

PREVENTION OF SURGICAL SITE INFECTIONS IN ORTHOPAEDICS

Róża Słowik^{1A,B,D}, Marta Zofia Wałaszek^{2E,F}, Małgorzata Kołpa^{2C,E}

¹Orthopaedics Department, Provincial Hospital, Tarnow, Poland

²Department of Nursing, State Higher Vocational School, Tarnow, Poland

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Address for correspondence:

Dr hab. Marta Zofia Wałaszek
Department of Nursing
State Higher Vocational School
Tarnow, Poland
e-mail: mz.walaszek@gmail.com

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ABSTRACT

Surgical site infections (SSI) are some of the most serious postoperative complications. Orthopaedic surgery involves a higher risk of developing SSI due to inserting implants into bones that have a very sensitive structure and a good blood supply. The ability to identify and classify SSI contributes to prompt treatment and better prognosis. Prevention of SSI encompassing preoperative, intraoperative, and postoperative periods should result in the optimal health condition of the patient prior to surgery, and professional preparation of the treatment team and the environment during the operation and postoperative care.

This study is a review of global guidelines concerning the prevention of surgical site infections, with particular emphasis on orthopaedics and traumatology.

Key words: surgical site infections, surgical site infection prevention, orthopaedics, perioperative care.

INTRODUCTION

Advances in medicine resulting from the improvement of surgical techniques and the introduction of more and more modern instruments have significantly improved the quality of life of patients treated for diseases of the musculoskeletal system. This progress, however, does not eliminate the risk of developing surgical site infections (SSI) [1].

Surgical site infections are healthcare-associated infections (HAI), and they are still some of the most severe complications emerging in contemporary surgery, which can be prevented or reduced to a minimum. Surgeries conducted on the bone tissue, which is sensitive to infection, require the operator to scrupulously follow the rules of the sanitary regime. The occurrence of a complication in the form of SSI changes the lives of patients completely, prolongs their hospital stay, lowers their quality of life, prolongs their inability to work, and can lead to disability and even death. The prestige of the institution also experiences a decline as a result of court claims. The negative effects of SSI also bring about increased costs due to prolonged hospitalization, performing additional diagnostic tests and operations, or administering antibiotic therapy [1-4].

In European studies, SSIs accounted for approximately 27% of all hospital-acquired infections [5]. In Poland, in one study, SSIs were in second position in the structure of hospital-acquired infections and accounted for 23% of all HAIs [6]. In another analy-

sis from 2001-2004, SSIs amounted to 32% and took the first place among all HAIs detected in the facility under study [7]. Such a high percentage of SSIs in the general pool of hospital-acquired infections also results in increased costs of patient treatment [8, 9]. In the literature, a wide incidence rate of SSIs can be found in orthopaedic surgery, which ranges from 1% to 14% depending on the type of surgery and coexisting risk factors [10-17].

One of the most vital actions as regards the surveillance of SSIs is detecting the SSI itself and documenting it through the knowledge of the HAI criteria and definitions. Activities undertaken in order to prevent SSIs should include clear and consistent procedures, which will prepare the patient for surgery in the optimal way and reduce the risk of SSI at every stage of hospital care.

This study is a review of global guidelines concerning the prevention of surgical site infections, with particular emphasis on orthopaedics and traumatology. It is not a systematic review; the selection of literature was conducted with the use of PubMed and Google Scholar databases. The analysed literature concerned surgical site infections and recommendations for SSI prophylaxis, particularly pertaining to orthopaedic and traumatology procedures. While looking for the material, the following key words were used: surgical site infections (SSI), SSI risk factors, orthopaedics, fractures, SSI prevention, antibiotic prophylaxis.

CRITERIA FOR DIAGNOSING SURGICAL SITE INFECTIONS

Surgical site infections are diagnosed and categorized according to the definitions and criteria accepted by the European Centre for Disease Prevention and Control (ECDC), which constitute the guidelines for the countries forming the European Union (EU) [18, 19].

Surgical site infections can be categorized into superficial, deep, and organ/space infections. In order to classify SSI into a particular group, the following criteria need to be met:

- **superficial** incisional SSI (SSI-S) is an infection that develops within 30 days of surgery, affects only the skin and subcutaneous tissue at the site of the incision, and meets at least one of the following conditions:
 - the presence of laboratory-confirmed or unconfirmed purulent discharge from the site of the superficial incision,
 - a positive fluid or tissue culture from the superficial incision site, performed under aseptic conditions,
 - at least one of the local symptoms of inflammation: pain, swelling, tension, tenderness, redness, or local warmth,
 - deliberate opening of the surgical wound by the surgeon, except when there are no microorganisms in the incision,
 - diagnosis of SSI-S from a doctor;
- **deep** SSI (SSI-D) can be diagnosed when an infection appears within 30 days of an operation that did not involve implantation of artificial elements, and if an implant is implanted, it is up to 90 days following the operation. If the implant is kept, and the infection is associated with the surgery and affects deeply located soft tissues (muscles and fascia), at the incision site, and meets one of the following conditions:
 - the presence of purulent discharge from deep layers around the incision (but not from the organs or body cavities),
 - spontaneous wound dehiscence or its deliberate opening by the surgeon, if at least one of the following symptoms occurs: fever (> 38°C), local pain, or tenderness, unless a negative culture is obtained,
 - the presence of an abscess or other symptoms of infection demonstrated during a physical examination, re-surgery, whether confirmed by the results of histopathological or radiological examinations,
 - diagnosis of SSI-D from a doctor;
- **organ/space** SSI (SSI-O) appears within 30 days of the operation if an artificial implant was not implanted or within 90 days if a biomaterial was

implanted during the operation and the infection may be associated with the surgery performed and includes any anatomical site other than the area of the incision of the integuments and the site that was opened or compromised during the operation, where at least one of the following circumstances is true:

- purulent discharge from the drain inserted through a puncture wound into an organ or body cavity,
- isolation of a microorganism from the culture of fluid or tissues from body cavities or an organ carried out under aseptic conditions,
- the presence of an abscess or other clinical signs of an organ/cavity infection, found in the course of a physical examination, re-surgery, or in histopathological or imaging examinations,
- diagnosis of SSI-O from a doctor.

HAND HYGIENE

One of the most important, and at the same time the simplest, SSI prevention procedures is hand hygiene. In 2009, the World Health Organization (WHO) [20] issued recommendations that include all the components of hygiene: preparation of hands, indications for washing and disinfection, proper decontamination techniques, proper selection of preparations for hand washing and disinfection, proper use of protective gloves as well as education and supervision of compliance with hand hygiene. It is recommended that hands are disinfected with an alcohol-based agent, which is held in higher regard than washing hands with soap and water, except for when there is visible contamination of hands that have been exposed to biological material, or after contact with a patient suspected of or diagnosed with the presence of spore-forming microorganisms, e.g. *Clostridium difficile*. The next significant element of hand hygiene is the *bare below the elbow* principle, which aims at preventing the transmission of microorganisms found on white coats, under jewellery, or on watches and bracelets. It is also recommended to have natural nails with length of up to 0.5 cm. The hand hygiene procedures recommended by the WHO involve 5 indications (moments) related to the provision of health services, and these are: before and after touching a patient, before clean procedure, after body fluid exposure (dirty procedure), and after touching patient surroundings. For proper hand decontamination, Ayliffe's 6-step technique should be employed, in which the sequence of steps and the number of repetitions are of importance. The use of protective gloves is an important aspect. The WHO recommends their use in the situations when one expects to come into contact with blood or another biological material, damaged skin, or mucous membrane. Hands should be disinfected before put-

ting on the gloves and after taking them off. Gloves should be changed or removed when moving from one dirty procedure to another [20].

Table 1 lists the recommendations of individual organizations regarding the prevention of SSI in orthopaedic surgery [21-33].

PREVENTION OF SURGICAL SITE INFECTIONS IN ORTHOPAEDIC SURGERIES

For many years, attempts have been made to develop a single standard of care as regards the prevention of SSI. In the literature, there are many recommendations concerning this topic, and these have developed over the years, depending on the country, the facility, or the surgical procedure carried out. Even though there are still no clear international standards or recommendations and there is an ongoing discussion on this subject, the literature indicates comparable recommendations from WHO, Centres for Disease Control and Prevention (CDC), or the National Institute for Health and Care Excellence (NICE) and from other institutions, and these recommendations are constantly being updated.

PERIOPERATIVE ANTIBIOTIC PROPHYLAXIS IN ORTHOPAEDIC SURGERY

Perioperative antibiotic prophylaxis (PAP) is one of the more significant elements of SSI prevention, which is generally applied in clean procedures with the insertion of an implant or in clean-contaminated procedures, which should not be confused with dirty procedures, in which antibiotic therapy is used. PAP consists of short-term administration of an antibiotic to the operated patient before the skin incision to reduce intraoperative microbial contamination to a level at which the body can fight the infection. The choice of antibiotic is dependent on the type of procedure and risk factors; the time of antibiotic administration depends on its half-life; and the duration of using it in PAP depends on the procedure type.

Table 1. Overview of recommendations concerning the prevention of surgical site infections in orthopaedic surgery

Bath before surgery	Recommended, ordinary soap or an antibacterial agent can be used. WHO [21]
	Recommended, with soap the day before surgery or on the day of surgery. NICE [22]
	Recommended, using soap or an antibacterial agent the evening before surgery. CDC [23]
	Recommended the day before surgery or on the day of surgery. Ireland & Royal College of Surgeons in Ireland [25]
	Body bath with chlorhexidine is recommended (which reduces the concentration of pathogens on the skin, but it does not reduce the frequency of SSI). Infection Society [24]
	Recommended, the day before surgery or on the day of surgery using ordinary soap. Health Protection Scotland [26]
	It is recommended to have a bath with chlorhexidine gluconate at least 3 days before the procedure. Institute for Healthcare Improvement: hip and knee arthroplasty [27]
	Recommended, at least 1 time before the procedure with soap or antibacterial soap. Asia Pacific Society of Infection Control (APSIC) [28]
	Recommended, using an antiseptic agent at least one night before surgery. Guideline for Prevention of Surgical Site Infection 1999 [29]
Prevention of <i>Staphylococcus aureus</i> infections through screening and nasal decolonization using 2% mupirocin ointment and/or a body bath with the use of chlorhexidine gluconate	Recommended for orthopaedic patients who carry <i>S. aureus</i> . WHO [21]
	It is recommended to perform nasal decolonization with mupirocin ointment and body bath with chlorhexidine in patients undergoing surgery, where <i>S. aureus</i> is a risk factor for SSI. NICE [22]
	Screening tests are recommended for patients undergoing orthopaedic surgery; in carriers of <i>S. aureus</i> (MRSA), implementation of the decolonization protocol. SHEA/IDSA [30]
	Screening tests are recommended for arthroplasty patients; in carriers of <i>S. aureus</i> (MRSA), implementation of the decolonization protocol. American College of Surgeons and Surgical Infection Society [24]
	Screening tests are recommended; in carriers of <i>S. aureus</i> , implementation of the decolonization protocol. Health Protection Scotland [26]
	Screening tests are recommended; carriers of <i>S. aureus</i> should be decolonized by administering intranasal mupirocin ointment for a period of at least 5 days and a bath with chlorhexidine gluconate should be taken for at least 3 days before the procedure. Institute for Healthcare Improvement: hip and knee arthroplasty [27]
Screening tests are recommended according to the <i>S. aureus</i> resistance rate; recommended implementation of 2% mupirocin ointment and/or a bath with chlorhexidine gluconate. APSIC [28]	

Table 1. Overview of recommendations concerning the prevention of surgical site infections in orthopaedic surgery (cont.)

Screening for carriage of microorganisms that produce extended spectrum β -lactamases (ESBL)	Not recommended. WHO [21]
Removal of hair from the surgical field	Not recommended; if necessary, it should be removed with a disposable clipper. WHO [21]
	Not recommended; if necessary, it should be removed with a disposable electric clipper just before the procedure. Guideline for Prevention of Surgical Site Infection 1999 [29]
	Not recommended; if necessary, it should be removed with a disposable electric clipper. NICE [22]
	Not recommended; if necessary, a clipper or depilatory agent should be used outside the operating theatre. SHEA/IDSA [30]
	Not recommended; if necessary, it should be removed with a disposable clipper. American College of Surgeons and Surgical Infection Society [24]
	Not recommended; if necessary, do not use a razor. Health Protection Scotland [26]
	Not recommended; if necessary, a disposable clipper should be used outside the operating theatre. Institute for Healthcare Improvement: hip and knee arthroplasty [27]
	Not recommended; if necessary, a disposable electric clipper should be used; there are no recommendations as to when it should be conducted. APSIC [28]
Skin disinfection before incision	Recommended alcohol antiseptic solutions based on CHG. WHO [21]
	Antiseptic solutions are recommended; a sufficiently large operating field should be prepared with a margin for the possible extension of the incision; placing wound drainage, start disinfecting with circular movements towards the periphery. Guideline for Prevention of Surgical Site Infection 1999 [29]
	2% chlorhexidine gluconate in 70% alcohol solution is recommended. NICE [22]
	A 2-component agent containing alcohol is recommended. SHEA/IDSA [30]
	The use of an alcohol solution is recommended. CDC [23]
	2% chlorhexidine gluconate in 70% isopropyl alcohol solution is recommended. Ireland & Royal College of Surgeons in Ireland [25]
	The use of an alcohol solution is recommended. American College of Surgeons and Surgical Infection Society [24]
	A disposable package of 2% chlorhexidine gluconate in 70% isopropyl alcohol solution is recommended. Health Protection Scotland [26]
	An alcohol-based solution with chlorhexidine iodophor or gluconate is recommended. Institute for Healthcare Improvement: hip and knee arthroplasty [27]
	The use of an alcohol solution is recommended. APSIC [28]
Antimicrobial skin sealant	It is not recommended to use self-adhesive foil drapes with or without an antibacterial agent. WHO [21]
	There is no evidence that the risk of SSI is reduced. CDC [23]
	In orthopaedic surgery, when self-adhesive drapes in the operating field are used, consider using them with an iodophor-impregnated agent. APSIC [28]
Surgical hand preparation	It is recommended that hands are washed with ordinary soap when they are dirty, then the dirt be removed from under the nails with a nail cleaner; it is not recommended to use brushes for surgical hand washing. For surgical hand washing, use antibacterial soap or a preparation based on 70% alcohol; do not use alcohol-based hand sanitizing and cleaning agents together; wear sterile gloves when the hands and forearms are dry. WHO [20]
	Use of an antiseptic on the hands and forearms for 2-5 minutes is recommended. SHEA/IDSA [30]
	Recommended; nail cleaning before the first surgery, perform 2 to 5 minutes of surgical hand washing with an antiseptic; when finished, keep elbows bent so that the fingertips point upwards so that the water runs from the fingers to the elbows, then pat dry with a sterile towel and put on a sterile gown and gloves. Guideline for Prevention of Surgical Site Infection 1999 [29]
	Before the first surgery from the list, hands should be washed with an antiseptic aqueous solution, use a disposable brush to keep hands and nails visually clean; in subsequent operations, it is enough to perform disinfection with an antiseptic or wash your hands; when the hands are dirty again repeat the procedure. NICE [22]
	Recommended. American College of Surgeons and Surgical Infection Society [24]
	Recommended. Health Protection Scotland [26]
	Use of soap or alcohol-based hand sanitizer is recommended before putting on sterile gloves and gown. Healthcare Improvement: hip and knee arthroplasty [27]

Table 1. Overview of recommendations concerning the prevention of surgical site infections in orthopaedic surgery (cont.)

Increasing nutritional support	Recommended; administration of nutrient-enriched oral or enteral formulations in underweight patients or in patients undergoing major surgery. WHO [21]
	Recommended in malnourished patients, especially before major surgery, and in oncological patients. Healthcare Improvement: hip and knee arthroplasty [27]
Discontinuation of immunosuppressive treatment in the perioperative period	Not recommended. WHO [21]
	Recommended. SHEA/IDSA [30]
	No recommendations. Guideline for Prevention of Surgical Site Infection 1999 [29]
	No recommendations. CDC [23]
Perioperative oxygen therapy	In adults under general anaesthesia with endotracheal intubation, it is recommended that a breathing mixture containing 80% oxygen be administered, also during and after the procedure for a period of 2-6 hours. WHO [21]
	It is recommended that the haemoglobin oxygen saturation be kept at 95% during surgery and during the recovery period. NICE [22]
	It is recommended that optimal tissue oxygenation be maintained in the perioperative period. SHEA/IDSA [30]
	In patients with normal lung function under general endotracheal anaesthesia, it is recommended that increased F _I O ₂ be administered during and after the CDC procedure [23]
	It is recommended that the haemoglobin oxygen saturation be kept above 95%. Ireland & Royal College of Surgeons in Ireland [25]
	Under general anaesthesia, it is recommended that a breathing mixture containing 80% oxygen be administered. American College of Surgeons and Surgical Infection Society [24]
	It is recommended that the haemoglobin oxygen saturation be kept above 95%. Health Protection Scotland [26]
Maintaining normothermia	It is recommended that body heating devices are used in the operating room and during the procedure. WHO [21]
	Recommended. NICE [22]
	It is recommended that the body temperature is maintained at 35.5°C or higher in the perioperative period. SHEA/IDSA [30]
	Recommended. CDC [23]
	It is recommended that the body temperature is maintained above 36°C in the perioperative period. Ireland & Royal College of Surgeons in Ireland [25]
	Recommended. American College of Surgeons and Surgical Infection Society [24]
	It is recommended that the body temperature is kept above 36°C. Health Protection Scotland [26]
Maintaining intensive glycaemic control protocol in the perioperative period	Recommended for both diabetic and non-diabetic patients; there are no recommendations as to the optimal glycaemic standards in the perioperative period. WHO [21]
	Recommended in patients with diabetes mellitus; avoiding hyperglycaemia is recommended. Guideline for Prevention of Surgical Site Infection 1999 [29]
	Routine administration of insulin to maintain normoglycaemia is not recommended in nondiabetic patients. NICE [22]
	It is recommended that postoperative glycaemia be maintained at < 180 mg/dl. SHEA/IDSA [30]
	It is recommended that perioperative glycaemia be maintained in patients with and without diabetes at the level of < 200 mmol/dl. CDC [23]
	In diabetic patients, glucose maintenance is recommended at < 11 mmol/l. Ireland & Royal College of Surgeons in Ireland [25]
	It is recommended that glycaemia be maintained in the perioperative period at the level of 110-150 mg/dl. American College of Surgeons and Surgical Infection Society [24]
	It is recommended that glycaemia be maintained in a patient with diabetes at the level of < 11 mmol/l during the operative period. Health Protection Scotland [26]
	Recommended; in order to keep the preoperative level of HbA _{1c} below 8%, it is recommended that perioperative glycaemia be maintained in diabetic and non-diabetic patients at 140-200 mg/dl. Institute for Healthcare Improvement: hip and knee arthroplasty [27]

Table 1. Overview of recommendations concerning the prevention of surgical site infections in orthopaedic surgery (cont.)

Maintaining normovolaemia	Perioperative fluid therapy is recommended. WHO [21]
	The use of fluid therapy is recommended. NICE [22]
	Recommended. APSIC [28]
Surgical drapes and gowns	Disposable and reusable surgical drapes and gowns are recommended. WHO [21]
	It is recommended that waterproof drapes and gowns are used. Guideline for Prevention of Surgical Site Infection 1999 [29]
	Routine use of iodophor-impregnated drapes is not recommended; when it is required, non-sterile surgical clothing is recommended for the patient and medical staff in the room. It is recommended that sterile operating gowns be worn. Movement within the block should be kept to a minimum. NICE [22]
	Routine use of antiseptic drapes is not recommended. SHEA/IDSA [30]
	It is recommended that a disposable outfit is used in the operating theatre. American College of Surgeons and Surgical Infection Society [24]
Use of surgical drapes is recommended. Health Protection Scotland [26]	
Wound irrigation	There are no recommendations or contraindications for rinsing the wound with a 0.9% NaCl solution before it is closed; irrigation of the wound with an aqueous solution of iodopovidone in clean and clean-contaminated wounds should be considered; rinsing wounds with antibiotics before closing them is not recommended. WHO [21]
	Not recommended. NICE [22]
	Recommended. SHEA/IDSA [30]
	Intraoperative irrigation of the wound with iodophor solution may be considered. CDC [23]
	There are no recommendations or contraindications for rinsing the wound with a 0.9% NaCl solution before it is closed; rinsing wounds with antibiotics before closing them should be avoided. APSIC [28]
Prophylactic negative pressure therapy	Recommended for adult patients with primary closure of a wound with a high risk of infection. WHO [21]
Use of surgical gloves	There are no recommendations concerning the use of 2 pairs of gloves, the time to change them during surgery, or their type. WHO [21]
	There are no recommendations concerning the use of 2 pairs of gloves, the time to change them during surgery, or their type. Guideline for Prevention of Surgical Site Infection 1999 [29]
	Wearing 2 pairs of gloves should be considered in operations with a high risk of glove tearing. NICE [22]
	Recommended use of 2 pairs of gloves as well as immediate replacement when the surface is damaged. SHEA/IDSA [30]
	Changing gloves during long operations (60-90 min), after completing the draping of the surgical field, and also immediately before implantations, and in the event of damage. ICM [31]
	Two pairs of gloves are recommended. American College of Surgeons and Surgical Infection Society [24]
Change of surgical instruments	No recommendations have been issued. WHO [21]
	It is recommended that the tip be changed for electrocoagulation in procedures with previously known infection, and before implantation; it is recommended to change the tip of the suction device every 60 minutes, and replace the scalpel blade after skin incision, when deep tissue incision begins. ICM [31]
	Recommended only for colon surgery. American College of Surgeons and Surgical Infection Society [24]
Antibacterial stitches	Use of triclosan-coated sutures is recommended. WHO [21]
	Use of triclosan-coated sutures is recommended. NICE [22]
	Routine use is not recommended. SHEA/IDSA [30]
	The use of triclosan-coated sutures should be considered. CDC [23]
	Recommended for abdominal surgery. American College of Surgeons and Surgical Infection Society [24]
An individual decision should be made; it is recommended when the SSI rate is high in clean wounds. APSIC [28]	

Table 1. Overview of recommendations concerning the prevention of surgical site infections in orthopaedic surgery (cont.)

Laminar flow theatre	It is not recommended during total arthroplasty. WHO [21]
	The use of laminar airflow in arthroplasty should be considered. Guideline for Prevention of Surgical Site Infection 1999 [29]
	Not recommended for arthroplasty. CDC and Healthcare Infection Control Practices Advisory Committee (HICPAC) [32]
	Recommended in primary and revision arthroplasty, with the use of bone implants and internal anastomoses. Royal College of Anaesthetists [33]
	Not recommended for clean orthopaedic surgeries and elective arthroplasty. ICM [31]
Specialized dressings	Not recommended. APSIC [28]
	It is not recommended, comparable with a standard dressing. WHO [21]
	Use of a specialized dressing is recommended after surgical wound closure. NICE [22]
Changing the dressing	A sterile dressing is recommended after the wound is closed. Ireland & Royal College of Surgeons in Ireland [25]
	Not recommended for routine use. APSIC [28]
	It is recommended that a sterile dressing be kept for a period of 24 to 48 hours in the case of wounds with the primary suture; apply the principles of asepsis; use the sterile technique when a dressing change is required; no recommendations were made to maintain the dressing after 48 h, or when to take a post-operative body shower. Guideline for Prevention of Surgical Site Infection 1999 [29]
	Employ the contactless technique to change the dressing; change the dressing using saline in the first 48 hours; change the dressing using tap water after 48 hours; the patient can take a shower 48 hours after the surgery. NICE [22]
	Do not change the dressing or tamper with it for up to 48 hours after the procedure, unless it is advisable; use the contactless technique to change the dressing. Ireland & Royal College of Surgeons in Ireland [25]
Changing the dressing	There are no recommendations as to when to change the dressing or how long to keep the dressing on; you can shower 12 hours after the surgery – no evidence of an increased risk of SSI. American College of Surgeons and Surgical Infection Society [24]
	It is recommended that a sterile dressing be put on at the end of the procedure and kept for 48 hours after the surgery; changing the dressing is possible earlier when there is excessive leakage from the wound, using the non-contact technique of changing the dressing; Health Protection Scotland [26]

APSIC – Asia Pacific Society of Infection Control, CDC – Centres for Disease Control and Prevention, CHG – chlorhexidine gluconate, ESBL – β -lactamases with extended substrate spectrum, HbA1c – glycated haemoglobin, HICPAC – Healthcare Infection Control Practices Advisory Committee, ICM – The International Consensus Meeting on Periprosthetic Joint Infection, MRSA – methicillin-resistant *Staphylococcus aureus*, NICE – National Institute for Health and Care Excellence, SHEA/IDSA – The Society for Healthcare Epidemiology of America/Infectious Diseases Society of America, WHO – World Health Organization

In Table 2, recommendations concerning PAP in orthopaedic surgery from selected institutions are summarized. The individual recommendations do not vary as regards the recommendations to administer an additional intraoperative dose if the procedure time is extended or there is a significant blood loss, or if the procedure involves the implantation of joint prostheses [21, 22, 24, 25, 30, 34-39].

The literature review that was carried out points to the fact that due to the growing number of orthopaedic procedures requiring insertion of implants, an increased percentage of SSIs can be expected. These infections have a significant impact on the patients' health. Although they cannot be completely eliminated, the use of SSI prophylaxis can substantially reduce the infection rate. Knowledge regarding the methods for SSI prevention should be popularized, and medical staff should be made aware of the consequences of developing infections. The recom-

mendations mentioned in this study may become a vital factor in reducing the number of infections and their complications. An attempt was made to collect recommendations concerning the prevention of SSI from several medical institutions. It is necessary to put greater focus on SSI because perioperative antibiotic prophylaxis, asepsis, and antiseptics do not solve the problem of infections. The recommendations presented in this study will allow the patient to be reliably prepared for surgery and the course of the procedure to be optimized, improving patient safety and the quality of postoperative care, and reducing the percentage of SSIs in orthopaedic surgeries.

In the presented work, the recommendations of individual organizations may differ from each other due to the method of identifying priority topics, asked questions, perception of critical points, research methodology, and the method of obtaining evidence.

Table 2. Recommendations of selected medical institutions regarding antibiotic prophylaxis in orthopaedic procedures

Name of the institution	Time of administration before skin incision	A single preoperative dose of antibiotics without re-administration during and after surgery	Additional intraoperative doses	Perioperative prophylaxis
The Scottish Antimicrobial Prescribing Group (SAPG) [36]	60 min	A single dose is recommended	It is recommended that another dose be administered if the operation lasts longer than 4 hours or if blood loss during the operation exceeds 1500 ml	It is recommended when it is an open fracture; administration as soon as possible – max. up to 3 hours since injury; administer for 72 hours or until the surgical wound closes; a single dose in closed fractures; in primary or revision arthroplasty: prophylaxis up to 24 hours
American Society of Health-System Pharmacists (ASHP) [37]	60 min		It is recommended that another dose be administered if the operation lasts longer than 4 hours or if there is significant blood loss	It is recommended in primary or revision arthroplasty, insertion of other implants, or in trauma surgeries: prophylaxis up to 24 hours
American College of Surgeons and Surgical Infection Society [24]	60 min	Recommended for clean procedures	It is recommended that another dose be administered if the operation is prolonged or if blood loss during the operation exceeds 1500 ml	Recommended in arthroplasty, without recommendation on the duration of use
Department for Health and Ageing, Government of South Australia [38]	15-30 min		It is recommended that another dose be administered if the operation is prolonged to up to 4 hours or when there is great loss of blood during surgery	Up to 24 hours, not recommended for clean procedures without implantation
National Institute for Health and Care Excellence (NICE) [22]		Clean procedures, without implants or joint prostheses	It is recommended that another dose be administered if the operation is longer than the half-life of the antibiotic given	Recommended in arthroplasty and with implants, in procedures with clean-contaminated and dirty wounds without recommendation on duration
WHO [21]	120 min			Recommended for arthroplasty
SHEA/IDSA [30]	60 min		It is recommended that another dose be administered if the operation exceeds 2 half-lives of the antibiotic given or there is a lot of blood loss during the procedure	Up to 24 hours
Royal College of Physicians of Ireland [25]	60 min	A single dose is recommended	It is recommended that another dose be administered if the operation lasts longer than 4 hours or when blood loss during surgery exceeds 1500 ml	Prophylaxis up to 24 hours only for arthroplasty
National Program for the Protection of Antibiotics [34, 35]	30 min	Clean-contaminated procedures, closed long bone fractures	It is recommended that another dose be administered if the operation is longer than the half-life of the antibiotic given	Prophylaxis is recommended when it is an open fracture according to the Gustilo and Anderson classification, grade I and II up to 24 hours, and grade III up to 72 hours, up to 24 hours in arthroplasty

ASHP – American Society of Health-System Pharmacists, NICE – National Institute for Health and Care Excellence, SAPG – The Scottish Antimicrobial Prescribing Group, SHEA/IDSA – The Society for Healthcare Epidemiology of America/Infectious Diseases

Global SSI oversight aims to standardize recommendations with proven effectiveness. The issued recommendations should be universal, innovative, and applicable in countries supervising SSI [21]. The application of these recommendations is not obligatory; however, it is expected that they are implemented according to the patient's needs and the possibility of their implementation in a given country [22, 40]. In line with the recommendations of the WHO and the European Commission, each country should have a developed HAI control strategy, including a strategy for SSI supervision at the national level. In Poland, however, there is no opinion-forming centre operating in the area of HAI prophylaxis [41]. One of the tasks of such a centre could be SSI prophylaxis, e.g. in the field of HPRO and KPRO, and others, such as staff hand hygiene and drug resistance monitoring [19, 41]. Centres of this type, which exist in other European countries, are expected to issue opinions on recommendations using the GRADE methodology (Grading of Recommendations Assessment, Development, and Evaluation), which can be implemented by consensus with individual organizations and associations. One of the most important documents on which the HAI supervision system in Poland is based are the recommendations of the Council of the European Union of 2009, which only set out general principles of the system's operation [42]. In Poland, as in other European Union (EU) countries, there is a differentiated approach to SSI monitoring, prevention programs, and personnel competences. ECDC is also attempting to standardize SSI control methods for certain orthopaedic procedures such as KRRO and HPRO in European countries [41]. As a result of the activities of ECDC, the HAI-Net (Healthcare-Associated Infections Surveillance Network), EARS-Net (European Antimicrobial Resistance Surveillance Network), and ESAC-Net (European Surveillance of Antimicrobial Consumption Network) networks were created for the EU countries [19, 41].

In Poland, since 1989, attempts have been made to organize the supervision of HAI, but it was not until 2001 that the first legal acts introduced the definition of HAI and systematized the practice of control. Despite the passage of many years, the passive system of HAI supervision is still dominant in Polish hospitals, the consequence of which is the lack of data necessary for the analysis and conclusions in the field of SSI prophylaxis [41, 43, 44]. The Infection Control Teams operating in Polish hospitals have a statutory obligation to develop and update HAI prophylaxis procedures in accordance with the current knowledge, but they rarely receive systemic support in the form of knowledge based on evidence-based medicine (EBM). It seems that the establishment in Poland of a consultative and advisory organizational unit with legal personality, supervised by the minister compe-

tent for health, could facilitate the activities of the healthcare management. This organization should evaluate scientific publications and the latest medical technologies in a repeatable, transparent manner, according to a defined methodological standard and based on scientific evidence in accordance with the EBM. However, until such an opinion-forming organization is established, efforts should be made to publish illustrative works by scientists attempting to conduct literature reviews such as this work.

Disclosure

The authors declare no conflict of interest.

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