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ORIGINAL RESEARCH

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MICROBIOLOGICAL EFFICIENCY EVALUATION OF USING PULSED ULTRAVIOLET UNITS AT POLYCLINICS

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The study presents the results of microbiological efficiency evaluation of using a portable pulsed ultraviolet unit for air and surfaces disinfection in polyclinic conditions. It demonstrates high bactericidal efficiency of air and open surfaces disinfection at a treatment room when treated by a pulsed ultraviolet unit.

Keywords: pulsed ultraviolet unit, air and surfaces disinfection, outpatient care

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One of the most crucial problems that affects the quality of delivered health care are the healthcare-associated infections (HAI) which are extremely important for healthcare facilities of any profile [1, 2]. Moreover, HAI at polyclinics (community clinics, health centers, joint practices, prenatal clinics, inpatient polyclinic departments, ambulatory clinics, medical and obstetrical station etc.) that deliver most demanded medical care, including primary medical care¹, have their own characteristic aspects resulting from intensive patient flow throughout the whole day and limited time for each patient. This greatly complicates preventive disinfection and can lead to ingressions of infections among patients [3].

Currently existing disinfection methods require either prolonged time (surfaces disinfection by wiping or spraying, open-type ultraviolet (UV) irradiators with mercury lamps), or are intended only for air disinfection (closed-type irradiators).

Thus, the problem of thorough disinfection of hospital environment objects and air at polyclinics within limited time, especially in between patients' visits, treatments and at times of seasonal flue and acute respiratory viral infection incidence rise, calls for new approaches.

Presently, one of the most efficient and fast methods of simultaneous air and surfaces disinfection is their exposure to continuous spectrum UV light generated by a pulsed xenon lamp. Pulsed UV units are successfully used both at Russian and foreign healthcare facilities and have long proved their high efficiency against bacteria, including their antibiotic-resistant strains (MRSA, VRE, *M. tuberculosis* strains with multiple and broad drug resistance etc.), bacterial spores (*C. difficile*) and viruses [4–6].

High germicidal efficiency of air and various surfaces disinfection (plastic, tile, metal) within short time (2 minutes) by a pulsed UV unit has been confirmed by the research performed by the Federal Budget Institution of Science “Scientific Research Institute of Disinfectology” of Rospotrebnadzor. Additional contamination of surfaces by organic (protein) matter hardly affected the decontamination efficiency (reduction of max 10%) [7]. The said research became the basis of the official Rospotrebnadzor guidelines².

The purpose of our study is the microbiological efficiency evaluation of air and surfaces disinfection at a doctor's office of a polyclinic by a pulsed UV unit with a xenon lamp.

Materials and methods

As a place of the research was chosen a doctor's office with daily 8-hours' long shift of outpatient medical care at the Central Scientific Research Institute of Epidemiology of Rospotrebnadzor.

A pulsed UV unit “Alfa-05” (pulsed UV unit) with a remote control and automated time setting for the 1–5 category rooms of up to 75 m³ in the absence of people was used as the continuous spectrum UV light source. The treatment was performed repeatedly for short periods of time (1 minute).

Test objects were air samples and wipe-samples from the surfaces in the doctor's office after a patient's visit before and after implementing a pulsed UV unit. The research was performed every hour after receiving 4–5 patients (or immediately after receiving a patient with signs of flue or acute respiratory viral infection) during 3 weeks (November–December 2018).

¹ Federal Law dated November 02, 2011 N 323-Ф3 (rev. of March 06, 2019) “On health protection of Russian citizens”. http://www.consultant.ru/document/cons_doc_LAW_121895

² Methodological guidelines MR 3.5.1.0100-15 “Use of continuous spectrum pulsed ultraviolet units at healthcare facilities”. https://ohranatruda.ru/ot_biblio/norma/395316/

The traditional bacteriological technique was implemented. Air samples were collected using the aspiration technique with the MAS-100 Eco sampler (Merck, Germany). Wipe-samples from the surfaces were collected in accordance with Methodological guidelines 4.2.2942-11 “Methods of sanitary-bacteriological research of environmental objects and air, and of sterility control at healthcare facilities”³. The microorganism species was confirmed by matrix-assisted laser desorption/ionization (MALDI-TOF-MS).

Air samples were collected during the general practitioner shift, in between patients’ visits. In accordance to the requirements of SanPiN 2.1.3.2630-10⁴, general microbial and *S. aureus* contamination (CFU/m³) were determined in the air.

On the surfaces in the hospital environment were detected the sanitary indicator microorganisms.

In course of doctors’ office work, the disinfection was performed twice in accordance with the requirements of SanPiN 2.1.3.2630-10 – before and after the doctors’ shift. The surfaces were disinfected by wiping with chemical disinfectants as recommended as an anti-viral measure. The air was disinfected by implementing a wall-mounted bactericidal UV irradiator (OBN-150) for 15 minutes.

When using the standard decontamination method at a doctor’s office, the air contamination during the working shift increased from 266.66±24.2 to 684.85±26.8 CFU/m³, i.e. by 2.6 times, which calls for disinfection during receiving the patients in order to decrease the microbial air contamination. When using a pulsed UV unit, the microbial air contamination did not exceed 61.33±6.8 CFU/m³ (refer to figure).

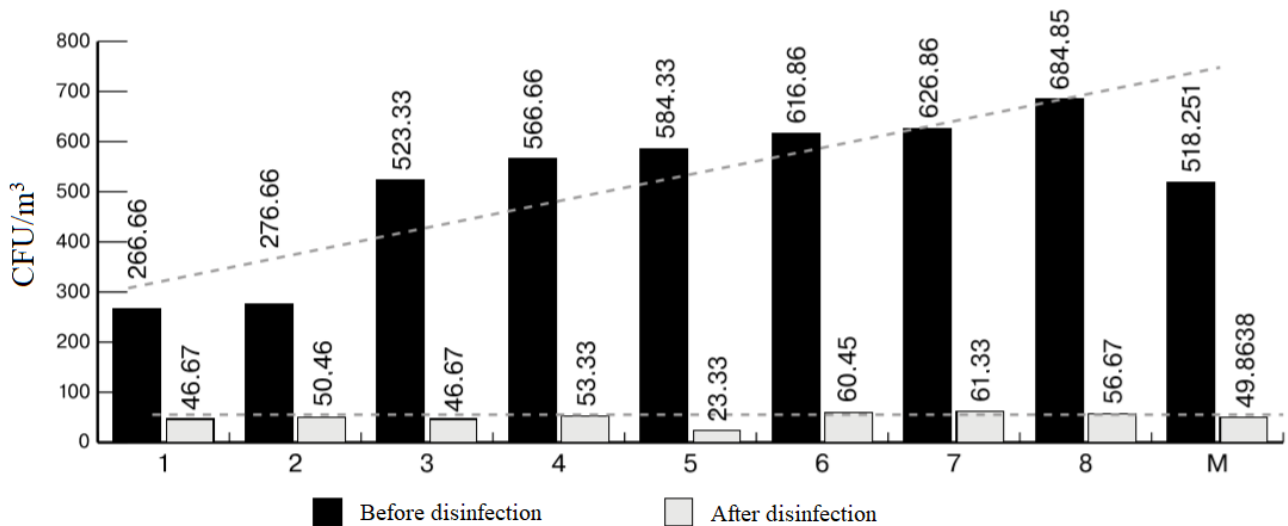
Thus, the general microbial air contamination during the shift decreased more than tenfold, which confirms high efficiency of the unit when used for air disinfection.

The sanitary indicator microorganism *S. aureus* was detected in 1 sample (12.5 %) in the amount of 20 CFU/m³ before implementing the pulsed UV unit, and was not detected at all after its use.

S. aureus was detected in 37.5 % of wipe-samples from the surfaces before disinfection, and was not detected after using the pulsed UV unit. *E. faecalis* was detected in 25.0 % of wipe-samples before disinfection and was not detected after implementing the pulsed UV unit.

The efficiency research of surfaces disinfection by a pulsed UV unit showed a 100 % contamination reduction

Figure: Dynamic pattern of general microbial air contamination under the influence of a pulsed UV unit in between patients’ visits



The abscissa is the test number. M – median. The dotted line is the trend direction.

on the studied surfaces: doctor’s desk and patient’s chair back (*S. aureus* – from 200 CFU/m² to 0), baby changing station, automatic measurer handle, and bed upper surface (*E. faecalis* – from 100 CFU/m² to 0).

The significance and urgency of using the pulsed UV units

corresponds to the current Ministry for Public Health and Social Development Decree No. 753 dated December 01, 2005 “On equipping the municipal outpatient hospitals and polyclinics with diagnostic equipment”⁵, that includes the units into the list of equipment at an operating surgeon’s office (with a dressing room), procedure room, women examination room at various healthcare facilities and polyclinic departments.

³ https://rospotrebnadzor.ru/documents/details.php?ELEMENT_ID=5074

⁴ Health and hygiene rules and standards SanPiN 2.1.3.2630-10 “Sanitary-epidemiological requirements to medical care providers” (rev. dated June 10, 2016). <http://docs.cntd.ru/document/902217205>

⁵ <https://normativ.kontur.ru/document?moduleId=1&documentId=94692>

Conclusions

1. The experimental research demonstrated the increase in air microbial contamination at a doctor's office during patients' visits by 2.6 times (from 266.66 ± 24.2 to 684.85 ± 26.8 CFU/m³), which shows the insufficiency of current disinfection methods in course of doctor's work.
2. High germicidal efficiency of a pulsed UV unit with a xenon lamp when implemented for preventive disinfection at a doctor's office was shown:
 - total microbial contamination of air was reduced more than tenfold during the working shift;
 - obvious germicidal efficiency (up to 100 %) of surfaces decontamination with regard to sanitary indicator microorganisms *S. aureus* и *E. faecalis* within 1 minute of unit's functioning.
3. For prevention disinfection of air and working surfaces at a doctor's office at healthcare facilities it is recommended to use a pulsed UV unit after receiving every 4-5 patients as recommended by the User's manual and the passport for the specific unit model and by the present experimental study data with 1-minute's exposure.

Conflict of interest

The authors declare no possible conflicts of interest.

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