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# ANALYSIS OF USED DISINFECTANTS IN CORRELATION WITH THE OCCURRENCE AND CAUSES OF HOSPITAL INFECTIONS - A COMPARISON OF DATA FOR GENERAL HOSPITAL IN OHRID IN THE PERIOD 2009 TO 2013

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## Abstract

Intra-hospital or nosocomial hospital infections mean infections that develop in hospitals or are caused by microorganisms acquired during the hospitalization of the patient, and clinically are manifested from 48 to 72 hours after admission at earliest. To achieve the goal in reducing and prevention of these infections, within the hospital hygiene, many processes and procedures that should be routinely carried out in the hospital are included. The control of intra-hospital infections is performed by intra-hospital infections Commission which is responsible for taking swabs of sediments and air for proving none/presence of bacteria, as well as taking measures if contamination occurs and timely detection of intra-hospital infections. This research is aimed at reviewing and selecting appropriate ways to prevent intra-hospital infections, which are serious problem in modern medicine.

Preparation and delivery of food to hospital patients is a challenge that can be a major route for the spread of infections. The procedures for disinfection and the type and quantity of disinfectants used are directly related to the effects. Statistical processing of data received from general hospital in Ohrid in the period 2009 to 2013 gives a complete insight into the connection between the use of disinfectants with occurrence and absence of intra-hospital infections.

Prevention of intra-hospital infections is possible only by implementing standard processes and procedures that enable optimal use of properly selected disinfectants in all departments in hospitals. Special attention should be given to the procedures for preparing and delivering food to patients and the procedures for disinfection and control of space and food preparation, store and distribute food.

***Key words**: Infection, Control, Prevention.*

## 1. Introduction

Antiseptics and disinfectants are widely used in hospitals and other medical facilities for different topical application and hard surfaces. In the composition of disinfectants there is wide variety of active chemical agents (biocides) applied over hundreds of years and according to the chemical composition they represent alcohols, phenols, iodine and chlorine compounds. Most of these active substances are showing broad spectrum of antimicrobial activity, but little is known about the mode of action of these agents compared with the principle of action of antibiotics. In general, biocides have a broader spectrum of action than antibiotics. While antibiotics tend to target specific intracellular targets, biocides have different, multiple goals. The widespread use of these products raises doubts among many scientists and researchers for the development of antibiotic resistance, especially cross-resistance and the question is whether resistance to antibiotics is caused by the use of antiseptics or disinfectants.

When speaking about biocides as chemicals use it is important to note that many of these biocides can be used independently or in combination with various other products that differ significantly in their activity. Antimicrobial activity may be influenced by many factors that can arise from the formulation, the synergistic activity, temperature, dilution and evaporation. Biocide is a general term used to describe a chemical agent, usually with a broad spectrum of activity, which inactivates microorganisms. Biocidal activity is within the antimicrobial activity, but depending on the conditions it can be "static" activity that is directed to agents that inhibit growth (bacteriostatic, fungistatic and sporostatic activity), and "cidal" activity as well, directed to agents that completely destroy all present microorganisms (bactericidal, sporocidal, fungicidal) [1].

Significant progress has been made in understanding the mechanism of antibacterial activity of antiseptics and disinfectants. In contrast, studies of their antifungal, antiviral and antiprotozoal activity are considerably fewer. The conducted studies indicate the possibility of determining the antiviral activity of antiseptics and disinfectants. There is a published study that completely describes the so-called method Viraden, based on direct counting of viruses adsorbed to nitro-cellulose acetate membrane. The characteristics and performance of the method makes this method most suitable for antiviral activity of disinfectants and antiseptics testing. Counting of adsorbed viruses on nitrate-acetate-cellulosic filter is quite simple procedure and it is proposed to determine the antiviral activity of disinfectants and antiseptics. Published reports are indicating that when examining the bactericidal activity of disinfectants and antiseptics significant difference occurs in the antimicrobial activities of different disinfectants and antiseptics, tested in different laboratories. One of the reasons for the differences that arise can be the relative complexity of procedures used. In the most of used methods, in order to prevent inactivation of the used disinfectant or antiseptic, it is necessary for the mixture to be diluted to prevent damage of the cell culture on which are viral cells counted [2].

Regardless of the type of organism that is present, there is always a common sequence of events: previous interaction of the disinfectant or antiseptic with the cell surface, followed by penetration into the cell or simply targeting cell activity. The nature and composition of the surfaces vary from one cell to the other. However, external or environmental factors can also affect antiseptics and disinfectants activity. Interaction with the bacterial cell surface can have a significant impact on the used chemicals sustainability effect, but the fact that most antimicrobial agents are acting intracellularly in not insignificant. The interior of the bacterial cell can thus have a significant impact on the general, overall durability of the bacterial cell or a different sensitivity to disinfectants and antiseptics, so how little is known is quite disappointing although there is evidence of the effect and impact of certain disinfectants and antiseptics to different types of bacterial cells. However, the potentiation of the action of certain disinfectants and antiseptics can be achieved by using different additives that significantly increase their potency.

### 1.1 Nosocomial, hospital infections

A great number of studies around the world show and prove that hospital infections are the major cause of morbidity and mortality. The high frequency of hospital infections is the evidence of the poor quality of health services and lead to unforeseen and unavoidable expenses. Many factors contribute to the incidence of hospital infections: for example, hospitalized patients are usually immuno-compromised. They are often subjected to invasive treatments and examinations, and practical patient care in the hospital environment can facilitate the transmission of microorganisms among patients. Intensive use of antibiotics promotes the microbial resistance to used antibiotics. Advances in the prevention of hospital infections is steadily increasing, and studies of the proper application and use of disinfectants, depending on their purpose and structure are constantly emerging [3].

According to numerous studies conducted worldwide, hospital infections mostly occur at certain specific areas of the hospital. Hospital infections, according to the World Health Organization, can be regarded as endemic or epidemic. Endemic infections are present the most. Epidemic infections occur during epidemics and they are defined as unusual increase over the basic, allowed line of certain infection or infected organism. Changes are needed to impose such legislation in the health care law, which include changes recommended by the World Health Organization that advocates reducing the number of hospital treatment of patients and increasing the number of ambulance treatments.

Hospital infections are occuring worldwide, nevertheless we speak about developed, developing or poor countries. Studies by the World Health Organization in 55 hospitals in 14 countries around the world that represent the four major regions of the World Health Organization (Europe, Eastern Mediterranean, Southeast Asia and Western Pacific) showed an average of 8.7% of patients in these hospitals that have nosocomial infections. At any time, more than 1.4 million people worldwide suffer from infectious diseases acquired in hospitals. The highest frequency of nosocomial infections were reported from hospitals in the Eastern Mediterranean and South-East Asia (11.8 and 10.0%, respectively), compared with 7.7% and 9.0%, respectively, in European countries and the Western Pacific region. Hospital infections are common infections of surgical wounds, urinary tract infections and infections of the lower respiratory tract. WHO study and other studies also show that the prevalence of hospital infections occurring in departments of intensive care and surgical and orthopedic care is the biggest. Infection rates are higher in older patients, previously untreated and improperly treated patients or patients who receive chemotherapy.

Besides the fact that hospital infections are one of the leading causes of death among patients, economic costs are also increasing. Increasing the duration of hospitalization of an infected patient poses additional and increased costs. One study shows that the total increase in the duration of hospitalization of patients with infected surgical wounds is in average 8.2 days, then 3 days of gynecology, 9.9 days in general surgery

and 19.8 days in orthopedics. The longer stay not only increases the direct cost but increases the indirect costs as well due to the increased workload for the care of these patients, such as the increased amount of drugs used, the need for isolation, the use of additional laboratory and other diagnostic methods [4].

There is a study conducted in the United States for the occurrence of infections in nursing homes which is the home of people over 85 years of age. In 2000, it was determined that 4,000,000 elder people lived in nursing homes and the risk of infection determined ranges from 3.3% to 15%. Research has shown that pneumonia and urinary tract infections in people with catheters consistently applied occur the most often. The main cause of the increased mortality was determined to be the occurrence of pneumonia. Factors that cause infections in these cases are not associated with outpatient examinations. Linking all possible factors affecting the incidence of infections associated with fixed patients were identified as a risk factor for urinary tract infections, pneumonia, which is followed by increased mortality in these patients. Daily treatment and care for these patients suggests that it is necessary to accurately identify all medical treatments of them, to use proven methods for disinfecting, and for prevention of these infections [5].

The emergence of hospital infections cause by Klebsiella studied in a worldwide study and indicates infection already occurred once in the hospital setting. Seriously ill patients (with long hospital stays) are frequently infected and the occurrence of urinary tract infection is the most common. Made comparison between non-infected and uninfected control group of patients from the same departments found that isolated infected cases differed only in the frequency of urinary catheterization and preantibiotic treatment. Although all cases were similar in terms of time of hospitalization before infecting them always in these cases were hospitalized while the difference from the control group [6].

For the incidence of nosocomial hospital infection there is another study conducted in 1966 on the occurrence of infection caused by the *Staphylococcus aureus*. The research has been done on different types of staphylococci responsible for the occurrence of cross infections in large hospitals between 1961 and 1966. Research has shown that infections are caused by three different types of staphylococci to later identify and prove new species resistant to antibiotics. Two main groups of staphylococci were isolated as species responsible for most of the cases of cross-infection in two hospitals. Species resistant to antibiotics were proven to be epidemiological types. It was proved that the typical group which causes infection is the main cause of infections in patients with open wounds and surgical areas with skin ulceration. The correlation was established between species resistant to antibiotics and the similar vines of the two different types of bacteria. This research has provided result in increased guidance for improving the control of the occurrence of infections in hospitals and taking appropriate measures to prevent further spreading [7].

The changes set in order to change health care for economic reasons are actually the changes that cause differences in occurrence of nosocomial infections in hospitals. Progress has been made in the prevention and control of hospital infections, but these infections continue to be the main cause of morbidity and mortality in hospitalized patients, leading to increased costs of care for patients. Programs for infection control should focus on preventing infections in patients who are at greatest risk of infection due to exposure to certain procedures and medical devices. The use of disinfectants and antiseptics including daily microbiological laboratory controls should necessary be involved in all aspects of infection control. The laboratory microbiological controls are particularly significant in terms of hospital supervision, data collection for the occurrence of infections, the emergence of resistant pathogens and non-pathogenic species of microorganisms used in antiseptics. This is the way of controlling the hospital activity, so the possible occurrence of hospital infections can be recognized and identified and hence timely prevented. Monitoring the rate of occurrence of infections within a given period of time can allow preparation of validated program on how to prevent infection and adjustment of external and internal risk factors which are responsible for the emergence of infections. When comparing the risk factors responsible for the occurrence of infections that can occur, it is easy to see that there is the need of further examination of potential infectious problems and improvement of their control [8].

Control of the occurrence of nosocomial infections is a challenge that is increasingly being examined worldwide and more studies have examined this. One of the most interesting studies is the study that highlights "why" and "how" to implement best practices to prevent these infections, as well their spread, revealing the most important key factors that determine success in this activity. This study was conducted across multiple hospitals in Europe covering only intensive care unit [9].

Most disinfectants and antiseptics used in hospitals are prepared as solutions in hospital pharmacies from where they are distributed to all hospital departments. Tests are showing that there is possiblity of contamination during their manufacture. The level of contamination of some bacterial species ranges from $10^2$ to $10^8$ bacterial colonies formed per milliliter disinfectant / antiseptic to the possibility of achieving the infectious dose at the site of application. Epidemiological reports indicate that many hospitals often use contaminated disinfectants and antiseptics which are applied direct-

ly to the skin of patients, and they are often used for decontamination of instruments and diagnostic devices for treatment of patients. For these reasons, it is important to note that contaminated disinfectants and antiseptics have reduced efficiency and effectiveness. The data indicate too many resistant bacteria isolated from disinfectants and antiseptics [10].

Food preparation and delivery to hospital patients is a challenge and it can be a major route for the spread of infections. Directly related to this fact are food safety procedures, procedures for disinfection, and the type and quantity of disinfectants used.

Having all of this in mind, the purpose of this paper is to show the connection between the used disinfectants and antiseptics in "General Hospital" in Ohrid for period of five years, from 2009 to 2013 and the potential of the possible occurrence of hospital infections.

## 2. Materials and Methods

The data used for antiseptics and disinfectants are derived from:

- Annual Evidence List of "General Hospital" Ohrid. They are processed separately for each ward.
- Annual reports of "Center for Public Health" Ohrid - Epidemiologic Service.

Descriptive statistical analysis is used for analyzing collected data of disinfectants and antiseptics annually, for each ward separately, in "General Hospital" Ohrid, compared with the results of the microbiological analyzes conducted in PHI "Center for Public Health" Ohrid. The possible occurrence of hospital infections over a period of five years is estimated.

When speaking about the food, following procedures and records were investigated: purchasing and food preparation procedures, food handling personal health status and health checks records, food preparation area, preparation and use of disinfectants.

Swabs were taken from: working areas, storage places, food preparation and serving dishes, staff, containers for transporting the food to the hospital units and, personnel of the units which are sharing food to patients. Food microbiological quality of food was performed and following parameters were investigated: *Staphylococcus aureus, Esherihia coli, Enterococcus* spp., *Pneudomonas aeruginosa, Bacillus subtilis,* Aspergilus spp. and *Enterobacter* spp.

## 3. Results and Discussion

The presented results are only part of a huge number of results that are separately obtained annually for each department.

The Table 1 and Figure 1 shows that in 2009 out of the used antiseptics and disinfectants, the biggest amounts are spent from spiritus (dilutes 70%), 1331 litres with a major share of 240 liters in internal medicine department. The least used is the formaldehyde sol, 3 liters, from which 2 of them are spent in pathology.

Table 2 and Figure 2 are showing that in 2010 out of the used antiseptics and disinfectants in liquid, the biggest amounts spent are Ecosal - 150 liters, with the highest proportion of 70 liters in gynecology, and Betadine is used at least (only 10%), or in total 35 liters, and 20 liters of them are spent in surgery.

Table 3 and Figure 3 shows that in 2011, out of the used antiseptics and disinfectants, the largest amounts spent are Asepsol - 207 liters, with a major share of 60 liters per day in internal medicine department. The least used is formaldehyde sol, from which 1 liter is spent in pathology.

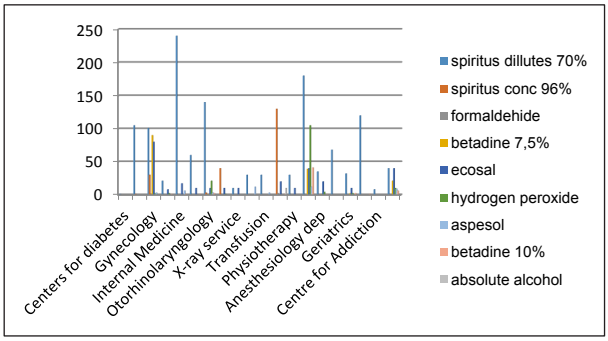


**Figure 1. Amount of spent antiseptics and disinfectants in all departments in General Hospital Ohrid in 2009**

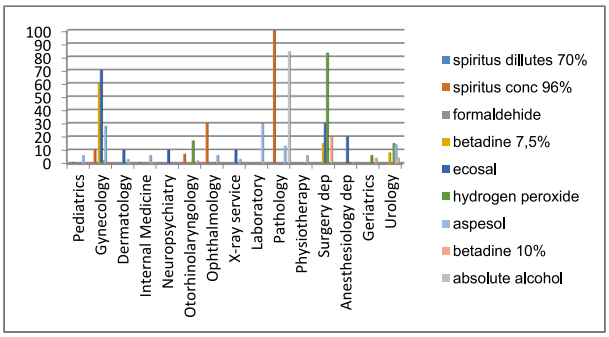


**Figure 2. Amount of spent antiseptics and disinfectants liquid in all departments of General Hospital Ohrid in 2010**

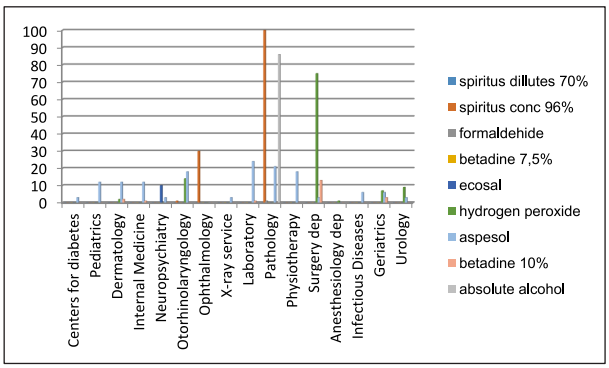


**Figure 3. Amount of spent antiseptics and disinfectants in all departments of General Hospital Ohrid in 2011**

**Table 1. Total quantity of commonly used antiseptics and disinfectants in all departments in General Hospital Ohrid in 2009**

| Dpt.* | Antiseptics and disinfectants | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Spiritus (70%) | Spiritus (96%) | Formaldehide | Betadine (7.5%) | Ecosal | $H_2O_2$ | Asepsol | Betadine (10%) | Absolute alcohol |
| Dia | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped | 105 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gyn | 101 | 30 | 1 | 90 | 80 | 2 | 3 | 0 | 0 |
| Der | 21 | 0 | 0 | 0 | 8 | 2 | 0 | 1 | 0 |
| Int | 240 | 0 | 0 | 0 | 17 | 0 | 6 | 1 | 0 |
| Neu | 60 | 0 | 0 | 0 | 10 | 0 | 0 | 1 | 0 |
| Oto | 140 | 3 | 0 | 1 | 10 | 21 | 3 | 2 | 0 |
| Oph | 0 | 40 | 0 | 0 | 10 | 1 | 0 | 0 | 0 |
| X-ray | 10 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 |
| Lab | 30 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 |
| Tran | 30 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 |
| Path | 0 | 130 | 2 | 0 | 20 | 0 | 0 | 1 | 10 |
| Phys | 30 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 |
| Surg | 180 | 0 | 0 | 39 | 40 | 105 | 12 | 41 | 0 |
| Anes | 35 | 0 | 0 | 1 | 20 | 4 | 0 | 1 | 0 |
| Infect | 68 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ger | 32 | 0 | 0 | 2 | 0 | 2 | 0 | 2 | 0 |
| Inter | 120 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Cent | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rad | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Uro | 40 | 0 | 0 | 21 | 40 | 40 | 9 | 6 | 0 |

Legend;
Departments*: Dia - Centers for diabetes; Ped - Pediatrics; Gyn - Gynecology; Der - Dermatology; Int - Internal Medicine; Neu - Neuropsychiatry; Oto - Otorhinolaryngology; Oph - Ophthalmology; X-ray - X-ray service; Lab - Laboratory; Tran - Transfusion; Path - Pathology; Phys - Physiotherapy; Surg - Surgery; Anes - Anesthesiology; Infect - Infectious Diseases; Ger - Geriatrics; Inter - Internal medicine; Cent - Centre for Addiction; Rad - Radiology; Uro - Urology.
Comment: Abbreviations for these departments are mentioned in Tables 2, 3, 4 and 5 too.

**Table 2. The total quantity of commonly used antiseptics and disinfectants in all departments of General Hospital Ohrid in 2010**

| Dpt.* | Antiseptics and disinfectants | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Spiritus (70%) | Spiritus (96%) | Formaldehide | Betadine (7.5%) | Ecosal | $H_2O_2$ | Asepsol | Betadine (10%) | Absolute alcohol |
| Ped | 0 | 1 | 0 | 0 | 0 | 0 | 6 | 1 | 0 |
| Gyn | 0 | 10 | 0 | 60 | 70 | 2 | 28 | 0 | 0 |
| Der | 0 | 0 | 0 | 0 | 10 | 1 | 3 | 1 | 0 |
| Int | 0 | 1 | 0 | 0 | 0 | 0 | 6 | 1 | 0 |
| Neu | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 |
| Oto | 0 | 7 | 0 | | 0 | 17 | 0 | 2 | 0 |
| Oph | 0 | 30 | 0 | 0 | 0 | 1 | 6 | 0 | 0 |
| X-ray | 0 | 0 | 0 | 0 | 10 | 0 | 3 | 0 | 0 |
| Lab | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 1 | 0 |
| Path | 0 | 100 | 0 | 0 | 0 | 0 | 13 | 0 | 84 |
| Phys | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 |
| Surg | 0 | 0 | 0 | 15 | 30 | 83 | 0 | 20 | 0 |
| Anes | 0 | 0 | 0 | 0 | 20 | 1 | 0 | 1 | 0 |
| Ger | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 4 | 0 |
| Uro | 0 | 0 | 0 | 8 | 0 | 15 | 14 | 4 | 0 |

*See Table 1 legend

**Table 3. The total quantity of commonly used antiseptics and disinfectants in all departments of General Hospital Ohrid in 2011**

| Dpt.* | Antiseptics and disinfectants | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Spiritus (70%) | Spiritus (96%) | Formaldehide | Betadine (7.5%) | Ecosal | $H_2O_2$ | Asepsol | Betadine (10%) | Absolute alcohol |
| Dia | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 |
| Ped | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 |
| Der | 0 | 0 | 0 | 0 | 0 | 2 | 12 | 2 | 0 |
| Int | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 1 | 0 |
| Neu | 0 | 0 | 0 | 0 | 10 | 0 | 3 | 0 | 0 |
| Oto | 0 | 1 | 0 | 0 | 0 | 14 | 18 | 0 | 0 |
| Oph | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| X-ray | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 |
| Lab | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 1 | 0 |
| Path | 0 | 100 | 1 | 0 | 0 | 0 | 21 | 0 | 86 |
| Phys | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 0 | 0 |
| Surg | 0 | 0 | 0 | 0 | 0 | 75 | 3 | 13 | 0 |
| Anes | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Infect | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 |
| Ger | 0 | 0 | 0 | 0 | 0 | 7 | 6 | 3 | 0 |
| Uro | 0 | 0 | 0 | 0 | 0 | 9 | 3 | 0 | 0 |

*See Table 1 legend

Table 4 and Figure 4 are showing that in 2012, out of the used antiseptics and disinfectants, the largest amounts spent are Asepsol - 309 liters, with a major share of 106 liters per day in the internal medicine department, while the least used is Betadine with 7,5%.

Table 5 and Figure 5 shows that in 2013, out of the used antiseptics and disinfectants, the largest amounts spent are Dezintal - 246 liters, with a major share of 246 liters in internal medicine department.

In 2009, the Center for Public Health gave the following report:

- During the first quarter 163 swabs were taken
- During the second quarter 58 swabs were taken
- During the third quarter 174 swabs were taken
- During the fourth quarter 166 swabs were taken.

Isolated pathogenic bacteria were: *Staphylococcus aureus* in 17 samples (3%), *Esherihia coli* in three samples (0%), *Enterococcus* spp. in 2 samples (0%), *Pneudomonas aeruginosa* in 9 samples (2%), *Bacillus subtilis* in 10 samples (2%), *Aspergilus* spp. in 3 samples (1%), *Enterobacter* spp. in 1 sample (0%) of total examined materials.

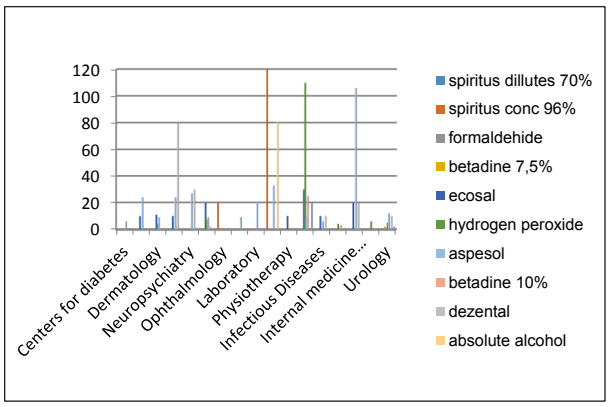


**Figure 4. Amount of spent antiseptics and disinfectants in all departments of General Hospital Ohrid in 2012**

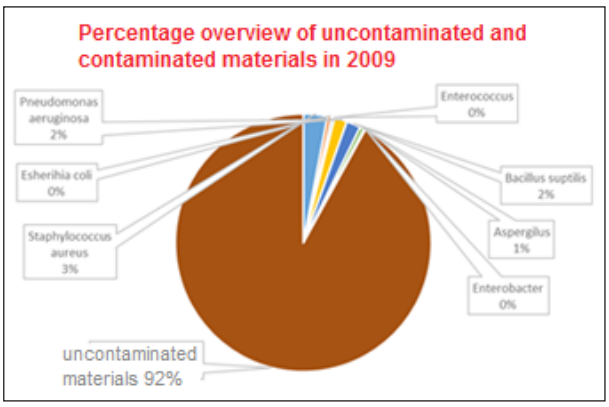


**Figure 5. Amount of spent antiseptics and disinfectants in all departments of General Hospital Ohrid in 2013**

**Table 4. The total quantity of commonly used antiseptics and disinfectants in all departments of General Hospital Ohrid in 2012**

| Dpt.* | Antiseptics and disinfectants | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Spiritus (70%) | Spiritus (96%) | Formal | Betad (7.5%) | Ecosal | $H_2O_2$ | Asepsol | Betad (10%) | Dezent | Absol. alcohol | Prov. (10%) |
| Dia | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 |
| Ped | 0 | 0 | 0 | 0 | 10 | 0 | 24 | 0 | 0 | 0 | 0 |
| Der | 0 | 0 | 0 | 0 | 11 | 4 | 9 | 1 | 0 | 0 | 1 |
| Int | 0 | 0 | 0 | 0 | 10 | 0 | 24 | 2 | 80 | 0 | 0 |
| Neu | 0 | 0 | 0 | 0 | 0 | 0 | 27 | 1 | 30 | 0 | 0 |
| Oto | 0 | 0 | 0 | 0 | 20 | 7 | 9 | 2 | 0 | 0 | 0 |
| Oph | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| X-ray | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 |
| Lab | 0 | 0 | 0 | 0 | 0 | 0 | 21 | 0 | 0 | 0 | 0 |
| Path | 0 | 120 | 0 | 0 | 0 | 0 | 33 | 0 | 0 | 81 | 0 |
| Phys | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| Surg | 0 | 0 | 0 | 0 | 30 | 110 | 9 | 25 | 0 | 0 | 20 |
| Infect | 0 | 0 | 0 | 0 | 10 | 0 | 6 | 0 | 10 | 0 | 0 |
| Ger | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 3 | 0 | 0 | 1 |
| Inter | 0 | 0 | 0 | 0 | 20 | 0 | 106 | 1 | 20 | 0 | 0 |
| Rad | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 |
| Uro | 0 | 0 | 0 | 2 | 0 | 5 | 12 | 0 | 10 | 0 | 2 |

*See Table 1 legend

**Table 5. The total quantity of commonly used antiseptics and disinfectants in all departments of General Hospital Ohrid in 2013**

| Dpt.* | Antiseptics and disinfectants | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Spiritus (70%) | Spiritus (96%) | Formal | Betad (7.5%) | Ecosal | $H_2O_2$ | Asepsol | Betad (10%) | Dezent | Absol. alcohol | Prov. (10%) |
| Dia | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped | 113 | 0 | 0 | 0 | 0 | 1 | 18 | 0 | 0 | 0 | 0 |
| Gyn | 123 | 17 | 0 | 67 | 50 | 3 | 42 | 2 | 60 | 0 | 0 |
| Der | 18 | 0 | 0 | 0 | 0 | 10 | 5 | 1 | 10 | 0 | 0 |
| Int | 197 | 0 | 0 | 0 | 140 | 0 | 54 | 3 | 246 | 0 | 0 |
| Neu | 46 | 0 | 0 | 0 | 10 | 0 | 42 | 0 | 13 | 0 | 0 |
| Oto | 100 | 3 | 0 | 1 | 3 | 22 | 18 | 1 | 0 | 0 | 2 |
| Oph | 10 | 30 | 0 | 0 | 10 | 1 | 6 | 1 | 12 | 0 | 0 |
| X-ray | 40 | 0 | 0 | 0 | 20 | 0 | 24 | 0 | 0 | 0 | 0 |
| Lab | 30 | 0 | 0 | 0 | 0 | 0 | 45 | 0 | 0 | 0 | 0 |
| Path | 0 | 148 | 1 | 0 | 0 | 0 | 24 | 0 | 0 | 128 | 0 |
| Phys | 45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| Surg | 95 | 0 | 0 | 0 | 20 | 98 | 6 | 29 | 61 | 0 | 21 |
| Anes | 33 | 0 | 0 | 0 | 10 | 0 | 3 | 1 | 0 | 0 | 1 |
| Infect | 99 | 0 | 0 | 0 | 30 | 1 | 18 | 3 | 20 | 0 | 1 |
| Ger | 34 | 0 | 0 | 1 | 10 | 9 | 0 | 1 | 0 | 0 | 2 |
| Inter | 135 | 0 | 0 | 0 | 50 | 0 | 0 | 0 | 0 | 0 | 1 |
| Cent | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Uro | 40 | 0 | 0 | 1 | 0 | 3 | 51 | 1 | 0 | 0 | 0 |

*See Table 1 legend

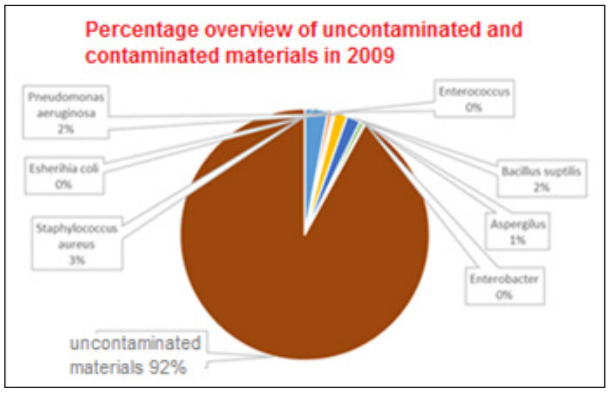


**Figure 6. Percentage overview of uncontaminated and contaminated materials in 2009**

In 2010, the Center for Public Health gave the report that:

- During the first quarter 138 swabs were taken
- During the second quarter 182 swabs were taken
- During the third quarter 161 swabs were taken
- During the fourth quarter 151 swabs were taken.

The isolated pathogenic bacteria were: *Staphylococcus aureus* in 20 samples (3%), *Esherihia coli* in 4 samples (0.6%), *Enterococcus* spp. in 3 samples (0.4%), *Pseudomonas aeruginosa* in 7 samples (2.7%), *Bacillus subtilis* in 10 samples (2.9%), *Enterobacter* spp. in 2 samples (0.25%) of the total examined materials.

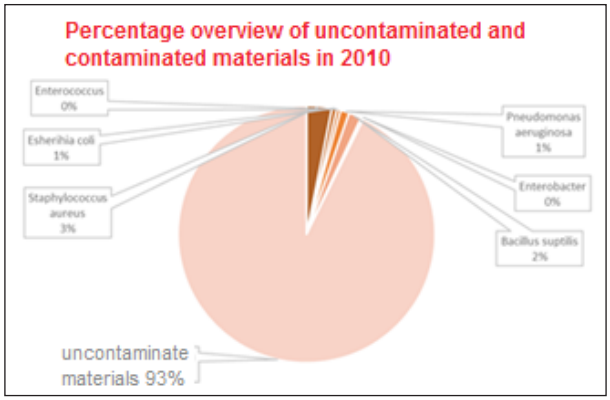


**Figure 7. Percentage overview of uncontaminated and contaminated materials in 2010**

For 2011, the Center for Public Health report stated that:

- During the first quarter 165 swabs were taken
- During the second quarter 58 swabs were taken
- During the third quarter 176 swabs were taken
- During the fourth quarter 166 swabs were taken.

The isolated pathogenic bacteria were: *Staphylococcus aureus* in 32 samples (4%), *Escherihia coli* in 2 samples (0.%), *Enterococcus* spp. in 2 samples (0.%), *Pseudomonas aeruginosa* in 6 samples (1%), *Bacillus subtilis* in 10 samples (1%), *Staphylococcus aureus* coagulase neg. 43 samples (6%), *Aspergilus* spp. in 2 samples (0%), *Enterobacter* spp. in 1 sample (0%) of the total examined materials.

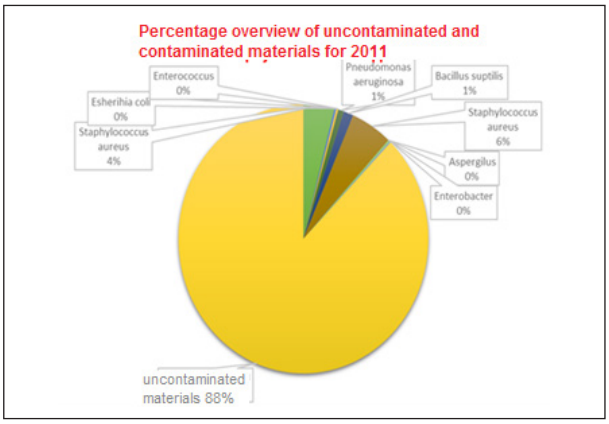


**Figure 8. Percentage overview of uncontaminated and contaminated materials for 2011**

In 2012, number of taken swabs per quarter were:

- 206 - during the first quarter
- 193 - during the second quarter
- 27 - during the third quarter
- 41 - during the fourth quarter.

The isolated pathogenic bacteria were: *Staphylococcus aureus* in 22 samples (5%), *Escherihia coli* in 5 samples (1%), *Enterococcus* spp. in 5 samples (1%), *Pseudomonas aeruginosa* in 13 samples (3%), *Bacillus subtilis* 6 samples (1%) of the total examined materials.

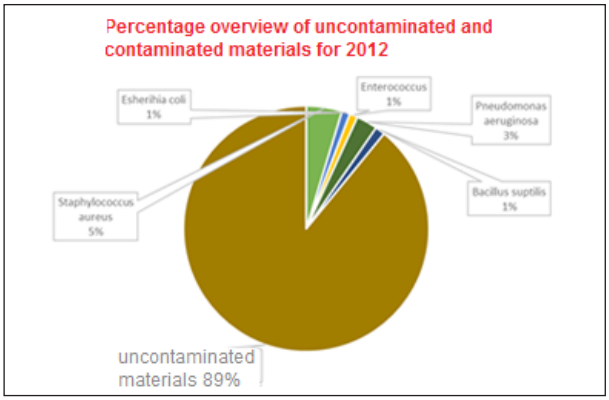


**Figure 9. Percentage overview of uncontaminated and contaminated materials for 2012**

And at last, for 2013, the Centre for Public Health have reported that:

- • During the first quarter 174 swabs were taken
- • During the second quarter 174 swabs were taken
- • During the third quarter 205 swabs were taken
- • During the fourth quarter 156 swabs were taken.

The isolated pathogenic bacteria were: *Staphylococcus aureus* in 17 samples (3%), *Escherihia coli* in two samples (0%), *Enterococcus* spp. in 2 samples (0%), *Pseudomonas* spp. in 3 samples (1%), *Bacillus subtilis* in one sample (0%), *Klebsiella* spp. in one sample out of the tested materials.

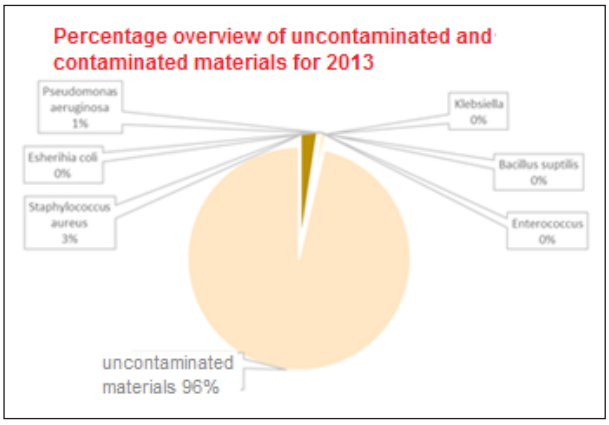


**Figure 10. Percentage overview of uncontaminated and contaminated materials for 2013**

Regarding food control it was established that:

- Purchasing and food preparation takes place under strictly defined procedures.
- All staff which have contact with the food go to regular health checks and are covered by appropriate medical records. Food preparation takes place in a controlled area separated from the other hospital departments.
- The use of disinfectants is appropriate under the hospital procedures and they are locally prepared. Asepsol and spirritus dilutes 70% are used in the largest quantity.
- Food microbiological safety was in the framework of legal requirements.

None of the results obtained during this period indicates that the department for food preparation has been the reason for any infection.

## 4. Conclusions

-The review of the processed data indicates good use of disinfectants and antiseptics in this hospital. The annual quantities of disinfectants and antiseptics show that full coverage and protection against the occurrence of infections in the hospital is achieved. The proper application in all departments, especially in those which are the most hazardous in terms of possible hospital infections indicates that the risk is minimal.

- The Reports from the Center for Public Health in any year do not show any occurrence of infection in the hospital. Considering these aspects, the hospital does not have unplanned, additional costs on annual level to treat diseases that could occur due to an infection acquired during the stay of the patients in the hospital. From the economic point of view, this is a particularly important issue for the functioning of the health institution.

- Food preparation and delivery to hospital patients is not a source and route for the spread of infections.

- The result of the study indicates the proper use of disinfectant and antiseptics in this clinical hospital.

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