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Clinical automation in the era of robotics: Biomedical robots for hospital disinfection

Emmanuel Adebola Adebanjo[1]; Kafayat Motomori Bakare[1]; Victoria Enemona Oseni[2]; Ajibola Olaosebikan Waliu[3]; Ugochukwu Okwudili Matthew[4]*

[1]Public Health (MPH), University of New Haven, USA.

[2]Data Science, University of Salford, UK.

[3]Applied AI and Data Science, Southampton Solent University, UK.

[4]Computer Science Department, Federal University of Lavras, Brazil.

***Corresponding Author: Ugochukwu Okwudili Matthew**

Computer Science Department, Federal University of Lavras, Brazil.

Email: macdon4ru2003@yahoo.com

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Abstract

Electromagnetic spectrum infrastructures and 5G biomedical robots are design to work in line with the national healthcare policy to advance the society well-being and improve human life expectancy as they are adopted to fight against hospital acquired infection. In order to increase public healthcare safety, the current study investigated the biomedical technology application of Ultraviolet Light Emitting Diodes (UV-LEDs). The study used a UV light disinfection device to potentially eradicate hospital-acquired diseases brought on by bacteria, viruses, and other pathogens in the medical settings. By breaking down the ribonucleic and deoxyribonucleic acids of bacteria, viruses, and other harmful microorganisms through the dispersion of light irradiation, the UV installation guarantees the elimination of these pathogens and stops them from growing. The system uses a light wavelength to enhance environmental cleanliness, which reduces pathogenic influences that could cause infection in hospital wards and removes human error and other consequential manual chemical disinfection agents. In order to protect healthcare facilities against hospital acquired infections, the paper suggested installing an autonomous internet of things (IoT) 5G medical disinfecting device for complete hospital disinfection. This device would provide a continuous UV light sterilization of high-touch areas as medical facilities become overcrowded with patients with reference to COVID-19 global pandemic and possible future pandemic. The study examined fifteen relevant biomedical publications that covered the subject of UV-based hospital disinfection. The study found that, since the risk of hospital acquired infection is particularly high in overcrowded healthcare facilities, installing autonomous IoT 5G UV-LED devices within hospital buildings will enable infectious surveillance that will successfully prevent prevalence of hospital acquired infection in medical facilities during future pandemic similar to COVID-19 bubonic plaque.

Keywords: Disease surveillance; Hospital acquired infections; E-Healthcare; Internet of things; 5G mobile network technology; Ultra violet light; COVID-19; Microbial infections; Electromagnetic radiation; Wireless transmission.

Introduction

Hospital Acquired Infections (HAIs) are one of the leading preventable health risks in the world, responsible for millions of deaths and billions of dollars in medical expenses each year [1]. The HAIs have remained a dominant force in the public health sector. These infections can lead to serious complications and tragic effects, including the loss of life and incalculable waste of resources. In order to enhance patient safety, care quality, and the sustainability of good health in society, infection prevention and pandemic control strategies have taken center stage in healthcare facilities and institutional management for HAIs. Seeing to it that each patient gets well from whatever health issues led them to the hospital is the ultimate aim of the global healthcare system. In order to accomplish such goals, the healthcare systems must define a thorough safety environment in which the focus must be shifted from patient treatment to complete disease prevention and timely interventions [2]. In order to respond to the trends and accept the smart healthcare approach toward a sustainable digital healthcare future, the stakeholders must be mobilized. In order to influence changes in the industry and provide a strong basis for the expansion of healthcare services, a comprehensive global healthcare reform must be implemented. According to [3], HAIs are typically classified as illnesses contracted on hospital property by patients who were typically admitted for a different reason than the infection they contracted while in the hospital setting. According to [4], the HAIs depicted an infection that was not immediately apparent or incubating when the patients were admitted to the hospital. Despite advancements in the public health sector, hospital staff members who are at the forefront of healthcare delivery were also negatively impacted by the ongoing rise in infections among hospitalized patients. Many variables, including weakened patient immunity, clinical practices, and somewhat invasive techniques, increased the risk of infection and the spread of drug-resistant bacteria among hospital populations that are densely populated and have a very high susceptibility to infection transmission. As things continue, the COVID-19 pandemic has created a highly unusual worldwide healthcare emergency, resulting in serious health issues that often exceed the capacity of the system to handle them. About 2million people have contacted HAIs at the crammed health centers, according to the Centers for Disease Control and Prevention. Staying in a hospital is one of the most common ways to get an infection because receiving medical care there can make you more likely to have an infection. Complementing the existing hospital disinfection approaches, along with its scaled budget consequences, are the proposed portable UV device systems. For its final submission, the current study examined a number of academic publications on UV light device disinfection technologies. Fifteen peer-reviewed clinical articles that met the requirements for UV disinfection technology eligibility were produced by the strategy. Seven papers were based on UV light emitting diode irradiation, with four articles focusing on mercury UV based technology and four articles using pulsed xenon UV technology. In order to combat Healthcare-Associated Infections (HAIs) and reduce their occurrence, autonomous IoT 5G UV device disinfection installations were found to be an effective addition to labor-intensive disinfection operations [5]. Due to its 5G network and Internet of Things capabilities, the research's autonomous 5G UV light equipment for hospital disinfection is anticipated to perform better than earlier UV devices presently on the market. Additionally, switchable synchronization allows for remote control of the device. In order to help hospitals throughout the world stop the spread of dangerous pathogens within their facilities, the UV light gadget can disinfect difficult-to-reach areas. In an American Journal of Infection Control (AJIC) study, the UV light device was used to condense the active microbial burden by 92% to 97.7% prior to and in between disinfection cases. The study measured the microbial burden on objects inside and outside of the environments before and after chemical disinfection. The UV light source also reduced, with an efficacy of 96.3% to 99.6%, the microbial load on items outside before chemical disinfection [6]. The advancement in 5G network as national telecommunication infrastructure will superlatively enhance the Internet of Things (IoTs) technology, Internet of Medical Things (IoTMs), 5G Medical Robotic innovations for hospital use and Industrial service automation, carefully planned to advance the current digital society life expectancy [5]. The global world will witness another computing paradigm shift in the establishment of 5G technology and IoTs enabled computing framework that will hitherto compel ubiquitous digital access as artificial intelligence, machine learning, natural language processing and data analytics is taking the stage of the digital world [7]. The paradigm shift in the novel 5G network technology and IoTs will advance the next level digitalization that will expand dramatically through technology automation and excessive robotization [8]. In order to strengthen ecosystems, supply chains, and operations across industries, the digital society will adopt management concepts that are human-centric, sustainable, and resilient. However, the widespread adoption of 5G cellular networks has drawn public attention, with some citizens viewed the fifth generation of wireless networks as a threat to public health [9], believing that Electromagnetic Field (EMF) exposure is greater than exposure from current 4G networks. Observations on 5G make it difficult for some countries to fully deploy 5G networks into wide scale digital consumption. The 5G electromagnetic spectrum are the ranges of electromagnetic radiative frequencies, wavelengths, and photon energies that a 5G base station can transmit [10]. The 5G electromagnetic spectrum includes electromagnetic waves with frequencies ranging from one hertz to more than 300 gigahertz [11], corresponding to wavelengths ranging from thousands of kilometers to the smallest fraction in the nearest radius. The digital society reliance on the 5G mobile broadband with extraordinary data rate will require more electromagnetic spectrum to be available in the nearest future. The novel technologies in conjunction with subsisting telecommunication infrastructures will require frequencies for their continual operations [9].

Research objectives: Presenting the cutting-edge biomedical application from the comprehensive investigation of UV light device disinfection for healthcare applications is the main goal of the current research paper. In addition to being used as a disinfectant, UV light therapy has practical uses in healthcare, such as treating HAIs, IoT, and 5G wireless networks. The utilization of autonomous IoT 5G UV devices for thorough hospital disinfection as a cure-all for HAI problems was examined in this research. The study suggested using IoT 5G UV devices as a more secure and economical method of routine hospital interior cleaning.

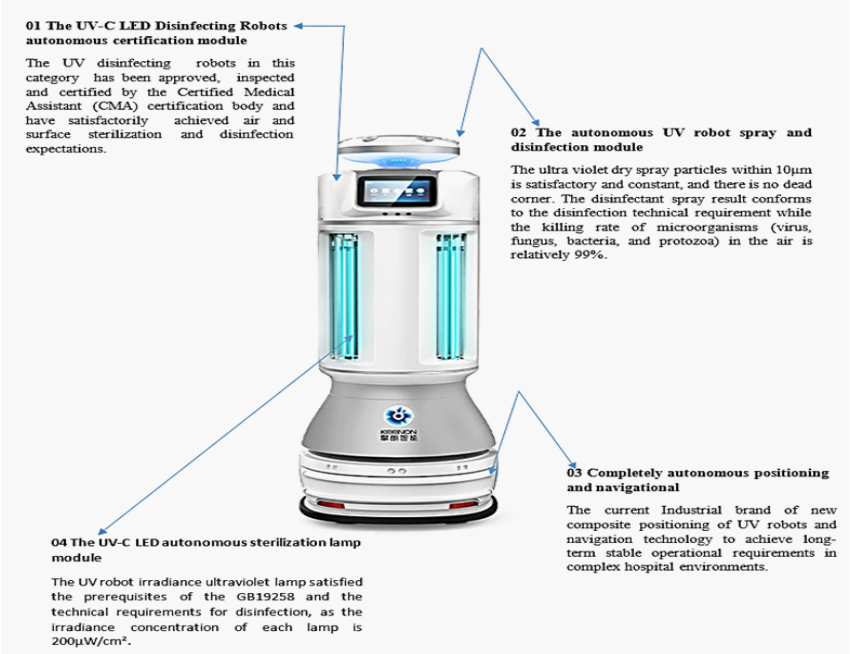

Figure 1: Hospital sterilization and disinfection Using a 5G IoT UV-C LED Autonomous Robot.

Table 1: Specifications of the UV autonomous IoT robot for hospital disinfection.

Size	500 x 500 x 1350 mm	Maximum Speed	0-0.8 m/s
Capacity	15 L	Network Interface	WIFI/5G/4G/ Bluetooth
Spray parameters	The amount of spray is 2-4 L/h, the spray substance is lower than 10 um	Battery Life	DC 48 V 15 Ah
No. of ultrasonic atomization	6 sets of ultra-dry mist atomization	Rated Power	150W
Applicable Disinfectant	Hydrogen peroxide , hypochlorous acid	Standby current	<0.5 A
No. of UV groups	4 short-wave UV-CLED lamp	Standby time	~24 h
UV irradiance intensity	>200 uW/cm^2	Battery life	=4 h
Product weight	70 kg	Life span	varied

Research methodology: In order to complementing the existing hospital disinfection approaches, along with its scaled budget consequences, the current research focused on the state-of-art technology mediated disinfection , from the depth of study the proposed portable UV device systems. On its final submission, the current study examined a number of academic publications on UV light device disinfection technologies. Fifteen peer-reviewed clinical articles that met the requirements for UV disinfection technology eligibility were produced by the strategy. Seven papers were based on UV light emitting diode irradiation, with four articles focusing on mercury UV based technology and four articles using pulsed xenon UV technology. In order to combat healthcare-associated infections (HAIs) and reduce their occurrence, autonomous IoT 5G UV device disinfection installations were found to be an effective in addition to labor-intensive disinfection operations which could as well complement whenever necessary.

Results

The automated UV robot can effectively eradicate bacteria, fungus, viruses, and other dangerous germs from the air, as shown in Figure 1. The 5G wireless Internet of Things autonomous robot for sterilization and disinfection was equipped with a set of preset tasks that included automated charging and autonomous operation skills, ensuring continuous mobility and preset schedules. Regarding Figure 1, the UV Robot is an interior walkable smart and autonomous IoT enabled device designed for internal virus, bacteria, and fungal prevention as well as microbial prevention within healthcare facilities to reduce the prevalence of hospital acquired infections, particularly in the ongoing COVID-19 where hospitals are overcrowded. With the help of state-of-the-art technological innovation, the 5G UV-C LED IoT disinfection robot can move around autonomously, emitting short-wave UV light and erupting beams of disinfectant when inside hospital wards. In order to stop the current COVID-19 epidemic from spreading throughout healthcare facilities, a number of companies have now embraced UV disinfection robots as one of the best robotic solutions, however their specifications differ. A single-cycle, whole-room disinfection system using short wave lamps is included with the UV Robot. UV autonomous disinfection robots are germicidal, meaning that they are effective at stopping microorganisms including viruses, bacteria, and protozoa from reproducing. Their wavelengths are typically between 200 and 300 nm. In light of this, UV-C LED disinfection robots are incredibly efficient, chemical-free, and eco-friendly in that they stop bacteria from growing in any setting, particularly in medical facilities where there is a high risk of hospital acquired infections.

The operational description of the IoT UV-C LED robot module, which is enabled for autonomous cross-floor disinfection and epidemic prevention services to lessen the scourge of HAIs in the ongoing COVID-19 global healthcare issues, is provided in Table 1. If the hospital wards and rooms are known to be the environmental means of transmission, then the UV-C LED irradiation technology might be a useful tool for sterilizing healthcare facilities. In patients undergoing the continuing COVID-19, the HAIs have precipitously increased morbidity and mortality.

In light of this, public health efforts have been concentrated on adopting environmental control measures in an attempt to prevent the virus from spreading. Microorganism extermination has seen an intriguing advancement with the use of UV-C LEDs or Ultraviolet Germicidal Irradiation (UVGI). The roadmap for healthcare delivery in the future emphasizes how safe and effective UV-C LED irradiation is for complete germ eradication in hospital cleaning processes.

At a time when novel paradigm shifts are much needed, portable UV-C LEDs have created a new wave of user safety experiences surrounding healthcare occupational contexts [12]. The UV-C LEDs not only served as a healthcare security corridor but also as compact, solid-state emitters with high radiation levels that managed all the unique tools for creating safe and efficient solutions for a variety of problems, including food safety, air and water quality, healthcare surface environments, office worker and commuter protection, and shopping mall and post-COVID-19 global occupational space [13]. By strengthening the relationship between doctors and patients, raising the bar for medical education and training, and improving diagnosis and treatment quality, the medical and clinical robots application has also increased medical execution efficiency [14]. The current state of healthcare practices and instructional methodologies are being driven by technological breakthroughs, the necessity to find safety and diversified practice for clinical procedures, and occupational professionalism. The clinical workforce will play multifaceted and important roles in promoting healthcare equity worldwide in the coming decades [15]. They will do this by taking on new duties, partnering with other communities and sectors, and experimenting with new ideas while working in cutting-edge digital environments. Legislation relevant to the scope of practice, Medicare, public health and health system guidelines, state laws governing the use of standing orders, and other guidelines around medical and clinical education must all be amended in order to solve this.

Conclusion

In the ongoing COVID-19 pandemic health risk management study, the prevalence of HAIs was reported in relation to the use of UV-C LED light equipment. Even if healthcare professionals have a thorough grasp of HAIs, decisive action is still needed to identify and mitigate the risks this health concern poses. Systematic HAI surveillance is necessary to minimize the transmission of hospital infections, improve patient and healthcare worker well-being, and maximize the effectiveness of the healthcare delivery system. The modern digital society thinks that the healthcare system of the future will offer amazing chances to link scientific advancements with humanity, enhancing Medicare's performance and healthcare options in ways never before seen or experienced. The UV-C LED light device that has been recommended for disinfection has the potential to be a useful tool for sanitizing hospital surfaces in the future. The suggested 5G autonomous IoT UV-C LED light device for the hospital environment has mobility issues that necessitate modifications to hospitals and UV light devices as they are currently set up. At the moment, routine sanitization is typically improved by automated UV disinfection systems rather than entirely replaced. In due course, they might provide sterilization methods that are reputable, trustworthy, and tested.

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