
PhD THESIS SUMMARY

Research on the implementation of new approaches in disinfection of healthcare premises

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I. INTRODUCTION

Maintaining optimal hygienic conditions in veterinary medical premises remains a priority in the desire for success and compliance with professional ethics. The last decade has seen a significant increase in the circulation of infectious organisms and zoonoses continue to be a daily challenge for health professionals. The integration of these diseases into national programs concerning their surveillance and the development and implementation of measures for their prevention and eradication represents a necessity.

In veterinary health care units the susceptibility for infections with various pathogens is much higher and represents an increased risk for both humans and animals. The fact that a large proportion of the pathogens implicated in nosocomial infections are zoonotic is a major problem due to the human suffering and economic losses they cause. (Bîrțoiu A. et al., 2004, Gonciarov M., 2014, Igna C., 2001, Savu C. et al., 2000) All of these pathogens have particularly serious implications for organisms, as they can cause genital, urinary tract, or mammary gland infections, gastric tube infections, skin infections, respiratory infections, or they can even cause generalized forms. (Cenariu M. et al., 2020, Groza I. et al., 1998, Mircean V. et al., 2007, Răpunțean S. et al., 2017) Because veterinarians are often the first to come into direct contact with potentially infected animals, they form a risk group and are exposed to zoonotic infections.

Preventing human and animal diseases and maintaining a clean and healthy environment can be achieved by destroying the sources of infection while maintaining strict hygiene measures. Today, we can no longer discuss human, domestic animal or wildlife health in isolation because there is only one health, and solutions can only be found if everyone works together at all levels.

The implementation of a new methodology offering a high rate of disinfection efficacy in veterinary medical establishments is an integral part of realizing the strategy to prevent risk factors for the health and well-being of both animals and humans.

The objectives of this thesis were set with the aim of identifying a new and efficient methodology for disinfection of medical premises. The research aimed to standardize the technique of performing cyclic disinfection, using the Cube Atomizers nebulizer, in accordance with current standards and specifications, and to evaluate its effectiveness in medical spaces with different purposes.

Therefore, the objectives of this thesis were:

- to determine the efficiency of the Cube Atomizers nebulizer in different spaces in the medical system (surgery rooms, reception rooms, consulting rooms);
- taking sanitation samples before and after disinfection and processing them in the laboratory;

- the use of another disinfection method, namely UV-C ultraviolet light lamps, in these premises for comparison of bacteriological analysis results;
- the elaboration and use of a questionnaire on current hygiene aspects in veterinary medical premises in different parts of Romania and the production of statistics on the basis of the data collected with the help of the questionnaire.

II. PERSONAL CONTRIBUTION

The Personal Contribution part of the thesis titled "Research on the implementation of new approaches in disinfection of healthcare premises" includes three researches, as follows:

1. Efficiency of disinfection by nebulization of surgical rooms in veterinary medical units

Given the mandatory need to maintain a high level of hygiene in surgical rooms, the main objective of this research was to determine the effectiveness of the Cube Atomizers nebulizer in surgical rooms in veterinary medical facilities, using sanitation samples obtained by sampling before and after the application of disinfection. The next objective was to use another method of disinfection, namely a UV-C ultraviolet lamp, in these premises to compare the results of the sanitation tests.

For this research, we used ten premises used as surgery rooms in ten veterinary clinics in Romania, Cluj county. The materials required for this study were the Cube Atomizers nebulizer, a UV-C ultraviolet lamp, safety materials, a telemeter with laser, Biosan Steridet (Pentapotassium Bis (peroximonosulphate) Bis (sulphate)) disinfectant solution, sterile swabs, Petri plates and growth mediums. By their implications in pathology, and by their frequency in air and on all surfaces, in addition to the total number of germs (NTG) determined using Agar culture medium, the following pathogens were determined in particular: staphylococci using Chapmann medium, streptococci using Holmes medium, gram-negative germs on Levine medium, and mycobacteria on Sabouraud medium.

The results obtained from the sanitation tests performed before and after disinfection with the Cube Atomizers nebulizer revealed the following: on Agar culture medium, there was a significant decrease in the total number of germs with an average of 94.26% after disinfection, and in some cases the value 0 was reached after disinfection (success rate was 100%). Regarding the use of Chapmann medium, in situations where staphylococci were present before the disinfection process, the number of staphylococci was reduced following nebulization by 93.86%, and in some situations the number of staphylococci was reduced to 0 (100% efficiency) following disinfection. Analyzing the samples obtained on the Holmes culture medium, it was observed that the number of streptococci decreased by an average of 94.38%, their number reaching 0 (100% efficiency) in some cases following disinfection by nebulizer. The samples obtained using Levine medium specifically for the isolation of gram negative bacteria showed an

efficiency of 97.92% on average, with a success rate of 100% in some cases. In the case of Sabouraud medium, an average reduction of 57.8% of fungi was observed.

After processing the sanitation samples taken before and after using the UV-C lamp in 5 operating rooms, we found the following: in the samples cultured on Agar culture medium, a decrease in the total number of germs was found with an average of 60.56%, the presence of staphylococci observed using Chapmann medium was reduced by 54.05%, in the situation of Holmes culture medium, a decrease in the number of streptococci was found with an average of 54.32%, and gram negative bacteria isolated on Levine culture medium showed a decrease with an average of 57.44%. In Sabouraud medium, no decrease was observed in any of the situations, the results remaining the same before and after the disinfection with the UV-C lamp.

Conclusions and recommendations:

- after processing all the samples, we found a 30-40% higher efficacy of the nebulizer used in this study than when using the UV lamp as a disinfection method.
- In many situations, for most germ categories, the value of the number of colony-forming units reached 0 after nebulization;
- the efficiency of the Cube Atomizers was 90-97% for the total number of germs, 85-95% for Staphylococci, 90-99% for Streptococci, 92-99% for gram-negative bacteria and around 50% for fungi;
- these results obtained with the Cube Atomizers are of particular importance in view of the need for a high degree of hygiene in these premises;
- In this study, the UV lamp had no effect on fungi, the number of fungi remaining unchanged after the disinfection was completed;
- The Cube Atomizers are all the more effective because they do not require a long time to use, use a reduced amount of disinfectant and do not require changing the disinfectant used by the veterinary unit;
- the advantage of the Cube Atomizers is that it leaves no residues and does not cause damage to surfaces;
- using the nebulizer is safe for the user and the environment.
- the initial investment is recovered in a short time due to the small volume of disinfectant used by the nebulizer, the short application time and the low manpower involved;
- the nebulization method with Cube Atomizers has the advantage of being able to disinfect all surfaces (floors, ceilings, appliances, windows, furniture, etc.) on all their surfaces (including backs, underneath, edges, pipes, etc.) which would take much longer or impossible to achieve with the UV-C lamp disinfection method, resulting in partial disinfection of the surfaces;
- veterinary staff must be educated on the obligation to maintain a high level of hygiene in veterinary establishments;
- maintaining a minimalist environment in these premises by reducing the number of potentially contaminated surfaces;
- regular disinfection with the Cube Atomizers in surgical wards on the basis of a protocol can ensure a high level of hygiene at all times and prevent nosocomial or zoonotic infections;

- in the event of an epidemiological risk or in times of need, nebulizer disinfection will be carried out whenever deemed necessary.

2. Effectiveness of disinfection of examination and reception rooms in veterinary medical units by nebulization

In view of the high traffic of people and animals in the examination rooms and reception rooms of veterinary medical establishments, and due to the increased risk of infection for both humans and animals, the main objective of this research was to determine the effectiveness of the Cube Atomizers nebulizer in these areas of veterinary clinics. This was done using sanitation samples obtained by sampling before and after disinfection. The next objective was to use another disinfection method, namely a UV-C ultraviolet lamp, in these premises to compare the results obtained from the sanitation tests.

For this research, we used ten spaces destined as examination rooms and reception rooms within veterinary clinics in Romania, Cluj County. The materials needed for this research were the same as those used in the previous research. By the frequency in the air and in all surfaces, as well as the implications in pathology, in addition to the total number of germs (NTG), as in the previous research, the following pathogens were determined in particular: staphylococci, streptococci, gram-negative germs and fungi.

The results obtained from the sanitation tests performed before and after disinfection with the Cube Atomizers nebulizer revealed the following: on Agar culture medium, there was a significant decrease in the total number of germs with an average of 95.20% after disinfection, in some cases the NTG value reached 0 after disinfection, with an efficiency of 100%. When using Chapmann medium, the staphylococci count was reduced by 92.57% following disinfection, with an efficiency of 100% in some cases. Analyzing the samples on Holmes culture medium, the streptococci count decreased by an average of 96.33%, reaching 0 (100% efficiency) in some cases following disinfection. The same was also true for the Levine medium specific for the isolation of gram-negative bacteria, with a decrease rate of 98.17% and an efficiency of 100% in some cases. In the case of Sabouraud medium, an average decrease of 60.14% was observed.

The nebulizer Cube Atomizers ensures the disinfection of all surfaces thanks to its patented way of dispersing the decontaminating solution throughout the entire space. It thus disinfects the various appliances in the room, furniture, ceilings, floors, windows, doors and their hidden parts.

After processing the sanitation samples before and after using the UV-C lamp, we found the following: in the samples grown on Agar culture medium, the total number of germs decreased by an average of 58.98%. For Chapmann medium the presence of staphylococci was reduced by 49.17%, the number of streptococci analyzed on Holmes culture medium had a decrease on average of 47.39%, in the case of Levine medium specific for the isolation of gram negative bacteria, a decrease on average of 52.50% was noted. In the case of Sabouraud medium, no decrease was observed in any of the two situations, the results remaining the same before and after UV-C lamp disinfection.

Conclusions and recommendations:

- After processing all the samples, we found a 30-40% higher efficacy of the nebulizer used in this research than when using the UV-C ultraviolet lamp as a disinfection method;
- in many cases, for most germ categories, the value of the number of colony-forming units reached 0 after nebulization with the Cube Atomizers
- the efficiency of the Cube Atomizers was 90-97% for total germ count, 85-95% for staphylococci, 90-99% for streptococci, 92-99% for gram negative bacteria and around 50% for fungi
- in this study, the UV-C lamp had no effect on fungi, the number of fungi remaining unchanged after disinfection was completed
- given the high foot and animal traffic in these areas, the Cube Atomizers are all the more effective as they require a short time to use, with the premises being usable in just a few minutes
- the Cube Atomizers leaves no residues and retain a neutral and pleasant smell after nebulization, so that staff can resume their work in those spaces in just a few minutes
- using the nebulizer is safe for the user and the environment
- being rooms where there are many objects that can retain infectious agents, the nebulization method that we used has the advantage of being able to disinfect surfaces on all sides, including the back, the areas underneath, the edges, which would take much longer or impossible to achieve with the UV-C lamp disinfection method, and the result would be a partial disinfection of the surfaces;
- veterinary staff should be educated on the obligation to maintain a high level of hygiene in all areas of the veterinary establishments;
- it is recommended to maintain a minimalist framework in these premises by reducing the number of unnecessary items of furniture, decorative fittings, or other items that are not necessary and can be easily contaminated
- regular disinfection with the Cube Atomizers nebulizer in consulting rooms and reception rooms on a regular scheduled basis can ensure a high level of hygiene at all times and prevent nosocomial or zoonotic infections;
- in times of need, disinfection will be carried out by nebulizer whenever deemed necessary.

3. Research on hygiene issues in veterinary medical premises in different areas of Romania (questionnaire)

The main objective of the present research was to gather information on current hygiene issues in veterinary medical facilities in different areas of Romania. In order to create an overview of the way hygiene rules are currently applied in veterinary medical premises, it was necessary, among other things, to construct and distribute a

questionnaire reflecting the current realities. The questionnaire is the basic tool for gathering information on a problem in veterinary medicine. And it can be a pillar in the success of a research (Jugănaru M., 1998).

For this research, we developed and used a questionnaire consisting of 16 questions to collect data from 100 different veterinary units on how disinfection is carried out, the methods and disinfectants commonly used, the frequency of disinfection, the incidence of zoonoses and nosocomial diseases in these units, and other hygiene-related issues. The participants in the research were practicing veterinarians in Romania, employed in a veterinary medical facility. Considering one of the aims of the research, that is the implementation of a new methodology in the disinfection of veterinary medical premises, the final question was designed to find out whether, after understanding the benefits of the Cube Atomizers, obtained from the extensive and comparative studies, the participants in the questionnaire would be willing to implement this new method of disinfection in the veterinary medical premises where they work.

The method of distribution of the questionnaire was face-to-face, so each participant was given a paper copy of the questionnaire. The questionnaire was confidential and anonymous to eliminate the possibility of evasive or false answers. Afterwards, the data obtained were centralized and processed for statistical purposes.

Conclusions and recommendations:

Analyzing the results obtained from the responses to the questionnaire, the following conclusions and recommendations were reached:

- in general the responsibility for carrying out the disinfection procedures in the veterinary medical premises lies with the veterinarians or technicians employed;
- the implementation in veterinary medicine of hygiene protocols such as those already existing in human medicine is a necessity, according to the majority of respondents (82%);
- the cleaning of premises is rarely done, with more than 60% of those surveyed are sanitizing their premises no more than 4 times a month;
- disinfection of hard-to-access areas in the veterinary medical premises is rarely carried out in the vast majority of cases;
- veterinarians believe that it would be necessary to carry out disinfection more often and more effectively in the veterinary medical unit in which they work;
- most of them remained anchored to the old methods of sanitizing the premises using only classical methods of hygiene (mopping, rags, cloths, wipes, liquid disinfecting solutions applied by spray pumps, etc.) or a UV-C ultraviolet light lamp. Thus, only 22% rated their act of disinfection in the veterinary medical premises where they work as very good or excellent
- although the majority of participants in the questionnaire stated that they were aware of the risks of working in an unhygienic environment, 67% of participants had contracted a zoonotic disease and 88% of them had experienced nosocomial infections in the health facilities where they worked;
- the majority of veterinarians are not aware of the risks they are exposing themselves to by using the disinfection methods they have chosen (various professional disinfectant solutions, UV-C ultraviolet light lamp, etc);

- short lead times, a satisfactory quality/price ratio, ease of application, increased efficiency, safety for the user, the animals, the environment and all materials treated, are all characteristics to be sought when choosing a disinfection method for a veterinary medical space;
- 78% of the participants would be willing to try the Cube Atomizers disinfection method in the veterinary medical unit where they work;
- it is thus observed that the participants are not satisfied with the way hygiene is currently carried out in the veterinary medical premises and are willing to implement new hygiene protocols and to approach new hygiene methodologies;
- there is a need to educate veterinary medical staff on the obligation to maintain a high level of hygiene in veterinary hospitals.

III. GENERAL CONCLUSIONS AND RECOMMENDATIONS

The most significant conclusions and recommendations drawn from the results obtained in this thesis are as follows:

1. the use of the Cube Atomizers nebulizer in veterinary medical premises showed a 30-40% higher efficiency than the UV-C ultraviolet light lamp;
2. the efficiency of the Cube Atomizers is of particular importance in view of the obligation to maintain a high degree of hygiene in veterinary medical premises;
3. the Cube Atomizers nebulizer offers safety for the environment and for the user, ensuring disinfection of all surfaces of a premises in a short time without leaving residues;
4. increased attention to disinfection in veterinary healthcare premises is imperative;
5. examination rooms and reception areas require the same level of attention to disinfection as surgical rooms;
6. the development and implementation of hygiene protocols in veterinary units are mandatory and necessary;
7. most veterinarians have encountered a zoonotic or nosocomial disease in the course of their practice;
8. it is necessary to make veterinarians aware of the existence and transmission of zoonotic and nosocomial diseases in veterinary establishments;
9. human, animal and environmental health are closely interlinked and require unified, coordinated, collaborative and multidisciplinary approaches;
10. research on this topic should be continued with the aim of improving animal health and welfare, protecting the environment and maintaining public health;
11. the pandemics and the notable effects of climate change in recent years underline the need for a 'One health' approach to tackling health and welfare issues.

IV. ORIGINALITY

1. The present thesis tested for the first time in Romania the efficiency of the Cube Atomizers nebulizer in surgery rooms, examination rooms and reception areas of veterinary medical units.

2. An innovative contribution is the use of the combination of the nebulizer and the disinfectant Biosan Steridet (50% Pentapotassium bis (peroximono-sulphate) bis (sulphate)).

3. This selection of growth mediums has been used for the first time to test for the presence of infectious pathogens of interest for surgical rooms, examination rooms and reception rooms in veterinary medical units.

4. For the first time in Romania, a comparative research is presented on the efficiency of the Cube Atomizers nebulizer in comparison with another disinfection system (UV-C ultraviolet lamp).

5. Another innovative contribution of this paper is the research carried out following the elaboration of a questionnaire on matters of hygiene in veterinary medical units, in different areas of Romania.

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