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Risk factors of infection in surgical wounds

Surgical wound infections belong to the most frequent forms of nosocomial infections occurring in patients of surgical wards. These infections constitute 38% of all nosocomial infections observed in surgical wards in the USA. In Poland there are about 37% of nosocomial infections and they constitute about 14–16% of all infections of this kind (2, 4).

According to the modified in 1999 by CDC – (Centres for Disease Control) (8) and recommended by Polish Hospital Infections Association for use in Polish conditions definition of surgical wounds infections (a more preferred term is “infection of surgical sites”), such infections are divided into the following categories:

1. Superficial surgical infections – they occur within 30 days since the surgery and affect skin and subcutaneous tissue;

2. Deep infection of the surgical site – diagnosed within 30 days since the surgical operation, which does not include implanting artificial bodies, or within a year after implantation (if the implant is still maintained), and the infection is closely connected with the operation and affects soft tissues of the surgical wound localized in the muscular and fascial areas;

3. Infections of organs and/or body cavities – they affect every anatomic location of the organism, other than the operated site during the original operation. The localization of the organ infection is not systemized yet. In order to diagnose it, the following criteria must be fulfilled: the infection lasts up to 30 days since the operation which is not implantation; the infection is closely related to the surgical operation, although it concerns the organ which has not been subject to incision, opening or manipulation during the operation.

Infections of both deep and superficial tissues are classified as deep infections of the surgical wounds. The profile of microorganisms responsible for infections of surgical wounds did not change fundamentally during the last ten years. The rough data gathered

in the USA by NNIS (National Nosocomial Infections Surveillance) – a system which monitors changes occurring during nosocomial infections in hospital admitting emergency patients (2) in the years 1986–1996, are shown in Table 1. Polish data in this respect are

Table 1. Aetiology of wound infections in surgical patients

Species	Percentage
<i>Staphylococcus aureus</i>	20%
<i>Staphylococcus coagulase neg.</i>	14%
<i>Enterococcus sp.</i>	12%
<i>Escherichia coli</i>	8%
<i>Pseudomonas aeruginosa</i>	8%
<i>Enterobacter sp.</i>	7%
<i>Proteus mirabilis</i>	3%
<i>Klebsiella pneumoniae</i>	3%
Other streptococci	3%
<i>Candida albicans</i>	3%
<i>Bacteroides fragilis</i>	2%
Other (constituting <2% of isolates)	17%
Total	100%

incomplete. According to the first results, presented during the 6th Meeting of PHIA in Zakopane, of a voluntary system registering nosocomial infections introduced by Polish Hospital Infections Association, the most frequent pathogens found in the infections of surgical wounds in Poland are: *Enterococcus sp.* (24.2%), *Escherichia coli* (22.8%) and *Staphylococcus aureus* (16.19%).

The most common origin of microorganisms in the surgical wound is the patient's own bacterial flora (of autogenic nature or after hospital-born colonization) – in such a case we deal with autogenic (endogenic) infection. When the source of microorganisms comes from the staff/personnel, the hospital or surgery-room environment (the equipment, instruments, air filled with bacteria released from the skin of or breathed out by the surgical team) – then we deal with exogenous infection (also called “cross infection” due to the way of spreading). Endogenic infections, caused by the patient's own flora, as a rule are easily treated due to small virulence of the microorganism and their high sen-

sitivity to the commonly-used antibiotics. In case of exogenous infections (or endogenic ones in patients who are colonized by hospital flora), we deal with menacing multiresistant strains, which makes the treatment more difficult, raises its costs, and which, in extreme cases, can lead to failures in treatment. A patient's colonization by hospital strains may occur already after 48 hours of the patient's hospitalization. After 7 days of hospitalization, 90% of patients are colonized with hospital flora (4, 15).

Surgical wound infection (SWI) makes the patient's hospitalization period remarkably longer, it often requires employing an additional operation or pharmacological treatment and in some cases destroys the results of the operation, especially when it includes implantation of a foreign body (10, 14). For many years a research has been conducted in order to reduce the frequency of the occurrence of this dangerous complication. The research has resulted in the discovery of a number of factors which raise the risk of wound infection taking place. The factors fall into three basic groups (14): 1. Individual factors. 2. Operation-related factors. 3. Bacteriological factors and factors related with the hospital environment.

INDIVIDUAL RISK FACTORS IN SURGICAL WOUND INFECTION

One of the elementary individual risk factors in surgical wound infection is the patient's age. Being over 65 years of age carries statistically more risk of SWI (5, 11). Some authors still claim. However, it is not the age but additional accompanying burdens that constitute risk factors in SWI (and which as a rule intensify with age) (1, 6). Similar contradictory beliefs refer to the patient's sex. Quite a number of authors confirm rare occurrence of SWI in women (1, 11), seeing explanation of this phenomenon in the bigger number of cleaning procedures among this sex, others do not confirm that (4, 6, 7). Other individual risk factors are less problematic. They include; diabetes, malnutrition, obesity (exceeding 20% of the proper body mass), reduced mental ability, systemic use of corticosteroids, cancer, immunosuppressive treatment and preoperative inflammatory focus existing in the body (1, 4, 6, 8). There is a discrepancy in the results of research referring to transfusion of blood-borne specimens to the patients during the perioperative period. Most authors observe the increase in the SWI percentage (especially when the specimen contains admixture of leukocytes) (8). Mynster et al. (9) shake this opinion, pointing out that blood transfusion is not an independent risk factor in SWI, but an exponent of progression of the basic disease and a large range of operations.

OPERATION-RELATED RISK FACTORS

The level of wound infection happening during a surgical operation was found as the earliest risk factor in SWI being scientifically described. Already in the 1960s the Ameri-

can College of the Surgeons introduced a division of surgical operations into 4 groups according to the different levels of risk in SWI (13). The division is as follows:

1. Aseptic operation – carried out in aseptic conditions on tissues free of its own bacterial flora. The surgery does not include opening of the lumen of cavitory organs; during the surgery the anatomic barriers of the respiratory, alimentary and urogenital systems are not broken. Such wounds heal by first intention and do not require drainage and antibiotics prophylaxis. The frequency of this kind of infections is 1.5–2% and determines the quality of sanitary procedures performed in the hospital and by the surgical team.

2. Aseptic-infected operations – surgeries during which, in a controlled way, the anatomic continuity of respiratory, alimentary and/or urogenital systems was broken, or there was a contact with the lumen of an organ with bacterial flora while a massive contamination with contents full of microorganisms does not take place. Such infections require perioperative antibiotic prophylaxis. The frequency of such infections rates from 7 to 9%.

3. Infected operations – surgeries performed in the surgical ward on the organs with inflammatory symptoms, or operations, during which, due to medical indication, aseptic conditions had to be rejected. Planned operations on large intestine are also included here. The infection risk is up to 15–17%.

4. Dirty operations – all traumatic wounds caused outside the operation room as well as the operations performed on massively infected organs are included in this group. The etiological factor in infection of surgical wound is present in the operation field prior to the operation itself. Such infections require antibiotics treatment before the operation. The risk of SWI is about 40%.

Another important risk factor in surgical wound infection lies in the operation qualification procedures. Emergency operations necessarily involve a higher risk factor in SWI (1, 6). How the patient is treated before and in the middle of the operation is also important. Still other risk factors in SWI in the preoperative stage are as follows: shaving off the hair in the area of the body on the day prior to the operation (4, 8), invasive intervention (especially vascular examinations) performed before the operation (4, 10); and inaccurate antibiotics prophylaxis or its lack (1, 14). A long stay in the hospital ward before the operation is perceived by some authors as an independent risk factor (4, 6, 14). Some authors, however, do not seem to notice this relationship in their research, ascribing the patient's long stay in hospital before the operation to the seriousness of the patient's illness, which may secondarily be the reason for a raised risk factor in SWI (1, 8). Other important risk factors in SWI occurring during an operation are: the length of the operation (1, 6), improper and brutal operation technique causing the increase in the number of dead tissues and haematomas inside the wound (1, 10, 14), mid-operation X-ray examination (1), an improper and too long drainage (especially with aseptic wounds) (8), colonization of the operation-room personnel with hospital strains (4, 14), and, seemingly unimportant things such as the right temperature in the operation room

which influences the patient's normothermia, the intensity of sweat in surgeons and the strict observance of the rules referring to the operation room (15).

BACTERIOLOGICAL FACTORS AND FACTORS RELATED TO THE HOSPITAL ENVIRONMENT

These factors have been partially discussed above. The most important ones include: the right antibiotics policy and the sanitary discipline, both of which make it impossible for the hospital pluri-resistant strains to spread; detecting and treating of carrier state among the staff; following the principles of hospital hygiene and efficient activities of the hospital-based Committee for Fighting with Nosocomial Infections (4, 10, 14).

The aforementioned spectrum of risk factors in SWI shows how much complex this phenomenon is and how little we know about it. Nevertheless, taking into consideration the consequences (presented in the introductory part of the paper) that surgical wound infection can bring about for the final result of the treatment; plus wide-scale research conducted by SENIC (Study of the Efficacy of Nosocomial Infection Control) and by NNIS (National Nosocomial Infections Study), supervised by CDC, resulted in working out certain range-scales which allow for some point-like evaluation of the risk of surgical wound infection.

According to SENIC (7, 12) there are 4 risk factors: 1. Abdominal operations. 2. Operations which last more than 2 hours. 3. Surgical field classified as contaminated or dirty. 4. Operation on a patient who was discharged from hospital with at least three diagnoses.

The NNIS range-scale indicates an infection risk of any surgery on the basis of factor summation (3): 1. Over 2 points in the preoperative evaluation according to the range-scale of ASA (American Society of Anesthesiologists). 2. A contaminated or dirty wound. 3. Duration time of an operation, exceeding the T-number of hours, where T is an approximation of 75 percentile of the duration-time of a given operation (eg. appendectomy - 1 hour).

The above range-scales enable in a simple way to evaluate the risk of SWI in every patient who is planned for an operation, the fact of which makes it possible to employ the proper prophylaxis procedures.

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SUMMARY

The article deals with the problem of surgical wound infections in patients of surgical wards. Modern definition and etiology of surgical wound infections in Poland and else-

where have been presented here. At the same time present opinions referring to the problem of surgical wound infections have been discussed.

Czynniki ryzyka zakażenia ran operacyjnych

W artykule poruszono problem zakażeń ran operacyjnych u pacjentów oddziałów chirurgicznych. Przedstawiono współczesną definicję i etiologię zakażeń ran operacyjnych w Polsce i na świecie. Omówiono także aktualne poglądy na czynniki ryzyka zakażenia ran operacyjnych.