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ANALYSIS OF USED DISINFECTANTS AND ANTISEPTICS CORRELATED WITH THE OCCURRENCE OF NOSOCOMIAL INFECTIONS - GENERAL HOSPITAL STRUMICA, REPUBLIC OF MACEDONIA IN PERIOD OF 2010 - 2014

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Abstract

Nosocomial infections represent worry in great proportions for both staff and patients. Therefore, the occurrence of nosocomial infections give great emphasis on proper prevention which includes primarily the optimal use of disinfectants and antiseptics, and regular microbiological testing and controls. Antiseptics and disinfectants are widely used in hospitals and other medical facilities in different topical applications and hard surfaces. Mechanical cleaning before application of disinfectants is essential. Mechanisms of antibacterial disinfectants are summarized in several large critical reports worldwide. The purpose of this paper is to show the connection between the used disinfectants and antiseptics in the General hospital - Strumica, Republic of Macedonia for five years, from 2010 to 2014 and the possible occurrence of hospital infections.

Intra-hospital or nosocomial hospital infections are caused by microorganisms acquired during the hospitalization of the patients, and clinically are manifested from 48 to 72 hours after admission at earliest. The procedures for disinfection and the type and quantity of disinfectants used are directly related to the effects.

The data used for antiseptics and disinfectants are derived from: annual reports of the Centre for Public Health Strumica - Epidemiologic Service, and the annual evidence list of General hospital – Strumica, Republic of Macedonia. They are processed separately for each ward with appropriate comparative statistical methods.

The processed data suggest that used antiseptics and disinfection agents are in accordance with the needs of each department. This goes in proportion to significant reduce of the incidence of nosocomial infections. The amount of used antiseptics and disinfectants is significantly reduced from 2010 to 2014.

After statistical processing of collected data, the results indicates the proper use of disinfectants and antiseptics and minimum risks of occurrence of nosocomial infections.

Key words: *Nosocomial infections, Prevention, Annual reports, Disinfectants, Antiseptics.*

1. Introduction

Understanding and study of hospital infection primarily involves the: study of the causes of these infections, characteristics of patients who are infected and how often these infections are occurring. By identifying the characteristics of patients who are at highest risk of infection, we can effectively streamline and prioritize opportunities to prevent and control them. That also provides close monitoring of the trend of infections have primarily to increased incidence [1].

Weak or low developed countries have not developed a system for monitoring and control of infection. Those countries which in turn have established this system are struggling with the complexity of the system and shortcomings in the standardization of criteria for diagnosing infections. While it is difficult to gather reliable information globally for the occurrence of these infections, results from many studies suggest thousands to millions infected patients worldwide. Usually hospital infections cause great public interest only when they take epidemic scale.

In less developed or developing countries, a limited number of data is associated with the occurrence of hospital infections. However recent analysis made by the World Health Organization (WHO) indicates an increased incidence of hospital infections due to small or

insufficient available resources. At any time the prevalence of hospital infection ranges from 5.7 - 19.1% for less developed or developing countries. Infants are also at risk especially in less developed or developing countries. In these countries the rate of occurrence of hospital infections is 3 - 20 times higher than in high-income and financially stable countries [2].

The most common hospital infections that occur are those to the surgical wound infections, urinary tract infections, and lower respiratory tract. Study by the World Health Organization and others, also shows that the highest prevalence of nosocomial infections occurs in intensive care units and in acute surgical and orthopaedic wards. The rate of infection was higher in patients with increased susceptibility to infections caused by the underlying disease, the age or chemotherapy [3].

1. 2 Nosocomial, hospital infections

Nosocomial or hospital infections can be defined as infections that occur within 48 hours of patient admission in hospital, three days after drop-in hospital, or 30 days from operation. These infections occur in one in ten patients. Annually, this results in 5,000 deaths. On average, a patient with hospital acquired infections spent 2.5 times more resources i.e. 2.5 times more additional hospital costs for treating these patients. Intensive care units (ICU) had the highest prevalence in the development of these hospital infections. In a study conducted by the European prevalence of infections in ICU covered 4,500 patients' demonstrated prevalence in hospital infections in the intensive care unit of 20.6%. Patients in this section are particularly at risk from infections resulting from the use of invasive procedures. Gram positive bacteria are the most common factor for nosocomial infections. The dominant pathogen bacterium is *Staphylococcus aureus*. The emergence of hospital infections is accompanied by an increased rate of bacterial resistance to the used antibiotic therapy [4].

Study conducted in 2003 database showed that 5 to 10% of patients admitted to hospitals in the departments of acute care hospitals, and approximately 2 million patients per year in the US acquire a nosocomial infection. At least 90,000 of deaths per year are result of these hospital infections, making the hospital infections fifth leading cause of death in hospitals in acute care departments.

It is estimated that these infections represent an additional 4.5 - 5.7 billion dollars annually to care for patients. Approximately 25% of hospital infections occur in intensive care units, where it is estimated that by increasing the length of stay from 4.3 to 15.6 days will cost the increase by an additional 20% of the total cost of intensive care.

Most hospital infections are associated with the use of devices such as: urinary catheters, intravascular catheters, mechanical ventilators that disrupt the normal mechanisms of protection for the patient as intact skin or mucous membranes. However, the immune status of the patient also affects the risk of nosocomial infections. For example, immunocompromised patients represent patients with an increased risk of infection, given the compromised immune system, overuse of health services and increase the rate of invasive procedures used.

Three separate groups of patients deserve special focus when it comes to their protection from the occurrence of hospital infection. The first group consists of patients with human immunodeficiency virus (HIV) infection in the second patient with a significant expressed immunosuppressed triggering of haematological malignancies and/or hematopoietic stem and the cells in the third group of patients with cystic fibrosis [5].

Back in 1970's the US health system introduces Centre for control and prevention of intra-hospital infections. By 2004 the control system of the entire health care system focused on different segments of health in different populations and activities. For this purpose from 2004 to 2005 a national network of health and safety was established. In order to help the Centre for Disease Control and Prevention in the supervision and control of hospital infections, National Network for Health and Safety Committee was set up under this centre for the control and prevention of intra-hospital infections with a single purpose, periodic counselling, audits and continuous improvement of the overall health system [6].

For optimal prevention of hospital infections in general and vascular infections that often appear after application of a catheter it should first be noted that many hospitals do not perform appropriate surveillance of hospital infections. The importance of monitoring the occurrence of hospital infections has been demonstrated by the study which demonstrated efficacy in the control of hospital infections. Using samples for examination of the probability of occurrence of hospital infections is best demonstrated through hospitals in the United States which showed a 32% lower rate of hospital infections in hospitals which implemented a programme to control infections compared to hospitals that do not have implemented any programme protection. Average programme for infection control study showed a decrease of 6% of nosocomial infections. The components that are included in the protection programme of nosocomial infections and that provide greater efficiency according to this study are the following, arranged in descending order of importance: intensity of supervision intensity control measures adequacy ratio practitioners that control infections with the number of beds patients and the presence of trained medical infection control [7].

The programme of prevention of infection in Finnish hospitals began in late 1997's and now are developed two modules for control of nosocomial infections and include a wide range of blood-borne surveillance of nosocomial infections. Conducted study showed the first results and they are comprised by combination of data collected from four hospitals participating in the surveillance programme in the period from 1999 to 2000. This study is identified 1,477 cases of nosocomial blood-borne infections, with a total rate of 0.8 blood-borne nosocomial infections per 1,000 patients per day. Blood transmitted nosocomial infections often appear in 33% of patients with haematological malignancies and 15% for other types of malignant diseases, 26% were patients who previously underwent surgery, 26% of infected patients are patients from intensive care, and 61% of patients with a central venous catheter [8]. Having all this in mid, the purpose of this paper is to show the connection between the used disinfectants and antiseptics in the General hospital - Strumica, Republic of Macedonia for five years, from 2010 to 2014 and 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 Strumica. They are processed separately for each ward.
- Annual reports of Centre for Public Health - Strumica - Epidemiologic Service.

Descriptive statistical analysis is used for analysing collected data of disinfectants and antiseptics annually for each ward separately, in General hospital Strumica, and they are compared with the results of the microbiological analyses conducted in Centre for Public Health - Strumica. The possible occurrence of hospital infections is estimated over a period of five years.

3. Results and Discussion

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

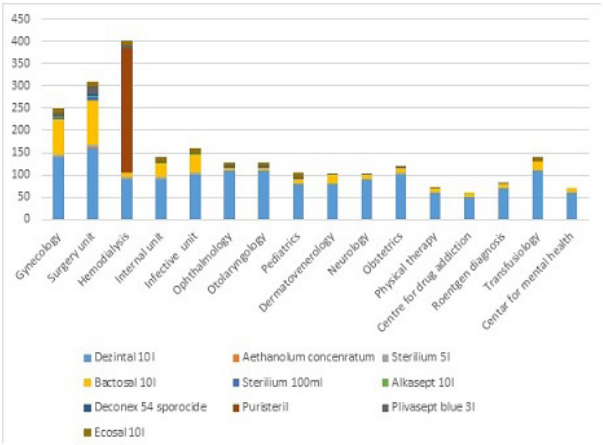

Figure 1. Graphic display of quantities of used disinfectants in 2010 in the departments in the General hospital in Strumica

Table 1. Volumes of used disinfectants expressed in litres used in 2010 in the different departments in the General hospital in Strumica

Disinfectant	Department															
	Gyn	Syr	Hem	Int	Inf	Oft	Orl	Pe	De	Neu	Obe	Ph	C.D	Ren	Tra	C.M
Dezint. 10 L	140	160	90	90	100	110	110	80	80	90	100	60	50	70	110	60
Aethan. con	1	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Sterilium 5 L	5	5	5	5	5	0	0	0	0	0	5	0	0	0	0	0
Bactos. 10 L	80	100	10	30	40	5	5	10	20	10	10	10	10	10	20	10
Sterilium	2	6	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Alkas. 10 L	2	2	0	2	2	0	0	0	1	0	0	0	0	0	0	0
Deconex 54 sporocide	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Puristeril	0	0	280	0	0	0	0	0	0	0	0	0	0	0	0	0
Plivasept bl.	9	18	6	3	3	6	6	6	3	3	6	3	0	3	0	0
Ecosal 10 L	10	10	10	10	10	5	5	10	0	0	0	0	0	0	10	0

Legend:
Departments*: Gyn - Gynaecology; Syr - Surgery unit; Hem - Haemodialysis; Int - Internal unit; Inf - Infective unit; Oft - Ophthalmology; Orl - Otorhinolaryngology; Pe - Paediatrics; De - Dermatovenerology; Neu - Neurology; Obe - Obstetrics; Ph - Physical therapy; C.D - Centre for drug diagnosis; Ren - Roentgen diagnosis; Tra - Transfusiology; C.M -. Centre for mental health.
Comment: Abbreviations for these departments are mentioned in Tables 2, 3, 4 and 5 too.

Figure 1 shows that in 2010 total, 2,375 litres of antiseptics and disinfectants was spent. This year had the highest consumption of antiseptics and disinfectants in the period from 2010 to 2014. Dezintal disinfectant is the most widely used in 2010 (a total of 1,500 litres), followed by Bactosal (380 litres) and Puristeril (280 litres). Most used antiseptics are Ecosal (80 litres) and Plivasept blue (75 litres).

Figure 2 shows that in 2011 total amount of 1,669 litres of antiseptics and disinfectants was spent. This year was used a smaller amount of antiseptics and disinfectants compared to 2010. Just like last year, in 2011 most utilized disinfectant is Dezintal (total 800 liters), followed by Bactosal (330 litres) and Puristeril (280 litres), and most used antiseptics are Ecosal (70 litres) and Plivasept blue (120 litres).

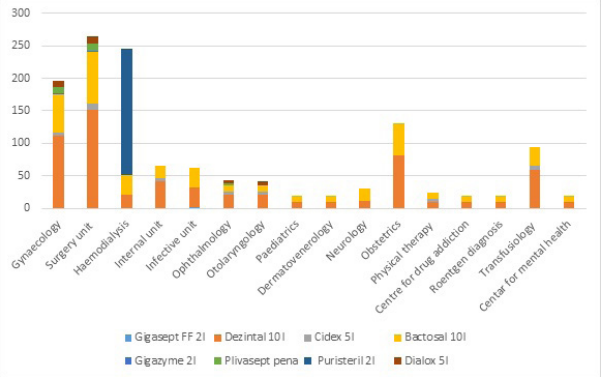

Figure 2. Graphic display of quantities of disinfectants used in 2011 in the different departments in the General hospital in Strumica

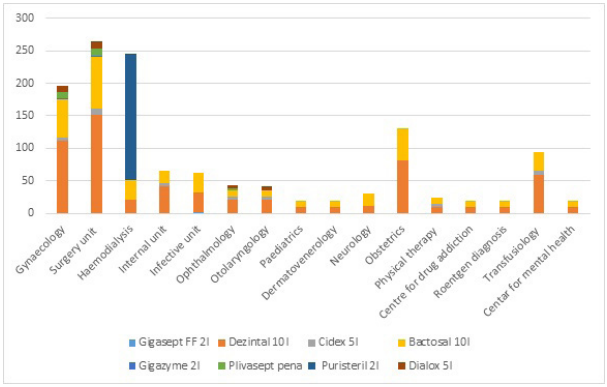

Figure 3. Quantities of disinfectants in litres used in 2012 in the departments in the General hospital in Strumica

Table 2. Amount of disinfectants used in litres, in 2011

Disinfectant	Department															
	Gyn	Syr	Hem	Int	Inf	Oft	Orl	Pe	De	Neu	Obe	Ph	C.D	Ren	Tra	C.M
Dezintal	110	130	80	30	40	70	70	50	40	30	70	20	10	20	20	10
Sterilium 5 L	10	10	0	0	0	5	5	0	0	0	0	0	0	0	0	0
Aeth. conc	2	2	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Bactosal	40	70	20	20	30	10	10	20	20	10	20	10	10	10	20	10
Sterilium	1	2	0	0	1	0	1	0	0	0	0	0	0	0	1	0
Alkasept	10	10	0	10	0	0	0	0	0	0	0	0	0	0	0	0
Dialox 5 L	5	5	0	0	0	0	0	0	0	0	5	0	0	0	5	0
Puristeril	0	0	300	0	0	0	0	0	0	0	0	0	0	0	0	0
Plivas. blue	9	12	6	6	9	6	6	3	6	3	9	3	0	3	6	0
Ecosal 10 L	10	10	10	10	10	5	5	10	0	0	0	10	0	0	10	0

Table 3. Amount of disinfectants used in litres 2012

Disinfectant	Department															
	Gyn	Syr	Hem	Int	Inf	Oft	Orl	Pe	De	Neu	Obe	Ph	C.D	Ren	Tra	C.M
Gigasept	1	1	1	1	2	1	1	0	0	1	1	0	0	0	0	0
Dezintal	110	150	20	40	30	20	20	10	10	10	80	10	10	10	60	10
Cidex 5 L	5	10	0	5	0	5	5	0	0	0	0	5	0	0	5	0
Bactosal	60	80	30	20	30	10	10	10	10	20	50	10	10	10	30	10
Gigazyme	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plivasep. fo.	9	12	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Puristeril	0	0	195	0	0	0	0	0	0	0	0	0	0	0	0	0
Dialox 5 L	10	10	0	0	0	5	5	0	0	0	0	0	0	0	0	0

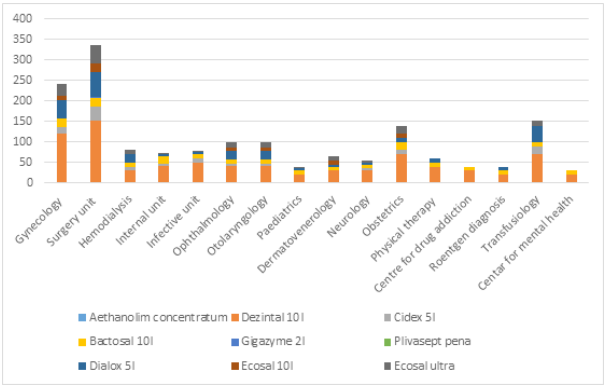

Figure 4. Quantities of disinfectants used in litres in 2013 in the departments in the General hospital in Strumica

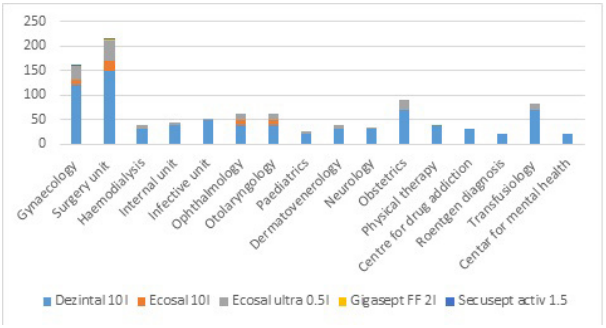

Figure 5. Quantities of disinfectants used in litres in 2014 in the departments in the General hospital in Strumica

Figure 3 shows that in 2012 total amount of 1,301 litre of antiseptics and disinfectants was spent, which is less than half of 2010. The most common disinfectants are Dezintal (600 litres) and Puristeril (195 litres). This year, most used antiseptics are Plivasept foam (24 litres).

Figure 4 shows that in 2013 total amount of 1,627 litres of disinfectants and antiseptics was spent, which is more than the previous 2012. The most common disinfectants in 2013 are: Dezintal (total 800 litres) and Dialox (total 260 litres). Most used antiseptics are: Ecosal ultra (165 litres) and Ecosal (70 litres).

Figure 5 shows that in 2014 total of 1,018 litres of antiseptics and disinfectants were spent, which marks this year as the year with the smallest used amount of antiseptics and disinfectants in the period from 2010 to 2014. Dezintal (total 800 litres) was again the most widely used disinfectant. From antiseptics most utilized was Ecosal (total 50 litres).

According Centre for Public Health in 2010 total number of swabs taken is 449 of which: 251 are uncontaminated, pathogenic bacteria are not found, while conditionally pathogens are present in 198 samples. Swabs were taken individually by all hospital departments.

Table 4. Amount of disinfectants used in 2013

Disinfectant	Department															
	Gyn	Syr	Hem	Int	Inf	Oft	Orl	Pe	De	Neu	Obe	Ph	C.D	Ren	Tra	C.M
Aeth. conc.	1	2	0	1	0	1	1	0	0	0	0	0	0	0	0	0
Dezint. 10 L	120	150	30	40	50	40	40	20	30	30	70	40	30	20	70	20
Cidex 5 L	15	35	10	5	10	5	5	0	0	5	10	0	0	0	20	0
Bactos. 10 L	20	20	10	20	10	10	10	10	10	10	20	10	10	10	10	10
Gigazy. 2 L	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plivas. foam	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Dialox 5 L	45	60	20	5	5	20	20	5	5	5	10	10	0	10	40	0
Ecosal 10 L	10	20	0	0	0	10	10	0	10	0	10	0	0	0	0	0
Ecosal ultra	30	45	10	3	2	12	12	5	10	5	19	0	0	0	12	0

Table 5. Amount of disinfectants used in 2014

Disinfectant	Department															
	Gyn	Syr	Hem	Int	Inf	Oft	Orl	Pe	De	Neu	Obe	Ph	C.D	Ren	Tra	C.M
Dezint. 10 L	120	150	30	40	50	40	40	20	30	30	70	40	30	20	70	20
Ecosal 10 L	10	20	0	0	0	10	10	0	0	0	0	0	0	0	0	0
Ecosal ultra	30	40	10	3	2	12	12	5	10	5	19	0	0	0	12	0
Gigasept FF	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Secus. activ	1.5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0

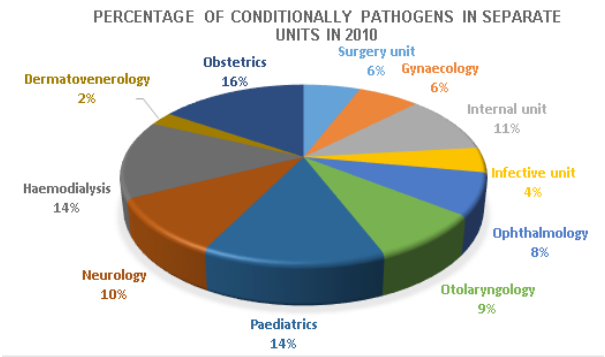

Figure 6. Percentage of swabs which determined the presence of conditionally pathogenic bacteria in different departments for 2010

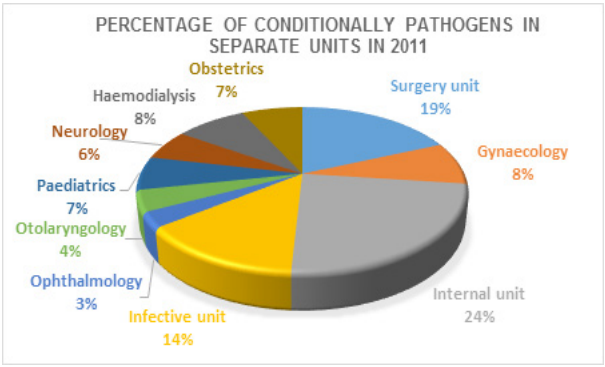

Figure 7. Percentage of conditionally pathogens microorganisms in different departments for 2011

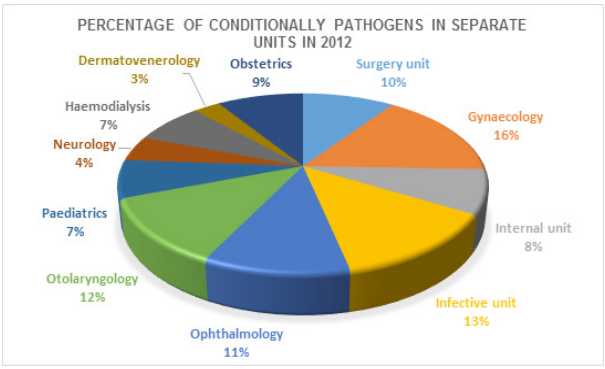

Figure 8. Percentage of conditionally pathogens microorganisms in different departments for 2012

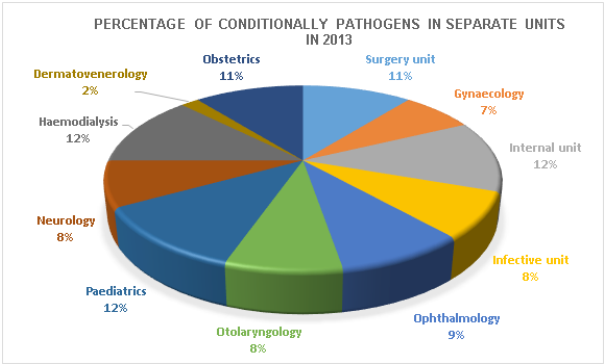

Figure 9. Percentage of conditionally pathogens microorganisms in different departments for 2013

In the Department of Haemodialysis most isolated pathogens (21) were: *Micrococcus* sp., *E. coli*, *B. subtilis*, coagulase negative *Staphylococcus*, and *Candida albicans*. The lowest number of isolated bacteria (4) was found at Department of Dermatovenerology and it belonged to coagulase negative *Staphylococcus*.

In 2011, according to the annual plan of the services of the Centre for Public Health, a total of 401 swabs and samples of air were taken. 234 of these were sterile, and 167 showed the presence of conditionally pathogenic microorganisms.

The largest number of swabs were taken of the Department of Surgery (102) and the lowest of the Department of Paediatrics (18). Most conditional pathogens were isolated at Internal unit (40) who beloned to: coagulase negative *Staphylococcus*, *Micrococcus* sp., *Streptococcus faecalis* and *Bacillus subtilis*. The lowest number of isolated bacteria (5) were found at the department of Ophthalmology or more precisely: Micrococcus sp., and *Bacillus subtilis*.

In 2012, there were a total of 428 swabs taken by the services of the Centre for Public Health. 252 of them were uncontaminated and 176 showed the presence of conditionally pathogens microorganisms.

Most swabs were taken of the Department of Surgery (96). Most conditionally pathogens in 2012 (28) were isolated from the Department of Gynaecology. They belonged to: *Micrococcus* sp. and *Bacillus subtilis*. The lowest number of isolated conditionally pathogenic bacteria was at the Department of Dermatovenerology (5).

In 2013 a total of 400 swabs and samples from the air had been taken. 288 of them were sterile, and 112 showed the presence of conditionally pathogenic.

Most swabs were taken of the Department of Surgery and the lowest from the Department of Dermatovenerology. Most conditional pathogens were isolated from the Department of Haemodialysis and Internal unit and the lowest at Dermatovenerology. From Internal unit were isolated following micororganisms: *Micrococcus* sp., *B. subtilis* and *Streptococcus faecalis*.

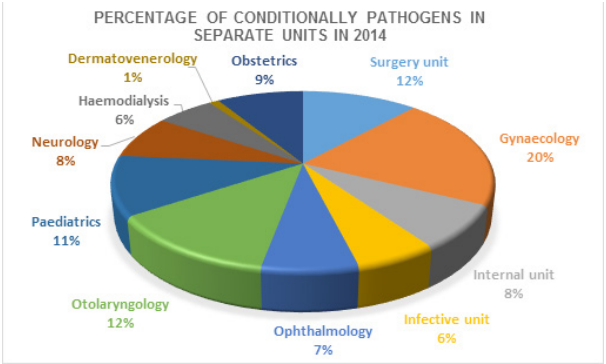

Figure 10. Percentage of conditionally pathogens microorganisms in different departments for 2014

From the Department of Haemodialysis were isolated: *Micrococcus* sp., *E. coli*, *B. subtilis*, coagulase negative *Staphylococcus*, and *Candida albicans*.

In 2014, a total of 400 swabs and samples of air were taken. 298 of them were sterile, and 102 showed the presence of conditionally pathogens.

Most swabs were taken from the Department of Surgery and the lowest from Department of Dermatovenerology. The largest number of smears that showed the presence of conditionally pathogens were observed at the Department of Gynaecology and the lowest at the Department of Dermatovenerology. As conditionally pathogenic were isolated: *Micrococcus* sp., coagulase negative *Staphylococcus*, *Bacillus subtilis*. In 2014 it was registered the lowest number of conditionally pathogens.

4. Conclusions

Based on this study and collected data from General hospital Strumica and Centre for Public Health in Strumica we made wide ranges of conclusions:

- Antiseptics and disinfection agents used according to the needs of each department improved prevention and safety of appearance of intra-hospital infections.

- The amount of antiseptic and disinfectant spent over the years steadily declines. At the same time, reduced number of conditionally pathogenic microorganisms talks about that at the beginning of the research period the used disinfectants and antiseptics were less rational in terms of economic performance.

- It can be said that with the introduction of team control of intra-hospital infections in General hospital Strumica use of disinfectants and antiseptics is improved, compliance procedures for cleaning and disinfecting are followed and the control of intra-hospital infections is also improved.

- The number and type of conditionally pathogenic microorganisms which were isolated in hospital departments were in their normal range. Found microbes do not pose a great danger for the hospital and its surroundings.

- What it should be taken into consideration is to continue with the regular procedures of sterilization, disinfection and proper hygiene in order to scrutinize the emergence of intra-hospital infections.

5. References

[1] Emori G. T., and Gaynes P. R. (1993). *An Overview of Nosocomial Infections, Including the Role of the Microbiology Laboratory*. Clinical microbiology reviews, Vol. 6, No. 4, pp. 429.

[2] World Health Organization, and a World Alliance for Safer Health Care. *The Burden of Health Care-Associated Infection Worldwide*. <URL:http://www.who.int/gpsc/country_work/summary_20100430_en.pdf. Accessed 25 October 2015.

[3] Ducel G., Fabry J., and Nicolle L. (Eds). (2002). *Prevention of hospital-acquired infections: A practical guide* (2nd Ed.). World Health Organization. <URL: http://www.who.int/csr/resources/publications/whocdscsreph200212.pdf. Accessed 25 October 2015.

[4] Inweregbu K., Dave J., Pittard A. (2005). *Nosocomial infections*. Continuing Education in Anaesthesia, Critical Care & Pain, Vol. 5 No 1, pp. 14.

[5] Sydnor M. R. E., and Perl M. T. (2011). *Hospital Epidemiology and Infection Control in Acute-Care Settings*. Clinical microbiology reviews, Vol. 24, No. 1, pp. 144.

[6] Tokars J., Richards C. C., Andrus M., Klevens M., Curtis A., Horan T., Jernigan J., and Cardo D. (2004). *The Changing Face of Surveillance for Health Care-Associated Infections*. Clinical Infectious Diseases, 39, pp. 1347-1352.

[7] Farr M. B. (2001). *Preventing Vascular Catheter-Related Infections: Current Controversies*. Clinical Infectious Diseases, 33, pp. 1733-1738.

[8] Lyytika O., Lumio J., Sarkkinen H., Kolho E., Kostiala A., Ruutu P. and the Hospital Infection Surveillance Team. (2002). *Nosocomial Bloodstream Infections in Finnish Hospitals during 1999 - 2000*. Clinical Infectious Diseases, 35, pp. 14-19.