REVIEW PAPER ON AIR STERILIZER SYSTEM FOR AMBULANCE

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ABSTRACT

The provision of safe and sterile air quality within the confined space of an ambulance is a critical concern in the healthcare industry, with far-reaching implications for patient and medical staff well-being. Existing air purification measures within these emergency vehicles fall short of ensuring adequate protection against airborne infections, necessitating innovative solutions to address this pressing challenge.

In response, the integration of an advanced "Air Sterilizer System for Ambulance" has emerged as a promising approach, combining two complementary technologies: High-Efficiency Particulate Air (HEPA) filtration and fogging technology.

HEPA filtration is known for its effective particulate removal capabilities, while fogging technology utilizes ultraviolet germicidal irradiation (UV-C) lamps for microbial sterilization. This integration introduces a multifaceted solution that addresses the complex problem of managing air quality during medical transport.

By examining the integration of HEPA filtration and fogging technology in the "Air Sterilizer System for Ambulance," aims to underscore the potential for elevating safety and healthcare standards during medical transport. It also offers insights into the prospects of this innovative healthcare technology.

Keywords: Air Sterilizer System, Ambulance Air Quality, HEPA Filtration, Airborne Infection Control

I. INTRODUCTION

The safety and well-being of patients during medical transport are paramount concerns in the healthcare industry. Within the constrained confines of an ambulance, the management of air quality plays a pivotal role in preventing the spread of airborne infections and ensuring the health of both patients and medical staff. The insufficiency of air purification measures within these emergency vehicles is a pressing issue, one that calls for innovative solutions to safeguard lives. In response to this critical challenge, the integration of an advanced "Air Sterilizer System for Ambulance" has emerged as a promising approach. This system combines two distinct yet synergistic technologies: High-Efficiency Particulate Air (HEPA) filtration and fogging technology, designed to provide comprehensive air sterilization within the ambulance cabin.

The synergy between HEPA filtration, renowned for its effective particulate removal capabilities, and fogging technology, utilizing ultraviolet germicidal irradiation (UV-C) lamps for microbial sterilization, presents a multifaceted solution that addresses the complex problem of air quality management in the context of emergency medical transport. Furthermore, we will discuss the practical aspects of installation and maintenance, the significance of compliance with healthcare regulations, and the financial considerations in implementing such an advanced solution.

By examining the integration of HEPA filtration and fogging technology in the "Air Sterilizer System for Ambulance," we aim to shed light on the potential for enhancing the safety and care standards in medical transport, as well as providing valuable insights into the prospects of this innovative healthcare technology.

II. LITERATURE REVIEW

This review involved identifying current research in the field and extracting relevant materials to synthesize the data for the final review. The selected research papers were published between 2015 and 2023, and they focused on keywords such as "Air Sterilizer System," "Ambulance Air Quality," "HEPA Filtration," and "Airborne Infection Control."
Wei Li [1] have developed a real-time air disinfection system based on pulsed xenon ultraviolet (PX-UV) light. This system utilizes high-intensity pulse germicidal UV for quick and effective disinfection, which is particularly crucial for preventing the transmission of infectious agents in ambulance environments. In this study, they implemented a pulsed xenon ultraviolet light-based air disinfection system designed specifically for real-time air disinfection within ambulances. The system makes use of pulsed xenon ultraviolet (PX-UV) to produce high-intensity ultraviolet light across a broad spectrum ranging from 200 to 320 nm. This UV light is effective in deactivating and eradicating various bacteria and viruses. The study’s results revealed the remarkable effectiveness of PX-UV in reducing the levels of E. coli, Staphylococcus albus, and other environmental pathogens within ambulances, with reductions of at least 90% achieved in just 30 minutes. A significant advantage of this device is its simplicity and ease of use. Importantly, it does not leave any chemical residues, and it poses no risk of exposing patients or healthcare workers to harmful chemicals.

Xiaohui Huang [2] used ultraviolet light-emitting diodes (UV LEDs) as a light source in TiO2 photocatalysis, offering advantages like long life, safety, and low pollution. In this experiment, a UV LED-based light source panel with uniform light intensities was created. The sterilization process involved using highly efficient particulate air (HEPA) filter paper coated with TiO2 photocatalyst to block aerosols, followed by gradual reduction of Staphylococcus aureus in the aerosol through UV LED/TiO2 photocatalysis. After 52 hours (about 2 days) of irradiation, all S. aureus were eliminated. The UV LED light source panel, with its larger irradiation surface, proved more effective than traditional methods. The feasibility of UV LED/TiO2 photocatalysis was demonstrated.

Zuleika Michelini [3] addressed the contamination of ambulances with pathogenic agents, including SARS-CoV-2. An advanced Ultraviolet Sanitizing System (UV-SAN) that utilizes UVC radiation at 254 nm was developed to sanitize ambulance compartments, with real-time monitoring and traceability. UVC irradiation efficiently reduced SARS-CoV-2 virus titer (>99.99%) on various surfaces, and the UV-SAN system was effective against multi-drug-resistant bacteria (>99.99%) after 10 to 30 minutes of irradiation. UV-SAN offers rapid, efficient, and sustainable sanitization procedures for ambulances.

Debasish Panda [4] presented a design and development project for a low-cost Air Sterilization System, primarily intended for developing countries. This system employs prefiltering, UV sterilization, negative ionization, and ionization and operates on the principle of positive air pressure. It provides three stages of air purification and sterilization, making it suitable for use in public health centers in rural areas, food processing units, dairy, bakeries, offices, and homes. The system is cost-effective, portable, and user-friendly, catering to the economic conditions of people in developing countries. It can be operated and maintained without technical expertise, and a working prototype was designed and tested.

Bernd Kramer, Daniela Warschat, and Peter Muranyi [5] developed a tube device grounded on a dielectric hedge discharge (DBD) that operates using medium air as the process gas. They introduced the humidified afterglow from the tube snoot into an ambulance with a volume of roughly 10 boxy measures. Different microorganisms, including Bacillus atrophies endospores, Staphylococcus aureus, and Phi 6 bacteriophages, dried on colorful shells like PET - flicks, glass slides, or aluminum antipode, were exposed to the reactive gas inside the ambulance at eight different positions. The results showed that the tube gas from the compact DBD tube snoot effectively reduced the spore counts by over four orders of magnitude on all shells and positions within two hours. Phi 6 bacteriophages ands. aureus counts, being more susceptible, were reduced by at least four orders of magnitude within 30 twinkles. This study demonstrated that compact tube systems could serve as an effective volition for disinfecting vehicles or enclosed spaces like ambulances.

III. CONCLUSION

The incorporation of an advanced "Air Sterilizer System for Ambulances," which combines HEPA filtration and fogging technology, marks a significant advancement in enhancing safety and healthcare standards in the context of emergency medical transport. This innovative approach directly addresses a critical concern - the management of air quality within the confined space of an ambulance. In this concluding statement, we will recall the key findings from our examination of this integration and underscore its broader significance. To continuously monitor and measure the air quality in the vicinity, we utilize the AQ Sensor ZP07-MP503 - Air-Quality Sensor Module for pollution detection. Additionally, the DHT11 temperature and humidity sensor is
employed, offering a basic and cost-effective digital solution for monitoring temperature and humidity levels. Furthermore, UV light is utilized for disinfecting the ambulance's surroundings, effectively eliminating bacteria and germs. As we strive to meet the ever-evolving demands of patient care, it is evident that innovation and progress are our trusted allies. The journey to enhance patient safety and healthcare standards is an ongoing one, and this integration serves as a prime example of the significant impact that technology can have in improving lives and ensuring the well-being of those who depend on our healthcare services.

IV. REFERENCES

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