

**Special Article**

## **Disinfection and Sterilization Related Situations for Patient Safety in Operation Rooms**

**Fatma Ay, PhD****Assistant Professor, Istanbul University, Faculty of Health Science, Istanbul, Turkey****Nuran Gencturk, PhD****Assistant Professor Istanbul University, Faculty of Health Science, Istanbul, Turkey**

**Correspondence:** Assistant Professor Ph.D. Fatma Ay, Istanbul University, Faculty of Health Science, Istanbul, Turkey e-mail: fatmaay@yahoo.com

---

**Abstract**

Since healthcare services offered at hospitals involve complex services possessing likelihood of "causing death or injury", it is considered being "High Risk Sector". Operation rooms are one of the most complex, risky environments where technologically well-advanced equipment are used, where operation techniques and methods established in the light of new and developed information are employed. It has utmost importance for the patient safety to protect operation rooms from asepsis and ensure maximum level of sterilization. Hospital infections and sterilized areas related issues in operation rooms are some of the situations posing risk to patient safety. In patients who went through surgical interventions, 14-17% all hospital-acquired infections are comprised of "Surgical Area Infections". Risky behaviors causing microorganisms to infect/spread in operation rooms, complications related to skin antiseptics, inadequacy and malfunctioning of sterilization and decontamination equipment, work overload, inefficiency in registration systems, wrong product choices in temperature-sensitive equipment sterilization/disinfection, lack of knowledge and attention among hospital staff, lack of communication, unsuitability of the architectural structure, utilization of technological products with no proven effectiveness for sterilization/disinfection, are among the situations which pose risks to patient safety in the sterilization and disinfection operation room. In preventing hospital infections determination of appropriate sterilization and disinfection methods, developing infection control procedures, risk management, providing adequate funds and efficient use of resources have great importance. As a result, protecting asepsis in operation rooms and ensuring maximum levels of sterilization is tremendously important for the surgery. Protecting patient safety in operation rooms are believed to; prevent surgical area infections, reduce complications, increase the quality of surgeries, reduce costs, thus contribute in offering quality healthcare services.

**Key Words:** Lack of knowledge, surgical site infection, skin antiseptic, nanotechnology, medical errors, quality

---

**Introduction**

Healthcare services provided at the hospital to cure especially serious diseases are included in the group of "High-Risk Industry" since they include complex services with "killing or debilitating" power (Ertem, 2015). This high risk makes it necessary to provide patient safety.

Patient safety cannot be considered apart from the studies on providing and sustaining quality at health institutions. Joint Commission International (JCI) which operates as a sub-commission of the Joint Commission International Accreditation Standards for Hospitals (JCAHO) collected hospital standards under two main headings being patient-based and administration-based standards (Ertem, 2015).

JCAHO has determined standards that are assessed in patient assessment and care, patients' rights, clinical ethics, organizational leadership, human resources management, and information management (Chen et al., 2003). Patient-based standards include patient safety and patient safety goals set in this regard are accepted all over the world (Ertem, 2015).

It was stated in the reports published by the Institute of Medicine (IOM) in 1999 in America that the two most important issues in health service presentation that should be taken into consideration were "Medical errors" and "Quality". Nowadays, it is possible to prevent 58% of medical errors by taking precautions for patient safety (Ertem, 2015). It is emphasized that

many decisions are taken by health care professionals under pressure in the rapidly changing environment with the use of technology at healthcare institutions. This situation may cause mistakes or errors in clinical decisions or applications and thus cause harm to the patient (Silen-Lipponen et al., 2005).

Maintaining asepsis in the operating room and providing sterility at the maximum level have a great importance for patient safety. Hospital-acquired infections are observed at the rate of 38% in patients who have had a surgical intervention and 14-20% of these make up Surgical Site Infections (SSI) (Kartal, 2014; Birgand, Saliou & Lucet, 2015). Operating rooms are one of the most complicated and risky work environments in which advanced technology equipment is used, various surgical techniques and methods are applied in the light of new and advanced information and teamwork and taking correct decisions and putting them into practice are important (Christian et al., 2006; Giuffre et al., 2007; Ozcelik, 2014; Silén-Lipponen et al., 2005). Operating room safety is significant in terms of patient safety (Hergul, Ozbayir & Gok, 2016). Hospital infections and problems regarding sterile field are conditions entailing risk for patient safety in operating rooms (Aren, 2008). Identifying appropriate sterilization and disinfection methods, creating infection control procedures, risk management, providing sufficient resources and the efficient use of resources are highly important to prevent hospital infections (Aren, 2008).

### Risky Behaviors Causing Infection/Contagion of Microorganisms

CAE development increases the length of stay in hospital, morbidity and mortality rates and raises the cost of healthcare service (Kartal, 2014; Birgand, Saliou & Lucet, 2015). Cleaning and disinfections of environmental surfaces, sterilization of surgical instruments, surgical clothes, and drapes, elements related to asepsis and surgical technique are among the factors affecting the infection development during the perioperative period (Kartal, 2014). These factors create risk in terms of patient safety and can substantially decrease infection development in patients when precautions are taken.

As a result of the fact that there is a large number of personnel in the operating room or personnel mobility increases, the number of microorganisms in the air increases. When the

personnel get into the operating room and leave the room or there is the unnecessary mobility traffic during the operation, air stream around the open wound cannot remove contaminated air from the sterile area (Kartal, 2014). This condition increases the risk of the development of an infection in a patient or wounded area.

The fact that unnecessary mobility in the operating room is high drew attention to the relationship between surface contamination and air contamination. Staphylococci spread with droplet nuclei can be infected to not only the wound but also the ground, shelves, and lamps of the operating room. Abnormal streams in the air of operation and operating room traffic can raise these to the air again. Dust is an important factor in aerosolization of microorganisms in the ground (Kartal, 2014; Birgand, Saliou & Lucet, 2015). It is necessary to have two separate filter systems in all ventilating systems including operating rooms in hospitals, the efficiency of the first should be 30% or more and the efficiency of the second should be 90% or more (Karatas, 2014). Therefore, it is required to use HEPA filters and easy-clean filters for the protection of sterile fields in operating rooms and prevention of spreading of infection factors. Moreover, hard-to-clean equipment such as laser devices, surgical microscopes, etc. should be covered with sterile plastic material by enabling easy asepsis.

According to the study conducted by Lange, microbial contamination risk was determined to be 94.9% in the parts of reusable eyeglasses, this rate was identified to be 37.7% in single use eyeglasses. The culture positivity rate was identified to be 74.4% in reusable eyeglasses after the disinfection (Lange, 2014). The efficiency of single-use surgical clothes was analyzed in a study conducted to decrease airborne bacteria in operating rooms and it was identified that wearing single-use clothes is important in terms of the protective efficiency (Tammelin et al., 2013). Thus, alternative methods for the disinfection and sterilization of protective materials especially used by the personnel in the operating room should be considered.

### Complications Regarding Skin Antiseptics

Surgical site infections are the most important condition creating risk in terms of patient safety in fields where surgical operations are conducted. The patient's own flora is accepted as the main factor in surgical site infections, even skin alone

can increase the infection development risk. Therefore, it is an obligation to clean the area with antiseptic solution before opening incision. However, this cleaning process can create a surgical site infection risk due to reasons such as not cleaning the skin with a correct antiseptic solution and with a correct method, not waiting for the sufficient time for the solution to take effect, expiration of the solution, not storing reusable antiseptics properly.

Antiseptic agents should remain on the skin for the time recommended in producer's instructions for them to be effective. For instance, povidone iodine reaches the maximum efficiency after it dries. When antiseptic agents applied to the surgical skin area are not allowed to dry and these solutions contact with the skin for a long time, the possibility of chemical burns and skin irritations is high. Povidone iodine preparation solutions are free until they dry and may irritate the skin chemically. The solution cannot dry when the skin is covered with a surgical drape, the duration of chemical contact extends and the skin becomes macerated (Ozcelik, 2014).

Skin antiseptics should be stored in their original containers. The facts that reusable containers are used for a long time, solutions are transmitted to secondary containers and povidone iodine containers are refilled cause the contamination of antiseptics with pseudomonas aeruginosa. These microorganisms can survive in povidone iodine for more than a year and contaminated povidone iodine may cause infections as a result of the fact that contaminating organism is infected (Ozcelik, 2014).

There are studies in the literature identifying the fact that agents used as skin antiseptics in the operating room cause skin reactions and superficial wound complications (Pell et al., 2014). Characteristics of the use of antiseptics should be known well by operators in terms of providing patient safety, assistant personnel should be well informed about the storage of antiseptics, making antiseptics ready to use and contamination.

Washing hands with the surgical hand washing method is the easiest and most basic application that should be done to prevent infection development in the patient or the contamination of microorganism to the surgical field and to protect patient safety.

Surgical hand washing is an important application to prevent spreading of infection factors. Not washing hands with an effective antiseptic agent for a recommended time (2-6 minutes) before the operation increases the risk of infection. The brush use is not required in surgical hand washing, instead, it is stated that the use of alcohol-based hand antiseptics is more appropriate (Ozbayir, 2014).

### **Insufficiency and Ineffective Work of Sterilization and Decontamination Devices**

Using sterile material is one of the important factors in preventing surgical site infections and providing patient safety. The facts that sterile material comes out of the sterilizer wet/moist, the indicator on the package does not have a color change, the material comes out burned and the material coming out of the sterilizer is cold indicate that these devices do not operate properly.

The sterilizer used in the operating room should be controlled before and after the use and the device should have the characteristic to prove its reliable result with validation tests (physical) repeated annually, chemical (indicator) tests conducted every day and biological (indicator) tests (Inan, 2014).

### **Work Load Density**

It is stated that increasing workload density poses a threat to patient safety (Christian et al., 2006). It is stated in the literature that increasing fatigue, operating speed, excess workload, the limited number of nurses working, loading off-the-job works on nurses and stress are important factors creating a risk for patient safety (Christian et al., 2006; Alfredsdottir and Bjornsdottir, 2008; Henry et al., 2012).

The fact that the duration of the contact of a disinfectant used is long regarding the excess workload causes a problem such as using a few number of temperature sensitive devices/tools without disinfecting. When the existence of the operation room personnel with insufficient information and education is taken into consideration, this situation confronts the patient with infection risk.

### **Insufficiencies in the Record System**

It is necessary to prepare and use the solution to be used in sterilization or disinfection, put the materials in the solutions, record information such as waiting period and inform shift changes

in written (Inan, 2014). Written records are significant in terms of patient safety. The Association of periOperative Registered Nurses (AORN) has stressed how nurses' clinical and organizational expertise can help find and correct system-related errors by simplifying and standardizing work processes as well as improving the work environment (Alfredsdottir and Bjornsdottir, 2008).

While the studies conducted regarding record systems and patient safety emphasize that information systems are significant, it is also emphasized that the seriousness with regard to reporting and archiving of cases that should be formally carried out is not provided yet (Hergul, Ozbayır & Gok, 2016; Adiguzel, 2010). Moreover, it is stated that all cases in the healthcare field should be reported and it should be focused on the subject since the results acquired from data will cause similar cases to be experienced (Hergul, Ozbayır & Gok, 2016; Adiguzel, 2010). Building an effective error reporting system will be beneficial to create the patient safety culture and sustain this culture (Hergul, Ozbayır & Gok, 2016; Alfredsdottir and Bjornsdottir, 2008; Kim et al., 2007; Henry et al., 2012).

The fact that volatile antiseptics purchased in reusable containers are not stored properly after they are opened, the opening date is not written on the box, the material is decontaminated while it is transmitted to small containers for use increase the risk of wound infection. The fact that the personnel preparing these agents for use and using them work carelessly or do not follow the rules increases that risk more.

#### **Wrong Product Selection in the Sterilization/Disinfection of Tools/Devices Sensitive to Temperature**

Preparing sensitive materials used in sterile tissues and sterile body cavities during the operation and which can be spoiled at high temperature or of which characteristic disappears with a correct method during the day is important to prevent surgical site infections.

The High-Level Disinfectant (HLD) with a sporicidal effect or short term gas sterilization method is preferred for sterilization. There are many disinfectant products on the market. People in charge of selection should make a selection among the products of which microbiological efficiency tests are conducted by reference

laboratories in internationally accepted test norms. The wrong selection of solution and wrong application or the fact that a tool/device is not suitable for low-temperature gas sterilization are the most significant problems to be experienced in the HLD use (Inan, 2014).

#### **Lack of Information and Attention of the Operating Room Personnel**

Personnel behaviors are significant in providing a sterile environment in the operation room and protecting sterile areas. The rules that should be followed in sterile areas should be determined in written and all personnel should ensure that the rules are followed (Karatas, 2014).

The operating room personnel should wear clothes that cover his/her skin as much as possible. The reason for this is that many bacteria coming from open areas in the bodies of the personnel are aerosolizable in operating rooms. It is indicated in the measurements conducted that the number of particles spreading from shoes and open areas in the face of personnel wearing common protective clothes is 10 times more than the personnel who wear protective boiler suit, mask and long gloves (Sungu, 2014). One out of 1000 of particles spreading from people contains reproducible bacteria and microorganisms. For instance, a person who sneezes spreads 1.000.000 particles, 40.000 of which contain a microbe; accordingly, a person who speaks 100 words loudly spreads 250 particles, 40 of which contain a microbe (Sungu, 2014). Surgical mask and bone should be worn properly to prevent microorganisms spreading during talking and sneezing from reaching the wound and prevent skin squams from falling in the wound. It was indicated in a study conducted that surgical masks decrease bacterial colonization in the operation field (Kartal, 2014). When the operating room personnel are observed nowadays, risky behaviors such as pulling mask under the chin, going out with operating room clothes, not completely covering hair with the bone, not taking off the gloves contacted with the used material, etc. cause the sterile field contamination.

Tearing of surgical gloves and not noticing this are one of the major contamination reasons for operative wounds. Humidity and heat in the gloves during long operations cause permanent flora in the skin to reproduce and thus, hands must be washed again while changing gloves (Kartal, 2014).

The fact that hands are washed with the appropriate technique, in the required time with the appropriate antiseptic solution is significant in terms of CAE (Kartal, 2014). However, since the risk of splashing water droplets around is high while washing hands, attention should be paid to keeping packaged sterile materials apart from surgical hand washing areas (Karatas, 2014). The operating room personnel should be informed and careful about washing hands properly and keeping the sterile material in a place not contacting with water. Even these simple precautions are important in terms of patient safety.

Sinks used for surgical handwashing should not be used for cleaning surgical tools or pouring the water used for cleaning of the room or liquids collected in aspirators (Karatas, 2014). Especially the personnel which have just started to work in the operating room should be warned of this issue, should be trained regarding the actions to be taken if such a case occurs and the case which has taken place should be reported immediately.

The facts that the material used is not kept in the environment and the sterile material is carried are an important issue in preventing contamination. The fact that carrier personnel are uninformed and careless about the conditions of the carriage will cause the deterioration of sterilization or sterile areas. Genc (2014) emphasized in the article that it is necessary to provide hand hygiene before touching sterile packages, contact with sterile packages as little as possible, carry sterile tools in proper, covered containers or covered carts reserved for this work (Genc, 2014; Genc, 2015). The carriage should be made by the personnel assigned and trained for this job and who knows what he/she carries and its risks. Not wearing protective clothes during the carriage and not decontaminating protective clothes properly after using them if they are reusable create a risk for sterile areas (Genc, 2015). The facts that the operating room personnel are careless and uninformed about the indicator on the container in which surgical tools are placed, filter and expire date on the container cover increase the infection risk. The fact that used medical instruments are not carried to a sterilization unit as soon as possible is an important issue in the infection of microorganisms. It was identified in a study conducted regarding this issue in the literature that when the number of colonies was measured

for all bacteria in medical instruments waited without any operation after they had been used, there was a logarithmic increase in terms of the control value from the 2nd hour (Genc, 2015). The fact that the carriage equipment is made of materials sensitive to rotting and corrosion, its surface is not smooth and easy clean, equipment is used for another operation and it is not clean and dry are the factors of the personnel and equipment deteriorating the sterility of sterile materials (Genc, 2014). Since there may be humidity based on the temperature, sterile medical instruments should not be carried before they are not cooled enough. Moreover, if it is not possible to provide a covered carriage cart, sterile packages should be covered with protective carrier bags which are dust and moist proof before they are carried. Institutional procedures must be created regarding the destruction of protective carrier bags used for carriage (Genc, 2014; Genc 2015). All these precautions are the applications which provide patient safety at hospitals.

### **Inadequate Communication**

Transferring information clearly is important while the operation environment is prepared in the operating room, materials are prepared for use, used materials are transmitted to a sterilization unit. It is required for patient safety that information is transferred to the next shift in written during the team change especially in operating rooms providing service for 24 hours or warning notes are written in specific places.

It was identified that 11% of 30.000 cases in Australia that originated from preventable side effects causing permanent disability resulted from problems related to communication. It was determined in the systematic analysis study conducted by Hergul et al. (2016) that there was a deficiency at the rate of 80% regarding evaluating incidents between surgical team members during the operation (Hergul, Ozbayir & Gok, 2016).

The fact that there are statistics related to the conditions of operating room-acquired infections at the institution and the evaluation of these reports periodically are important to take effective precautions for sustaining patient safety. Thus, all records related to the operating room are important. Especially records related to the condition of materials coming out of sterilization (wet, moist, without indicator), the carriage of sterile material, the existence of warnings regarding the characteristics of use of reusable

antiseptics and the results of culture samples acquired from different areas regularly must be complete. The fact that the results and evaluations obtained, precautions to be taken and the rules to be followed are written, they are announced to all operating room personnel and training programs depending on the requirements are organized are necessary to prevent infections.

### **Inappropriate Architectural Structure**

Contaminated medical instruments are the source of infection both for the personnel and the environment due to their bio-load. The facts that contaminated or used medical instruments are not carried in closed containers or special carriage carts, carriage carts are not decontaminated after they are used, carriage is performed in areas in which people circulation is high, the carriage of sterile and non-sterile tools is performed in the same corridor (single-corridor architectural structure) increase the risk of contamination and contact (Genc, 2014; Karatas, 2014). The fact that necessary precautions are not taken increases the risk of the contamination of infection factors to the patient.

### **Unconfirmed Technology**

While many scientific studies are conducted on subjects such as the mechanism of action, action time, spectrum, and the effects of biocidal materials produced with nanotechnology and used for sterilization on human and environmental health, there are no internationally accepted reference methods and definitions that can be used (Budak, 2014; Budak 2015). It is not possible to test nanoproduct and materials with the current test and analysis methods valid for biocidal products used in Operating Rooms and Central Sterilization Units (Budak, 2014; Budak 2015).

There are no special provisions for nanomaterials in the **Biocidal Products Regulations** (*Nanomaterials under Biocidal Products Regulations*). According to this regulation, as long as there is not a special explanation, an active material which is used in Operating Rooms and Central Sterilization Units and has a biocidal license does not contain a nanomaterial (Budak, 2014). A different action is taken in all authorization processes for active materials including a nanomaterial and a different file should be prepared. In case active or inactive materials contain a biocidal nanomaterial, a

special risk evaluation is performed (Budak, 2014).

It is necessary to take into consideration the details which have a critical importance such as the production of sterilization products including a nanomaterial, their manner of application, concentration, dose-response analyses, chemical and microbiological spectrum analyses, efficiency follow-up in the application area and conducting booster application (Budak, 2014; Budak 2015).

### **Conclusion**

Protecting asepsis in the operating room and providing high sterilization are significant for operation. It is considered that protecting patient safety in operating rooms prevents surgical site infections, decreases complications, increases the quality of the operation and contributes to quality healthcare service by decreasing cost.

### **References**

- Adiguzel O. (2010). A research on the perception of the patient security culture by the health staff (Turkish). Dumlupinar University Social Sciences Journal, 28:159-170.
- Alfredsdottir H. & Bjornsdottir K. (2008) Nursing and patient safety in the operating room. Journal of Advanced Nursing, 61:29-37.
- Aren A. (2008). Safety of patients and health workers in operating rooms (Turkish). Istanbul Medical Journal, 3:141-145.
- Birgand, G., Saliou, P., & Lucet, J. C. (2015). Influence of staff behavior on infectious risk in operating rooms: what is the evidence?. Infection Control & Hospital Epidemiology, 36(1), 93-106.
- Budak G.G. (2014) Nanoteknoloji ile üretilmiş malzemelerin merkezi sterilizasyon uniteleri ve ameliyathanelerde kullanımı. 2. Ulusal Sterilizasyon Ameliyathane Dezenfeksiyon Kongresi Kongre Kitabı, Dezenfeksiyon, Antisepsi, Sterilizasyon Derneği Publication No: 8, Arvin Publishing House,Istanbul Turkey, p:15-17.
- Budak G.G. (2015) Nanotechnology in antiseptic and disinfectant applications. 9th International Sterilization Disinfection Congress - Congress Book, Disinfection, Antisepsis, Sterilization Association Publication No: 14, Arvin Publishing House,Istanbul,Turkey, p:2-3.
- Chen, J., Rathore, S. S., Radford, M. J., & Krumholz, H. M. (2003). JCAHO accreditation and quality of care for acute myocardial infarction. Health Affairs, 22(2), 243-254.
- Christian C.K., Gustafson M.L., Roth E.M., et al. (2006) A prospective study of patient safety in the operating room. Surgery, 139:159-173.

- Christian, C. K., Gustafson, M. L., Roth, E. M., Sheridan, T. B., Gandhi, T. K., Dwyer, K., ... & Dierks, M. M. (2006). A prospective study of patient safety in the operating room. *Surgery*, 139(2), 159-173.
- Ertem U.T. (2015). Patient Safety. In: Basic Concepts and Skills in Health Practices, Fatma Akca Ay (Ed.). Nobel Type Bookstores, Istanbul, Turkey, p: 207-221.
- Genc M. (2014). Appropriate transfer between surgical instruments and materials operating room, clinics and MSU, appropriate consignment material transfer. 2nd National Sterilization Disinfection Congress Book, Disinfection, Antisepsis, Sterilization Association Publication No. 8, Arvin Publishing House, Istanbul, Turkey, p:83-87.
- Genc M. (2015). Transportation of medical equipment. 9. International Conference on Sterilization Disinfection Sterilization - Congress Book, Disinfection, Antisepsis, Sterilization Association Publication No: 14, Arvin Publishing House, Istanbul, Turkey, p:38-41.
- Gioffre, A., Dragone, M., Ammoscato, I., Iannò, A., Marramao, A., Samele, P., & Sorrentino, D. (2007). The importance of the airborne microorganisms evaluation in the operating rooms: the biological risk for health care workers. *Italian Journal of Occupational Medicine and Ergonomics*, 29(3 Suppl), 743-745.
- Henry L, Hunt S, Kroetch M & Yang Y.T. (2012) Evaluation of patient safety culture. *Innovations: Techonogy & Techniques in Cardiothoracic & Vascular Surgery*, 7:328-337.
- Hergul F.K., Ozbayir T. & Gok F. (2016). Patient safety in the operating room: A systematic review. *Pamukkale Medical Journal*, 9:87-98.
- Inan C.Y. (2014). Hidden danger in the operating room; instrument disinfection. 2nd National Sterilization Disinfection Congress Congress Book, Disinfection, Antisepsis, Sterilization Association Publication No: 8, Arvin Publishing House, Istanbul, Turkey, p:20-22.
- Karatas S. (2014). Operating room: General definition, functions and concepts. 2nd National Sterilization Disinfection Congress Congress Book, Disinfection, Antisepsis, Sterilization Association Publication No: 8, Arvin Publishing House, Istanbul, Turkey, p:58-72.
- Kartal E.D. (2014). Causes of hospital infections related to surgery. 2nd National Sterilization Disinfection Congress Congress Book, Disinfection, Antisepsis, Sterilization Association Publication No. 8, Arvin Publishing House, Istanbul, Turkey, p:23-27.
- Kim, J., An, K., Kim, M. K., & Yoon, S. H. (2007). Nurses' perception of error reporting and patient safety culture in Korea. *Western journal of nursing research*, 29(7), 827-844.
- Lange V.R. (2014). Eye wear contamination levels in the operating room: Infection risk. *American Journal of Infections Control*, 42:446-447.
- Ozbayir T. (2014). Surgical handwashing. 2nd National Sterilization Operation Room Disinfection Congress Congress Book, Disinfection, Antisepsis, Sterilization Association Publication No: 8, Arvin Publishing House, Istanbul, Turkey, p:123-130.
- Ozcelik E.A. (2014). Pre-operative skin cleansing. 2nd National Sterilization Operating Room Disinfection Congress Congress Book, Disinfection, Antisepsis, Sterilization Association Publication No: 8, Arvin Publishing House, Istanbul, Turkey, p:112-122.
- Peel T.N, Cheng A.C, Busing K.L, Dowsey M.M, Choong P.F.M, (2014) Alcoholic Chlorhexidine or Alcoholic Iodine Skin Antisepsis (ACAISA): protocol for cluster randomised controlled trial of surgical skin preparation for the prevention of superficial wound complications in prosthetic hip and knee replacement surgery. *BMJ Open*, 4: 1-6. doi:10.1136/bmjopen-2014-005424.
- Peel, T. N., Cheng, A. C., Busing, K. L., Dowsey, M. M., & Choong, P. F. M. (2014). Alcoholic Chlorhexidine or Alcoholic Iodine Skin Antisepsis (ACAISA): protocol for cluster randomised controlled trial of surgical skin preparation for the prevention of superficial wound complications in prosthetic hip and knee replacement surgery. *BMJ open*, 4(5), e005424.
- Silén-Lipponen, M., Tossavainen, K., Turunen, H., & Smith, A. (2005). Potential errors and their prevention in operating room teamwork as experienced by Finnish, British and American nurses. *International journal of nursing practice*, 11(1), 21-32.
- Sungu A. (2014). Air conditioning in hospitals. 2nd National Sterilization Operating Room Disinfection Congress Congress Book, Disinfection, Antisepsis, Sterilization Association Publication No: 8, Arvin Publishing House, Istanbul, Turkey, p:73-82.
- Tammelin A., Ljungqvist B., Reinmuller B. (2013). Single-use surgical clothing system for reduction of airborne bacteria in the operating room. *Journal of Hospital Infections*, 84:245-7.