on IPC related practical actions in the establishment, maintenance and disestablishment of the

sterile field. In this study the observed and evaluated areas of AP are based on criteria by Aholaakko (2018; 2020) and CDC standard precautions (Table 1), international guidelines on AT and AB, hand hygiene, use of personal protective equipment (PPE), and sterile field work in the establishment and maintenance phases of the operation. The tool was constructed using the Baseline model for intraoperative AP (Aholaakko 2018, Figure 1) and Baseline principles for development of intraoperative AP (Aholaakko 2018, Table 2) as framework with the permission of the copyright holder. The observed areas were included to the instrument based on international and national guidelines and evidence-based recommendations. The research questions in the observation tool (Appendix 11) are focused on the sterile field establishment and maintenance phases of AP principles, but not evaluating the disestablishment of sterile fields.

The selected AP included in the study were chosen based their easy real-time observational factors after Aholaakko's (2018) Baseline principles (Table 2). The observed aspects of the applied Baseline model (Aholaakko 2018) are summand below (Figure 4). To improve validity of the research settings, the operations observed were clean orthopaedic surgeries with wound classification one. Topics under observation were divided to hand hygiene resources and realisation, PAP administration, preparations of sterile personnel, aseptic behaviour, and establishment and maintenance of sterile fields.

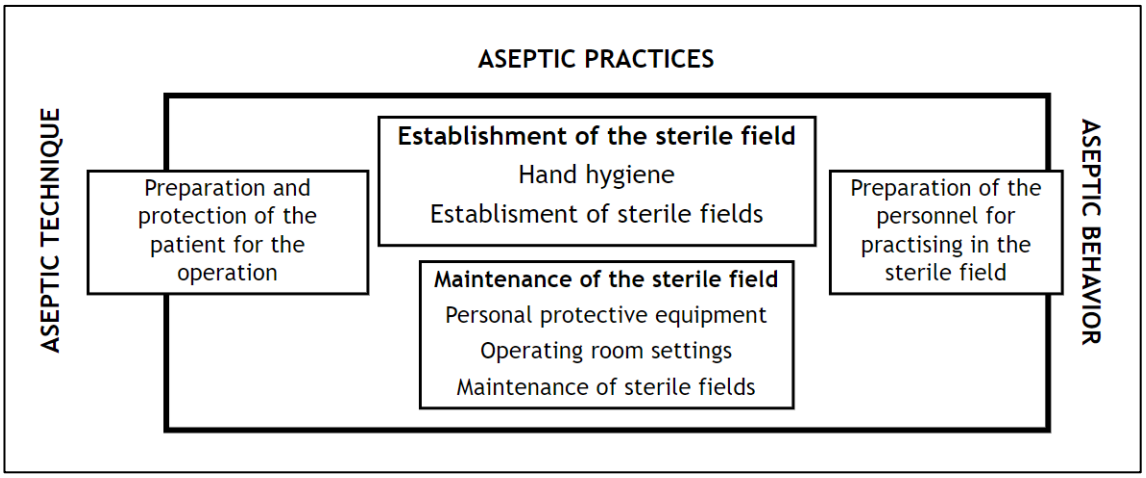

Figure 4: Foci of observation applied according to the Baseline model for intraoperative aseptic practices (Aholaakko 2018©)

Based on research evidence (DeOliveira and Gama 2015; Aholaakko 2018; Qvistgaard, Lovebo & Almerud-Österberg 2019; Parnikh et.al. 2022), international prospective and qualitative studies on AP and AT have been implemented, but the results are not directly comparable because of versatile study methods and different objectives of observation. Clinical observation and criteria-based evaluation were the used methods in Aholaakko's (2018) study, which enables the comparison and utilization of research results. DeOliveira and Gama (2015) evaluated pre- and intraoperative practices of medical and nursing teams in Brazil including

an analysis of surgical glove tearing during surgery. Handaya and Werdana (2019) observed the performance of surgical hand scrub and sterile gowning among perioperative personnel in Indonesia. Ojanperä et.al. (2022) implemented an eight-year observational research on hand hygiene compliance and SSI incidence in Finland. Focused on the AP in the OR, the only Finnish academic level research conducted is Aholaakko's study in 2018, which suggests that there is a need for further research.

4.3 Literature search for observation tool construction

The databases and terms used for relevant and reasoned criteria for the observation study tool construction search were the following: PubMed: (aseptic practices operating room) NOT (medication) NOT (pharmaceutical); EBSCO CINAHL: Aseptic practices AND operating room OR operating theatre OR surgery OR perioperative, hand hygiene operating room, surgical site infection operating room. The used citation management tool was Zotero and duplicates were removed after transferring the studies to Zotero application with the Zotero connector. Full text articles were searched between years 2005 and 2022. With EBSCO 22 results were retrieved and with Pubmed 23 search result, after removing duplicates, recommendations, and medical and medication related studies, 30 publications were achieved. Individual searches for sterile PPE, sterile table and sterile fields were performed in Laurea Finna-portal, when also few abstract only-results were included due to lack of research material with a "seek further info"-note attached. Inclusion and exclusion criteria are presented in Table 3. A total of 45 research articles and 34 international and national recommendations were included in the literature review for tool construction (Appendices 1-3).

Inclusion criteria	Exclusion criteria
Scientific research conducted in the last 17 years (from 2005 to 2022), Cochrane-reviews between 1999 and 2022	Thesis reports, newspaper articles
Full text	Abstract only (or seek further info-note included)
Peer-reviewed: Qualitative studies, observation studies, prospective studies, quantitative studies, mixed methods research, systematic and integrative literature reviews	Case reports, narrative literature reviews
Language English and Finnish	Other languages
Scientific articles and official guidelines related to AP, AT and AB in OR and prevention of surgical SSI	Other than OR AP, AT and AB and SSI prevention related articles and guidelines

Table 3: Inclusion and exclusion criteria

The strength of the research evidence used for tool construction were evaluated with the JBI Checklist for Analytical Cross-Sectional studies (JBI 2020), the table of research strength evaluation is the Appendix 1. The standard system used in CDC Guideline for the Prevention of Surgical site infection (Table 4, Berrios-Torres et.al. 2017) which describes the evidence

basis levels in recommendations, was used to assess the strength of the recommendations in in Appendix 2. Appraisal on literature reviews and other relevant studies are in Appendix 3. The rationale of evidence strength is combined in the following chapters.

Category	Recommendation
IA	A strong recommendation supported by high to moderate-quality evidence suggesting net clinical benefits or harms
IB	A strong recommendation supported by low-quality evidence suggesting net clinical benefits or harms or an accepted practice (e. g. aseptic technique) supported by low to very low-quality evidence
IC	A strong recommendation required by state or federal regulation
II	A weak recommendation supported by any quality evidence suggesting a trade-off between clinical benefits and harms
No recommendation/ unresolved issue	An issue for which there is low to vey low-quality evidence with uncertain trade-offs between the benefits and harms or no published evidence on outcomes deemed critical to weighing the risks and benefits of a given intervention

Table 4: CDC Standard System in the Guideline for the Prevention of Surgical site infection (Berrios-Torres et.al. 2017)

4.4 Clinical observation and criteria-based evaluation

Research method of the project was clinical observation and criteria-based evaluation; the researcher evaluated the defined objectives as an outside observer without participating in the OR work. A qualitative approach was chosen to be the study method to be able to adjust the used tool during observation period and to make field notes for development purposes for the organization. Previous research results indicate that observation is an effective way to support behaviour change (Ojanperä et.al. 2022) and according to Polit and Beck (2004, 320), nursing related problems are more suitable for observational studies rather than research methods based on self-reporting. Observation of hand-hygiene compliance is a commonly used tool of infection prevention quality control (Joint Commission International 2009, xxiii). The observations in the study were processed with a tailored, anonymous data collection instrument for observation: The Intraoperative Aseptic Practices of Operating Room Personnel-tool (Appendix 11). The tool was mutual for all OR-units, but data collection papers were marked unit specifically to enable comparison of results between units for separate evaluation. No staff or patient related personal information was collected as part of data. The language of the information letter and informed consent for the participating OR-personnel, and media release on research results was Finnish. The observation tool, final thesis report and abstract were written in English.

Observation was chosen to be the study method, to ensure the stability of the observed points and reliability of the IPC measures in orthopaedic surgeries. Based on previous studies

(Aholaakko 2018; DeOliveira & Gama 2015) and theory basis (Polit & Beck 2004, 320), clinical observation and criteria-based evaluation using structured data collection tools were suitable collection methods for the study. The OR personnel might be euphemistic when being observed, but observation usually shows realistically the practices carried out, especially if the surgery is urgent and AP are not considered as the priority of the operation. Observation is a reliable method for data collection because the researcher has the opportunity to focus on the routine details and make field notes (Burns & Grove 2011, 88).

4.5 Operations under observation

According to CDC guidelines by Garner (1982) and Simmons (1984) in Mangram et.al. (1999), wound classifications of the surgical site can be divided in four categories (Table 5): clean, clean-contaminated, contaminated and dirty-infected. The criteria for the operations included to research were clean class I orthopaedic procedures including hand surgery operations, and neck and lumbar spine procedures performed by neurosurgeon. The study was implemented in five OR-units, one week (five working days) at a time in five-week interval.

Wound class	**Description**
1: Clean	Uninfected operative wound, respiratory, alimentary, genital or uninfected urinary tract is not entered, wound is primarily closed
2: Clean-contaminated	Operative wound, respiratory, alimentary, genital or urinary tracts are entered under controlled conditions and without unusual contamination, operations involving the biliary tract, appendix, vagina and oropharynx, no evidence of infection
3: Contaminated	Open, fresh, accidental wound, major break in sterile technique or significant spillage from the gastrointestinal tract, acute inflammation encountered during incision
4: Dirty-infected	Old traumatic wound with retained devitalized tissue, existing clinical infection or perforated viscera, postoperative infection agents are present in the operative field before the operation

Table 5: Wound classifications by CDC (Mangram et.al. 1999)

4.5.1 Hand hygiene

The WHO's (2021) multimodal hand hygiene improvement strategy states that reliable and uninterrupted provision of alcohol-based hand rub and continuous supplies of hand hygiene enabling equipment need to be available for healthcare personnel and patients. Also AORN (2010, 69) and THL (2022b) state that to be able to carry out hand hygiene in OR, the tools need to be present.

The criterion of the observed aspects is for frequent hand hygiene to be possible, the instruments to enable hand disinfection need to be accessible for OR personnel (WHO 2021, 5)

and hand disinfectant is available and easily accessible in at least three spots in the room. According to international guidelines, to protect healthcare personnel by preventing blood and fluid contamination, gloves should be used when handling patient mucous and secretions (Mangram et.al. 1999; WHO 2021, 5; Phillips & Hornacky 2021, 252-265; Parnikh et.al. 2022). The observed aspect was that gloves are available and easily accessible in at least three spots in the room. When dressing nonsterile gloves, hand should be clean to prevent the contamination of the products (Spruce 2013; AORN 2017, THL 2022b), based on recommendations the observed aspect was that hand disinfectants are located near the glove boxes.

Jewellery and watches are microbe contamination risks and prevent hand hygiene: Perioperative team members should not wear jewellery on hands during patient care (AORN 2005; WHO 2009; AORN 2017; Boucherabine et.al. 2022). Although AORN (2010, 76) mentions that research results do not yet sufficiently support the total denial of nail polish in HCW, the guidelines of The Finnish Institute for Health and Welfare (THL 2022a) state that the use of nail polish is forbidden for healthcare personnel. Objectives of the study are that there are no watches or rings, visible nail polish/gel polish/artificial nails on any team member. The criteria under observation for hand hygiene are presented in Appendix 4.

4.5.2 Preparations of the patient

Based on strong research evidence, a PAP administrated in a favourable time frame before incision significantly reduces both deep and superficial surgical site infections. A safe and effective antibiotic prophylaxis should be selected by the surgeon based the best agent depending on patient and procedure related features. The correct dose of PAP should be administered at adequate time to achieve antibiotic concentration in blood serum and tissue, to minimize the microbe load in the surgical site at the time of the incision. (Mangram 1999; ECDC 2013; WHO 2016.)

The study observed if a designated PAP was administered 60 minutes pre-incision or tourniquet inflation as recommended by Finnish welfare-area-focused instructions after international guidelines. Other patient related preparations included in observation were regarded as establishment of sterile field. The criterion for PAP administration is presented in Appendix 5.

4.5.3 Establishment of sterile field

All criteria on sterile field establishment are presented in Appendix 5 together with the criterion of PAP administration. Preparing the sterile field as near to the time of performance as possible reduces the risk of contact, droplet and airborne microbe contamination (AORN 2006; AORN 2010, 94-95; Bussieres et.al. 2017). There are no specific recommendations and

little research on the time frame of sterile field creation, but it is estimated that sterile tables should not be created more than one hour before starting the operation (Aholaakko 2018). As a side note, AORN (2010, 94-95) recommends not to cover sterile tables to be used afterwards and highlights that sterile tables should not be moved between rooms, but stored in the same environment they are used.

Sterile items should be given to a sterile team member or handled with a sterile instrument to avoid contamination of the equipment and breakage of the sterile tablecloth (AORN 2010, 91; Aholaakko 2018). An observed aspect was that sterile items were not tossed on the sterile table but given to a sterile person/team member with sterile gloves or that they are handled with a sterile instrument if assistance is not available.

Surgical skin asepsis is performed before sterile field creation to reduce skin flora on the incision site (WHO 2009, 51). When disinfecting the surgical site, the personnel should pay heavy attention to not touching the disinfected areas with unsterile clothing. Surgical site asepsis should be performed in the order from clean to dirty areas, while following the flowing direction of the used disinfection fluid (AORN 2010, 260-261; Rantala et.al. 2010, 221; Carroll 2015). The observed aspects were that unsterile clothing was not touching the sterile area during skin disinfection and that the surgical site asepsis is performed as instructed by the product manufacturer and hospital guideline, taking account the direction from clean to dirty areas and the flowing direction of the fluid.

4.5.4 Preparations of sterile personnel

Sterile personnel related preparations are presented in Appendix 6. Covering mouth and all the body hair of the team members when working in the sterile field to reduce the risk of person-to-person and vector borne contact microbe contamination is strongly recommended (AORN 2005; WHO 2009, 58; Phillips & Hornacky 2021, 267-276; Aholaakko 2018), based on the guidelines the observed objectives are that each OR team member is wearing a surgical attire (hair cap and a mask) at all times during the operation and that all sterile team members have a hair cap and mask and accordingly dressed PPE (sterile jacket & gloves, sterile hood for implant surgery) (Mangram et.al. 1999).

Based on several international and national recommendations surgical hand preparation should be performed using an alcohol-based hand rub before donning sterile gloves and is an objective of the study (WHO 2009a, 54-60; AORN 2010, 79; Spruce 2014; AORN 2017; HUCH 2019; Fernando et.al. 2017; WHO 2018). The surgical hand rub is observed based on structural criteria and the quality and durance of the process itself was not evaluated in the study.

The risk of contamination and glove perforation increase with duration of surgery and double gloving is considered to be an efficient way to ensure patient and worker safety by revealing

tears in outer glove and enabling the changing of clean gloves during surgery without risking the surgical site (Mangram et.al. 1999; AORN 2007; AORN 2010, 279; Parnikh et.al. 2022; Matsuoka et.al. 2022; Karakus et.al. 2020; Hughes et.al. 2013; Phillips & Hornacky 2021, 267-276). Although WHO (2009, 58) did not find significant difference on SSI-rates between single and double gloving, based on CDC (Mangram et.al. 1999) and AORN (2010, 279) recommendations and study results of Aarnio and Laine (2001; 2004), the observed objective is that sterile indicator (double) gloves are used in orthopaedic operations.

As an occupational safety factor, goggles should be used when there is a risk of blood or fluid splatter (Mangram et.al. 1999; AORN 2010, 70; TYKS 2020). As a patient safety aspect should be noticed that if a sterile team member has eyelash extensions, they wear protective eyewear to protect the surgical site and sterile areas from falling eye lashes (Meriö-Hietaniemi & Palosara 2019). The guidelines related to eyelash extensions and false eyelashes vary between welfare-areas and are forbidden to use in perioperative settings in some Finnish hospitals. The aspects observed are that if there is a risk of splatter during the procedure, protective eyewear is used and if a sterile team member has eyelash extensions, they wear protective goggles.

4.5.5 Aseptic behaviour

Surgical attire and behavioural aspects required in OR work are presented in Appendix 7. OR traffic is considered a significant SSI risk (Tarabichi & Parvizi 2023), traffic in and out of the OR should be avoided to enable the efficient functions of clean air-conditioning (Aholaakko 2018). Based on research evidence (Dharan & Pittet 2002; Sadrizadeh et.al. 2014), times of opening the OR door when sterile fields were prepared was observed.

Disinfection of a bloodstain should immediately be performed with nonsterile gloves and a suitable disinfectant product to avoid microbe growth in environmental surfaces (Mangram et.al. 1999; Aholaakko 2018).

According to CDC (Mangram et.al. 1999) and AORN (2005; 2010, 67-68, 2018) recommendations, perioperative personnel should wear clean surgical attire; tops should fit close to the body or be tucked in pants to prevent the clothing from touching the disinfected area (Bashaw et.al.2017). In acute and invasive patient care units the healthcare organization is obliged to provide a suitable work outfit and PPE for the personnel according to collective labour agreements and national regulations (Finlex 2021). It was observed that guideline-compliant attire was worn by all OR team members during the operation.

AORN (2007) recommendations note that contact to personal items and clothing brought from outside the aseptic areas should be avoided in the OR (Aholaakko 2018; Phillips & Hornacky 2021, 252-265), which indicates that personal items or clothing such as doctor’s jackets, bags

or backpacks should not be stored in the OR. Based on recommendations (AORN 2007; 2010, 281), food and drinks should not be consumed in OR settings to avoid risk of bloodborne contamination of the eatable product and to avoid risk of cross contamination from personnel to patient (Aholaakko 2018). The observed aspect was that no eating or drinking was done in the OR.

Research evidence indicates that sterile gloves used in surgery should be changed when gloves are noticed broken (AORN 2007) or the risk of glove perforation is significantly increased. Based on research the adequate time of glove changing is 60-150 min after incision (Harnoss et.al. 2010; Padhye et.al. 2011; Autorino et.al. 2019). The observed aspect was that sterile gloves were changed if noticed to be broken or if the operation lasted longer than 120 min = 2h, relating to national guidelines (TYKS 2020). The duration in none of the 49 observed surgeries was more than 120 minutes and the criteria was not included in result analysis.

CDC (2022) emphasizes that a patient known to be a carrier of an antibiotic resistant microbe or is at significant risk of being a carrier, should be tested negative for the microbe or be treated with contact precautions during their hospital stay which is also included in Finnish University Hospital intraoperative care contact precaution guidelines (AORN 2007; AORN 2010, 289-291; Ayukekbong 2019, 158-161, 244-247; Similä 2020, 6-9; TAYS 2021; Phillips & Hornacky 2021, 249, 257). The observed aspect in the tool was that if the patient was known to be carrying an antibiotic resistant microbe, they were treated with contact precautions according to the organization contact precaution protocol and referring to international guidelines on IPC (CDC 2022). However, none of the patients of the observed operations was known to be an antibiotic resistant microbe carrier and contact precautions were not required in any of the observed cases and based on zero variables the aspect was not included in the results analysis.

4.5.6 Maintenance of sterile field

Appendix 8 describes the observed areas related to sterile field maintenance. Unscrubbed person should remain eye contact and visible distance to sterile field when moving near the area and not move between two sterile fields (AORN 2010, 91-94; Aholaakko 2018; Phillips & Hornacky 2021, 254-255, 261). The sterile field should be kept between areas with lower contamination risk, and regions of the gown that are not considered sterile after moving near unsterile areas should not be in direct contact with the operative field (Bible et.al. 2009). This leads to the conclusion that the operating team should not turn their back to sterile fields (Bible et.al.2009; AORN 2010, 91-94; Aholaakko 2018), which was included in the observation.

4.6 Data collection and recruiting of the informants

The participating units were chosen based on the volume of operations, from which the units with most patients were elected to ensure the adequate number of observations in the time frame planned. The managers and medical directors of the participating units received information letter on January 9th, 2023, through e-mail and had a possibility to influence on the planned observation period if the tentative dates were not suitable for the unit or the criterion for the observation was not fulfilled during the planned timeline. The information letter was printed available for unit personnel a week before research implementation. A total of five OR units participated in the research, 49 observations were collected in 15 days.

The OR coordinators of the units addressed the suitable procedures for observation each day in co-operation with the researcher. Information letter was presented together with the informed consent form for all surgery team members during the research before each observation event. The participants had the possibility to decline from observation. A risk of the research was that not enough operations were performed during the time frame planned for the observation. The number of operated patients is dependent on several variables and for example winter holiday season had an effect on the surgery schedule, when less operating surgeons were available. Delays in intraoperative care caused interference in planned research settings. The presence of the observer may have affected on the participant behaviour and reflected a temporary change in their usual activities. Also not receiving informed consent from participants was a realistic risk for the study success. Possible negative attitude against the study topic and unwillingness to participate in observation could have prevented the research implementation in a part or all of the units planned. The aims and objectives of the research project were important to be introduced for the participants to gain their acceptance and informed consent for the observation. The research method was not measuring the level of knowledge among the OR personnel and it was not a self-assessment tool.

Data was collected with the “Intraoperative aseptic practices of operating room personnel”-observation tool (Appendix 11). Answers in the tool were valued between 0-1 depending on the presence of the variable and recoded into suitable variable form based on topic for summation variable examination. Summation variables were created to evaluate the possible mutual effect and reliability of AP themes. Notes on OR environmental features and possible deviations during surgery were documented in the measurement tool notes-section for staff feedback and unit-specific development purposes, which were not included in the report.

4.7 Data analysing method

The research was implemented as local small scale observational clinical AP quality improvement study with statistical data analysis. The observational data of 49 operations was

processed with SPSS-software: Mean and standard deviation were used for the descriptive analysis of the research data. Also summation variables constructed of sets of criteria according to the evaluation foci were examined (Table 6). The results were analysed using 2-point dichotomous scale: The answers “yes” and “no” were valued with numbers “1” and “0” to enable data analysis in SPSS-programme, “not applicable” answers appeared as missing values in SPSS, or they were converted to a suitable variable by re-adjusting the research question to match the scale. The number of door openings were counted as frequencies of door openings per operation and the durations of each observed surgery were counted as minutes.

Summation variable	Variable
Hand hygiene enabling instruments are available	Hand disinfectant is available and easily accessible in at least three spots in the room Gloves are available and easily accessible in at least three spots in the room Gloves are located near the glove boxes
Hand hygiene realisation	No watches or rings No nail polish or gel/artificial fingernails
Preparations of the patient	Preoperative AB-prophylaxis
Establishment of sterile field	Sterile field is created less than an hour before operation Sterile items are not tossed on the sterile table, but are given to a sterile person/team member with sterile gloves/are handled with a sterile instrument When disinfecting the surgical site unsterile clothing is not touching the sterile area. Surgical site asepsis is performed as instructed by the product manufacturer and hospital guideline, taking account the direction from clean to dirty areas and the flowing direction of the fluid.
Preparations of sterile personnel	Surgical hand rub is performed by sterile team members All sterile team members have a hair cap and mask, and accordingly dressed PPE (sterile jacket & gloves, sterile hood for implant surgery) Indicator gloves are used Protective eyewear is used if risk of splatter or sterile team member has eyelash extensions
Aseptic behaviour	Each OR team member is wearing a hair cap and a mask at all times during the operation Sterile gloves are changed if noticed to be broken No personal items or clothing (backpacks, doctor’s jackets) are stored in the OR No eating or drinking in the OR Disinfection of a bloodstain is immediately performed with nonsterile gloves Times of opening the OR door when sterile fields are prepared
Maintenance of sterile field	Unscrubbed person does not move between two sterile fields Unscrubbed person keep eye contact and visible distance to sterile field when moving near the area Sterile field is visible for sterile members at all times (back is not turned)

Table 6: Summation variables of aseptic technique during operation

The variables were combined to theme-related summation variables based on their mutual features to be able to examine correlations and reliability of the material. The reconstruction of summation variables is also beneficial to prevent the variable dispersion into too small groups (Alkula, Pöntinen & Ylöstalo 1994, 153-154). According to Burns and Grove (2011, 95-96), especially when processing results of a qualitative research, it is important to rigorously

identify suitable variables from original data for theme reconstruction. In this study the qualitative observations were quantified and used as summation variables. The structure and content of the tool were adjusted during the research based on observation experiences due to the requests of the informants, who were willing to get feedback concerning the surgical site asepsis. To meet face validity and increasing acceptance of the informants, the evaluation of surgical site asepsis performance was added to the observation tool. This appears as missing values in the first five observations. During tool construction the codes linked to data were divided to themes and evaluated to be suitable for theme-focused evaluation based on their characters. "The number of door openings"-variable was not included to the summation variable "Aseptic behaviour" because of its continuous measure, which was not suitable to be analysed among the nominal variables. Means and standard deviations of the items and scales were analysed. The differences between means of normally distributed independent items were tested by independent sample t-tests with equal variances assumed. Pearson coefficient, which measures the correlation of continuous and dichotomous variables between -1 to 1 (Heikkilä 1998, 203), was used to analyse the linear relationship of two variables. However, a strong correlation did not reflect a causal connection between the items (Heikkilä 1998, 91). The normality of continuous variables distribution was analysed with skewness or kurtosis and when being >2.0 the variable was assumed to have a non-normal distribution. The constructed summation variables included different number of items, so the reliability analysis by Cronbach α was not implemented.

5 Research results

This chapter introduces the results according to study objectives. Total of 49 observations were collected during research in five participating OR units located in different parts of Finland. The operations included in observation were clean orthopaedic, hand and spine surgeries: Spinal microdiscectomies, lower limb and hand fracture stabilizations, knee and shoulder arthroscopies, knee ligament reconstructions and hand nerve releases. Six of the observed operations were joint replacement surgeries which are required to be performed within strict aseptic limitations. Duration and number of door openings after sterile field creation were calculated in all operations. The mean time of the operations was 51.38 minutes. Minimum time of a surgery was 12 minutes and maximum time was 98 minutes. Because none of the procedures lasted over 120 minutes, the aspect of glove changing after 120 minutes was not included in the result analysis. Also the criterion of contact precaution use was removed from result analysis because none of the operated patients was known to be a carrier of an antibiotic resistant microbe or exposed to one.

The results are presented in the following chapters in the order of the summation variables describing AB and AT in the used tool. Table 7 describes the key results in all themes and

objectives. When evaluating all objectives describing AB and AT performed during operation, the means between the summation variables varied from 1.82 to 4.82, but the number of items used in the summation variables are not identical.

	Variable	Realisation %	Realisation %	Min-max	Mean (SD)
Hand hygiene enabling instruments are available	Hand disinfectant is available and easily accessible in at least three spots in the room	98	74.9	0-3	2.24 (0.751)
	Gloves are available and easily accessible in at least three spots in the room	49			
	Gloves are located near the glove boxes	77.6			
Staff adherence to hand hygiene	No nail polish or gel/artificial fingernails	83.7	90.9	0-2	1.82 (0.391)
	No watches or rings	98			
Preparations of the patient	Preoperative AB-prophylaxis	97.7	97.7	0-1	0.98 (0.143)
Establishment of sterile field	Sterile field is created less than an hour before operation	91.8	89.5	0-4	3.51 (0.545)
	Sterile items are not tossed on the sterile table, but are given to a sterile person/team member with sterile gloves/are handled with a sterile instrument	100			
	When disinfecting the surgical site unsterile clothing is not touching the sterile area.	98			
	Surgical site asepsis is performed as instructed by the product manufacturer and hospital guideline, taking account the direction from clean to dirty areas and the flowing direction of the fluid.	68.2			
Preparations of sterile personnel	Surgical hand rub is performed by sterile team members	100	96.4	0-4	3.82 (0.354)
	All sterile team members have a hair cap and mask, and accordingly dressed PPE (sterile jacket & gloves, sterile hood for implant surgery)	100			
	Indicator gloves are used	93.9			
	Protective eyewear is used if risk of splatter or sterile team member has eyelash extensions	91.8			
Aseptic behaviour	Each OR team member is wearing a hair cap and a mask at all times during the operation	95.9	90.7	0-5	4.82 (0.441)
	Sterile gloves are changed if noticed to be broken	100			
	No personal items or clothing (backpacks, doctor's jackets) are stored in the OR	93.9			
	No eating or drinking in the OR	98			
	Disinfection of a bloodstain is immediately performed with nonsterile gloves	66			
	Times of opening the OR door when sterile fields are prepared	N/A			
Maintenance of sterile field	Unscrubbed person does not move between two sterile fields	81.6	76.9	0-3	2.31 (0.822)
	Unscrubbed person keep eye contact and visible distance to sterile field when moving near the area	79.6			
	Sterile field is visible for sterile members at all times (back is not turned)	69.4			

Table 7: Summated variables describing aseptic practices performed during operation

The highest means appeared in the preoperative AB-prophylaxis (mean 0.98, SD 0.143), hand hygiene realisation (mean 1.82, SD 0.391), preparations of sterile personnel (mean 3.86, SD

0.354) and aseptic behaviour (mean 4.82, SD 0.441). Standard deviation between themes varied, describing the distribution of the values around the mean, from 0.354 to 0.822, being highest in sterile field maintenance (SD 0.822) and availability of hand hygiene products (SD 0.751). The SD varied less in preoperative AB-prophylaxis (SD 0.143), preparations of sterile personnel (SD 0.354) and hand hygiene realisation (SD 0.391) making coherent AP visible during the observed operations. The least coherent AT was the sterile field maintenance (mean 2.3, SD 0.822): In some of the observed operations none of the measured objectives realised.

5.1 Hand hygiene

Hand hygiene-area describes the denominators of the availability of hand hygiene products, and the use of watches, rings, nail polish, gel or artificial nails in surgery. When evaluating the hand hygiene enabling instruments (Table 7), the availability of products was 74.9% (mean 2.24, SD 0.751). Hand disinfectant was available in three or more spots in 98% (n=48, mean 0.98, SD 0.143) of all observed surgeries and gloves were available in at least three spots in the room in 49% (n=24, mean 0.49, SD 0.505) of the observed operations. Hand disinfectants were located near glove boxes in 77.6% of operations (n=38, mean 0.78, SD 0.422).

	Yes	No	Total
Adherence to hand hygiene in nail polish	n=41 (83.7%)	n= 8 (16.3%)	N=49 (100%)
Adherence to hand hygiene in use of watches or rings	n=48 (98%)	n= 1 (2%)	N=49 (100%)

Table 8: Actualization of hand hygiene in nail polish products

The realisation of hand hygiene was 90.9% (mean 1.82, SD 0.391) of all observed operations: one point in 18.4% (n=9) and two points in 81.6% (n=40), which indicates that staff adherence to hand hygiene was in an acceptable level in 40 operations and low in nine observed cases. During the observed operations, 16.3% (n=8) of personnel was wearing nail products during surgery and hand jewellery or watch was worn by 2% (n=1) of the observed staff members (Table 8). The results suggest little variation (SD 0.391) in AP in hand hygiene realisation, but higher differences in the availability of hand hygiene products (SD 0.751). A statistically significant correlation between hand disinfectant and glove availability ($л$ = -0.147, p > 0.05) in the OR was not identified, but a correlation between hand hygiene realisation and availability of hand hygiene products ($л$ = -0.411, p = 0.003) was statistically significant. The availability of hand hygiene products and aseptic behaviour ($л$ = -0.364, p = 0.010) correlated in a statistically significant manner suggesting that increase in hand hygiene products would be connected to less coherent aseptic behaviour. However, there was no visible connection between the two themes during observation. Also a weak correlation between hand hygiene

realisation and aseptic behaviour ($л$ = 0.404, p = 0.004) was discovered meaning that in operations where the hand hygiene was performed in an adherent manner also the aseptic behaviour was performed in an adherent manner.

5.2 Preparations of the patient

In 44 of the operations preoperative antibiotic was prescribed by the surgeon and was correctly administered in 97.7% (n=43, mean 0.98, SD 0.143) of the observed cases. In 2.3% (n=1) of observed operations PAP was prescribed to be given, but not administered to the patient before tourniquet inflation due to a staff member's human factor which delayed the incision. In 10.2% of all observed operations (n=5) PAP was not instructed to be given preoperatively by the surgeon based on guidelines related to the surgery characteristics.

5.3 Establishment of sterile field

Establishment of sterile field was adherent to recommendations in 89.5% (mean 3.51, SD 0.545) of operations. In 8.2% (n=4) of the observed operations sterile table was created more than 60 minutes before operation and covered with a sterile cloth. In 91.8% (n=45, mean 0.92, SD 2.77) of operations the sterile table was created less than 60 minutes before surgery.

	Yes	No	Total
Surgical site is not contaminated by clothing during asepsis	n=48 (98%)	n= 1 (2%)	N=49 (100%)
Surgical site asepsis is performed as instructed by the product manufacturer and hospital guideline, taking account the direction from clean to dirty areas and the flowing direction of the fluid	n=30 (68.2%)	n= 14 (31.8%)	N=44 (100%)

Table 9: Surgical site asepsis

Surgical site was contaminated by unsterile clothing during surgical asepsis in 2% (n=1) of the observed operations and remained intact in 98% (n=48, mean 0.98, SD 0.143) of observations (Table 9). In all of the observed surgeries sterile items were placed on sterile table according to guidelines and not tossed but given to a sterile person. Surgical site asepsis was performed in a manner instructed by the product manufacturer and complying with AT guidelines in 68.2% (n=30, mean 0.68, SD 0.471) of the observed operations. The surgical site asepsis was not performed according to AT-guidelines when the swiping was done against the fluid flow or from dirty to clean areas in 31.8% (n=14) of the operations. In all the observed cases, ethanol alcohol fluid was used as the surgical asepsis product and in one case also chlorhexidine-ethanol fluid was used to clean a part of the operated limb. In the first five cases the aspect was not evaluated due to modification of the tool during research period, which appear as missing values in the table.

5.4 Preparations of sterile personnel

Preparations of sterile personnel was adherent to recommendations in 96.4% (mean 3.82, SD 0.354) of operations. Sterile team members were dressed according to AT-guidelines in all operations, including joint replacement surgeries. Surgical hand rub was performed by sterile team members in all observed operations. The duration and quality of the performance were not assessed.

Indicator gloves were used adherently in 93.9% (n=46, mean 0.94, SD 0.242) of all operations and not used despite the need in 6.1% (n=3) of operations. Adherence to goggle use was 91.8% (n=17, mean 0.92, SD 0.277), the nominator of protective eyewear was recoded to present both options of goggle use need. Protective eyewear was used in 91.8% of cases with risk of splatter or eyelash extensions (2%, n=1) worn by a sterile team member, no other members with false eyelashes were recorded during the study period. Protective eye shields were not used regardless of splatter risk in 8.2% (n=4) of operations. In 42.9% (n=28) use of protective eyewear was not necessary because of very low risk of splatter, however the hospital guidelines state that the use of protective eyewear is always recommended for sterile team members.

5.5 Aseptic behaviour

Aseptic behaviour was recommendation adherent in 90.7% (mean 4.82, SD 0.441) of observed operations. All OR team members were dressed according to surgical attire guidelines at all times during surgery in 95.9% (n=47, mean 0.96, SD 0.2) of operations (Table 10), the guideline was not partly followed and the attire was incomplete during the surgery in 4.1% (n=2) of cases. Food or drinks were not consumed according to guidelines in 98% (n=48, mean 0.98, SD 0.143), and were consumed during 2% (n=1) of operations.

	Yes	No	Total
All team members are dressed accordingly	n=47 (95.9%)	n= 2 (4.1%)	N=49 (100%)
Personal items are not stored in OR	n=46 (93.9%)	n= 3 (6.1%)	N=49(100%)
No eating or drinking in the OR	n=48 (98%)	n=1 (2%)	N=49 (100%)
Sterile gloves changed if noticed to be broken	n=8 (100%)	n=0	N=8 (100%)
Adherent blood stain removal during surgery	n=6 (66%)	n=3 (34%)	N=9(100%)

Table 10: Aseptic behaviour

Sterile gloves were noticed to be broken in 16.3% (n= 8) of all observed operations and were changed immediately after noticing according to guidelines in every event. In 83.7% (n=41) of all operations the gloves remained intact based on observation by sight and in none of the observed operations broken gloves were kept in use. No statistically significant correlation between adherent indicator glove use and changing of broken gloves was noticed (η =0.421, *p*

> 0.05). Blood stains were immediately removed according to guideline in 66% (n=6, mean 0.67, SD 0.5) and not removed in 34% (n=3) of the observed operations with visible splatter (n=9). No need for blood stain removal was noted in 40 observed operations.

5.6 Door openings during surgery

The number of door openings-variable was not included in the summation variable of aseptic behaviour because of its scale-form and was examined as a separate objective. The mean number of door openings during the observed 49 operations was 6.45 (SD 3.753), with a maximum of 18 and minimum of one door opening (Table 11). The range of door openings was 17. In 89.8% of cases the door openings during surgery were 10 or less and in 10.2% the doors were opened 11 times or more. In operations which lasted 45 minutes or less (n=24), the doors were opened approximately five times (mean 4.88, SD 2.708). When the operation lasted more than 45 minutes (n=25), the times opening the door was approximately eight (mean 7.96, SD 4.036). The Pearson correlation ($л$ = 0.415, p = 0.003) points that an operation with duration more than 45 minutes has a statistically significant connection with the number of door openings, resulting that a longer operation possibly leads to more traffic than a surgery with shorter duration.

The average number of door openings in implant surgeries (n=6) was 10 times (mean 10.33, SD 3.933) and in non-implant surgeries (n=43) six times (mean 5.9, SD 3.435). The variation of door openings was wide between operations: In implant surgeries the range varied from seven to 18, and from one to 17 in non-implant operations. The normally distributed data was analysed by t-test leading to the conclusion that the differences in mean number of door openings between implant and non-implant surgeries (t = -2.91, p = 0.006) was statistically significant. With small sample size of implant surgeries, the result is not directly comparable to non-implant surgeries.

Number of door openings during operation	N	Mean	SD	Minimum	Maximum
All operations	49	6.45	3.753	1	18
Operation time 45min or less	24	4.88	2.708	1	12
Operation time 46 min or more	25	7.96	4.036	3	18
Implant surgery	6	10.33	3.933	7	18
Non-implant surgery	43	5.91	3.435	1	17

Table 11: Number of door openings

5.7 Maintenance of sterile field

Maintenance of sterile field was recommendation adherent in 76.9% (mean 2.31, SD 0.822) of operations. The actualisation of sterile field maintenance is presented in Table 12. The most

adherent part of sterile field maintenance was unscrubbed person not moving between two sterile areas: In 81.6% (n=40, mean 0.82, SD 0.391) of operations the guideline was followed accordingly. Unscrubbed personnel kept eye contact and visible distance to sterile fields in 79.6% (n=39, mean 0.80, SD 0.407) of observed operations. Back was not turned to sterile fields buy sterile team members in 69.4% (n=34, mean 0.69, SD 0.466) of operations.

	Yes	No	Total	Mean	SD
Unscrubbed person does not move between two sterile fields	n=40 (81.6%)	n= 9 (18.4%)	N=49 (100%)	0.82	0.391
Unscrubbed person keep eye contact and visible distance to sterile fields	n=39 (79.6%)	n= 10 (20.4%)	N=49(100%)	0.80	0.407
Back is not turned to sterile fields by sterile team members	n=34 (69.4%%)	n=15 (30.6%)	N=49 (100%)	0.69	0.466

Table 12: Sterile field maintenance

5.8 Surgery duration

Table 13 presents duration of the operations related to AP. Aseptic behaviour did not differ in operations with duration of 45 minutes or less (n=24, mean 4.83, SD 0.482) and in operations of 46 minutes or more (n=25, mean 4.8, SD 0.408). During the maintenance of sterile field the recommendation adherence was higher in surgeries with shorter duration (n=24, mean 2.42, SD 0.776) than in operations of 46 minutes or more (n=25, mean 2.2, SD 0.866). There were no statistically significant differences in recommendation adherence between surgery duration and aseptic behaviour (t = 0.262, p >0.05) or sterile field maintenance (t = 0.921, p >0.05).

	Operation time 45-minute cut-off	N	Mean	SD
Aseptic behaviour	Duration 45min or less	24	4.83	0.482
	Duration 46min or more	25	4.80	0.408
Maintenance of sterile field	Duration 45min or less	24	2.42	0.776
	Duration 46min or more	25	2.20	0.866

Table 13: Surgery duration, aseptic behaviour and sterile field maintenance

5.9 Aseptic practices in implant surgeries

Of the observed operations 12% (n=6) were joint replacement surgeries. When evaluating the AP in implant surgeries, it was found similarly coherent as non-implant surgeries (Table 14). The SDs of mean values, measuring the distribution of recommendation adherence in implant surgeries varied from 0.00 to 0.333, being highest in aseptic behaviour and hand hygiene. Sterile team member preparations were highly adhered (100%) in joint replacement operations, no statistically significant difference between implant and non-implant surgeries was noted. There were statistically significant differences between non-implant and implant

surgeries in hand hygiene realisation (t = 2.197, p = 0.033), and aseptic behaviour (t = 3.110, p = 0.003). In implant surgery the door openings ($л$ = 0.391, p = 0.006) were frequent. A statistically significant correlation between surgery duration and implant surgery ($л$ = 0.531, p < 0.001) was also noted suggesting that joint replacement operations require longer operation time than non-implant operations. The correlation between implant surgery and hand hygiene realisation ($л$ = 0.305, p = 0.033) was statistically significant. Hand hygiene adherence was high (mean 1.5, SD 0.548) in joint replacement surgeries. A statistically significant correlation between implant surgery and aseptic behaviour ($л$ = -0.413, p = 0.003) was noticed.

	Implant surgery	N	Mean	SD	t-test, p
Hand hygiene products available	Yes	6	2.50	0.548	t = -0.886,
	No	43	2.21	0.773	p = 0.380
Hand hygiene realisation	Yes	6	1.50	0.548	t = 2.197,
	No	43	1.86	0.351	p = 0.033
Establishment of sterile field	Yes	6	3.67	0.516	t = -0.748,
	No	43	3.49	0.551	p = 0.458
Preparations of sterile personnel	Yes	6	4.00	0.000	t = -1.058,
	No	43	3.84	0.374	p = 0.296
Aseptic behaviour	Yes	6	4.33	0.516	t = 3.110,
	No	43	4.88	0.391	p = 0.003
Maintenance of sterile field	Yes	6	2.83	0.408	t = -1.711,
	No	43	2.23	0.841	p = 0.094
Number of door openings during operation	Yes	6	10.33	3.933	t = -2.909,
	No	43	5.91	3.435	p = 0.006
Surgery duration (minutes)	Yes	6	85.33	12.644	t = -4.292,
	No	43	45.23	22.256	p < 0.001

Table 14: Aseptic practices in implant surgeries and non-implant surgeries

6 Discussion

6.1 Realisation of aseptic practices in observed operations

There is little research implemented in observational research method to evaluate the behaviour and compare the actions of perioperative personnel although the AP of healthcare staff have been globally a target of interest in several studies. DeOliveira and Gama (2015) identified partial adherence to proposed measures for the prevention of SSI by the observed professionals and recommended training and monitoring as part of patient safety and quality control. Aholaakko (2018) stated that due to varying compliance to existing intraoperative

recommendations, the OR staff's adherence to AP requires improvement and that evidence-based recommendations to AP oblige thoroughly planned and implemented patient- and worker-safety focused projects which highlight the importance of continual multidisciplinary development in SSI-preventive actions. Similar findings were noticed in the results of this study.

Staff adherence to hand hygiene was in a good level in 91% of operations, but in 16.3% of observed surgeries a staff member was wearing nail products during surgery, although the national and hospital guidelines recommend to not wear nail polish in healthcare work with physical contact to the patient or healthcare equipment. The non-use of watches and rings was well established (98%), but according to guidelines the presence of hand jewellery should not be acceptable regardless of job description and surgery characteristics in the OR.

Preparations of the patient regarding timely AB-prophylaxis of 60 minutes before incision or tourniquet inflation was excellent 97.7%, compared to a Brazilian study with 81.8% PAP adherence (DeOliveira & Gama 2015), however in which the criterion of timing was 30-60 minutes and the results are not directly relatable. The aspect of contact precautions use was discarded from data analysis because no patients with need of isolation were operated during research period. The aspect of glove changing after 120 minutes was also removed from results, because there were no operations with duration of more than 98 minutes.

When evaluating the establishment of sterile fields, creating sterile table less than one hour before operation and not tossing sterile items on sterile table was 96% in this study evaluating orthopaedic operations. The acceptance of recommendations was 81.5% in breast surgery (Aholaakko 2018), which suggests that the adherence to sterile field creation recommendations is more rigorous in orthopaedic surgeries or has possibly improved among personnel since previous observation study. In four of the observed cases (8.2%) sterile table was created more than 60 minutes before operation and covered with a sterile cloth, which is not recommended by AORN (2010, 94-95) guidelines. Disinfection of a blood stain was performed in 66% of the observed events. In breast surgery the self-reported adherence to blood spill disinfection was 83.3% (Aholaakko 2018).

The surgical site asepsis, which was asked to be included to observation by study participants, was one of the most non-adherent areas observed (68.2%), and the personnel requested more education and information on the procedure. There is little education material on how to perform the theory of surgical site disinfection in practice and the policies between staff members and units vary based on learned practices, individual familiarization and former work experience. Previous findings of Zucco et.al. (2019) reasoned the lack of adherence to evidence-based practices among ward nurses to be attributed to inadequate training.

Sterile surgical team attire-related recommendations were well-established (100%), which reflects to the findings of DeOliveira and Gama (2015) with similar results. Adherence to double gloving was 93.9% and to the use of protective eyewear 91.8%, which is relatable to previous, although self-reported, results (Aholaakko 2018) suggesting that self-protective equipment is respected among personnel and willingness to protect oneself from patient-originated microbes is high. The adherence to goggle wearing was found consistent (SD 0.277) in this study compared to Aholaakko's (2018) results, in which variation was notable (SD 1.0) despite the good 80% acceptance of the recommendation. In this study the adherence of protective eyewear use was however evaluated only when there was a recognized risk of splattering and in the comparison study the goggle use was evaluated regarding all breast operations. Due to unpredicted events during invasive surgery the risk of droplet contamination is always present and there is a possibility of fluid contact e.g. when dosing local anaesthesia. It is justifiable to use protective eyewear in all operations despite the identified risk of notable splatter.

Aseptic behaviour without including the aspect of door openings was 90.7% of all operations. Use of adherent attire when sterile fields were open was 95.9% of observed operations, where usually mask was not worn at all times in the OR. A tear in sterile gloves was noticed in 16.3%, but in a Brazilian study (DeOliveira & Gama 2015) the glove breakage rate was 66.7% when inspected. Broken gloves were changed immediately after noticing a tear and reflected to sterile team attire-related results on self-protection. Because the integrity of the gloves was not inspected after wound closure, absolute results were not available. In the study of DeOliveira and Gama (2015), perforated gloves were discovered in 32.7% of cases of which half of the breakages were noticed by the participants. According to literature, there is little evidence on contamination rates between intraoperative glove change and not changing gloves. Ward et.al. (2014) stated that glove change after 60 minutes was associated with decreased intraoperative glove contamination rates. Lee et.al. (2015) discovered that gloves were torn in every fourth persons in joint replacement operations and Matsuoka et.al. (2021) noted that gloves did not remain intact even during laparoscopic operations where there was no contact to sharp bone edges. The most important aspect is for the operator to change the glove immediately after becoming aware of a breakage (Padhye et.al. 2011).

Personal backpacks or doctor's jackets were brought to OR in 6.1% of operations where they were highly exposed to secretion splatter. A connection between joint replacement operations and aseptic behaviour was noticed suggesting that aseptic behaviour during surgery was less coherent in implant surgeries, which practically meant that personal backpacks or doctor's jackets were often present in the room. According to guidelines, staff members should acknowledge the risk of microbe contamination of personal belongings and avoid bringing them to the OR. During observation the recommendations regarding not eating and drinking during surgery were highly adhered. The consuming of food and drinks in the OR

and other intensive healthcare environments remains as a substantial, but little examined contamination risk and should be included in organisational AP guidelines.

The average number of door openings was six in all observed operations and 10 in joint replacement operations, and based on results an operation with duration of more than 45 minutes had more door openings than a surgery of shorter duration. In the study of Aholaakko (2018), the average times of opening the OR door during breast surgery were between six and seven, and relatable to this study: When dividing the durations of surgeries to 45 minutes, it was noted that a shorter operation had approximately five door openings and a longer operation had eight. DeOliveira and Gama (2015) stated that OR door openings were noticed to be often unnecessary to the progress of the surgery and highlighted that the importance of the recommendation to remain doors closed should be strengthened. It was also detected during this research that there were several unnecessary door openings related to the operations of the surgery especially in joint replacement surgeries, which indicates that implementation of a prosthetic surgery-focused policy and guideline is current. The sample size of joint replacement surgeries was however relatively small (n=6) with wide range of door openings being between seven and 18 (mean 10.33, SD 3.933). To reach plausible results on AP in implant surgeries, a study focused on joint replacement operations with adequate sample size should be implemented. Based on literature (DeOliveira & Gama 2015; Tarabichi & Parvizi 2023) and results of this study, a culture of minimizing door openings during operation is advisable to be assimilated in the OR to reduce traffic. Aholaakko´s (2018) study found high acceptance for recommendations on sterile field maintenance among sterile personnel in limiting the number of door openings and supervising the sterile field. In this study the realisation of sterile field supervision and unscrubbed person not moving between two sterile fields was 76.9% with relatively wide variation (SD 0.822) between items. In Aholaakko's (2018) study, the acceptance of the same objectives was 93.9% and more consistent (SD 0.499). The result suggests most importantly that improvement on maintaining and supervising sterile fields is current.

6.2 Reliability, validity and biases of the study

High-quality study requires evaluation on reliability, validity and possible biases. Reliability evaluates the consistency, dependability and repeatability of the measuring instrument, and validity describes the ability of the measuring instrument to provide data on the intended objective (Polit & Beck 2004, 35-36). Clinical observation and criteria-based evaluation are commonly used in observational studies and are beneficial to analyse healthcare work. Statistical analysis can be used to analyse the collected quantitative data (Heikkilä 1998, 17-18). The used study method was qualitative research followed by quantitative data analysis, which included qualitative features in open ended field notes for organizational purposes and feedback sessions for the participants after observations. Each criterion in the

“Intraoperative aseptic practices of operating room personnel”-observation tool was verified by internationally acknowledged, approved and peer reviewed academic research, existing international and national guidelines (Appendices 1-3) and Aholaakko’s (2018) Baseline model for intraoperative aseptic practices. The aspects of assessment are simple and easy to observe by a single observer to minimize the risk of actions left unnoticed. The final assessment of usefulness and possible bias of the study method was done with CASP Critical Appraisal Skills Programme-tool. Answering “yes” to the first two questions when planning the research project led to the conclusion that continuation of the project was profitable.

A limitation of the study was that no post-operative follow-up on SSI rates related to the observed operations was conducted, or a separate follow-up study on the development of intraoperative AP. Also no information was collected about the age, background, level of experience or education of the participants, which would have been useful to be able to evaluate the reasons of certain AP. The process of surgical hand preparation and use of hand disinfectant during the surgery were not assessed in the study. The observation of hand disinfection events and surgical rub with alcohol-based hand disinfectant performed before donning sterile gloves requires specific attention and should be evaluated as a separate aseptic practice measure or by another observer because surgical hand rub often starts outside the OR in the hand washing station. Hence there are existing instruments for measuring hand hygiene compliance (Ojanperä et.al. 2022; Flowmedik: eHuuhde, eLeikkaus), observational research regarding the topic should be easy to implement and is highly recommended to be regularly evaluated in Finnish public hospital wards and OR-units. Also aspects of sterile field disestablishment were not included to study objectives. The tool for quality control created can be used for the evaluation of future development and modified for individual purposes, for example by including aspects of sterile field disestablishment, maintenance of OR equipment and devices or a separate observation form on hand hygiene in the OR and awakening room facility.

Real-time clinical observation is vulnerable for external distractions because the reliability of data collecting is based on visible actions detected by the observer. Observational study method requires rigor, careful planning and accurate implementation for successful data collection (Crosby et.al. 2006, 126). The probable biases in the research results are data collecting-related, where AP are falsely interpreted or undetected by the observer. Because of the limited settings of the organization, the participants of the research were not able to be previously determined and same participants were likely be observed multiple times, which increased the risk of bias. The presence of the observer may have affected on the behaviour of the participants during the observation, but Crosby et.al. (2006, 188) note that momentary behaviour change is necessarily not leading to permanent development in practice.

The researcher observed possible breaches in sterility during the operation and informed the personnel if such breach occurred. Hence it would have been unethical not to inform a breach in sterility due to patient safety reasons, the researcher was not able to remain completely objective during observation. The subjectivity of the researcher is a significant factor of study trustworthiness to prevent distortion in collecting and processing the data (Polit & Beck 2004, 37). The researcher was obligated to provide adequate information in the published research report to allow a thorough critical assessment of the study characteristics and avoid mirroring their own values and experiences in the study settings (Burns & Grove 2011, 75, 97). During the observation there were interpretable aspects, such as distance between sterile and unsterile areas, which cannot be accurately measured by sight. The aspect of surgical site disinfection is performed in the direction of the flow was added to the tool at the beginning of the research based on staff feedback and was not evaluated in the first five observation events.

For the evaluation of scale reliability and internal consistency the Cronbach's α-reliability coefficient has been used in similar studies (Aholaakko 2018, Parnikh et.al. 2022), but was not chosen for this study after receiving unreliable results in tests. Probable reasons for receiving inaccurate values in tests were different scales, missing values and low number of items in a scale, which was in many themes was as little as two. A larger scale of four to seven items is at its best when using Cronbach α to evaluate the scale reliability (Burns & Grove 2011, 357-358). Also a larger sample size would possibly increase the reliability of the themes; according to Heikkilä (1998, 187), the smaller the sample size, the more random and imprecise are the results and a decent sample size is considered above 100. To reach reliable information on the internal consistency of the summation variables, the tool and variable scores of the data should be readjusted to match an equal scale (Burns & Grove 2011, 357-358) which was not possible without substantially changing the evaluated themes or analysing methods. In this study the scoring of the scales varied from 1 to 5 depending on the number of items in scale. Using an equal scale, adding more variables or combining them could have improved the value. Previous studies have used 25- and 19-item scales of 4- and 5-point scoring when measuring sterile field establishment and maintenance (Aholaakko 2018, Parnikh et.al. 2022), which increases the reliability of the scales when using Cronbach α-coefficient for the analysis. The evaluation of scale reliability was decided not to be included in the report due to small sample size and uneven scores of the summation variables.

Several previous studies on AP have been conducted with cross-sectional methods using self-evaluating questionnaires when also the use of Likert-scale has been possible. To develop the used tool for future use, it should be adjusted to reach matching scores in the scales. The themes also should be narrowed and combined to have as high amount of items in scales as possible to increase scale reliability. During the research, the importance of IPC, AT and AB were brought to the attention of staff members and highlighted as part of patient safety in

the organization. The study can be repeated and continued in similar environments in previous or other ORs as a follow-up study or as separate quality control of a single unit, but for academic research purposes the adjustment of the tool and data analysis is necessary to reach plausible scale reliability values.

6.3 Ethical issues

Permission to implement the research project was given by the medical director of all the five study hospitals in the organization. Research permit was approved by administrative director of the organization based on thesis plan. Study implementation was approved by medical directors and nurse managers of each OR unit.

The research was conducted following the ethical guidelines of the Rectors' Conference of Finnish Universities of Applied Sciences Arene (2023) and the Finnish National Board on Research Integrity TENK (2019, 8-10) which has defined the ethical principles of research with human participants in Finland. An ethical review of the ethics committee was not applied because patient records or customer related information were not subjects of the study or handled in any way during the process. The medical and administrative directors of the organization stated that there was no need for informed consent of patients because no patient data was included in the project. The researcher was already obliged to professional confidentiality based on professional status in the organization.

The privacy of all stakeholders was protected during and after the research project. The confidentiality of information regarding the organization, participants and study results was secured. The information letter (Appendix 9) and participation document (Appendix 10) of staff members were distributed anonymously and research material was collected without including personal data in the process. According to the European Data Protection Board (EDPB 2016) article 32, if personal data is processed during a study, the researcher is obliged to ensure the security of personal data handled during and after the research process by providing a carefully planned data preservation. All identity included data must be handled encrypted, but by ensuring the accessibility to the data in case of a technical incident (EDPB 2016). General Data Protection Regulation (EDPB 2016) article 33 states that if a personal data breach should occur, the researcher is required to inform the supervisory authority. No personal information on study participants was necessary to collect and all research related data content was handled anonymously. The participating units were informed about the upcoming research in early January 2023 (Appendix 9). Research integrity was ensured by informing the personnel observed in advance via the information letter sent by email and verbal personnel informed consent. The informed consent was collected verbally from each staff member of the OR participating and being under observation during the research

(Appendix 10). The collected study material was secured and stored by the researcher. The feedback on AP was given respectfully and in an encouraging manner.

The relationship between researcher, participants and the commissioning organization was evaluated. The researcher was working in the administration of the organization which enabled access to the study environments. The role of the profession required unbiased and objective approach to the personnel, IPC measures and AB, which was the prevalent policy in research implementation. The researcher had no personal advantage regarding research results. The funding of the research was covered by the commissioning organization acting as employer of the researcher. Research related expenses were travel and accommodation expenses of the observation period.

6.4 Recommendations according to results

Based on the results of this study, there are areas of improvement in the AP of OR personnel especially when it comes to sterile field establishment and maintenance, and aseptic behaviour during surgery. AP are teamwork that are affected by all individuals in the OR and are fulfilled based on everyone's effort. To enable adequate IPC in intraoperative settings, it is recommended to implement simple common guidelines and policies, regular education, training and monitoring of AP concerning all OR staff members regardless of their job description.

For future development, the presence of hand hygiene enabling instruments should be ensured in OR settings especially regarding the positioning of the products: Gloves were accessible in three spots in the room in half of the observed cases, and located near hand disinfectants in 77.6%. The importance of hand hygiene and not wearing nail polish, jewellery and rings in healthcare work should be emphasized to improve staff hand hygiene adherence. Hands-on training on surgical site asepsis is recommended.

A national guideline for joint replacement procedures should be implemented to achieve a compatible IPC-policy based on international and welfare-area targeted recommendations. Limiting OR-door traffic during surgery should be highlighted and the use of phone calls as primary communication method between OR and exteriors should be preferred to minimize the number of door openings. A clear AP guideline is recommended to be implemented in prosthetic joint surgery process.

The use of double gloves and eyewear as self-protection is recommended for sterile team members as the hospital guidelines already state. The maintenance of sterile fields should be acknowledged as an important task of both sterile and non-sterile personnel. To ensure that sterile fields remain sterile and to minimize the risk of contamination eye contact and visible distance to sterile areas should be kept by all unsterile staff members and especially by the

circulating nurse, who acts as the supervisor of breaches in sterility. The sterile team has the responsibility of supervising the sterile instrument table and not turning their back to it.

The observed personnel were open-minded for research during the study period, requested feedback on their AP during surgery and pursued to behaviour change and practice development immediately afterwards. The reflection between staff members and the observer was productive during feedback sessions after observation. Because of the enthusiastic involvement of the OR personnel, it would be most profitable to involve staff in behaviour change targeting policy development. The expected impact of the study was that after development measures taken based on results AP become a routine in daily work. The results enable to educate staff for better AB and AT, which leads to improved hand hygiene among OR staff and possibly decreased number of SSI. The aim was to create an instrument for measuring the AP of OR personnel, to achieve information on staff adherence to AP in the OR, to achieve comparable results between units and provide proposal of improvement. All the previously mentioned outcomes can be a medium to improve the AP of OR staff.

References

Printed

AORN, Association of periOperative Registered Nurses. 2010. Perioperative Standards and Recommended Practices for Inpatient and Ambulatory Settings, 2010 Edition. Denver: AORN Inc.

Alkula, T., Pöntinen, S. & Ylöstalo, P. 1994. Sosiaalitutkimuksen kvantitatiiviset menetelmät. Juva: WSOY.

Anttila, V-J. & Asikainen, V. 2010. Sairaaloiden ja hoitolaitosten LVI-ratkaisut ja infektioidentorjunta. In the book: Anttila, V., Hellstén, S., Rantala, A., Routamaa, M., Syrjälä, H. & Vuento, R. 2010. Hoitoon liittyvien infektioiden torjunta. Helsinki: Suomen kuntaliitto.

Ayukekbong, J. 2019. Infection prevention and control guide for health care professionals. Nanaimo, BC, Canada: EpiTech Public Health. 257-261.

Burns, N. & Grove, S.K. 2011. Understanding nursing research: Understanding an evidence-based practice. 5th edition. Maryland Heights: Elsevier inc.

Crosby, R. A., DiClemente, R. J., Salazar, L. F. & Salazar, L. F. 2006. Research methods in health promotion. San Francisco, CA: Jossey-Bass. 126, 188.

Heikkilä, T. 1998. Tilastollinen tutkimus. Helsinki: Edita. 187.

Phillips, N. F. & Hornacky, A. 2021. Berry & Kohn's operating room technique. Fourteenth edition. St. Louis, Missouri: Elsevier. 252-259.

Polit, D. F. & Beck, C. T. 2004. Nursing research: Principles and methods. 7. ed. Philadelphia (Pa.): Lippincott Williams & Wilkins. 320–321.

Rantala, A., Huotari, K., Hämäläinen, M. & Teirilä, I. 2010. Leikkausalueen infektioiden ehkäisytoimet. In the book: Anttila, V., Hellstén, S., Rantala, A., Routamaa, M., Syrjälä, H. & Vuento, R. 2010. Hoitoon liittyvien infektioiden torjunta. Helsinki: Suomen kuntaliitto.

Rantala, A. 2010. Leikkaussalin ilmastointi. In the book: Anttila, V., Hellstén, S., Rantala, A., Routamaa, M., Syrjälä, H. & Vuento, R. 2010. Hoitoon liittyvien infektioiden torjunta. Helsinki: Suomen kuntaliitto.

Teirilä, I. & Pekkala, S. 2010. Siivous ja pintojen desinfektio. In the book: Anttila, V., Hellstén, S., Rantala, A., Routamaa, M., Syrjälä, H. & Vuento, R. 2010. Hoitoon liittyvien infektioiden torjunta. Helsinki: Suomen kuntaliitto.

WHO. 2009a. Guidelines on hand hygiene in healthcare. ISBN 9789241597906. Geneva: World Health Organization.

WHO. 2015. World Health Organization. Global Action Plan on Antimicrobial Resistance. ISBN 9789241509763. Geneva: WHO Document Production Services.

WHO. 2016. World health organization. Global guidelines for the prevention of surgical site infection, 2nd edition. Geneva: WHO Document Production Services.

WHO. 2021. World health organization. Resource considerations for investing in hand hygiene improvement in health care facilities. ISBN 978-92-4-002589-9. Geneva: World Health Organization.

Electronic

Aarnio, P. & Laine, T. 2001. Glove perforation rate in vascular surgery - a comparison between single and double gloving. VASA, 30 (2):122-124. Accessed November 27th, 2022. https://doi.org/10.1024/0301-1526.30.2.122.

Aholaakko, T-K. & Metsälä, E. Aseptic practice recommendations for circulating operating theatre nurses. British Journal of Nursing (Mark Allen Publishing), 24 (13): 670-678. Accessed November 3rd, 2022. https://doi.org/10.12968/bjon.2015.24.13.670.

Aholaakko, T-K. 2018. Intraoperative aseptic practices and surgical site infections in breast surgery. Academic Dissertation. University of Helsinki 2018. https://helda.helsinki.fi/handle/10138/249327. Accessed August 26, 2022.

Aisien, A. & Ujah, I. 2006. Risk of blood splashes to masks and goggles during caesarean section. Medical science monitor, 12 (2): CR94-CR97. Accessed November 10th, 2022. https://medscimonit.com/abstract/index/idArt/445245.

Allegranzi, B. & Pittet, D. 2009. Role of hand hygiene in healthcare-associated infection prevention. Journal of Hospital Infection, 73 (4): 305-315. Accessed October 29th, 2022. https://doi.org/10.1016/j.jhin.2009.04.019.

Allegranzi, B., Sax, H. & Pittet, D. 2013. Hand hygiene and healthcare system change within multi-modal promotion: A narrative review. The Journal of hospital infection, 83: S3-S10. Accessed December 11th, 2022. https://doi.org/10.1016/S0195-6701(13)60003-1.

Allegranzi, B. 2014. The burden of surgical site infections worldwide. SSI surveillance in Europe 2008-2009.14th IFIC Conference, Malta, 12-15 March 2014. Accessed October 29th, 2022. https://www.theific.org/wp-content/uploads/2014/10/025.pdf

Allegranzi, B., Aiken, A. M., Zeynep Kubilay, N., Nthumba, P., Barasa, J., Okumu, G., Mugarura, R., Elobu, A., Jombwe, J., Maimbo, M., Musowoya, J., Gayet-Ageron, A. & Berenholtz, S. M. 2018. A multimodal infection control and patient safety intervention to reduce surgical site infections in Africa: A multicentre, before–after, cohort study. The Lancet infectious diseases, 18 (5): 507-515. Accessed February 6, 2022. https://doi-org.nelli.laurea.fi/10.1016/S1473-3099(18)30107-5

AORN. 1998. Recommended practices for surgical attire: The Official Voice of Perioperative Nursing. AORN Journal, 68 (6). Accessed November 27th, 2022. https://doi.org/10.1016/S0001-2092(06)62146-7.

AORN. 2005. Recommended Practices for Surgical Attire. AORN Journal, 81 (2): 413,418-416,420, https://doi.org/10.1016/S0001-2092(06)60424-9. Accessed September 30th, 2022.

AORN. 2006. AORN Recommended Practices: Recommended Practices for Maintaining a Sterile Field. AORN Journal, 83 (2): 402,407,410,413-404,408,410,416. Accessed December 10th, 2022. https://doi.org/10.1016/S0001-2092(06)60171-3.

AORN. 2007. Recommended Practices for Prevention of Transmissible Infections in the Perioperative Practice Setting. AORN journal, 85 (2): 383-396. Accessed November 9th, 2022. https://doi.org/10.1016/S0001-2092(07)60049-0.

AORN. 2017. Guideline Summary: Hand Hygiene. AORN Journal, vol. 105 (2): 213-217. Accessed September 30th, 2022. https://doi.org/10.1016/j.aorn.2016.12.00.

AORN. 2018. Sterile Technique. AORN Journal, 108 (6): 705-710. Accessed March 2nd, 2023. https://doi.org/10.1002/aorn.12458.

Arene. 2023. The Rector´s conference of Finnish Universities of Applied Sciences. Accessed May 16th, 2023. https://www.arene.fi/the-rectors-conference-of-finnish-universities-of-applied-sciences-arene/

Arrowsmith, V. A. & Taylor, R. 2014. Removal of nail polish and finger rings to prevent surgical infection. Cochrane Database of Systematic Reviews 2014, Issue 8. Art. No.: CD003325. Accessed November 25th, 2022. https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD003325.pub3/epdf/full

Autorino, C. M., Battenberg, A., Blom, A., Catani, F., ElGanzoury, I., Farrell, A., Georgini, A., Goswami, K., Hernandez, V., Karas, V., Kunutsor, S.K., Lewallen, D.G., Mahmoud, A.N. & Young, S. 2019. General Assembly, Prevention, Operating Room - Surgical Attire: Proceedings of International Consensus on Orthopedic Infections. The Journal of arthroplasty, 34 (2): S117-S125. Accessed November 25th, 2022. https://doi.org/10.1016/j.arth.2018.09.061.

Badia, J., Casey, A., Petrosillo, N., Hudson, P., Mitchell, S. & Crosby, C. 2017. Impact of surgical site infection on healthcare costs and patient outcomes: A systematic review in six European countries. The Journal of hospital infection, 96 (1): 1-15. Accessed October 15th, 2022. https://doi.org/10.1016/j.jhin.2017.03.004

Bashaw, M.A. & Keister, K.J. 2019. Perioperative Strategies for Surgical Site Infection Prevention. AORN journal, 109 (1): 68-78. Accessed October 29th, 2022. https://doi.org/10.1002/aorn.12451.

BD. 2023. Chloraprep Patient preoperative skin preparation product. Accessed March 19th, 2023. https://www.bd.com/en-us/products-and-solutions/products/product-brands/chloraprep#applicators

Bekele, A., Makonnen, N., Tesfaye, L. & Taye, M. 2017. Incidence and patterns of surgical glove perforations: Experience from Addis Ababa, Ethiopia. BMC surgery, 17 (1): 26. Accessed December 7th, 2022. https://doi.org/10.1186/s12893-017-0228-8.

Berrios-Torres, S. I., Umscheid, C. A., Bratzler, D. W., Leas, B., Stone, E. C., Kelz, R. R., Reinke, C., Sherry, M., Solomkin, J. S., Mazuski, J. E., Dellinger, E. P., Itani, K. M. F., Berbari, E. F., Segreti, J., Parvizi, J., Blanchard, J., Allen, G., Kluytmans, J. A. J. W., Donlan, R. & Schecter, W. P. 2017. CDC Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017. JAMA surgery, 152 (8): 784-791. Accessed November 21st, 2022. https://doi.org/10.1001/jamasurg.2017.0904.

Bible, J.E., Biswas, D., Whang, P.G., Simpson, A K. & Grauer, J.N. 2009. Which Regions of the Operating Gown Should be Considered Most Sterile? Clinical orthopaedics and related research, 467 (3): 825-830. Accessed November 9th, 2022. https://doi.org/10.1007/s11999-008-0341-1.

Bible, J. E., O'Neill, K. R., Crosby, C. G., Schoenecker, J. G., McGirt, M. J. & Devin, C. J. 2013. Implant contamination during spine surgery. The spine journal, 13 (6): 637-640. Accessed November 10th, 2022. https://doi.org/10.1016/j.spinee.2012.11.053.

Birgand, G., Azevedo, C., Toupet, G., Pissard-Gibollet, R., Grandbastien, B., Fleury, E. & Lucet, J. 2014. Attitudes, risk of infection and behaviours in the operating room (the ARIBO Project): A prospective, cross-sectional study. BMJ open, 4 (1): e004274. Accessed March 7th, 2023. https://doi.org/10.1136/bmjopen-2013-004274.

Birgand, G., Haudebourg, T., Grammatico-Guillon, L., Ferrand, L., Moret, L., Gouin, F., Mauduit, N., Leux, N., Le Manche, Y., Lepelletier, D., Tavernier, E., Lucet, J-C. & Giraudeau, B. 2019. Improvement in staff behavior during surgical procedures to prevent post-operative complications (ARIBO(2)): Study protocol for a cluster randomised trial. Trials, 20 (1): 275. Accessed March 7 th, 2023. https://doi.org/10.1186/s13063-019-3370-z.

Blom, A., Barnett, A., Ajitsaria, P., Noel, A. & Estela, C. 2007. Resistance of Disposable Drapes to Bacterial Penetration. Journal of orthopaedic surgery (Hong Kong), 15 (3): 267-269. Accessed December 10th, 2022. https://doi.org/10.1177/230949900701500303.

Boucherabine, S., Nassar, R., Mohamed, L., Olsen, M., Alqutami, F., Zaher, S., Hachim, M., Alkhajeh, A., MicKirdy, S., Alghafri, R., Tajouri, L. & Senok, A. 2022. Healthcare Derived Smart Watches and Mobile Phones are Contaminated Niches to Multidrug Resistant and Highly Virulent Microbes. Infection and drug resistance, 15: 5289-5299. Accessed November 4th, 2022. https://doi.org/10.2147/IDR.S378524.

Bussieres, M., L'Esperance, S., Coulombe, M. & Rhainds, M. 2017. Evaluation of the surgical tray opening procedure in operating suites: Systematic review and recommendations/ Evaluation de la procedure d'ouverture des plateaux chirurgicaux dans les blocs operatoires: revue systematique et recommandations. ORNAC journal, 35 (1): 46. Accessed December 10th, 2022. https://www-proquest-com.nelli.laurea.fi/scholarly-journals/évaluation-de-la-procédure-douverture-des/docview/1881949436/se-2.

Carroll, H. 2015. Department of Health: Surgical Skin Disinfection Guideline. Australian Department of Health. Approved December 9th, 2015. Accessed March 5th, 2023. https://www.health.qld.gov.au/__data/assets/pdf_file/0020/444422/skin-disinfection.pdf

CASP Critical Appraisal Skills Programme-tool. Creative commons contribution. www.casp-uk.net. Accessed November 4th, 2022.

CDC. 2002. Centers for Disease Control and Prevention. Guideline for Hand Hygiene in Health-Care Settings: Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. Recommendations and Reports October 25, 51 (RR-16). Accessed November 27th, 2022. https://www.cdc.gov/mmwr/PDF/rr/rr5116.pdf#page=19.

CDC. 2016. Centers for Disease Control and Prevention. Standard precautions for all patient care. Last reviewed January 26th, 2016. Accessed November 25th, 2022. https://www.cdc.gov/infectioncontrol/basics/standard-precautions.html

CDC. 2022. Centers for Disease Control and Prevention. Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings (2007, updated May 2022). Accessed November 11th, 2022. https://www.cdc.gov/infectioncontrol/pdf/guidelines/isolation-guidelines-H.pdf.

DeKay, K. 2022. Five New Hand Hygiene Practices to Reduce Infection. AORN. Accessed November 27th, 2022. https://www.aorn.org/about-aorn/aorn-newsroom/periop-today-newsletter/2022/2022-articles/new-hand-hygiene-practices.

DeOliveira, A. C. & Gama, C. S. 2015. Evaluation of adherence to measures for the prevention of surgical site infections by the surgical team. Revista Da Escola De Enfermagem Da U S P, 49 (5): 767. Accessed December 2nd, 2022. https://www.scielo.br/j/reeusp/a/cWs5fQWDxSn7XQcBFbNL8Vq/?format=pdf&lang=en

Dharan, S. & Pittet, D. 2002. Environmental controls in operating theatres. The Journal of hospital infection, 51 (2):79-84. Accessed November 27th, 2022. https://doi.org/10.1053/jhin.2002.1217.

Dumville, J. C., McFarlane, E., Edwards, P., Lipp, A. & Holmes, A. 2013. Preoperative skin antiseptics for preventing surgical wound infections after clean surgery. Cochrane database of systematic reviews, 3: CD003949. Accessed March 5th, 2023. https://doi.org/10.1002/14651858.CD003949.pub3.

ECDC. 2013. Systematic review and evidence-based guidance on perioperative antibiotic prophylaxis. June 2013. Stockholm: ECDC.ISBN 978-92-9193-484-3. Accessed November 30th, 2022. https://www.ecdc.europa.eu/sites/default/files/media/en/publications/Publications/Perioperative%20antibiotic%20prophylaxis%20-%20June%202013.pdf

ECDC. 2019. Healthcare-associated infections: surgical site infections - Annual Epidemiological Report for 2017. Accessed November 15th, 2022. https://www.ecdc.europa.eu/en/publications-data/healthcare-associated-infections-surgical-site-infections-annual-1.

EDPB 2016. European Data Protection Board. REGULATION (EU) 2016/679 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation). Accessed December 15th, 2022. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32016R0679&from=FI#d1e3722-1-1

Fernando, S. A., Gray, T. J. & Gottlieb, T. 2017. Healthcare-acquired infections: Prevention strategies. Internal medicine journal, 47 (12): 1341-1351. Accessed November 9th, 2022. https://doi.org/10.1111/imj.13642.

Finlex 1994. Health Care Professionals Act No. 559/1994, 7 § (20.3.2015/262). Accessed November 25th, 2022. https://www.finlex.fi/en/laki/kaannokset/1994/en19940559_20110312.pdf.

Finlex 2021. Valtioneuvoston asetus henkilönsuojainten valinnasta ja käytöstä työssä 427/2021 (20.5.2021). Accessed April 7th, 2023. https://finlex.fi/fi/laki/alkup/2021/20210427

Finntensid. 2023. Erisan Pro Dermades. Accessed March 19th, 2023. https://www.finntensid.fi/Dermades-Ihodesinfektioaine-500-ml

Flowmedik. 2022. Infection prevention and hospital cleaning services. eHuuhde and eLeikkaus. Accessed November 6th, 2022. https://www.flowmedik.com/tuotteet/infektiotorjunta-ja-laitoshuolto.

Friberg, B. & Friberg, S. 2005. Aerobiology in the operating room and its implications for working standards. Proceedings of the Institution of Mechanical Engineers. Part H, Journal of engineering in medicine, 219 (2): 153-160. Accessed December 2nd, 2022. https://doi.org/10.1243/095441105X9282.

Friberg, B., Friberg, S., Östensson, R. & Burman, L. 2001. Surgical area contamination – comparable bacterial counts using disposable head and mask and helmet aspirator system, but dramatic increase upon omission of headgear: An experimental study in horizontal laminar airflow. The Journal of hospital infection, 47 (2): 110-115. Accessed December 7th, 2022. https://doi.org/10.1053/jhin.2000.0909.

GBD 2022. Global burden of disease GBD 2019 Antimicrobial Resistance Collaborators. Global mortality associated with 33 bacterial pathogens in 2019: a systematic analysis for the Global Burden of Disease Study 2019. Accessed November 22nd, 2022. https://doi.org/10.1016/S0140-6736(22)02185-7.

Gillespie, W. J. & Walenkamp G. H. I. M. 2010. Antibiotic prophylaxis for surgery for proximal femoral and other closed long bone fractures. Cochrane Database of Systematic Reviews 2010, Issue 3. Art. No.: CD000244. Accessed December 5th, 2022. https://doi.org//10.1002/14651858.CD000244.pub2

Gillespie, B.M., Kang, E., Roberts, S., Lin, F., Morley, N., Finigan, T., Homer, A & Chaboyer, W. 2015. Reducing the risk of surgical site infection using a multidisciplinary approach: an integrative review. Journal of Multidisciplinary Healthcare, 8: 473-487. Accessed November 3rd, 2022. https://doi.org/10.2147/JMDH.S73565.

Girard, N. J. 2008. Eating or Drinking in the OR: Another Safety Factor? AORN journal, 87 (5): 901-902. https://doi.org/10.1016/j.aorn.2008.04.004.

Gosselin, R. A., Roberts, I. & Gillespie, W. J. 2004. Antibiotics for preventing infection in open limb fractures. Cochrane Database of Systematic Reviews 2004, Issue 1. Art. No.: CD003764. Accessed December 5th, 2022. https://doi.org//10.1002/14651858.CD003764.pub2

Handaya, A. Y. & Werdana, V. A. P. 2019. Adherence to preoperative hand hygiene and sterile gowning technique among consultant surgeons, surgical residents, and nurses: A pilot study at an academic medical center in Indonesia. Patient safety in surgery, 13 (1): 11. Accessed November 9th, 2022. https://doi.org/10.1186/s13037-019-0193-5.

Harnoss, J. C., Kramer, A., Heidecke, C. D. & Assadian, O. 2010. What is the Appropriate Time-Interval for Changing Gloves During Surgical Procedures? Zentralblatt fur Chirurgie, 135 (1): 25-27. Accessed November 10th, 2022. https://doi.org/10.1055/s-0029-1224684.

Hopper, R. & Moss, R. 2010. Common Breaks in Sterile Technique: Clinical Perspectives and Perioperative Implications. AORN Journal, 91 (3): 350-367. Accessed March 5th, 2023. https://doi.org/10.1016/j.aorn.2009.09.027.

HUCH 2017. Helsinki University Central Hospital. 2.4 Staff clothing. 7.9.2017. HUCH Infectious diseases clinic. Accessed December 14th, 2022. https://www.hus.fi/sites/default/files/2020-09/2.4_Ty%C3%B6vaatetus.doc

HUCH 2019. Helsinki University Central Hospital. 2.2 Surgical hand disinfection. 6.9.2019. HUCH Infectious diseases clinic. Accessed December 14th, 2022. https://www.hus.fi/sites/default/files/2020-09/2.2_Kirurginen_k%C3%A4sienpesu_ja_desinfektio.docx

HUCH 2021. Helsinki University Central Hospital. Preparing of adult patient for a surgical operation. 9.7.2021. HUCH Infectious diseases clinic. Accessed December 14th, 2022. https://www.hus.fi/sites/default/files/2022-01/Aikuispotilaan%20valmistelu%20leikkaukseen%20ja%20leikkausalueen%20infektioiden%20ehk%C3%A4isy.pdf

HUCH 2022. Helsinki University Central Hospital. Hand hygiene protocol. HUCH Infectious diseases clinic 4.5.2022. Accessed December 14th, 2022. https://www.hus.fi/sites/default/files/2022-05/kasihygienia_0.pdf

Hughes, K. A., Cornwall, J., Theis, J. & Brooks, H. J. L. 2013. Bacterial contamination of unused, disposable non-sterile gloves on a hospital orthopaedic ward. Australasian Medical Journal (Online), 6 (6): 331-338. Accessed November 10th, 2022. https://doi.org/10.4066/AMJ.2013.1675.

JBI 2020. Analytical Checklist for Cross-Sectional Studies. Critical Appraisal tools for use in JBI Systematic Reviews. Accessed December 10th, 2022. https://jbi.global/sites/default/files/2020-07/Checklist_for_Analytical_Cross_Sectional_Studies.pdf

The Joint Commission. 2009. Measuring Hand Hygiene Adherence: Overcoming the Challenges. Accessed May 11th, 2022. https://www.jointcommission.org/-/media/tjc/documents/resources/hai/hh_monograph.pdf.

Karakus, O. & Sarı, A. S. 2020. At what point during total knee arthroplasty operations are gloves most frequently torn? Journal of orthopaedic surgery (Hong Kong), 28 (3): 2309499020959167. Accessed November 10th, 2022. https://doi.org/10.1177/2309499020959167.

KiiltoClean. 2022. Erisan Pro Käsidesi. Accessed November 9th, 2022. https://pim.kiiltoclean.com/kiilto-pim-api/api/pdf/download/edd7f7fb-190b-41b6-aa76-33cda70a4776.

Knoll, P.A. & Browne, J.A. 2017. Prepping the knee in maximal flexion: getting into every nook, cranny, and fold. Arthroplasty today, 3 (2): 99-103. Accessed March 2nd, 2023. https://doi.org/10.1016/j.artd.2016.08.004

Korhonen, A., Ojanpera, H., Puhto, T., Jarvinen, R., Kejonen, P. & Holopainen, A. 2015. Adherence to hand hygiene guidelines - significance of measuring fidelity. Journal of clinical nursing, 24 (21-22): 3197-3205. Accessed November 4th, 2022. https://doi.org/10.1111/jocn.12969.

Korniewicz, D. & El-Masri, M. 2012. Exploring the benefits of double gloving during surgery: The official voice of perioperative nursing. AORN Journal, 95 (3): 328-36. Accessed March 7th, 2023. https://doi.org/10.1016/j.aorn.2011.04.027.

Kurvinen, T., Terho, K., Kaarto, A-M., Harttio-Nohteri, A., Laaksonen, M., Yli-Takku, E., Valkama, K., Rintala, E., Marttila, H. & Ylitupa, E. 2018. Sairaalahygienia ja infektiontorjunta: Suositus hoitoon liittyvien infektioiden torjunnasta Varsinais-Suomen sairaanhoitopiirin alueella. 22.10.2018. Accessed December 2nd, 2022. https://hoito-ohjeet.fi/OhjepankkiVSSHP/Suositus%20hoitoon%20liittyvien%20infektioiden%20torjunnasta.pdf.

Laine, T. & Aarnio, P. 2004. Glove perforation in orthopaedic and trauma surgery - A comparison between single, double indicator gloving and double gloving with two regular gloves. Journal of bone and joint surgery. British volume, 86B (6): 898-900. Accessed November 27th, 2022. https://doi.org/10.1302/0301-620x.86b6.14821.

Laurea University of Applied Sciences 2022. Degree programme in nursing. Accessed November 25th, 2022. https://www.laurea.fi/en/degree_programmes/social-services-and-nursing/nursing/.

Lee, S. W., Cho, M. R., Lee, H. H., Choi, W. K. & Lee, J. H. 2015. Perforation of Surgical Gloves during Lower Extremity Fracture Surgery and Hip Joint Replacement Surgery. Hip Pelvis 27(1):17-22. PMID: 27536597. Accessed May 25th, 2023. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4972615/

Liu, Z., Dumville, J. C., Norman, G., Westby, M. J., Blazeby, J., McFarlane, E., Welton, N. J., O'Connor, L., Cawthorne, J., George, R. P., Crosbie, E. J., Rithalia, A. D. & Cheng H. Y. 2018. Intraoperative interventions for preventing surgical site infection: an overview of Cochrane Reviews. Cochrane Database of Systematic Reviews 2018, Issue 2. Art. No.: CD01265. Accessed November 30th, 2022. https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD012653.pub2/epdf/full.

Mangram, A. J., Horan, T. C., Pearson, M. L., Silver, L. C. & Jarvis, W. R. 1999. CDC Guideline for Prevention of Surgical Site Infection, 1999. Infection Control Hospital Epidemiology, 20 (4): 250-78; 279-80. Accessed November 27th, 2022. https://stacks.cdc.gov/view/cdc/7160.

Markel, T. A., Gormley, T., Greeley, D., Ostojic, J. & Wagner, J. 2018b. Wearing long sleeves while prepping a patient in the operating room decreases airborne contaminants. American

journal of infection control, 46 (4): 369-374. Accessed November 3rd, 2022. https://doi.org/10.1016/j.ajic.2017.10.016.

Matsuoka, S., Kondo, T., Seishima, R., Okabayashi, K., Tsuruta, M., Shigeta, K., Ishida, T., Hasegawa, H. & Kitagawa, Y. 2022. Surgical glove perforation during laparoscopic colorectal procedures. Surgical endoscopy, 36 (5): 3489-3494. Accessed November 10th, 2022. https://doi.org/10.1007/s00464-021-08670-0.

Ministry of Social Affairs and Health Finland. 2022. The Client and Patient Safety Strategy and Implementation Plan 2022–2026. Accessed February 17th, 2023. https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/164212/STM_2022_12.pdf?sequence=1&isAllowed=y.

Meriö-Hietaniemi, I. & Palosara, J. 2019. Standard precautions in IPC. Online course. Oppiportti. Published 8.3.2019, updated 23.9.2022. Accessed May 27th, 2022. https://www.oppiportti.fi/op/dvk00140

Moralejo, D., El Dib, R., Prata, R. A., Barretti, P. & Corrêa, I. 2018. Improving adherence to Standard Precautions for the control of health care-associated infections. Cochrane Database of Systematic Reviews 2018, Issue 2. Art. No.: CD010768. . Accessed November 30th, 2022. https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD010768.pub2/epdf/full

Neo, F., Edward, K. & Mills, C. 2013. Understanding compliance with protective eyewear amongst peri-operative nurses: A phenomenological inquiry. Australian journal of advanced nursing, 31 (1): 20-27. Accessed November 10th, 2022. https://doi.org/10.3316/ielapa.798704868531957.

O'Hara, L. M., Calfee, D. P., Miller, L. G., Pineles, L., Magder, L. S., Johnson, J. K., Morgan, D.J. & Harris, A. D. 2019. Optimizing Contact Precautions to Curb the Spread of Antibiotic-resistant Bacteria in Hospitals: A Multicenter Cohort Study to Identify Patient Characteristics and Healthcare Personnel Interactions Associated With Transmission of Methicillin-resistant Staphylococcus aureus. Clinical infectious diseases, 69 (Supplement 3): S171-S177. Accessed December 5th, 2022. https://doi.org/10.1093/cid/ciz621.

Ojanperä, H., Kanste, O. I. & Syrjala, H. 2020. Hand-hygiene compliance by hospital staff and incidence of health-care-associated infections, Finland. Bulletin of the World Health Organization, 98 (7): pp. 475-483. Accessed October 12th, 2022. https://dx.doi.org/10.2471/BLT.19.247494

Ojanperä, H., Ohtonen, P., Kanste, O. & Syrjälä, H. 2022. Impact of direct hand hygiene observations and feedback on hand hygiene compliance among nurses and doctors in medical and surgical wards: An eight-year observational study. The Journal of hospital infection, 127: 83-90. Accessed December 11th, 2022. https://doi.org/10.1016/j.jhin.2022.06.007.

Padhye, M. N., Girotra, C., Khosla, A. R. & Gupta, K. V. 2011. Efficacy of double gloving technique in major and minor oral surgical procedures: A prospective study. Ann Maxillofac Surg, Jul; 1 (2): 112-9. Accessed November 11th, 2022. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3591024/.

Parnikh, H., Kalantari, R., Abnavi, S., Hasanshahi, M. & Gheysari, S. 2022. Assessment of Circulating Nurses' Aseptic Practices in Orthopedic and General Surgeries of Public Hospitals in Shiraz, Iran. International Journal of Infection, 9 (3): e123759. Accessed October 15th, 2022. https://brieflands.com/articles/iji-123759.html.

Puhto, T. 2018. The burden of healthcare-associated infections in primary and tertiary healthcare wards and the cost of procedure-related prosthetic joint infections. Academic dissertation. The Medical Research Center of Oulu. Oulu University. Accessed March 19th, 2023. http://urn.fi/urn:isbn:9789526219851

Qvistgaard, M., Lovebo, J., & Almerud-Österberg, S. 2019. Intraoperative prevention of Surgical Site Infections as experienced by operating room nurses. International journal of qualitative studies on health and well-being. 14 (1): 1632109. Accessed February 19th, 2022. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6610460/

Sadrizadeh, S., Holmberg, S. & Tammelin, A. 2014. A numerical investigation of vertical and horizontal laminar airflow ventilation in an operating room. Building and Environment, 82: 517–525. Accessed November 27th, 2022. https://doi.org/10.1016/j.buildenv.2014.09.013.

Silva, P. 2014. The Right Skin Preparation Technique: A Literature Review. Journal of perioperative practice, 24 (12): 283-285. Accessed March 5th, 2023. https://doi.org/10.1177/175045891402401204.

Similä, E. 2020. Standard and Contact Precautions in the Operating Room and Recovery Room. Oulu University Hospital. 17.4. 2020. Accessed November 11th, 2022. https://www.ppshp.fi/dokumentit/Turvallisuusohje%20sislttyyppi/Tavanomaiset%20ja%20eristysvarotoimet%20leikkaussalissa%20ja%20her%C3%A4%C3%A4m%C3%B6ss%C3%A4.docx

Spruce, L. 2013. Back to basics: hand hygiene and surgical hand antisepsis. AORN Journal, 98 (5): 449-460. Accessed November 4th, 2022. https://doi.org/10.1016/j.aorn.2013.08.017.

Schwartz, X., Schmitz, M., Safdar, N. & Pop-Vicas, A. 2018. Adherence to surgical hand antisepsis: Barriers and facilitators in a tertiary care hospital. American journal of infection control, 46 (6): 714-716. . Accessed December 6th, 2022. https://doi.org/10.1016/j.ajic.2017.12.011.

Tanner, J. 2006. Surgical Gloves: Perforation and Protection. Journal of perioperative practice, 16 (3): 148-152. Accessed November 15th, 2022. https://doi.org/10.1177/175045890601600305.

TAYS. 2021. Tampere University Hospital. Contact precautions in the operating room. 21.7.2021. Accessed November 11th, 2022. https://www.tays.fi/fi-FI/Ohjeet/Infektioiden_torjunta/Toimintayksikoiden_infektioiden_torjunta/Kosketusvarotoimet_leikkausosastolla_ja_(87760)

Tarabichi, S. & Parvizi, J. 2023. Prevention of surgical site infection: A Ten-Step Approach. Arthroplasty, 5 (1): 21. Accessed May 5th, 2023. https://doi.org/10.1186/s42836-023-00174-7

TENK. 2019. Finnish National Board on Research Integrity TENK guidelines 2019. The ethical principles of research with human participants and ethical review in the human sciences in Finland. Accessed May 16th, 2023. https://tenk.fi/sites/default/files/2021-01/Ethical_review_in_human_sciences_2020.pdf

Teter, J., Guajardo, I., Al-Rammah, T., Rosson, G., Perl, T. M. & Manahan, M. 2017. Assessment of operating room airflow using air particle counts and direct observation of door openings. American journal of infection control, 45 (5): 477-482. Accessed October 30th, 2022. https://doi.org/10.1016/j.ajic.2016.12.018.

THL. 2022a. The Finnish Institute for Health and Welfare. Hand hygiene instructions for healthcare professionals. Updated 26.9.2022. Accessed November 29th, 2022. https://thl.fi/fi/web/infektiotaudit-ja-rokotukset/taudit-ja-torjunta/infektioiden-ehkaisy-ja-torjuntaohjeita/kasihygieniaohjeet-ammattilaisille.

THL. 2022b. The Finnish Institute for Health and Welfare. Standard precautions. Updated 15.12.2022. Accessed May 6th, 2023. https://thl.fi/fi/web/infektiotaudit-ja-rokotukset/taudit-ja-torjunta/infektioiden-ehkaisy-ja-torjuntaohjeita/tavanomaiset-varotoimet-ja-varotoimiluokat.

TYKS. 2020. Turku University Hospital. Aseptic practices in the Operating Room. Personnel guideline. 14.5.2020. Accessed December 11th, 2022. https://hoito-ohjeet.fi/OhjepankkiVSSHP/Aseptinen%20toiminta%20leikkausosastolla.pdf.

TYKS. 2022. Turku University Hospital. Screening and positioning of antibiotic resistant microbes in an Operating Room unit. 4.3.2019, updated 8.9.2022. Accessed December 11th, 2022. https://hoito-ohjeet.fi/OhjepankkiVSSHP/Resistenttien%20bakteerien%20seulonta%20ja%20potilassijoittelu%20leikkaus-%20ja%20p%C3%A4ikiyksik%C3%B6ss%C3%A4.pdf

Walits, E. & Carpo, M. F. 2014. The role of the perioperative nurse in implementing contact precautions to prevent transmission of multidrug-resistant organisms: The official voice of perioperative nursing. AORN Journal, 114 (6): 573-582. Accessed December 5th, 2022. https://doi.org/10.1002/aorn.13565.

Ward, W. G., Cooper, J. M., Lippert, D., Kablawi, R. O., Neiberg, R. H. & Sherertz, R. J. 2014. Glove and gown effects on intraoperative bacterial contamination. Ann Surg., 259 (3):591-7. PMID: 24045444. Accessed May 25th, 2023. https://journals.lww.com/annalsofsurgery/Abstract/2014/03000/Glove_and_Gown_Effects_on_Intraoperative_Bacterial.26.aspx

Weaving, P., Cox, F. & Milton, S. 2008. Infection prevention and control in the operating theatre: Reducing the risk of surgical site infections (SSIs). The Journal of Perioperative Practice, 18 (5): 199-204. Accessed March 7th, 2023. https://www.proquest.com/scholarly-journals/infection-prevention-control-operating-theatre/docview/217749151/se-2.

Weber, W. P., Marti, W. R., Zwahlen, M., Misteli, H., Rosenthal, R., Reck, S. Fueglistaler, P., Bolli, M., Trampuz, A., Oertli, D. & Widmer, A.F. The timing of surgical antimicrobial prophylaxis. Ann Surg. 247 (6): 918-26. Accessed December 5th, 2022. https://doi.org/10.1097/SLA.0b013e31816c3fec.

WHO. 2009b. Your five moments for hand hygiene. Accessed May 12, 2022. https://cdn.who.int/media/docs/default-source/integrated-health-services-(ihs)/infection-prevention-and-control/your-5-moments-for-hand-hygiene-poster.pdf?sfvrsn=83e2fb0e_16

Zucco, R., Lavano, F., Nobile, C. G. A., Papadopoli, R. & Bianco, A. 2019. Adherence to evidence-based recommendations for surgical site infection prevention: Results among Italian surgical ward nurses. PloS one, 14(9), e0222825. Accessed March 12th, 2022. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6762080/

Unpublished

Pitko, N. 2022. Feedback from infection control responsible staff members of the organization. June 12th, 2022.

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CROSS-SECTIONAL STUDIES

						JBI Critical Appraisal Checklist for Analytical Cross Sectional Studies 2020								
						Were the criteria for inclusion in the sample clearly defined?	Were the study subjects and the setting described in detail?	Was the exposure measured in a valid and reliable way?	Were objective, standard criteria used for measurement of the condition?	Were confounding factors identified?	Were strategies to deal with confounding factors stated?	Were the outcomes measured in a valid and reliable way?	Was appropriate statistical analysis used?	**Overall appraisal**
Objective	**Reference**	**Criteria**	**Purpose and aim of the study**	**Design, Data and methods**	**Results**	Yes No Unclear Not applicable	Yes No Unclear Not applicable	Yes No Unclear Not applicable	Yes No Unclear Not applicable	Yes No Unclear Not applicable	Yes No Unclear Not applicable	Yes No Unclear Not applicable	Yes No Unclear Not applicable	Include □ Exclude □ Seek further info □
Hand hygiene	**Korhonen, A., Ojanpera, H., Puhto, T., Jarvinen, R., Kejonen, P. & Holopainen, A. 2015. Adherence to hand hygiene guidelines - significance of measuring fidelity. Journal of clinical nursing, 24(21-22), pp. 3197-3205. ABSTRACT ONLY**	**Is hand disinfectant available and easily accessible in at least three spots in the room? Are gloves available and easily accessible in at least three spots in the room?**	To evaluate the usability of fidelity measures in compliance evaluation of hand hygiene.	A cross-sectional observation study in a university hospital setting, direct observation by trained staff,Descriptive statistics (frequency, mean, percentages and range) were used as well as compliance rate by using a standard web-based tool	Evaluating fidelity measures is useful in terms of revealing the gaps between optimal and actual performance in hand hygiene, the main gap related to too short duration of hand rubbing	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	SEEK FURTHER INFO
	O'hara et.al. 2019. Optimizing Contact Precautions to Curb the Spread of Antibiotic-resistant Bacteria in Hospitals: A Multicenter Cohort Study to Identify Patient Characteristics and Healthcare Personnel Interactions Associated With Transmission of Methicillin-resistant Staphylococcus aureus. Clinical infectious diseases, 69(Supplement_3), pp. S171-S177.	**Are hand disinfectants near the glove boxes?**	To evaluate which patients are more likely to transfer MRSA to HCP and to identify which HCP interactions are more likely to lead to glove or gown contamination	A prospective, multicenter cohort study of cultured HCP gloves and gowns for MRSA. Samples obtained from patients' anterior nares, perianal area, and skin of the chest and arm to assess bacterial burden	Gloves and gowns are frequently contaminated with MRSA when treating a patient carrying the microbe. Glove use is applicable when touching an MRSA carrying patient and their domain. Hospitals may consider using fewer precautions for low-risk interactions and more for high-risk interactions and personnel.	YES	YES	YES	YES	YES	YES	YES	YES	INCLUDE
	Hughes, K. A., Cornwall, J., Theis, J. & Brooks, H. J. L. 2013. Bacterial contamination of unused, disposable non-sterile gloves on a hospital orthopaedic ward. Australasian Medical Journal (Online), 6(6), pp. 331-338.		To investigate glove use on a hospital orthopaedic ward to examine whether pathogen contamination occurs prior to contact with patients.	Glove samples were aseptically removed from boxes on a hospital orthopaedic ward on opening and days 3, 6 and 9 thereafter. Following elution of bacteria and viable counts, glove isolates were identified by standard techniques and 16s rDNA sequencing. Methicillin resistance of staphylococci was determined by disc diffusion, Epsilon tests and PCR. Gloves were inoculated to determine two isolate survival rates.	HCW introduced skin commensals and pathogenic bacteria into glove boxes indicating that unused, non-sterile gloves are potential pathogen transmission vehicles in hospitals. Findings highlight adherence to handwashing guidelines, common glove retrieval practice, and glove-box design as targets for decreasing bacteria transmission via gloves on hospital wards.	YES	YES	YES	YES	NOT APPLICABLE	NOT APPLICABLE	YES	YES	INCLUDE
	Boucherabine, S., Nassar, R., Mohamed, L., Olsen, M., Alqutami, F., Zaher, S., Hachim, M., Alkhajeh, A., MicKirdy, S., Alghafri, R., Tajouri, L. & Senok, A. 2022. Healthcare Derived Smart Watches and Mobile Phones are Contaminated Niches to Multidrug Resistant and Highly Virulent Microbes. Infection and drug resistance, 15, pp. 5289-5299.	**No watches or rings on any team member**	Microbial contamination of smart watches of healthcare workers (HCWs) was assessed and compared to the individual's mobile phone and hands.	prevalence survey of microbial contamination of mobile phones of HCWs at the emergency unit of a tertiary care facility. Swabs from smart watches, mobile phones and hands were obtained from four HCWs with dual ownership of these digital devices. Bacterial culture was carried out for all samples and those from smart watches and mobile phones were further assessed using shotgun metagenomic sequencing.	report on microbial contamination of smart watches using metagenomics next generation sequencing showed similar pattern of contamination with microbes, VFG and antibiotic resistance genes across digital devices	YES	YES	YES	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	YES	YES	INCLUDE
	RECOMMENDATION/REVIEW	**No artificial nails/nail polish on any team member**												
Preparations of the parient	**RECOMMENDATION/REVIEW**	**An antibiotic prophylaxis is administered within 60 minutes pre-incision if designated**												
Establishment of sterile field	**Parnikh ei.al. 2022.**	**Sterile field is created less than hour before operation**				YES	YES	YES	YES	YES	YES	YES	YES	INCLUDE

	Friberg, B. & Friberg, S. 2005. Aerobiology in the operating room and its implications for working standards. Proceedings of the Institution of Mechanical Engineers. Part H, Journal of engineering in medicine, 219(2), pp. 153-160. ABSTRACT ONLY	**Sterile items are not tossed on the sterile table, but are given to a sterile person/team member with sterile gloves/are handled with a sterile instrument**	Two novel operating room (OR) ventilation concepts were evaluated from a bacteriological point of view: thermal convection system vs. conventional ventilation	No description	In the different areas important for surgical asepsis, the thermal system resulted in a twofold to threefold increase in bacterial air and surface counts compared to the conventional system. In the areas important for surgical asepsis the turbulent ventilation systems yielded highly significant correlation between air and surface contamination, no correlation in the LAF systems.	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	SEEK FURTHER INFO
	Blom, A., Barnett, A., Ajitsaria, P., Noel, A. & Estela, C. 2007. Resistance of Disposable Drapes to Bacterial Penetration. Journal of orthopaedic surgery (Hong Kong), 15(3), pp. 267-269.		To test the bacterial penetrability of disposable non-woven drapes used specifically for total hip arthroplasty.	A prospective analysis of drape peneatribility. A logarithmic scale for CFUs was used to present the results.	Drapes were directly exposed to the heavily contaminated agar, based on previous study evidence reusable cotton/linen drapes are weaker than disposable drapes under similar conditions. It is recommended that drapes are on their resistance to bacterial penetration.	YES	YES	YES	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	YES	YES	INCLUDE
	Birgand et.al. 2014	**Surgical site asepsis is performed as instructed by the product manufacturer and hospital guideline, taking account the direction from clean to dirty areas and the flowing direction of the fluid**			Upcoming project, no results	YES	YES	NOT APPLICABLE	YES	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	SEEK FURTHER INFO
Preparations of sterile personnel	**Schwartz, X., Schmitz, M., Safdar, N. & Pop-Vicas, A. 2018. Adherence to surgical hand antisepsis: Barriers and facilitators in a tertiary care hospital. American journal of infection control, 46(6), pp. 714-716.**	**Surgical hand rub is performed by sterile team members**	A pilot study to evaluate staff members' adherence to hospital surgical hand antisepsis policy and identify barriers and facilitators for correct performance.	Mixed methods: direct observations of hand hygiene and semistructured interviews. Adherence for each element of the recommended technique and for the overall scrub procedure were summarized, interviews were recorded and identified	Low adherence to the scrub technique recommended by the institutional policy. Full compliance with the entire technique was present for 9 (18%) of the surgical hand antisepsis observations. Of these, 5 (31%) were among water-based scrubs, and 4 (12%) were among alcohol-based rubs. Less than 25% of observed staff performed the alcohol-based rub correctly	YES	YES	YES	YES	YES	YES	YES	YES	INCLUDE
	Birgand, G., Azevedo, C., Toupet, G., Pissard-Gibollet, R., Grandbastien, B., Fleury, E. & Lucet, J. 2014. Attitudes, risk of infection and behaviours in the operating room (the ARIBO Project): A prospective, cross-sectional study. BMJ open, 4(1), p. e004274.		A multicentre prospective cross-sectional study in 10 ORs. The staff behaviour is assessed by an objective, continued and prolonged quantification of movements within the OR and behavioural data obtained is compared to the 'best behaviour rules' in the OR, pre-established using a Delphi method. Assessment and description of OR staff behaviours and on its association with the SSI risk during surgical procedures. Study aims at describing and assessing the staff behaviours in the OR and their variability by recording staff displacements using a motion tracking system and door opening	An observational study based on the correlation between the data on OR behaviours obtained using new technology tools and the 'best behaviour rules' established by an expert panel during an earlier part of the study and surrogates of the infectious risk in the OR.	Upcoming project, no results	YES	YES	NOT APPLICABLE	YES	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	SEEK FURTHER INFO
	Hughes, K. A., Cornwall, J., Theis, J. & Brooks, H. J. L. 2013.	**All sterile team members have a hair cap and mask, and accordingly dressed PPE (sterile jacket &**				YES	YES	YES	YES	NOT APPLICABLE	NOT APPLICABLE	YES	YES	INCLUDE

Birgand, G., Azevedo, C., Toupet, G., Pissard-Gibollet, R., Grandbastien, B., Fleury, E. & Lucet, J. 2014. Attitudes, risk of infection and behaviours in the operating room (the ARIBO Project): A prospective, cross-sectional study. BMJ open, 4(1), p. e004274.				Upcoming project, no results	YES	YES	NOT APPLICABLE	YES	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	SEEK FURTHER INFO
Friberg, B., Friberg, S., Östensson, R. & Burman, L. 2001. Surgical area contamination - comparable bacterial counts using disposable head and mask and helmet aspirator system, but dramatic increase upon omission of head-gear: An experimental study in horizontal laminar air-flow. The Journal of hospital infection, 47(2), pp. 110-115.		To evaluate the efficiency of a helmet aspirator system and a disposable head cover consisting of squire-type hood plus face mask, compared with the complete omission of head-gear in respect of dispersal of bacteria and particles in a cross-flow (horizontal) LAF unit.	An experimental study in horizontal laminar air-flow: Air counts of bacteria, Bacterial sedimentation rates and Air counts of dust particles were measured.	A properly enclosed head reduces bacteriological sedimentation rate in the wound area in a cross-flow LAF-unit. A regular non-sterile squire-type disposable hood plus a triple laminar facemask is as effective as a sterile helmet aspirator system and prevented the emission of large numbers of sedimenting particles mainly containing streptococci and presumably originating from the upper respiratory tract.	YES	YES	YES	YES	YES	YES	YES	YES	INCLUDE
Korniewicz, D. & El-Masri, M. 2012. Exploring the benefits of double gloving during surgery: The official voice of perioperative nursing. Aorn J. 2012;95(3):328-36.	**Indicator gloves are used in a high-risk/ orthopaedic operation**	To examine the effect of routine double gloving and the use of inner color indicator gloves (ie, underlying gloves) on the durability of inner gloves and the detection of glove tears or perforations during surgery.	An observation/prospective study, standardised visual and water-testing techniques were used to test the gloves for perforations.	Visible defects 1.3% among those who did not double glove and 0.3% in the inner glove among those who did double glove. Rate of water leak in gloves among those who did not double glove was 6.3% and inner water glove leak of 1.9% among those who double gloved. Double gloving minimizes the risk of defect to the inner	YES	YES	YES	YES	YES	YES	YES	YES	INCLUDE
Bekele, A., Makonnen, N., Tesfaye, L. & Taye, M. 2017. Incidence and patterns of surgical glove perforations: Experience from Addis Ababa, Ethiopia. BMC surgery, 17(1), p. 26.		To describe the incidence and patterns of surgical glove perforation during surgical procedures and to compare the rates between emergency and elective surgeries	A prospective study, standardised visual and hydro insufflation techniques were used to test the gloves for perforations. Parameters recorded included type of procedure performed, number of perforations, localisation of perforation and the roles of the surgical team.	The total rate of perforation in emergency procedures was 41.4%, while perforation in elective surgeries was 30.0%. A statistically significant difference was found in between emergency and elective surgeries. Only 0.4% of inner gloves were perforated when using doble gloves. The use of different colour indicator gloves as the inner glove is highly recommended so that the surgical personnel can change their gloves once they realise	YES	YES	YES	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	YES	YES	INCLUDE
Parnikh ei.al. 2022.					YES	YES	YES	YES	YES	YES	YES	YES	INCLUDE
Padhye, M. N., Girotra, C., Khosla, A. R. & Gupta, K. V. 2011. Efficacy of double gloving technique in major and minor oral surgical procedures: A prospective study. Ann Maxillofac Surg. 2011 Jul;1(2):112-9.		To assess the efficacy of double gloving technique in preventing cross infection in both major and minor oral surgical procedures.	A prospective analysis was carried out to assess gloves used during 100 major and 100 minor oral surgical procedures to test for efficacy of double gloving, Chi-square test was used to determine whether there was difference between expected and observed values	A higher number of glove perforations was seen in minor oral surgical procedures compared with major surgeries, dominant hand compared with the nondominant, outer gloves compared with the inner, in procedures which took a longer duration of time to complete and involving wiring. Double gloving technique using sterile gloves can be used as an effective means of infection control for all major and minor surgical procedures, especially high-risk procedures involving patients who maybe suffering from or carriers of blood-borne infections.	YES	YES	YES	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	YES	YES	INCLUDE

	Aarnio, P. & Laine, T. 2001. Glove perforation rate in vascular surgery - a comparison between single and double gloving. VASA, 30(2), pp. 122-124. ABSTRACT ONLY		To compare puncture rates between the double gloving color indication system and single-use gloves and the other to determine the extent to which glove perforations remain undetected during the course of vascular surgical operations.	A prospective and randomized analysis where gloves were tested immediately after the surgical procedure using the approved standardized water-leak method.	The perforation occurred in the double gloves 3 times and with single gloves 12 times. The overall perforation rate was 15 out of 200 gloves (7.5%). The detection of perforation during surgery was 60%. Most frequently the perforation was located in the second finger of the left hand, 9 out of 15 perforations. Double gloving is recommended in high risk operations.	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	SEEK FURTHER INFO
	Laine, T. & Aarnio, P. 2004. Glove perforation in orthopaedic and trauma surgery - A comparison between single, double indicator gloving and double gloving with two regular gloves. Journal of bone and joint surgery. British volume, 86B(6), pp. 898-900.		To assess the frequency of the perforation of surgical gloves during orthopaedic and trauma surgery and compared the efficiency of single and double gloving	A prospective and randomized analysis where gloves were tested immediately after the surgical procedure using the approved standardized water-leak method. Statistical analysis with chi-squared test.	Perforations were detected in 18.5% of the operations. The use of indicator gloves significantly increased the detection of perforations during surgery. The risk of blood contamination was 13-fold when using single gloves compared with double gloves	YES	YES	YES	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	YES	YES	INCLUDE
	Aisien, A. & Ujah, I. 2006. Risk of blood splashes to masks and goggles during cesarean section. Medical science monitor, 12(2), pp. CR94-CR97. Accessed November 10th, 2022. https://medscimonit.com/abstract/index/idArt/445245.	Protective eyewear is used when risk of splatter or if a sterile team member has eyelash extensions	The purpose was to identify the risk of blood splashes to masks and goggles during cesarean section	A prospective study. The surgeons were requested to examine all their masks and goggles and those of the assistants and scrub nurses for obvious blood splashes at the end of each procedure and record them in a data sheet. There were 144 cases of cesarean section done (19 elective and 125 emergencies) during the study period.	The rate of blood splashes was 62.5% on the surgeons' masks, 63.2% on surgeons' goggles, 35.4% on assistants' masks, 38.9% on assistants' goggles, 11.1% on scrub nurses' masks, and 16.0% on scrub nurses' goggles.	YES	YES	YES	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	YES	YES	INCLUDE
Aseptic behaviour	Friberg, B., Friberg, S., Östensson, R. & Burman, L. 2001. Surgical area contamination - comparable bacterial counts using disposable head and mask and helmet aspirator system, but dramatic increase upon omission of head-gear: An experimental study in horizontal laminar air-flow. The Journal of hospital infection, 47(2), pp. 110-115.	Each OR team member is wearing a hair cap and a mask at all times during the operation				YES	YES	YES	YES	YES	YES	YES	YES	INCLUDE
	Hughes, K. A., Cornwall, J., Theis, J. & Brooks, H. J. L. 2013.					YES	YES	YES	YES	NOT APPLICABLE	NOT APPLICABLE	YES	YES	INCLUDE
	RECOMMENDATION/REVIEW	Personal items or clothing (doctor's jackets) are not stored in the OR												
	RECOMMENDATION/REVIEW	Eating or drinking is not done in the OR												
	Matsuoka, S., Kondo, T., Seishima, R., Okabayashi, K., Tsuruta, M., Shigeta, K., Ishida, T., Hasegawa, H. & Kitagawa, Y. 2022. Surgical glove perforation during laparoscopic colorectal procedures. Surgical endoscopy, 36(5), pp. 3489-3494.	Sterile gloves are changed if noticed to be broken or if the operation lasts longer than 2h	To evaluate surgical glove perforation during laparoscopic colorectal procedures	A total of 616 surgical gloves used in the surgeries were collected for analysis. The presence of glove perforation was tested by the standard water leak test method (EN455-1).	No significant correlation between the presence of glove perforation and SSI occured. Double gloving in laparoscopic colorectal surgery is recommended not to prevent SSI but to protect medical workers from harmful infections after direct contact with the patient	YES	YES	YES	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	YES	YES	INCLUDE

	Karakus, O. & Sarı, A. S. 2020. At what point during total knee arthroplasty operations are gloves most frequently torn? Journal of orthopaedic surgery (Hong Kong), 28(3), p. 2309499020959167. .		To determine the time points during a total knee arthroplasty operation when there is the greatest possibility of tearing a surgical glove, thus the stage of the operation at which there is the greatest risk of infection and demonstrate the importance of wearing double gloves during total knee arthroplasty surgery	Using a chronometer during the operation, the upper layer of each surgical glove was removed and inflated with sterile saline at 10-min intervals. When a tear was determined, a record was made of the time, stage of the operation, the finger that was torn, and the side.	The mean time of the glove perforation was 40.74 ± 10.69 min. The fingers requiring the most care during total knee arthroplasty are the thumb and index finger. The stages of the operation with the greatest risk for glove tears are trial component reduction and wound closure. Changing gloves after these high-risk surgical stages would help to decrease the risk of periprosthetic infections.	YES	YES	YES	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	YES	YES	INCLUDE
	Bekele, A., Makonnen, N., Tesfaye, L. & Taye, M. 2017.					YES	YES	YES	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	YES	YES	INCLUDE
	Birgand, G., Haudebourg, T., Grammatico-Guillon, L., Ferrand, L., Moret, L., Gouin, F., Mauduit, N., Leux, N., Le Manche, Y., Lepelletier, D., Tavernier, E., Lucet, J-C. & Giraudeau, B. 2019. Improvement in staff behavior during surgical procedures to prevent post-operative complications (ARIBO(2)): Study protocol for a cluster randomised trial. Trials, 20(1), p. 275.	Times of opening the OR door when sterile fields are prepared	A parallel-group, cluster randomised, controlled trial	To assess the impact of a bundle of measures optimising discipline (frequency of door opening and level of noise) in the OR in preventing POC in prosthetic hip and knee orthopaedic surgery, to assess the impact of a bundle of measures to optimise OR discipline for each element of POC composite criteria; the impact of a bundle of measures to optimise the traffic flow in the OR using process indicators (number of door openings, level of noise and interruptions/distractions) of surgical team behaviour during procedures; and the sustainability of the approach in a follow up study	Upcoming project, no results	YES	YES	NOT APPLICABLE	YES	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	SEEK FURTHER INFO
	Teter, J., Guajardo, I., Al-Rammah, T., Rosson, G., Perl, T. M. & Manahan, M. 2017. Assessment of operating room airflow using air particle counts and direct observation of door openings. American journal of infection control, 45(5), pp. 477-482.			Measurement of air particulate counts (APCs) to determine if they increased in relation to traffic, door opening, and other common activities.	There were 13.4 door openings per hour during cases. Door opening rates ranged from 0.19-0.28 per minute. Numerous instances of verbal communication and equipment movement were observed. Improving efficiency of communication and equipment can aid in reduction of traffic.	YES	YES	YES	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	YES	YES	INCLUDE
	Sadrizadeh, S., Holmberg, S. & Tammelin, A. 2014. A numerical investigation of vertical and horizontal laminar airflow ventilation in an operating room. Building and Environment, Vol. 82. S. 517-525.		To assess and explore the performance of unidirectional vertical and lateral airflow ventilation scenarios in reducing the BCP concentration in the surgical zone.	A numerical investigation to assess the performance of the horizontal and vertical ventilation systems, two different internal constellations of staff members were created: A model for Horizontal case-1 and vertical scenario and a	In all examined cases, increasing airflow rate reduces the BCP concentration in the surgical zone. Proper outcome depends not only on overcoming technical complications, but also on solving and incorporating human factors	YES	YES	YES	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	YES	YES	INCLUDE
	RECOMMENDATION/REVIEW	Disinfection of a bloodstain is immediately performed after detection with nonsterile gloves												
	RECOMMENDATION/REVIEW	If the patient is carrying an antibiotic resistant microbe, they are treated with contact precautions according to the organization contact precaution protocol												
Maintenance of sterile field	Friberg, B. & Friberg, S. 2005. ABSTRACT ONLY	Unscrubbed person does not move between two sterile fields				UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	SEEK FURTHER INFO
	Friberg, B. & Friberg, S. 2005. ABSTRACT ONLY	Unscrubbed person keep eye contact and visible distance to sterile field when moving near the area				UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	SEEK FURTHER INFO

	Bible, J.E., Biswas, D., Whang, P.G., Simpson, A K. & Grauer, J.N. 2009. Which Regions of the Operating Gown Should be Considered Most Sterile? Clinical orthopaedics and related research, 467(3), pp. 825-830.		To evaluate gown sterility after major spinal surgery to assess the legitimacy of recommendations	Sterile culture swabs were used to obtain samples of gown fronts at 6- inch increments and at the elbow creases of 50 gowns at the end of 29 spinal operations. Another 50 gowns were swabbed immediately after they were applied to serve as negative controls. Bacterial growth was assessed using semiquantitative plating techniques on a nonselective, broad-spectrum media. Contamination was observed at all locations of the gown with	Bacterial growth was observed most frequently in the areas above the chest and below the operating room table, the portion of the gown between the chest and the operating room table had the lowest contamination rates (	YES	YES	YES	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	YES	YES	INCLUDE
	Bible et al. 2009.	**Sterile field is visible for sterile members at all times (back is not turned)**				YES	YES	YES	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	YES	YES	INCLUDE
	Parnikh, H., Kalantari, R., Abnavi, S., Hasanshahi, M. & Gheysari, S. 2022. Assessment of Circulating Nurses' Aseptic Practices in Orthopedic and General Surgeries of Public Hospitals in Shiraz, Iran. International Journal of Infection. 2022 July; 9(3):e123759.	**Indicator gloves used in high risk operations / Sterile field created less than an hour before the operation / Sterile field is visible for sterile members at all times (back is not turned) / Unscrubbed person does not move between two sterile fields /**	To assess the circulating nurses' aseptic practices in orthopedic and general surgeries	A cross-sectional study conducted on 296 circulating nurses working in public hospitals in Iran, data collection tools included a demographics questionnaire and the Aseptic Practices among Circulating Nurses Scale	There is a need to improve some aseptic practices. Supplying the hospitals with necessary materials, using appropriate guidelines and educational programs, supervising, and setting appropriate policies can help improve aseptic practices. The aseptic practice score was significantly different in circulating nurses with different academic educational levels.	YES	YES	YES	YES	YES	YES	YES	YES	INCLUDE

***Category IA**: A strong recommendation supported by high to moderate-quality evidence suggesting net clinical benefits or harms.*	***Category IB**: A strong recommendation supported by low-quality evidence suggesting net clinical benefits or harms or an accepted practice (eg. aseptic technique) supported by low to very low-quality evidence.*	***Category IC**: A strong recommendation required by state or federal regulation. **Category II**: A weak recommendation supported by any quality evidence suggesting a trade-off between clinical benefits and harms.*	***No recommendation/unresolved issue**: An issue for which there is low to very low-quality evidence with uncertain trade-offs between the benefits and harms or no published evidence on outcomes deemed critical to weighing the risks and benefits of a given intervention.*
Objective	**Recommendation/Review**	**Criteria**	**Strength of the recommendation (Berrios-Torres et.al. 2017)**
Hand hygiene	CDC. 2002. Centers for Disease Control and Prevention. Guideline for Hand Hygiene in Health-Care Settings: Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. Recommendations and Reports October 25, 2002 / Vol. 51 / No. RR-16.	**Is hand disinfectant available and easily accessible in at least three spots in the room? Are gloves available and easily accessible in at least three spots in the room? Are hand disinfectants near the glove boxes?**	Category IB: A strong recommendation supported by low-quality evidence suggesting net clinical benefits or harms or an accepted practice supported by low to very low-quality evidence.
	AORN. 2005. Recommended Practices for Surgical Attire. AORN Journal, vol. 81, no. 2, 2005, 413,418-416,420.		IB
	AORN. 2007. Recommended Practices for Prevention of Transmissible Infections in the Perioperative Practice Setting. AORN journal, 85(2), 383-396.		IB
	AORN 2010 Perioperative standards and recommended practices for inpatient and ambulatory settings, 2010 Edition. Denver: AORN Inc, 69.		IB
	AORN. 2017. Guideline Summary: Hand Hygiene. AORN Journal, vol. 105, no. 2, 2017, 213-217,		IB
	CDC 2016. Centers for Disease Control and Prevention. Standard precautions for all patient care. Last reviewed January 26th, 2016.		IB
	Allegranzi, B. & Pittet, D. 2009. Role of hand hygiene in healthcare-associated infection prevention. Journal of Hospital Infection, 73(4), 305-315.		IB
	Allegranzi, B., Sax, H. & Pittet, D. 2013. Hand hygiene and healthcare system change within multi-modal promotion: A narrative review. The Journal of hospital infection, 83, S3-S10.		IB
	Bashaw, M.A. & Keister, K.J. 2019. Perioperative Strategies for Surgical Site Infection Prevention. AORN journal, vol. 109, no. 1, 2019, 68-78.		IB
	THL 2022b. The Finnish Institute for Health and Welfare. Standard precautions. Updated 15.12.2022.		IC
	WHO. 2021. World health organization. Resource considerations for investing in hand hygiene improvement in health care facilities. ISBN 978-92-4-002589-9. Geneva: World Health Organization.		IB

	AORN 2005; 2010, 75-76; 2017	**No watches or rings on any team member**	IB
	WHO. 2009a. Guidelines on hand hygiene in healthcare. ISBN 9789241597906. Geneva: World Health Organization.		Category IA: A strong recommendation supported by high to moderate-quality evidence suggesting net clinical benefits or harms
	Arrowsmith, V. A. & Taylor, R. 2014. Removal of nail polish and finger rings to prevent surgical infection. Cochrane Database of Systematic Reviews 2014, Issue 8. Art. No.: CD003325.		IA
	Kurvinen et.al. 2018. Sairaalahygienia ja infektiontorjunta: Suositus hoitoon liittyvien infektioiden torjunnasta Varsinais-Suomen sairaanhoitopiirin alueella. 22.10.2018.		Category IC: A strong recommendation required by state or federal regulation.
	HUCH 2022. Helsinki University Central Hospital. Hand hygiene protocol.		IC
	Mangram et.al. 1999 (CDC)	**No artificial fingernails/gel nails/nail polish on any team member**	Artificial nails IA/ nail polish II
	Arrowsmith & Taylor 2014.		IB
	AORN 2010, 76		IA
	CDC 2016		IA
	Kurvinen et.al. 2018		IC
	HUCH 2022.		IC
Preparations of the patient	CDC: Mangram et.al. 1999; Berrios-Torres et.al. 2017	**An antibiotic prophylaxis is administered within 60 minutes pre-incision if designated**	IA
	ECDC. 2013. Systematic review and evidence-based guidance on perioperative antibiotic prophylaxis. June 2013. Stockholm: ECDC.ISBN 978-92-9193-484-3.		IA
	HUCH 2021. Helsinki University Central Hospital. Preparing of adult patient for a surgical operation.		IC
	WHO 2016, 71-74		IA
	Gillespie, W. J. & Walenkamp G. H. I. M. 2010. Antibiotic prophylaxis for surgery for proximal femoral and other closed long bone fractures. Cochrane Database of Systematic Reviews 2010, Issue 3. Art. No.: CD000244.		IA
	Gillespie, B.M., Kang, E., Roberts, S., Lin, F., Morley, N., Finigan, T., Homer, A & Chaboyer, W. 2015. Reducing the risk of surgical site infection using a multidisciplinary approach: an integrative review. Journal of Multidisciplinary Healthcare. 2015; 8: 473-487.		IA
	Gosselin, R. A., Roberts, I. & Gillespie, W. J. 2004. Antibiotics for preventing infection in open limb fractures. Cochrane Database of Systematic Reviews 2004, Issue 1. Art. No.: CD003764.		IA

Establishment of the sterile field	AORN. 2006. AORN Recommended Practices: Recommended Practices for Maintaining a Sterile Field. AORN Journal, vol. 83, no. 2, 2006, 402,407,410,413-404,408,410,416.	**Sterile field is created less than hour before operation**	No recommendation/unresolved issue: An issue for which there is low to very low-quality evidence with uncertain trade-offs between the benefits and harms or no published evidence on outcomes deemed critical to weighing the risks and benefits of a given intervention.
	AORN 2010, 94-95; 2018		IC - Note: Covering of sterile table is not recommended
	Bussieres, M., L'Esperance, S., Coulombe, M. & Rhainds, M. 2017. Evaluation of the surgical tray opening procedure in operating suites: Systematic review and recommendations/ Evaluation de la procedure d'ouverture des plateaux chirurgicaux dans les blocs operatoires: revue systematique et recommandations. *ORNAC journal*, *35*(1), 46.		No recommendation/unresolved issue
	Aholaakko, T-K. 2018. Intraoperative aseptic practices and surgical site infections in breast surgery. Academic Dissertation. University of Helsinki 2018.		No recommendation/unresolved issue
	TYKS 2020. Turku University Hospital. Aseptic practices in the Operating Room. Guideline for personnel. 14.5.2020.		IC - Note: Sterile table is created less than 2 hours before operation and covered with a sterile cloth, if not used immediately
	AORN 2006; 2010, 91; 2018	**Sterile items are not tossed on the sterile table, but are given to a sterile person/team member with sterile gloves/are handled with a sterile instrument**	II
	Aholaakko 2018		II
	TYKS 2020		IC
	Bashaw & Keister 2019	**When disinfecting the surgical site unsterile clothing is not touching the sterile area**	IB
	Carroll, H. 2015. Department of Health: Surgical Skin Disinfection Guideline. Australian Department of Health. Approved December 9th, 2015.	**Surgical site asepsis is performed as instructed by the product manufacturer and hospital guideline, taking account the direction from clean to dirty areas and the flowing direction of the fluid**	IB
	AORN 2010, 260-261		IB
Preparations of sterile personnel	CDC 2002.	**Surgical hand rub is performed by sterile team members**	IA
	Spruce, L. 2013. Back to basics: hand hygiene and surgical hand antisepsis. AORN Journal. 2013;98(5):449-460.		IA
	WHO 2009a, 54-60		IA
	WHO. 2016. World health organization. Global guidelines for the prevention of surgical site infection, 2nd edition. Geneva: WHO Document Production Services.		IA
	AORN 2010 Perioperative standards and recommended practices 2010 Edition, 79		IA

	AORN. 2018. Sterile Technique. AORN Journal, vol. 108, no. 6, 2018. 705-710.		IB
	Kurvinen et.al. 2018		IC
	HUCH 2019. Helsinki University Central Hospital. Surgical hand disinfection.		IC
	AORN 2010, 91	**All sterile team members have a hair cap and mask, and accordingly dressed PPE (sterile jacket & gloves, sterile hood for implant surgery)**	IA
	WHO 2016, 149-151		IA
	CDC 2022. Centers for Disease Control and Prevention. Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings (2007, updated May 2022).		IA
	AORN 2007; 2010, 279	**Indicator gloves are used in a high-risk/orthopaedic operation**	IB
	Autorino et.al. 2019. General Assembly, Prevention, Operating Room - Surgical Attire: Proceedings of International Consensus on Orthopedic Infections. The Journal of arthroplasty, 34(2), S117-S125.		IB
	Tanner, J. 2006. Surgical Gloves: Perforation and Protection. Journal of perioperative practice, 16(3), 148-152.		IB
	Neo, F., Edward, K. & Mills, C. 2013. Understanding compliance with protective eyewear amongst peri-operative nurses: A phenomenological inquiry. Australian journal of advanced nursing, 31(1), 20-27.	**Protective eyewear is used when risk of splatter or if a sterile team member has eyelash extensions**	Category II: A weak recommendation supported by any quality evidence suggesting a trade-off between clinical benefits and harms.
	AORN 2007; 2010, 70		IC
	TYKS 2020		IC - Note: False eyelashes are forbidden in OR work
	HUCH 2017		IC
	Meriö-Hietaniemi, I. & Palosara, J. 2019. Standard precautions in IPC. Online course. Oppiportti. Published 8.3.2019, updated 23.9.2022.		IC
Aseptic behaviour	Mangram et.al. 1999 (CDC)	**Each OR team member is wearing a hair cap and a mask at all times during the operation**	IA
	AORN 2010 pp. 67-69		IA
	Kurvinen et.al. 2018		IC
	HUCH 2020. Helsinki University Central Hospital. Surgical attire. 7.9.2020.		IC
	AORN 2007	**Sterile gloves are changed if noticed to be broken or if the operation lasts longer than 2h**	IB
	AORN 2007	**Personal items or clothing (doctor's jackets) are not stored in the OR**	IB

	Girard, N. J. 2008. Eating or Drinking in the OR: Another Safety Factor? AORN journal, 87(5), 901-902.	**Eating or drinking is not done in the OR**	IB
	AORN 2007; AORN 2010, 281		IB
	Bashaw & Keister 2019.	**Times of opening the OR door when sterile fields are prepared**	II
	CDC 2016. Centers for Disease Control and Prevention. Standard precautions for all patient care. Last reviewed January 26th, 2016.	**Disinfection of a bloodstain is immediately performed with nonsterile gloves**	II
	Kurvinen et.al. 2018		IC
	AORN 2007; 2010, 279-281	**If the patient is carrying an antibiotic resistant microbe, they are treated with contact precautions according to the organization contact precaution protocol**	IB
	Similä, E. 2020. Standard and Contact Precautions in the Operating Room and Recovery Room. Oulu University Hospital. 17.4. 2020.		IC
	TAYS. 2021. Tampere University Hospital. Contact precautions in the operating room. 21.7.2021.		IC
	HUCH 2021		IC
	TYKS 2022. Turku University Hospital. Screening and positioning of antibiotic resistant microbes in an Operating Room unit. 4.3.2019, updated 8.9.2022.		IC
	CDC 2022. Centers for Disease Control and Prevention. Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings (2007, updated May 2022).		IB
	Walits, E. & Carpo, M. F. 2014. The role of the perioperative nurse in implementing contact precautions to prevent transmission of multidrug-resistant organisms: The official voice of perioperative nursing. Aorn J. 2021;114(6):573-582.		IB
Maintenance of the sterile field	AORN 2006; 2010, 91-94; 2018	**Unscrubbed person does not move between two sterile fields**	II
	Aholaakko 2018		IC
	AORN 2006; 2010, 91-94; 2018;	**Unscrubbed person keep eye contact and visible distance to sterile field when moving near the area**	II
	Aholaakko 2018		IC
	AORN 2006; 2010 pp. 91-94; 2018	**Sterile field is visible for sterile members at all times (back is not turned)**	II
	Aholaakko 2018		IC

								Overall appraisal
Objective	**Reference**	**Criteria**	**Purpose and aim of the study**	**Design**	**Data and methods**	**Results**	**Other features, possible bias, validity**	Include □ Exclude □ Seek further info □
Hand hygiene	Allegranzi, B. & Pittet, D. 2009. Role of hand hygiene in healthcare-associated infection prevention. Journal of Hospital Infection, 73(4), pp. 305-315.	Are gloves available and easily accessible in at least three spots in the room?	To review factors influencing hand hygiene compliance, the impact of hand hygiene promotion on microbe cross-transmission and infection rates, and issues related to universal adoption of alcohol-based hand rub	Review on most relevant studies assessing the impact of hand hygiene promotion on HCAI 1977-2008	Hospital setting, Intervention, Impact on hand hygiene compliance, Impact on HCAI, Duration of follow-up and Reference were reviewed	Multimodal interventions are most suitable strategy to determine behavioural change leading to improved hand hygiene compliance and reduction in HCAI rates. Introduction of alcohol-based hand rubs and continuous educational programmes	No evaluation on risk of bias, research validity or reliability	Include
	Arrowsmith, V. A. & Taylor, R. 2014. Removal of nail polish and finger rings to prevent surgical infection. Cochrane Database of Systematic Reviews 2014, Issue 8. Art. No.: CD003325.	No artificial fingernails/gel nails/nail polish on any team member	To assess the effect of the presence or absence of rings and nail polish on the hands of the surgical scrub team on postoperative wound infection rates.	Review on randomised controlled trials (RCTs) evaluating the effect of wearing or removing finger rings and nail polish on the efficacy of the surgical scrub and postoperative wound infection rate.	The Cochrane Wounds Group Specialised Register (searched 23 July 2014); The Cochrane Central Register of Controlled Trials (CENTRAL) (The Cochrane Library); Ovid MEDLINE; Ovid MEDLINE (In-Process & Other Non-Indexed Citations); OvidEMBASE and EBSCO CINAHL were used in search	No RCTs that compared wearing of rings with the removal of rings; and no trials of nail polish versus no nail polish that measured surgical infection rates:ne small RCT (102 scrub nurses) that evaluated the effect of nail polish on the number of bacterial colony forming units on hands after pre-operative surgical scrubbing	Insufficient evidence to determine whether wearing nail polish affects the number of bacteria on the skin post-scrub.	Include
	Fernando, S. A., Gray, T. J. & Gottlieb, T. 2017. Healthcare-acquired infections: Prevention strategies. Internal medicine journal, 47(12), pp. 1341-1351.	Surgical hand rub is performed by all sterile team members	Overview of common healthcare-acquired infections with examples of prevention strategies	Overview of HAI's, Background, Examples of prevention strategies	Review focused on problems of carbapenem resistance, CDI, and on Infection Control and Antimicrobial Stew-ardship (AMS), areas	Effective HAI management strategies should be implemented in hospitals and HCW recognise the importance of individual role in HAI prevention. Surgical hand preparation using	No evaluation on risk of bias, research validity or reliability	Include

						antimicrobial soap and water or alcohol-based hand rub.		
Preparations of the patient	Fernando, Gray & Gottlieb 2017.	An antibiotic prophylaxis is administrated within 60 minutes pre-incision if designated				Optimal route, dose and timing for surgical prophylaxis (when indicated).		Include
	Gillespie, W. J. & Walenkamp G. H. I. M. 2010. Antibiotic prophylaxis for surgery for proximal femoral and other closed long bone fractures. Cochrane Database of Systematic Reviews 2010, Issue 3. Art. No.: CD000244.		To determine whether the prophylactic administration of antibiotics in people undergoing surgical management of hip or other closed long bone fractures reduces the incidence of SSI's and other HAI's	A systematic Cochrane review	Randomised or quasi-randomised controlled trials comparing any regimen of systemic antibiotic prophylaxis administered at the time of surgery, compared with no prophylaxis, placebo, or a regimen of different duration, in people with a hip fracture undergoing surgery for internal fixation or prosthetic replacement, or with any closed long bone fracture undergoing internal fixation. All trials needed to report SSI.	Antibiotic prophylaxis should be offered to those undergoing surgery for closed fracture fixation.	Not enough data available to confirm the expected tendency for increased adverse drug-related events such as gut problems and skin reactions	Include

					Randomised or quasi-randomised controlled trials involving open fractures of the limbs; intervention - antibiotic administered before or at the time of primary treatment of the open fracture compared with placebo or no antibiotic; outcome measures - early wound infection, chronic drainage, acute or chronic osteomyelitis, delayed unions or non-unions, amputations and deaths.	Antibiotics reduce the incidence of early infections in open fractures of the limbs.	Further research is necessary to the determine the avoidable burden of morbidity in countries where antibiotics are not used routinely in the management of open fractures.	Include
Establishment of sterile field	Dumville, J. C., McFarlane, E., Edwards, P., Lipp, A. & Holmes, A. 2013. Preoperative skin antiseptics for preventing surgical wound infections after clean surgery. Cochrane database of systematic reviews, 3, p. CD003949.	Surgical asepsis is performed as instructed by the product manufacturer and hospital guideline, taking account the direction from clean to dirty areas and the flowing direction of the fluid	To determine whether preoperative skin antisepsis immediately prior to surgical incision for clean surgery prevents SSI and to determine the comparative effectiveness of alternative antiseptics.	A systematic review	Randomised controlled trials evaluating the use of preoperative skin antiseptics applied immediately prior to incision in clean surgery	A single, poorly reported study indicated that preoperative skin preparation with 0.5% chlorhexidine in methylated spirits was associated with lower rates of SSIs following clean surgery than alcohol-based povidone iodine paint	There is very little good quality research around skin cleansing before surgery and it is not possible to choose whether one antiseptic is better than another at preventing wound infections. More research is required to show whether one antiseptic is better than the others at preventing wound infection after a clean surgery.	Seek further info

	Silva, P. 2014. The right skin preparation technique: a literature review. Journal of Perioperative Practice. Vol 24(12), 283-285.		Is concentric circles motion technique or a back-and-forth scrubbing technique more effective in disinfecting the surgical site?	A literature review	No description	Until conclusive studies are presented, it is reasonable to follow a skin preparation technique that offers a good rationale for its use. The literature referred to in this review seems to suggest that a back and forth technique should be used, as it is more effective in reaching deeper layers of the skin	There is very limited evidence comparing skin preparation techniques	Seek further info
Preparations of sterile personnel	Tanner, J. 2006. Surgical Gloves: Perforation and Protection. Journal of perioperative practice, 16(3), pp. 148-152.	Indicator gloves are used in a high-risk/ orthopaedic operation		Article				Seek further info
	Neo, F., Edward, K. & Mills, C. 2013. Understanding compliance with protective eyewear amongst peri-operative nurses: A phenomenological inquiry. Australian journal of advanced nursing, 31(1), pp. 20-27.	Protective eyewear is used when risk of splatter or if a sterile team member has eyelash extensions	To obtain an in-depth understanding of the phenomenon of peri-operative nurses' use of protective eyewear in the operating room (OR), and to understand nurses' attitudes and beliefs towards protective eyewear	A qualitative analysis	Data was collected via one-on-one interviews with eight peri-operative nurses working in a private hospital in Melbourne. The data collected underwent rigorous thematic analysis using an extended version of Colaizzi's method of phenomenological inquiry.	For nurses, being compliant with protective eyewear is a combination of intrapersonal, environmental and professional factors, including protecting self, risk appraisal, beliefs, previous experiences, fear, comfort and functionality, professionalism, leadership, forgetting versus routine, time pressure and accessibility, alternatives and patient-	Focusing on only one type of PPE, selection bias, findings are not generalisable to the OR nursing population as a whole	Include

						centred care. Peri-operative nurses are more compliant when they are well informed and are in a supportive work environment.		
Aseptic behaviour	Autorino, C. M., Battenberg, A., Blom, A., Catani, F., ElGanzoury, I., Farrell, A., Georgini, A., Goswami, K., Hernandez, V., Karas, V., Kunutsor, S.K., Lewallen, D.G., Mahmoud, A.N., Osman, W.S., Sheehan, E., Smith, B.M., Soliman, R.A., Spangehi, M. & Young, S. 2019. General Assembly, Prevention, Operating Room - Surgical Attire: Proceedings of International Consensus on Orthopedic Infections. The Journal of arthroplasty, 34(2), pp. S117-S125.	Sterile gloves are changed if noticed to be broken or if the operation lasts longer than 2h	Question 5: Does changing gloves during prolonged operations reduce the risk of SSIs/PJIs? If so, how frequently should gloves be changed during the procedure?	A systematic review	Records identified through database search N= 1326, studies included N= 17	Changing gloves intraoperatively may reduce the risks of SSIs/PJIs in arthroplasty surgery by reducing contamination. Based on prior studies, gloves should be changed after draping, before handling implants, and when macroscopic perforation of the glove occurs. Gloves should also be changed at least once every 60 to 90 minutes, as contamination and glove perforation rates increase with duration of surgery. Level of Evidence: Limited Delegate Vote: Agree: 92%, Disagree: 5%,	More studies are required to draw a definitive conclusion regarding the effectiveness of changing gloves in reducing the risk of SSIs/PJIs	Include

						Abstain: 3% (Super Majority, Strong Consensus)		
	Harnoss, J. C., Kramer, A., Heidecke, C. D. & Assadian, O. 2010. What is the Appropriate Time-Interval for Changing Gloves During Surgical Procedures? Zentralblatt fur Chirurgie, 135(1), pp. 25-27.		To elaborate an objective recommendation for the time-interval of glove change, the medical literature was searched in the data bases MEDLINE and PubMed.	An integrative review	No description	Various imprecise recommendations were expressed for the time point of glove changing ranging from 30 min to 180 min.	Further studies are needed that correlate the types of surgical procedures with specific perforation rates in order to provide basis for recommendations	Include
	Fernando, Gray & Gottlieb 2017.	Number of door openings				Limit operating room traffic to essential movement only		Include
Maintenance of sterile field	Gillespie, B.M., Kang, E., Roberts, S., Lin, F., Morley, N., Finigan, T., Homer, A & Chaboyer, W. 2015. Reducing the risk of surgical site infection using a multidisciplina		To identify and describe the strategies and processes used by multidisciplinary teams of health care professionals to reduce surgical site infections (SSIs).	An integrative literature review. A following review of the included studies.	Data were abstracted using summary tables and the methodological quality of each study assessed using the Standards for Quality Improvement Reporting Excellence	Patient-centered interventions aimed at increasing patient participation in SSI prevention and evaluating the contributions of allied	The possibility of missing eligible studies, lack of consistency in the terminology used to describe team	Include

	ry approach: an integrative review. Journal of Multidisciplinary Healthcare. 2015; 8: 473-487.				guidelines by two reviewers	health professionals in team-based SSI prevention requires future research	collaborations	
OTHER RELEVANT STUDIES								
Establishment of sterile field	Knoll, P.A. & Browne, J.A. 2017. Prepping the knee in maximal flexion: getting into every nook, cranny, and fold. Arthroplasty today, 3 (2), p.99-103.	Surgical site asepsis is performed as instructed by the product manufacturer and hospital guideline, taking account the direction from clean to dirty areas and the flowing direction of the fluid	Article to describe a simple surgical skin preparation technique for total knee arthroplasty that permits the application of skin prep agent with the knee in maximal flexion. Usually the knee is prepped in extension, but it is believed that prep of the knee in flexion will provide superior coverage of the skin surface and reduce the potential for surgical-site infection	A qualitative analysis	No description	The technique has improved the quality and thoroughness of surgical-site preparation, it involves an additional scrub in maximal flexion after the final drapes are placed	Lack of objective evidence for the technique: No retrospective comparison between practices	Seek further info
	Hopper, R. & Moss, R. 2010. Common Breaks in Sterile Technique: Clinical Perspectives and Perioperative Implications. AORN Journal. Vol 91(3), 350-367		Key responsibilities of perioperative nurses are to recognize and correct common breaks in sterile technique that are made in preparation for and during a surgical procedure and to implement methods to prevent future occurrences	Article: Summary on AORN guidelines	No description	The principles of AT and basic tenets of prepping are to begin at the center (the point of the incision) and continue to the periphery of the area and never bring a soiled applicator back over a previously prepped surface. A common error	No evaluation on risk of bias, research validity or reliability	Include

						is to not follow these principles.		
Maintenance of sterile field	Allegranzi et.al. 2018. A multimodal infection control and patient safety intervention to reduce surgical site infections in Africa: A multicentre, before–after, cohort study. The Lancet infectious diseases, 18(5), pp. 507-515.		Establish the effect of a multimodal intervention on SSIs in Africa, evaluate if the implementation of a multimodal SSI prevention strategy is feasible in low-resource settings and is able to improve preventive measures and reduce the SSI risk.	Before–after multimodal intervention cohort study using a stepwise implementation protocol, including five planned periods supported by a range of tools, and SSI surveillance throughout the study based on methods described by the CDC and Prevention National Health Care Safety Network	Descriptive data were analysed by study period in a combined dataset and then stratified by site. Comparisons of mean values were done using Student's t tests and x^2 tests for categorical variables. The 95% CI was estimated for proportions with the Clopper-Pearson exact method. Data were clustered at site level, a logistic regression model with mixed effects was used to assess the effect of the intervention on outcomes.	The implementation of a multimodal SSI prevention strategy is feasible in low-resource settings and can improve preventive measures and reduce the SSI risk. Multisite SSI surveillance is feasible in African settings, typically with a single member of the nursing staff able to collect high quality data for around 50 operations per month. Approximate 60% reduction in SSI risk across all sites, as a result of the intervention.	Decreased rate of surgical-site infection using this technique.	Include

Criteria	Reasoning	Reference	Strength of the criteria
Hand disinfectant is available and easily accessible in at least three spots in the room	For hand hygiene to be efficient, the instruments that enable hand disinfection need to be accessible for OR personnel. Supplying healthcare environments with materials necessary helps improve aseptic practices. Fidelity of hand disinfection is relevant and can be influenced by assuring tools.	CDC 2002; AORN 2007; Allegranzi & Pittet 2009; AORN 2010; Allegranzi, Sax & Pittet 2013; Korhonen et.al. 2015; CDC 2016; Bashaw & Keister 2019; WHO 2021; Parnikh et.al. 2022	Category IB: A strong recommendation supported by low-quality evidence suggesting net clinical benefits or harms or an accepted practice supported by low to very low-quality evidence.
Gloves are available and easily accessible in at least three spots in the room	To protect healthcare personnel by preventing blood and fluid contamination, gloves should be used when handling patient mucous and secretions. Supplying healthcare environments with materials necessary helps improve aseptic practices.	CDC 2002; Allegranzi & Pittet 2009; Bashaw & Keister 2019; WHO 2021; Parnikh et.al. 2022	IB
Hand disinfectant are near the glove boxes	When dressing protective gloves, hand should be clean to prevent the contamination of the products. When gloves are worn and hand hygiene is indicated, the gloves should be removed to perform hand hygiene.	CDC 2002; AORN 2007; Allegranzi & Pittet 2009; Spruce 2013; Hughes et.al. 2013; Bashaw & Keister 2019; O'hara et.al. 2019; AORN 2017; THL 2022b	IB
No watches or rings on any team member	Perioperative team members should not wear jewellery on the hands or wrists in patient care areas. Research indicates that removing rings, removing or containing watches and covering ear and nose piercings with head coverings and masks reduces contact contamination risk. Jewellery and watches prevent successful hand hygiene by leaving moist and bacteria between skin and item, which can cause inflammation or be transmitted from person to another. Study showed significant load of microbe contamination on HCW smart watches.	AORN 2005; WHO 2009; AORN 2010; Arrowsmith & Taylor 2014; AORN 2017; HUCH 2022; Kurvinen et.al. 2018; Boucherabine et.al. 2022	IB
No artificial fingernails / gel nails/nail polish on any team member	Artificial fingernails or extenders should not be worn in perioperative settings. Nail polish and gel nails enable microbes to contact in cracked surfaces, are worn out quickly from constant disinfectant use and have been associated with infections.	AORN 2005; AORN 2010; WHO 2009; Arrowsmith & Taylor 2014; CDC 2016; AORN 2017; HUCH 2022; Kurvinen et.al. 2018	Artificial fingernails: Category IA: A strong recommendation supported by high to moderate-quality evidence suggesting net clinical benefits or harms. Nail polish: Category II: A weak recommendation supported by any quality evidence suggesting a trade-off between clinical benefits and harms.

Appendix 6: Criteria for preoperative AB-prophylaxis and sterile field establishment 80

Criteria	Reasoning	Reference	Strength of the criteria
Preoperative AB-prophylaxis	An antibiotic prophylaxis is administered within 60 minutes pre-incision if designated	Mangram et.al. 1999; Gosselin, R. A., Roberts, I. & Gillespie, W. J. 2004; Gillespie, W. J. & Walenkamp G. H. I. M. 2010; ECDC 2013; WHO 2016; HUCH 2021	Category IA: A strong recommendation supported by high to moderate-quality evidence suggesting net clinical benefits or harms
Sterile field is created less than an hour before operation	Sterile fields should be prepared as near as possibly of the starting time of the surgery	AORN 2006; AORN 2010; Bussieres et.al. 2017; Aholaakko 2018; TYKS 2020	No recommendation/unresolved issue: An issue for which there is low to very low-quality evidence with uncertain trade-offs between the benefits and harms or no published evidence on outcomes deemed critical to weighing the risks and benefits of a given intervention. Note: TYKS (2020) guideline recommends 2h and covering with a sterile cloth
Sterile items are not tossed on the sterile table, but are given to a sterile person/team member with sterile gloves/are handled with a sterile instrument	Tossing sterile items on sterile table includes a risk of contamination for the item, risk of breakage of the sterile tablecloth and risk of vectorborne contamination from personnel's attire if moving too close the sterile area.	(Friberg & Friberg 2006); AORN 2006; AORN 2010; Blom et.al. 2007; Aholaakko 2018; TYKS 2020	Category II: A weak recommendation supported by any quality evidence suggesting a trade-off between clinical benefits and harms.
When disinfecting the surgical site unsterile clothing is not touching the sterile area.	When preparing surgical site, perioperative personnel should wear clean surgical attire, tops should fit close to the body or be tucked in pants to prevent the unsterile clothing from touching the sterile area.	Bashaw & Keister 2019	Category IB: A strong recommendation supported by low-quality evidence suggesting net clinical benefits or harms or an accepted practice supported by low to very low-quality evidence.
Surgical site asepsis is performed as instructed by the product manufacturer and hospital guideline, taking account the direction from clean to dirty areas and the flowing direction of the fluid.	When preparing surgical site, the asepsis should be performed as instructed by the manufacturer depending on the product used, eg. when using alcohol, the asepsis should be done in the flowing direction of the fluid and when using clorhexidine swabs, the asepsis is performed with back on forth scrubbing technique. The direction from clean to dirty should also be followed to prevent the contamination of the recently disinfected area and the used product.	Hopper & Moss 2010; AORN 2010; Dumville et.al. 2013; Birgand et.al. 2014; Silva 2014; Carroll 2015; Knoll & Browne 2017	IB

Appendix 6: Criteria for sterile personnel preparations 81

Criteria	Reasoning	Reference	Strength of the criteria
Surgical hand rub is performed by sterile team members	Surgical hand preparation should be performed using an alcohol-based hand rub before donning sterile gloves.	CDC 2002; WHO 2009a; AORN 2010; Spruce 2013; AORN 2017; Schwartz et.al. 2018; Fernando et.al. 2017; WHO 2018; Kurvinen et.al. 2018; HUCH 2019	Category IA: A strong recommendation supported by high to moderate-quality evidence suggesting net clinical benefits or harms
All sterile team members have a hair cap and mask, and accordingly dressed PPE (sterile jacket & gloves, sterile hood for implant surgery)	Covering all the skin and hair of the team members and patient when working in the sterile field to reduce the risk of microbe contamination. To avoid body fluid contamination the use of masks and protective eye wear as part of routine surgical attire is recommended.	Friberg et.al. 2001; AORN 2005; AORN 2007; Aisien & Ujah 2006; WHO 2009; AORN 2010; Aholaakko 2018; WHO 2018; HUCH 2017; CDC 2022	IA
Indicator gloves used in high-risk (clean/orthopaedic) operations	Risk of contamination and glove perforation increase with duration of surgery. Double gloving helps revealing tears in outer glove and changing of clean gloves during surgery without risking the surgical site.	Mangram et.al. 1999; Aarnio & Laine 2001; Laine & Aarnio 2004; AORN 2007; AORN 2010; Padhye et.al. 2011; Korniewicz & El-Masri 2012; Hughes et.al. 2013; Bekele et.al. 2017; Matsuoka et.al. 2022; Karakus & Sari 2020;	Category IB: A strong recommendation supported by low-quality evidence suggesting net clinical benefits or harms or an accepted practice supported by low to very low-quality evidence.
Protective eyewear is used if risk of splatter or sterile team member has eyelash extensions	To prevent surgical site contamination from falling eye lashes, the use of protective eye wear is recommended. Note: In some welfare-area guidelines the use of false lashes is restricted in OR.	AORN 2007; AORN 2010; Weaving, Cox & Milton 2008; Neo et.al. 2013; HUCH 2017; TYKS 2020	Risk of splatter: Category IC: A strong recommendation required by state or federal regulation. Eyelash extensions: Category II: A weak recommendation supported by any quality evidence suggesting a trade-off between clinical benefits and harms.

Criteria	Reasoning	Reference	Strength of the criteria
Each OR team member is wearing a hair cap and a mask at all times during the operation	The risk of vector borne contamination should be minimized by wearing clean clothes suitable for OR settings. Personnel should cover head and facial hair, including sideburns and necklines in the OR to prevent hair, dandruff and skin cells from falling to surgical site. Surgical attire guideline includes scrub attire, shoes, head coverings, and masks. All individuals entering restricted areas of the OR suite should wear a mask when open sterile items and equipment are present.	Mangram et.al. 1999; Friberg et.al. 2001; AORN 2005; AORN 2007; AORN 2010; WHO 2009; Kurvinen et.al. 2018; TYKS 2020	Category IA: A strong recommendation supported by high to moderate-quality evidence suggesting net clinical benefits or harms
Sterile gloves are changed if noticed to be broken or if the operation lasts longer than 2h	Based on research evidence, gloves should be changed after draping, before handling implants, and when macroscopic perforation of the glove occurs. Gloves should also be changed at least once every 60 to 90 minutes, as risk of contamination and glove perforation increase with duration of surgery.	AORN 2007; Harnoss et.al. 2010; Padhye et.al. 2011; Autorino et.al. 2019; TYKS 2020	Change of broken gloves: Category IB: A strong recommendation supported by low-quality evidence suggesting net clinical benefits or harms or an accepted practice supported by low to very low-quality evidence. Change of gloves after 2h: Category IC: A strong recommendation required by state or federal regulation.
No personal items or clothing (backpacks, doctor's jackets) are stored in the OR	Avoiding contact to personal items and clothing brought from outside the aseptic area, avoiding unnecessary movements in the sterile field and respecting air-current models to reduce the risk of contact, droplet and airborne microbe contamination.	AORN 2007; Aholaakko 2018	IB
No eating or drinking in the OR	Hand-to-hand, hand-to-skin, hand-to-nose, hand-to-mouth, or hand-to-eye action can lead to direct or indirect transmission via inanimate surfaces and should be prohibited in the OR. Food and drink should not be present in perioperative settings.	AORN 2007; Girard 2008; AORN 2010	IB
Times of opening the OR door when sterile fields are prepared.	The OR door openings during a surgical procedure increases air turbulence, when pathogens move through the air and increases risk of exposing the incision site to microbes. Change in air quality and disturbance in the airflow may increase the risk of an SSI: Avoiding traffic in and out of the OR.	Dharan & Pittet 2002; Sadrizadeh et.al. 2014; Teter et.al. 2017; Aholaakko 2018; Bashaw & Keister 2019; Birgand et.al. 2019	Category II: A weak recommendation supported by any quality evidence suggesting a trade-off between clinical benefits and harms.
Disinfection of a bloodstain is immediately performed with nonsterile gloves.	Environmental cleaning is an essential measure to prevent the spread of pathogens. Body fluids and blood cause a risk of cross contamination for the OR environment and team members: Bloodstains should be appropriately removed with a suitable product.	Mangram et.al. 1999; Kurvinen et.al. 2018; Aholaakko 2018	II
If the patient is carrying an antibiotic resistant microbe, they are treated with contact precautions according to the organization contact precaution protocol.	To protect the personnel and other patients from being transmitted an antibiotic resistant microbe during perioperative care, the patient carrying a contagious microbe should be isolated during their hospital stay.	AORN 2007; AORN 2010; Similä 2020, 6-9; TAYS 2021; HUCH 2021; TYKS 2022; CDC 2022	IB

Unscrubbed person does not move between two sterile fields	Avoiding unnecessary movements in the sterile field and respecting air-current models to reduce the risk of contact, droplet and airborne microbe contamination	(Friberg & Friberg 2006); AORN 2010; Aholaakko 2018	Category II: A weak recommendation supported by any quality evidence suggesting a trade-off between clinical benefits and harms.
Unscrubbed person keep eye contact and visible distance to sterile field when moving near the area	Avoiding unnecessary movements in the sterile field and respecting air-current models to reduce the risk of contact, droplet and airborne microbe contamination	Bible et. al. 2009; AORN 2010; Aholaakko 2018	II
Sterile field is visible for sterile members at all times (back is not turned)	Sterile fields are kept between areas of low contamination risk	Bible et. al. 2009; AORN 2010; Aholaakko 2018	II

Tutkimustiedote
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Laurea Ammattikorkeakoulu

"Intraoperative Aseptic Practices of OR-personnel" - Leikkaussalihenkilökunnan aseptisten toimintatapojen toteutuminen

Pyyntö osallistua tutkimukseen

Teitä pyydetään mukaan tutkimukseen, jossa tutkitaan leikkaussalihenkilökunnan aseptisten toimintatapojen toteutumista. Olemme arvioineet, että sovellutte tutkimukseen, koska työskentelette tutkimukseen osallistuvassa leikkausyksikössä. Tämä tiedote kuvaa tutkimusta ja teidän osuuttanne siinä. Perehdyttyänne tähän tiedotteeseen teille järjestetään mahdollisuus esittää kysymyksiä tutkimuksesta, jonka jälkeen teiltä pyydetään suostumus tutkimukseen osallistumisesta.

Vapaaehtoisuus

Tutkimukseen osallistuminen on täysin vapaaehtoista. Kieltäytyminen ei vaikuta oikeuksiinne tai asemaanne. Voitte myös keskeyttää tutkimuksen koska tahansa syytä ilmoittamatta. Mikäli peruutatte suostumuksen, teistä keskeyttämiseen ja suostumuksen peruuttamiseen mennessä kerättyjä tietoja ja näytteitä voidaan käyttää osana tutkimusaineistoa.

Tutkimuksen tarkoitus

Tämän tutkimuksen tarkoituksena on arvioida leikkaussalihenkilökunnan aseptisten toimintatapojen toteutumista kirurgisen toimenpiteen aikana.

Tutkimuksen toteuttajat

Tutkimus tehdään organisaation valtuuttamana ja sen toteuttajana sekä pääyhteyshenkilönä toimii Ninamari Pitko. Tutkimusprojektin rahoittajana toimii organisaatio. Tutkimuksen arvioijana ja tarkistajana toimii Laurea Ammattikorkeakoulun yliopettaja Teija-Kaisa Aholaakko. Tutkimuksen julkaisija ja tekijänoikeuksien omistaja on Ninamari Pitko.

Tutkimusmenetelmät ja toimenpiteet

Tutkimus toteutetaan 4-5 leikkausyksikössä havainnointina leikkausryhmän jäsenien aseptisista käytännöistä.

Työn tarkoituksena on testata leikkaussalin aseptisten toimintatapojen arvioinnin työkalua käytännön tutkimuksella perioperatiivisessa toiminnassa ja arvioida sen avulla aseptisten toimintatapojen toteutumista. Tutkimustulosten myötä voidaan selvittää steriliteetin toteutumisen ja ylläpitämisen tasoa puhtaissa toimenpiteissä, sekä kartoittaa mahdollisia kehityskohtia aseptisissa toimintatavoissa.

Aseptisten toimintatapojen havainnointi tapahtuu leikkaussalissa, jossa havainnoija tarkastelee ennalta määritettyjä kohtia aseptisissa ja steriileissä käytänteissä vaikuttamatta toimenpiteeseen tai sen aikaiseen toimintaan. Havainnoinnin kohteena on toimenpide, leikkaussaliympäristö ja toimenpiteen toteuttamiseen osallistuvat henkilöt.

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Intraoperative aseptic practices of operating room personnel
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Henkilötietojen käsittely

Osallistujien henkilötietoja ei käsitellä prosessissa tai kirjata tutkimusmateriaaliin. Tutkimuksessa ei käsitellä henkilötietoja tai eritellä taustatietoja niin, että tiedot olisivat jäljitettävissä tutkimukseen osallistuvaan henkilöön. Ainoastaan tutkimuksen toteuttaja käsittelee sen aikana kerättyä materiaalia. Kaikki tutkimukseen liittyvä tieto käsitellään anonyymisti tutkijan toimesta, eikä sitä voida yhdistää yksittäisiin osallistujiin.

Kustannukset ja niiden korvaaminen

Tutkimukseen osallistuminen ei maksa teille mitään. Osallistumisesta ei myöskään makseta erillistä korvausta.

Tutkittavien vakuutusturva

Tutkimukseen ei liity vakuutusta edellyttäviä mittauksia.

Tutkimustuloksista tiedottaminen

Tutkimustulokset julkaistaan toukokuun 2023 aikana. Tulosten avulla organisaatio saa tietoa toimenpiteiden aikaisten aseptisten toimintatapojen laadusta ja mahdollisista kehitysehdotuksista. Kyseessä on opinnäytetyö, joka julkaistaan avoimesti Theseus-tietokannassa.

Tutkimuksen päättyminen

Myös tutkimuksen suorittaja voi keskeyttää tutkimuksen, mikäli tutkimuksen mahdollistavat tekijät eivät toteudu: yksikössä ei tehdä tutkimukseen suunniteltuja toimenpiteitä tai niiden määrä jää tutkimusaikavälillä selvästi alle tavoitetason (10).

Lisätiedot

Pyydämme teitä tarvittaessa esittämään tutkimukseen liittyviä kysymyksiä tutkijalle/tutkimuksesta vastaavalle henkilölle.

Tutkijoiden yhteystiedot

Tutkija / opinnäytetyötekijä
Nimi: Ninamari Pitko
Puh.

Tutkimuksesta vastaa / opinnäytetyön ohjaaja
Titteli: Yliopettaja
Nimi: Teija-Kaisa Aholaakko
Korkeakoulu / yksikkö: Laurea Ammattikorkeakoulu / Tikkurila
Puh.

Suostumus
Intraoperative aseptic practices of operating room personnel -
Leikkaussalihenkilökunnan aseptisten toimintatapojen toteutuminen
Pitko 2022
Laurea Ammattikorkeakoulu

Tutkimuksen nimi: Leikkaussalihenkilökunnan aseptisten toimintatapojen toteutuminen

Tutkimuksen toteuttaja: Laurea ammattikorkeakoulu. Tutkija: Ninamari Pitko Ohjaaja: Teija-Kaisa Aholaakko

Minua on pyydetty osallistumaan yllä mainittuun tutkimukseen, jonka tarkoituksena on leikkaussalihenkilökunnan aseptisten toimintatapojen toteutumisen arviointi.

Olen saanut tiedotteen tutkimuksesta ja ymmärtänyt sen. Tiedotteesta olen saanut riittävän selvityksen tutkimuksesta, sen tarkoituksesta ja toteutuksesta, oikeuksistani sekä tutkimuksen mahdollisesti liittyvistä hyödyistä ja riskeistä. Minulla on ollut mahdollisuus esittää kysymyksiä ja olen saanut riittävän vastauksen kaikkiin tutkimusta koskeviin kysymyksiini.

Olen saanut tiedot tutkimukseen mahdollisesti liittyvästä henkilötietojen keräämisestä, käsittelystä ja luovuttamisesta ja minun on ollut mahdollista tutustua tutkimuksen tietosuojaselosteeseen.

Osallistun tutkimukseen vapaaehtoisesti. Minua ei ole painostettu eikä houkuteltu osallistumaan tutkimukseen.

Minulla on ollut riittävästi aikaa harkita osallistumistani tutkimukseen.

Ymmärrän, että osallistumiseni on vapaaehtoista ja että voin peruuttaa tämän suostumukseni koska tahansa syytä ilmoittamatta. Olen tietoinen siitä, että mikäli keskeytän (voin jatkaa sitä myöhemmin) tutkimuksen, keskeyttämiseen asti kerättyjä tietoja voidaan käyttää tutkimuksessa.

Tutkimuksessa ei käsitellä henkilötietoja tai eritellä taustatietoja niin, että tiedot olisivat jäljitettävissä tutkimukseen osallistuvaan henkilöön. Minulla on oikeus peruuttaa suostumukseni tietosuojaselosteessa kuvatulla tavalla.

Tutkimustiedote liitteineen ja suostumuslomake jäävät tutkittavalle.

Appendix 11: Intraoperative aseptic practices of operating room personnel-observation tool 87

1/2 Unit number:_____

Intraoperative aseptic practices of operating room personnel-Observation tool

Pitko 2022 Operation number:_____

Laurea University of Applied Sciences

Implant surgery _____ Operation time:_____

Hand hygiene enabling instruments	**Yes**	**No**	**Not applicable**
1. Is hand disinfectant available and easily accessible in at least three spots in the room?	□	□	□
2. Are gloves available and easily accessible in at least three spots in the room?	□	□	□
3. Are hand disinfectants near the glove boxes?	□	□	□
Hand hygiene realisation			
4. No watches or rings on any team member	□	□	□
5. No artificial fingernails/gel nails/nail polish on any team member	□	□	□
Preparations of the patient			
6. An antibiotic prophylaxis is administered within 60 minutes pre-incision if designated	□	□	□

Establishment of sterile field	**Yes**	**No**
7. Sterile field is created less than hour before operation	□	□
8. Sterile items are not tossed on the sterile table, but are given to a sterile person/team member with sterile gloves/are handled with a sterile instrument	□	□
When disinfecting the surgical site		
9. unsterile clothing is not touching the sterile area	□	□
10. the asepsis is performed as instructed by the product manufacturer and hospital guideline, taking account the direction from clean to dirty area and the flowing direction of the fluid	□	□

Preparations of sterile personnel	**Yes**	**No**	**Not applicable**
11. Surgical hand rub is performed by sterile team members	□	□	□
12. All sterile team members have a hair cap and mask, and accordingly dressed PPE (sterile jacket & gloves, hood/sterile helmet for implant surgery)			
13. Indicator gloves are used in a high-risk/ orthopaedic operation	□	□	□
Protective eyewear is used			
14. By all sterile team members if risk of splatter	□	□	□
15. A sterile team member if with eyelash extensions	□	□	□

Aseptic behaviour	**Yes**	**No**	**Not applicable**
16. Each OR team member is wearing a hair cap and a mask at all times during the operation	□	□	

Appendix 11: Intraoperative aseptic practices of operating room personnel-observation tool 88

2/2
Aseptic practices of operating room personnel- Observation tool
Pitko 2022
Laurea University of Applied Sciences

Unit number:_____
Operation number:_____

Sterile gloves are changed	Yes	No	Not applicable
17. If noticed to be broken or	□	□	□
18. If the operation lasts longer than 2h	□	□	□
19. Personal items or clothing (backpacks, doctor's jackets) are not stored in the OR	□	□	
20. Eating or drinking is not done in the OR	□	□	
21. Disinfection of a bloodstain is immediately performed with nonsterile gloves	□	□	□
22. If the patient is carrying an antibiotic resistant microbe, they are treated with contact precautions according to the organization contact precaution protocol	□	□	□
23. Times of opening the OR door when sterile fields are prepared _____			

Maintenance of the sterile field:

24. Unscrubbed person does not move between two sterile fields	□	□
25. Unscrubbed person keep eye contact and visible distance to sterile field when moving near the area	□	□
26. Sterile field is visible for sterile members at all times (back is not turned)	□	□

Notes: