Recommendations for the prevention of surgical site infections and use of antibiotic therapy during preoperative nursing care in surgery departments

Zalecenia profilaktyki zakażeń miejsca operowanego i stosowania antybiotykoterapii w okresie przedoperacyjnej opieki pielęgniarskiej na oddziałach zabiegowych

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Abstract

Poland lacks uniform national guidelines for the prevention of surgical site infections (SSI) in the area of perioperative antibiotic and nursing care. Key criteria for effective SSI prevention are included in the current CDC recommendations. The present document contains a total of 13 recommendations that aim to organize scientific data collected to date, and address activities undertaken primarily by surgical nurses with respect to SSI prevention. The recommendations apply to the preoperative period.

Key words: preoperative care, perioperative antibiotic prophylaxis, SSI prevention.

Introduction

Hospital-acquired (nosocomial) infections are a major problem faced by contemporary medicine. They occur across the world, both in hospitals of the lowest reference levels and in very specialized research and teaching hospitals in highly developed countries [1]. The most common clinical manifestation of infections identified in surgery departments are surgical site infections (SSI) which are currently defined as infections occurring up to 30 or 90 days after surgical intervention, depending on the operative procedure [2-4]. Despite improvements in prophylaxis SSI continue to be a considerable clinical problem, as they result in increased morbidity and mortality, prolong hospitalization and increase costs of hospital treatment. The most serious consequences are observed among patients treated in intensive care units and surgery departments after abdominal operative procedures or cardiac operations. SSI accompany approx. 3% of all surgical

procedures, and affect 20% of patients undergoing emergency operations due to acute abdominal illnesses. The incidence of SSI may reach 20% depending on the surgical procedure, criteria of follow-up monitoring and quantity of collected data [5]. Therefore, it is necessary to monitor risk factors on an ongoing basis, taking into account patient condition, type of procedure and hospital environment, in order to minimize the incidence of infections [3, 6].

Authors specializing in this subject area [3, 6, 7] point out that an increased number of SSI and severe infections is associated with a range of factors including:

- performance of increasingly complex operations in elderly patients having multiple coexisting diseases (ASA classes III, IV and even V),
- development of transplant surgery which inevitably requires immunosuppression,
- use of a variety of implants (meshes, prostheses),
- performance of operations in patients with impaired immunity,
- broad-spectrum antibiotic therapy resulting in increased microbial resistance [8, 9].

Furthermore, the emergence of increasingly narrow medical specializations leads to high rates of patient transfer between units and between hospitals, potentially resulting in an elevated incidence of hospital-acquired infections [8, 9].

Definitions of healthcare-associated infections (HAI) which are in force in all EU Member States and collaborating countries were first developed in 2009 by a team of experts appointed by the European Centre for Disease Prevention and Control (ECDC). The experts were tasked with unifying the criteria used for the diagnosis of infections. They are applied during point surveying and in the determination of incidence in long-term monitoring. Detailed criteria for the diagnosis of infections, including SSI, were defined in the Polish National Programme of Antibiotic Protection (National Programme of Antibiotic Protection for 2011-2015) [10,11]. Guidelines adopted in the documents referred to above are based on SSI definitions used by IPSE/HELICS (Improving Patient Safety in Europe) and U.S. CDC (Centres for Disease Control and Prevention). The guidelines distinguish three types of SSI:

- SSI type 1 (superficial) – involve only superficial tissues, i.e. the skin and subcutaneous tissue at the incision site,
- SSI type 2 (deep) – infections of deep tissues down to and/or involving muscle fascia at the incision site,
- SSI type 3 (organ/space) – infections involving any part of the body other than the incision site, e.g. an organ or body cavity which is in direct contact with the surgical site.

In addition to SSI location, the current guidelines also include diagnostic criteria and monitoring periods which differ depending on SSI type, as shown in Table 1. The table compares the definitions which were originally proposed and promoted worldwide by CDC: first published in CDC recommendations in 1999 [2, 12] and then revised in 2013 [2-4]. It needs to be noted that the revised classification no longer mentions implant use and introduces variable time frame criteria for SSI types 2 and 3 (30 or 90 days) depending on the performed surgical procedure. The procedures requiring a 90-day monitoring period were supplemented e.g. with knee and hip arthroplasty, herniorrhaphy, craniotomy, CABG (coronary artery bypass graft), breast surgery, open repositioning of fractures and peripheral vascular procedures. Also, relatively detailed procedures were introduced for reporting SSI in cases requiring two incisions at two different sites during a single procedure (e.g. harvesting of the saphenous vein for CABG). CDC guidelines also differentiate between primary and secondary SSI depending on whether infection is identified in the first or subsequent wound during a procedure involving multiple incisions [2].

Risk factors for SSI

A number of factors have been identified that have a direct effect on the incidence of infectious complications after operative procedures. They can be divided into environmental, patient-associated and surgery-associated factors. Some can be eliminated or minimized, however others are non-modifiable.

Factors increasing the risk of SSI include [3, 9, 13]:

- patient-dependent factors: different clinical conditions, chronic and systemic diseases reducing the effectiveness of a systemic immune reaction; foci of infection including chronic inflammatory states;
- factors related to the operative site including:
  - factors increasing the risk of endogenous contamination e.g. as a result of opening of the gastrointestinal tract or transfer of pathogens from the patient's skin and mucous membranes;
  - factors increasing the risk of exogenous contamination related e.g. to an extensive or long-term exposure of the operative site or inappropriate/insufficient postoperative wound care;
  - reoperations impairing local immune response and affecting the process of wound healing (e.g. as a result of excessive tissue traumatization, presence of foreign bodies, haematoma, drainage).
  - factors related to the microbiological infectious agent (pathogen species, degree of virulence, antibiotic sensitivity, source of origin and immediate contamination), according to the formula:

$$\text{Risk of SSI} = \frac{\text{Dose of microbiological contamination} \times \text{virulence}}{\text{Patient immunity}}$$

Table 1. Comparison of definitions and diagnostic criteria applicable to surgical site infections [2, 4, 10, 12]

SSI type	Criteria	Original CDC definition (1999) Definitions included in the Official Journal of the European Union of 2012 (2012/506/EU)	Definitions revised by CDC in 2013
Type 1 – superficial	Location	Superficial tissues, i.e. skin and subcutaneous tissue at the incision site	
	Monitoring period	Up to 30 days after surgical procedure	
	Diagnostic criteria	purulent drainage from the wound	
		positive culture of material obtained aseptically from the wound	
		one of typical manifestations of infection (pain/tenderness in the wound, swelling, erythema or heat)	
		the incision site is deliberately opened by a surgeon (except where the culture is negative)	the incision site is deliberately opened by a surgeon (with a positive culture or no culture)
		diagnosis by a physician	
Type 2 – deep	Location	Deep soft tissues (e.g. muscle fascia, muscles) at the incision site	
	Monitoring period	0-30 days after surgery unless an implant was placed Up to a year in cases of implant placement	0-30 days or 0-90 days depending on procedure type (CDC guidelines specify a list of procedures with a longer monitoring period regardless of implant placement)
	Diagnostic criteria	purulent drainage from the deep layers of the wound	
		wound dehiscence or a deeply infected wound that is deliberately opened by a surgeon	
		one of manifestations of infection (fever > 38°C, pain or tenderness in the wound, heat)	
		an abscess or other evidence of infection that is detected during an examination, invasive procedure or imaging tests	
		diagnosis by a physician	
Type 3 (organ/space)	Location	Any part of the body (e.g. organs, spaces) other than the incision site that is opened or manipulated during the operative procedure.	
	Monitoring period	0-30 days after surgery unless an implant was placed Up to a year in cases of implant placement	0-30 days or 0-90 days depending on procedure type
	Diagnostic criteria	purulent drainage from a drain that is placed in a body space/organs	
		positive culture of material obtained aseptically from body organs/spaces	
		an abscess or other evidence of infection involving body spaces/organs that is detected during an examination, invasive procedure, histopathological examination or imaging tests	
		diagnosis by a physician	

The risk of SSI is considered when the wound contamination level is 10^5 CFU/g of tissue (CFU = colony-forming units) [14], though a lower value can be considered in situations involving the implantation of a foreign material into the body of a patient [12]. The diagnosis of SSI should include the virulence of pathogens correlated with their toxin-producing ability or other factors increasing the capacity to invade or damage tissues. The mortality rate among patients infected with highly virulent strains such as leukocidin-producing *S. aureus* or erythrogenic toxin-producing *Streptococcus pyogenes* can be 74% [15].

The hospital is a specific environment in which infections occur much more frequently because treatment is provided concurrently, in a limited space, to patients with and without infection and with impaired immunity due to disease [6]. Therefore, before performing an operative procedure it is vital to eliminate or minimize as many SSI risk factors as possible.

Among multiple risk factors under analysis, there are several factors demonstrating a particularly strong correlation with the emergence of SSI. They are, among others, factors related to the general condition of the patient including [16-21]:

- age (> 65 years of age, newborns),
- smoking,
- obesity,
- circulatory system diseases, e.g. atheromatosis,
- other coexisting diseases, e.g. chronic obstructive pulmonary disease (COPD), diabetes, chronic kidney failure,
- malnutrition, hypoalbuminaemia,
- alcoholism,
- immune disorders,

- presence of foci of necrosis or skin infection.

Literature on the topic also mentions factors associated with the operative procedure [12, 22]:

- type of patient admission,
- duration of hospitalization,
- preparation of the operative site,
- prolonged operative procedure,
- surgical site (e.g. groin, anal area),
- drain placed in the area of the postoperative wound,
- postoperative accumulations (e.g. haematomas) in the wound area,
- implantation of a foreign material (metal fusion material, hip prosthesis, vascular prosthesis, mesh made of an artificial material),
- intubation and controlled ventilation,
- central vascular catheters,
- haemodialysis procedures,
- gastric tube,
- tracheostomy tube,
- urinary catheters,
- loss of circulating blood volume and blood transfusion,
- improper hand hygiene by medical personnel engaged in the surgical procedure.

The occurrence of an infection is also frequently conditional on the pathogenic species and strain. The most common pathogens identified in surgical infections are microbial components of normal skin flora of patients and members of the operating team. They are the cause of surgical infections in over 50% of cases. *Staphylococcus aureus* and coagulase-negative staphylococci (CNS) are the most common aetiology of SSI and are detected in around 17-25% of cases [23]. Other pathogens include *Escherichia coli* (in 8% of cases), strains of *Enterococcus spp.* (in ca. 12% of cases), streptococci (in 6%), strains of *Klebsiella spp.*, and anaerobic bacteria (e.g. *Bacteroides fragilis*). The proportions of different pathogens in SSI depend on the procedure. Pathogens can also originate in preoperative infections in locations beyond the operative site, particularly in patients during the placement of prosthesis or a different implant type. Furthermore, microorganisms causing SSI can come from exogenous sources – not only from members of the operating team but also from the operating room environment, tools and materials brought into the sterile field during surgical procedures. They are predominantly aerobes, especially Gram-positive bacteria, staphylococci and streptococci [12, 24]. Non-spore forming anaerobic bacteria (*Bacteroides* spp.*, Peptostreptococcus* spp.), clostridia causing gas gangrene, particularly the species *Clostridium perfringens* (especially in ischaemic tissues), are characteristic of infections developing after abdominal surgery. *Pseudomonas aeruginosa* and *Acinetobacter baumannii* trigger highly treatment-resistant SSI due to their multiresistance to antibiotics. The increasing number of SSI associated with antibiotic-resistant pathogens is a consequence of the increased number of patients with severe underlying diseases or immunodeficiency, and the use of broad-spectrum antibiotics [3, 24]. *Serratia spp*. rods are usually non-pathogenic, however in patients with impaired immunity they are pathogenic microbes. Organisms isolated from abscesses and fistulas also include fungi, e.g. *Histoplasma, Coccidioides* and *Candida* [9, 23].

Classification of wound cleanliness based on Cruse

One of the widely used SSI risk assessment scales is the classification of wounds which takes into account the degree of cleanliness of the operative site and the incidence of infections. The classification was proposed by the American College of Surgeons in the 1960s. However, the classification does not make it possible to precisely determine the likelihood of SSI, as it only describes one of multiple risk factors for SSI [25, 26].

Clean wound – a result of planned surgery with primary wound closure not requiring drainage, without signs of infection and inflammatory process in the operative site, without any contact with the alimentary, respiratory and urogenital systems. The group comprises e.g. orthopaedic, vascular and cardiac procedures. The incidence of infections in this class of wounds is 2-12% [25].

Clean contaminated wound – a result of surgery involving the opening of the alimentary, respiratory and urogenital systems under controlled conditions, combined with the entry into the viscera (stomach, gallbladder, intestines). Procedures classified in this group include appendectomy, procedures within the urogenital tract without urinary infections, procedures within the biliary tract without signs of biliary infections, procedures performed in the stomach, hysterectomy or surgical procedures in the nasopharyngeal cavity, reoperation within 7 days after clean surgery, blunt trauma. The incidence of infections in this class of wounds is 2-10% [25].

Contaminated wound – a fresh traumatic wound; an operation performed with a break in aseptic technique and intraoperative spillage from the gastrointestinal tract or an inflammatory process other than an infection within the operative site (e.g. appendectomy for non-perforated appendicitis, cholecystectomy for cholecystitis). A penetrating trauma occurring within < 4 hours after surgery, chronic wound to be covered by a graft. At 10-20% [25], the incidence of SSI in this category of wounds is higher than in clean contaminated wounds.

Dirty infected wound – an old traumatic wound with necrotic tissues, involving an active inflammation

Table 2. Dosage regimens and times of administration of the next intraoperative dose of drugs used in PAP [28, 29]

Antibiotic	Dose in adults	Dose in children	Time of administering the next intraoperative dose
Cefazolin	1 g in patients with BW < 80 kg, 2 g in patients with BW > 80 kg [acc. to 1]; 2 g in patients with BW up to 120 kg, 3 g in patients with BW >120 kg [acc. to 2].	20-30 mg/kg < 40 kg – maximum 1 g	4 hours
Cefuroxime	1.5 g	50 mg/kg	3-4 hours
Cefamandol	1 g	–	3-4 hours
Metronidazole	15 mg/kg administered over 30-60 minutes to finish the infusion one hour before the procedure		7.5 mg/kg 6-12 hours after the initial dose

and presence of pus; penetrating trauma > 4 hours; preoperative perforation of the alimentary tract, biliary system and urinary tract. The operative site is in constant contact with the source of infection. The incidence of infections in this class of wounds ranges between 10 and 40% [4, 9, 12, 23, 25, 26].

A significant role in reducing the incidence of SSI in surgery departments is played by the awareness of risk and accurate modification of risk factors. It is vital to adopt a multi-faceted approach taking account of mutual interactions and dynamics of individual pre-, intra- and postoperative factors. Establishing a potential cause of SSI is difficult because a range of factors/causes can be involved. A crucial element of SSI prevention is preoperative preparation of the patient and a clean environment in which the patient stays from the time of hospital admission until the completion of treatment. The preparation of patients for surgical procedures comprises a number of stages and activities [13, 27].

Perioperative antibiotic prophylaxis

Based on information given in source documents [28, 29], the majority of operative procedures performed in hospitals do not require perioperative antibiotic prophylaxis (PAP). Each hospital should develop its own PAP rules adjusted to the types of surgical procedures performed in a given facility, so that every person engaged in the care of surgical patients is provided with clear information regarding indications, drug selection, dosage regimen and duration of treatment. The drugs of choice for the majority of procedures which require PAP are first-generation cephalosporins (cefazolin) or second-generation cephalosporins (cefuroxime, alternatively cefamandol) [28, 29]. For some surgical procedures, cephalosporins combined with metronidazole are recommended. Other drugs can be used for PAP practically only in carriers of methicillin-resistant *Staphylococcus aureus* (MRSA), patients who are allergic to beta-lactam antibiotics (immediate hypersensitivity reactions), in selected urological procedures and in ophthalmology. Dosage regimens of the main drugs used for PAP together with the times of administration of the next intraoperative dose are listed in Table 2.

Recommendation 1

The preparation of patients before planned operative procedures should begin in the outpatient setting.

Rationale

An extended period of patient hospitalization before an operation is connected with the risk of colonization with hospital strains which already occurs during 24-48 hours after patient admission to hospital. Study results justify early commencement of preparatory activities and provision of comprehensive education to patients at the stage of pre-hospital care. The above applies in particular to elective and planned procedures [3, 31]. During the period of preparation for surgery in the outpatient setting, patients should receive accurate and clear information on ways to reduce risk factors for SSI including the manner and time of preparation of the operative site, good hygiene of the whole body, treatment of dental caries, removal of calculus, limitation of the number of visitors during hospitalization (especially those with various types of infections, e.g. in the upper respiratory tract) [13, 31]. Before a scheduled operation, including in particular cardiac, vascular and other procedures that require using artificial implants, every patient should arrange a standard dental appointment in order to treat diseased teeth, extract dead teeth and remove calculus. The authors of the recommendations also suggest that before planned cardiac or vascular surgery the "cleanliness" of the oral cavity should be additionally confirmed by a written certificate issued by a dentist [32].

Practical implications

An assessment of the general physical and mental condition of the patient in the outpatient setting makes it possible to identify risk factors for infections and implement educational activities that are targeted at prophylaxis and conscious participation of the patient in the process of treatment.

Recommendation 2

Assessment of SSI risk and identification of factors associated with risk increase should be performed in every patient prepared for an operative procedure.

Rationale

An assessment of the risk of infection is an extension of medical history-taking and physical examination which aims to estimate risks associated with the scope of activities planned for the patient's hospitalization.

There are risk indices developed specifically for the assessment of SSI risk, of which the most common are SENIC *(Study of the Efficacy of Nosocomial Infection Control)* and NNIS (*National Nosocomial Infections Surveillance System)*.

SENIC is an index based on four risk factors:

- operation on the abdomen,
- operation lasting for more than two hours,
- contaminated or dirty operative site,
- more than three components of the final medical diagnosis [8, 22].

NNIS is an index focusing in particular on the assessment of three risk factors:

- contaminated or dirty operative site,
- operation lasting more than 75% of time set for a given procedure,
- patient's general condition score > III in the ASA scale *(American Society of Anaesthesiologists)* [8, 10, 33-35].

An accumulation of factors assessed on the basis of both indices means that a patient is under an increased risk of SSI [8, 24, 36]. Entering information about the risk of infection assessed on hospital admission in the medical records of patients is a requirement resulting from the legal acts in force [37, 38]. A significant element of preparing patients for a surgical procedure is the identification of active infections including urinary

tract infection, pneumonia, sinusitis, recurring boils and bedsores which are potential sources of contamination of the operative wound. Emergency procedures require empiric antibiotic therapy followed by targeted antibiotic therapy after results of microbiological tests become available [8, 30].

Practical implications

The task of a nurse, a specialist in surgical nursing as well as physicians and other members of the medical team is to identify primary and modifiable risk factors for infection in every patient, document them and follow all SSI prevention procedures which are in place in the unit.

Recommendation 3

Every patient is provided with a clean hospital bed and clean bedding.

Rationale

Reservoirs of pathogens in the hospital environment include bed frames and bedding, taps, hospital worktops and floors, door handles, curtains, stethoscopes, blood pressure monitor cuffs, tourniquets, ball pens, personnel ID badges and mobile phones. The most commonly isolated hospital pathogens are able to persist on these objects for up to several months under dry conditions and much longer in a humid environment [39].

The most effective method of bed decontamination is washing and disinfection in a washer-disinfector or cleaning the entire surface with a cleaning and disinfecting agent. In order to reduce the number of pathogens which are capable of surviving in an inanimate environment, hospital beds should preferably have mattresses with washable covers as well as pillows and duvets/blankets that can be washed at 93-95°C. They have breathable covers with washable surfaces. When no longer used by a patient, the pillow and duvet should be washed and disinfected (particularly after being used by a patient with a nosocomial infection or after the death of a patient, and each time after soiling with a biological material) [27].

Practical implications

The charge nurse is responsible for implementing and ensuring compliance of subordinate personnel with hygienic procedures applicable to the cleanliness of beds and bedding in the unit, and for providing disinfecting agents.

Recommendation 4

Every patient should have a whole-body bath with a detergent containing a substance with proven antibacterial and antifungal effectiveness on the day before surgery and in the morning of the day of the surgical procedure, and change into a clean hospital gown.

Rationale

The majority of surgical site infections are caused by components of the patient's physiological microflora including CNS, *Staphylococcus aureus*, enterococci, Gram-negative rods and – less commonly – anaerobic bacteria [3]. Strains of species making up the patient's natural skin microflora are the most frequent aetiology of SSI in clean wounds [40]. Appropriate preparation of the operative site, aimed at eradicating transient and reducing resident microflora, is one of the more important elements of hospital preparation. The procedure includes thorough washing of the area of the planned incision and the whole body with detergents containing an antiseptic [3, 9, 12, 41]. It has been demonstrated that a bath taken in the evening of the day preceding the operation followed by another bath in the morning on the day of surgery is a more effective approach than a single bath immediately before the surgical procedure. However, chlorhexidine has not been proven to be superior to other antiseptics used for preoperative baths [4, 42]. Studies comparing chlorhexidine baths with chlorhexidine-free soap baths (placebo) have failed to demonstrate a significant difference between two bath

types in terms of SSI incidence [43]. Considering the above, it is vital to ensure that every patient has two baths prior to an operation. Single-use washing mitts, sponges or (single-use) sachets are recommended. Body areas that should be washed with particular care include the armpits, groins, crotch, buttocks, skin folds, navel (before abdominal and laparoscopic surgery) and hair. The navel area is a perfect habitat for microbial growth. Positive cultures were demonstrated in 88.6% of cases before navel disinfection, and in 17.3% also after disinfection. In 73.1% of cases, the same strains were cultured in both tests. Although skin disinfection before laparoscopy is not completely effective, it is not a factor affecting the incidence of SSI [44].

Patients should receive detailed information about the importance of taking two thorough preoperative baths with soap or a single bath with an antibacterial and antifungal substance, e.g. with an addition of octenidine hydrochloride, and other antiseptics with proven biocidal effectveness. Baths are used not only for hygienic (e.g. genital hygiene) and aesthetic reasons but primarily as a prophylactic measure. After taking a bath on the day of the operation the patient should receive a hospital gown of the type suited to the nature of the procedure and clinical conditions, and ensuring easy access to the surgical site and venous access (e.g. PVC) locations. The preferred option are cotton or disposable gowns which do not restrict the patient's movements and easily soak up perspiration. The selection of hospital gowns or pyjamas should also take into account the comfort, dignity and intimacy of the patient [45].

Practical implications

A double preoperative bath with single-use sponges, washing mitts or (single-use) sachets and a detergent containing a substance with proven antibacterial and antifungal effectiveness, and clean hospital gowns, reduce the skin microflora and consequently decrease the incidence of surgical site infections. Hospital gowns should be washed at high temperatures in a laundry or, alternatively, disposable products should be used.

Recommendation 5

After each bath, patients should dry their body with a clean bath towel or a disposable towel. Washed hands should only be dried with disposable towels. Personal underwear and pyjamas should be clean and dry.

Rationale

Patients tend to repeatedly use the same bath towels brought from home for drying the body after taking a bath. However, multiple use of the same towels, which are often damp, is a factor predisposing to body colonization by a variety of microbes transferred from other areas (when one towel is used for drying both the upper and lower body) and pathogens multiplying in the damp towel fabric [13, 27]. Introducing cotton drapes (washable at high temperatures in a hospital laundry) or disposable towels for body drying in the perioperative period can be an alternative to the multiple use of the patient's own towels.

Appropriate methods of hand drying, applied both by medical personnel and patients, play a key role in the entire process of hand washing and risk of microbial transfer. Hand drying with disposable towels has been shown to be associated with the lowest rate of pathogen spread in the air and pathogenic infections, e.g. after using the toilet, of all available drying methods. Disposable towels have the lowest microbial transfer rates and pose the lowest risk of cross-contamination when compared with hot air hand dryers, high speed hand dryers and textile tower rolls [46].

Practical implications

Using bath towels only once or applying disposable towels for body and hand drying, as well as wearing clean and dry personal underwear/pyjamas, are practices which reduce the risk of infection by pathogens propagating in a humid environment.

Recommendation 6

Hair removal from the operative site should be performed no sooner than 1-2 hours before the surgical procedure and only if hair might interfere with the operation.

Rationale

Hair removal should not be performed as a routine procedure in all surgical patients. If hair removal is necessary, CDC recommends using a safety razor with replaceable blades or a surgical clipper (removes hair ca. 1 mm above the skin surface). Hair should be removed immediately (between one and two hours) before the operative procedure [9, 47, 48]. Hair removal > 24 hours before surgery carries the risk of microcuts and epidermal colonization by pathogens. The likelihood of SSI also depends on the method of hair removal: it increases by 2.5% for mechanical shaving (razor blades and traditional disposable safety razors) and decreases by 1.4% for shaving with an electric razor and 0.9% when no shaving is performed.

Practical implications

Following the recommendations (indications for hair removal, time frame and method of hair removal) reduces the risk of operative site infection.

Recommendation 7

Nasopharyngeal decolonization should not be performed as a routine procedure in all *Staphylococcus aureus* carriers in the perioperative period.

Rationale

Before patient transfer to the operating suite, the recommended practice is rinsing the mouth with a solution removing biofilm which usually builds up on dental plate. However, routine eradication of pathogens inhabiting the nasopharyngeal cavity, including *Staphylococcus aureus* (60%), is not recommended [45, 49, 50]. Decolonization of *Staphylococcus aureus* from the nasopharyngeal cavity can be indicated/justified in specific patient groups, e.g. before cardiac and orthopaedic surgery and other procedures [13, 27, 31, 50].

Practical implications

Thorough oral hygiene and justified nasopharyngeal decolonization in carriers of *Staphylococcus aureus* reduces the incidence of infections originating in the nasopharyngeal cavity.

Recommendation 8

Before an operative procedure all patients should have their nutritional status evaluated according to a scale used by the hospital/unit. Patients at an increased risk associated with the nutritional status should be subjected to nutritional assessment. Emaciated and severely malnourished patients should receive nutritional treatment for 10-14 days prior to surgery even at the cost of delaying the planned operative procedure. Excluding the intake of solid foods before a procedure should not exceed 6 hours, however anaesthesiological recommendations for abstaining from food intake because of planned anaesthesia should be considered in each individual case.

Rationale

Upon admission to the unit, patients should be screened for their nutritional status using one of available scales: SGA (Subjective Global Assessment) (Annex 1) or NRS 2002 (Nutritional Risk Screening 2002) (Annex 2) [51]. Patients at an increased risk due to their nutritional status (e.g. diagnosed with cancer) should undergo nutritional assessment (nutritional interview, anthropometric measurements, biochemical tests, immune tests) [33]. The aim of nutritional assessment is to determine whether nutritional support should be provided or albumin and electrolyte deficiency should be corrected prior to surgery [52]. The nutritional regime and diets depend on the clinical condition of the patient, and the type and extensiveness of surgery [23]. According to guidelines developed by the European Society of Anaesthesiology, patients should not ingest any solid foods for at least six hours before planned surgery, and should not drink any fluids for two hours before the operation. However, anaesthesiological recommendations for abstaining from food and drink because of planned anaesthesia should be considered in each individual case. Many authors [49, 53, 54] are of the opinion that prior to an operative procedure patients should not avoid the intake of fluids for any longer than necessary.

Practical implications

The obligation to assess the nutritional condition of patients who are hospitalized for planned procedures stems from the Regulation of the Minister of Health of 22 November 2013 on guaranteed hospital treatment services (Annex 3).

An evaluation of the patient's nutritional status and nutritional assessment make it possible to diagnose disorders and introduce appropriate nutritional support and/or correct deficiencies before performing an operative procedure.

The assessment should be performed by the attending physician or a member of the nutritional team, e.g. a nurse who has completed a specialist course in parenteral and enteral nutrition or a specialist in surgical nursing.

Recommendation 9

Patients with marked obesity should reduce their body weight before a planned operative procedure.

Rationale

There is a multifold increase in the risk of perioperative complications and SSI in patients with a high body mass index (BMI > 35). Obese individuals have been shown to have higher levels of bacterial contamination of the skin and develop intertrigo, oedema and vascular disorders predisposing to bacterial colonization and infections. The recommendation for obese patients is to reduce and stabilize their body weight, which includes consistent changes in lifestyle and nutritional habits. Typically, obese patients require prolonged and complex therapy, not only dietary but also psychological [3].

Practical implications

One of important elements of patient care is education focused on proper diet and regular exercise adjusted individually to the patient, monitoring of blood glucose levels, blood pressure measurements, BMI monitoring and emotional support for the patient. Obese patients should be referred to an obesity treatment outpatient clinic to receive care that helps with the loss of body weight.

Recommendation 10

Smoking patients should be provided with information about the adverse effects of nicotine and the need to refrain from smoking for at least 6-8 weeks before their planned operative procedure.

Rationale

A significant correlation has been demonstrated between smoking and septic complications in the perioperative period. Nicotine interferes with the healing of postoperative wounds by reducing the oxygen transport ability of haemoglobin and producing strong local vascular constriction, thus impairing the delivery of oxygenated blood to tissues [3, 35]. Cohort studies of smokers vs non-smokers have demonstrated a significantly higher incidence of postoperative complications including necrosis in the wound area, a delay or lack of progress in the process of healing, development of fistulas and hernias in the postoperative wound/scar (a two-fold risk increase in smokers). A significantly lower risk of SSI has been observed in people with no history of smoking [26, 56, 57]. A restrictive ban on smoking is validated by studies: partial oxygen pressure in healthy individuals after smoking two cigarettes within 15 minutes decreased in a statistically significant manner on average from 63% to 54.5% [58].

Practical implications

A physician/nurse informs the patient about the effects of nicotine on the human body including postoperative consequences. An assessment of the degree of nicotine dependence, motivation to quit smoking and reasons for breaking nicotine addiction is performed, and various strategies for stopping smoking are presented, e.g. nicotine replacement therapy, pharmacotherapy or behavioural therapy. A physician/nurse also counsels smoking patients about the availability of outpatient clinics specializing in addiction treatment.

Recommendation 11

Patients require the correction of systemic disorders resulting from coexisting diseases in the preoperative period.

Rationale

The number of coexisting diseases and their advancement exhibit a strong correlation with the development of SSI [3, 8]. Surgical risk evaluated as the ASA score of 3 or 4 indicates a poor general condition of the patient and an increased susceptibility to infection [17]. The most common clinical conditions and coexisting diseases which affect the risk of SSI include diabetes, atheromatosis, hypertension, cancer, kidney failure, malnutrition (particularly hypoalbuminaemia), inflammatory skin diseases and immunosuppression. The risk of SSI increases during certain therapies which are inevitable in the perioperative period, e.g. steroid therapy, antibiotic therapy and immunosuppressive treatment [3, 4, 9, 12, 42]. Diabetes has also been shown to cause a two- or even three-fold increase in the risk of SSI. The likelihood rises together with an increase in hyperglycaemia in the perioperative period. According to CDC guidelines, the level of post-meal glycaemia before a procedure should be maintained at < 200 mg/dl [4]. American Diabetes Association (ADA) emphasizes the importance of achieving an optimum level of glycosylated haemoglobin (HbA_{1c} < 7%), and average pre-meal glucose level of 90-130 mg/dl, and post-meal glucose level < 180 mg/dl [59]. It is also vital to prepare the patient for self-control and appropriate dietary adjustments. Similar recommendations should also apply to patients with modifiable systemic disorders depending on their daily activities, health habits and lifestyle factors, e.g. patients with atheromatosis (regardless of clinical anatomical manifestations) and hypertension [56, 60].

Practical implications

Based on the ASA assessment of risk in surgical patients (Annex 4) performed by an anaesthesiologist, as well as other specialist consultations, a nurse implements medical diagnostic and therapeutic recommendations. In addition, a nurse monitors the vital signs of patients, controls glycaemia and provides patient care according to an individually arranged schedule.

Recommendation 12

Preoperative gastrointestinal preparation is recommended in procedures performed under regional anaesthesia.

Rationale

One of multiple components involved in the prevention of perioperative infections is bowel preparation for colorectal surgery. Although there are studies demonstrating that preoperative mechanical decontamination has no effect on the incidence of intestinal anastomotic leakage, development of abscesses or SSI in patients undergoing planned surgery [5], many medical centres continue to perform preoperative bowel cleansing with oral medicines as a standard procedure [61].

Mechanical bowel cleansing is contraindicated in patients with symptoms of gastrointestinal obstruction (tumours narrowing gastrointestinal lumen) and perforation.

Practical implications

The removal of faecal matter from the gastrointestinal system prevents the contamination of patients on the operating table and penetration of gastrointestinal pathogens into the peritoneal cavity during the period of paralytic ileus observed in every patient operated under general anaesthesia for 24-72 hours after surgery.

Recommendation 13

Each hospital should have in place guidelines for perioperative antibiotic prophylaxis.

Rationale

Cephalosporins used in PAP should be administered no sooner than 30 minutes prior to the procedure (0-30 minutes before skin incision) and in procedures performed under tourniquet ischaemia – 10-15 minutes before tourniquet placement. Medicines should preferably be administered in the operating suite, after the patient is placed in an appropriate position and anaesthesia is induced, e.g. when the operative site is being cleaned. Based on study results, the procedure lowers the risk of SSI [28, 29]. In the majority of cases, a single PAP dose is recommended, and PAP should not be used for longer than 48 hours. Prolonged use is recommended only in procedures involving the implantation of biomaterials. PAP administered for more than 24 hours has not been shown to have a superior efficacy [28, 29].

Practical implications

Medicines used for perioperative antibiotic prophylaxis should be available in the operating suite area.

Hospital guidelines regulating the administration of PAP should take into account the responsibilities and competencies of people involved in the process of treatment, and the method used for documentation purposes.

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Załączniki

Annex 1. Subjective Global Assessment of nutritional status.

SGA (Subjective Global Assessment) form

I. Medical history

1. Age (years) ..... **Body height (cm)** ..... **Body weight (kg)** ..... **Sex F M**

2. Weight change/weight loss in past six months ..... **(kg)** ..... **(%)**

Weight change in past two weeks: increased ..... unchanged ..... decreased .....

3. Overall change in dietary intake

No change/changes: duration ..... (weeks)

Type of diet: suboptimal solid diet ..... full liquid diet .....

hypocaloric liquid diet ..... starvation diet .....

4. Gastrointestinal symptoms (persisting for > 2 weeks)

no symptoms ..... nausea ..... vomiting ..... diarrhoea ..... anorexia .....

5. Physical capacity

No change/changes: duration ..... (weeks)

Type: limited scope of activity ..... walking ..... bedridden .....

6. Effect of disease on metabolic demand:

Increased metabolic demand caused by underlying condition: none ..... low ..... moderate ..... high .....

II. Physical findings (specify severity):

0 – no change, 1 – mild, 2 – moderate, 3 – severe) .....

Loss of subcutaneous fat at triceps and the chest .....

Muscle wasting (quadriceps, deltoid) ..... oedema at sacrum ..... oedema at ankles ..... ascites .....

III. Subjective Global Assessment (SGA):

Normal nutritional status .....

Suspected malnutrition or moderate malnutrition .....

Cachexia .....

High risk of malnutrition .....

Annex 2. Nutritional Risk Screening – NRS 2002

NUTRITIONAL RISK SCREENING FORM – NRS 2002

Initial screening			
1	Is BMI < 20.5?	**Yes**	**No**
2	Has the patient lost weight within the last 3 months?	**Yes**	**No**
3	Has the patient had a reduced dietary intake in the last week?	**Yes**	**No**
4	Is the patient severely ill? (e.g. in intensive therapy)	**Yes**	**No**

If the answer to any of the questions is Yes → go to section 2 (extended screening).
If the answer to all the questions is No (NRS 2002 = 0 score) → perform rescreening in a week's time.

IMPAIRED NUTRITIONAL STATUS		**SEVERITY OF DISEASE = INCREASE IN NUTRITIONAL REQUIREMENTS**	
Absent Score 0	Normal nutritional status	**Absent Score 0**	Normal nutritional requirements
Mild Score 1	Weight loss > 5% in 3 months OR food intake < 50-75% of normal requirement in preceding week	**Mild Score 1**	hip fracture, chronic diseases with acute complications: cirrhosis, COPD, chronic haemodialysis, diabetes, cancer
Moderate Score 2	Weight loss >5% in 2 months OR BMI 18.5-20.5 + impaired general conditions OR food intake 25-60% of normal requirement in preceding week	**Moderate Score 2**	major abdominal surgery, stroke, severe pneumonia, haematologic malignancy
Severe Score 3	Weight loss > 5% in 1 month (> 15% in 3 months) OR BMI < 18.5 + impaired general condition OR food intake 0-25% of normal requirement in preceding week	**Severe Score 3**	head injury, bone marrow transplantation, patients requiring intensive care (APACHE score >10)
Total score:		Total score:	
Age:		If a patient is >70 years old, add 1 to total score above.	

Annex 3. Regulation of the Minister of Health of 22 November 2013 on guaranteed hospital treatment services

§ 6.

1. The provider of hospitalization and planned hospitalization services screens all beneficiaries admitted for treatment (except for A&E department) for their nutritional status (based on SGA or NRS 2002 in adults, and growth charts in children and adolescents) in accordance with guidelines set out in "Standards of Parenteral and Enteral Nutrition" prepared by the Polish Society for Parenteral and Enteral Nutrition or, in the case of children, according to guidelines proposed by the Polish Society for Clinical Nutrition of Children.
2. Beneficiaries who are repeatedly hospitalized are subject to nutritional status screening referred to in section 1 during their first hospitalization and then at least every 14 days.
3. Beneficiaries of hospital and planned hospitalization services of one day's duration are screened for their nutritional status if their decrease in body weight during the preceding six months exceeds 5% of regular body weight.
4. Nutritional status screening is not performed in departments of ophthalmology, otorhinolaryngology, allergology, and orthopaedics and traumatology of the motor system, if the period of hospitalization is shorter than three days.
5. Beneficiaries screened according to the procedure referred to in section 1 who are found to be at an increased risk due to their nutritional status are referred for nutritional assessment [37].

Annex 4. ASA classification of the general condition of patients.

ASA PS classification	Definition
ASA I	A normal healthy patient
ASA II	A patient with mild systemic disease
ASA III	A patient with severe systemic disease
ASA IV	A patient with severe systemic disease that is a constant threat to life
ASA V	A moribund patient who is not expected to survive without the operation
ASA VI	A declared brain-dead patient whose organs are removed for donor purposes.
E	Emergency surgery