# BIOTECHNOLOGY APPLICATIONS IN COMBATING HOSPITAL ACQUIRED INFECTIONS (HAIS) THROUGH UTILIZATION OF AUTONOMOUS 5G INTERNET OF THINGS (IOTS) ULTRA VIOLET (UV) LIGHT DEVICE

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## 1. EXECUTIVE SUMMARY

Hospital acquired infections (HAIs) are among the topmost global avoidable healthcare risk that had contributed to millions death and billions expenditure yearly within the healthcare sector. The HAIs continued to dominate the public health sector wearisomeness, resulting into severe complications and the outcomes are generally disastrous with consequential loss of human lives and unquantifiable resource wastage. The current research proved that ultra-violet (UV) light disinfection technology can potentially eliminate up to 99.7 percent of HAIs caused by bacteria, viruses and other pathogens within the healthcare facilities. The UV technology is designed for disinfection of hospital operating wards, patient wards, intensive care unit and other hospital high touch areas. The UV installation ensures destruction of bacteria, viruses and other dangerous microbes through ravaging their Deoxyribonucleic acid (DNA) and Ribonucleic acid (RNA) using dispersion of light irradiation, preventing the microbes from multiplying. The UV light technology potentially eliminates human errors and other consequential manual chemical disinfecting substances by utilizing light wavelength for optimized environmental cleanliness, resulting in decreased pathogenic influences that could potentially cause infection in the hospital wards. The installation of autonomous internet of things (IoTs) medical disinfecting machines for entirely hospital disinfection provided a continuous sterilization of high-touch areas with UV light to secure the healthcare facilities against hospital acquired infections as all the medical facilities are getting overcrowded with patients in the ongoing COVID-19 global pandemic. The research concluded that installation of autonomous IoTs UV devices within the hospital facilities will provide means for infectious surveillance that will effectively control the menace of HAIs in the medical facilities in the ongoing COVID-19 as the susceptibility of HAIs are exceedingly high in the overcrowded healthcare centres.

**Keyword:** Hospital Acquired Infections (HAIs), e-Healthcare, Biotechnology Applications, Internet of Things (IoTs), 5G Mobile Network Technology, Ultra Violet (UV) Light, COVID-19 and Microbial infections.

## 2. LITERATURE REVIEW

The ultimate goal of Global Health Security Agenda (GHSA) is to ensure that the Centre for Disease Control (CDC) corporates with countries of the world to support public healthcare systems and control epidemics at the source, prior to uncontrollable escalation into regional pandemics or global bubonic plague(Standley, Sorrell, Kornblet, Fischer, & Katz, 2015). The public health hazards, health emergencies and communicable diseases do not distinguish the continental boundaries, to that effect, the effective public health systems in all countries diminishes the possibility of global health terrorisations as we witnessed in the ongoing COVID-19 which potentially originated from Wuhan, a Chinese province(Phelan, Katz, & Gostin, 2020) . From the broader perspective, the hospital acquired infections (HAIs) may also be contemplated as endemic or epidemic(Nekkab, Astagneau, Temime, & Crepey, 2017). The hospital acquired infections (HAIs) otherwise known as "Nosocomial infections" are among the infections contacted within the hospital or healthcare facilities which appeared first within the 48hrs or beyond following hospital admission or within 30 days after discharge from the outpatient care unit (OPCU)(Revelas, 2012). Such developments are unconnected to the initial health conditions that brought the patients to the hospital and neither existing nor developing as at the moment of the hospital admittance. More than a few reasons exist why HAIs are alarmingly prevalent in the twenty century healthcare management observance and in the ongoing COVID-19 global pandemic. According to (Revelas, 2012),the factors that potentially promote HAIs within the twenty first century healthcare management system include; (i.) Pattern of the hospitals building (ii.) oversized number of populations who are on admission (sick) and whose body immune system are often very weak to resist pathogens (iii.) Intensified outpatient treatment significance, which implies that individuals who are on admission in the hospitals are sicker when thoroughly evaluated (iv.) Healthcare personnel or medical staff interchanges from patient to patient thus increasing the chances for the pathogens to spread easily (v.)Unsatisfactory sanitation and hospital disinfecting protocols taking into account the uniformity of equipment sterilization and disinfecting high sensitive touch areas (vi) Sanitization, washing and other precautionary procedures that may either be overlooked by hospital personnel or too negligent to appropriately quarantine patients from the potential infectious agents (vii) Routine utilization and adoption of anti-microbial agents in the healthcare facilities to adequately generate selection pressure for the emergence of the resistant strains of microorganisms.

The HAIs take place in both adult and paediatric patients(Zingg et al., 2017). The bloodstream infections, alongside pneumonia and urinary tract infections are among the commonest healthcare associated infections in children while urinary tract infections and surgical site infections are among the simplest healthcare associated infections in adults(Haque, Sartelli, McKimm, & Bakar, 2018). In understanding the risk associated with contracting COVID-19 in the hospital and interpreting the exact scenario of such cases

in relation to the proportion of all hospitalised COVID-19 patients that were already diagnosed after 14 days hospital stays, the current research do not comprehend if those patients with HAIs who died did so as a result of the COVID-19 infection or of the original ailment that kept them in the hospital for the time being. Although, it is possible that most community acquired COVID-19 cases died of the coronavirus complications(Kobayashi et al., 2020). Our study discovered diminished HAIs incidences in patients hospitalized in the Teaching Hospital (our case study) during the COVID-19 eruption when juxtaposed with the events of the previous years, notwithstanding the comparable clinical severity imposed by the COVID-19 outbreak. Taking into account the imaginable correlation between reduced HAIs risk and compliance to rigorous decontamination approaches in the ongoing COVID-19, our investigation further highlights the obvious impressions of preventive measures, robotic technology adoption to continuously provide sterilization to all sensitive touch areas capable of harbouring pathogens using Ultra-Violet(UV) light and the use of personal protective equipment (PPE) within the hospitalized patients' care unit and overall hospital ward for effective management. The findings seemed exceptionally applicable when deliberating on the potentialities of the encumbrances of HAIs on the global healthcare system with respect to mortality and public healthcare budget expenditures.

## 3. RESEARCH IMPLEMENTATION

The current research was a conception from the ongoing COVID-19 global pandemic to fashion an innovative technology paradigm required for the current society extreme digital healthcare automation. The research was designed to enable a high command technology innovation that will address the key aspect of the current society healthcare challenges, relying on:

*Implementation of automated hospital disinfection procedure using IoTs ultra violet (UV) light to kill pathogens responsible for hospital acquired infections which contribute to death of patients and add to the healthcare budget expenditures from time to time.*

The UV sterilization and disinfection robot according to **Figure1** will readily exterminates germs in the healthcare operating environment through decomposing the DNA structures of the pathogens, in this manner preventing the spread of microbes , bacteria, viruses and other diseases causing microorganisms responsible for hospital acquired infections. The fundamental aspect of the UV disinfection and sterilization procedure requires condensation of the ultraviolet beams into an emitting dispersion to kill bacteria and other harmful microorganisms with a disinfection rate of 99% accomplishments(Plazas Tuttle, 2017). According to **Figure1**, the automated UV robot is capable of successfully killing microorganisms in the air such as viruses, fungi, bacteria and other harmful microbes. The 5G wireless IoTs autonomous patrol robot for disinfection and sterilization had set of predetermined activities having proficiencies in autonomous operation and automatic charging therefore guaranteeing continuance mobility and predefined routine operations. Referring to **Figure1,** the UV Robot is an interior walkable smart and autonomous IoTs robot, conceived for internal virus, bacteria , fungus in addition to microbial prevention within the healthcare facilities to lower the prevalence of the hospital acquired infections especially in the ongoing COVID-19 where the hospital are overcrowded(Kaiser, Al Mamun, Mahmud, & Tania, 2020). The UV IoTs disinfecting robot is furnished with cutting-edge technological innovation that allows it to traverse autonomously, producing short-wave UV light and spontaneously spraying disinfectant beams within interior spaces of the hospital wards. At present, several organizations have adopted UV disinfecting robots as one of the ultimate robotic solution to combat the spreading of the contemporary COVID-19 pandemic in the healthcare centres. The UV Robot is provided with a short wave lamp system to fill a single-cycle, whole-room disinfection. The UV autonomous disinfecting robot wavelengths are usually within the range of 200 and 300 nanometres, making them germicidal which implies that they are proficient in incapacitating microorganisms, like protozoa, viruses and bacteria from replicating(Zheng, Ahmad, & Abbasi, 2020). On this note, the UV disinfecting robots energy level are very effective, chemical-free and environmentally-friendly in a way to prevent microorganisms from multiplying in any environment especially within the healthcare facilities where the risk of hospital acquired infection are high.

## 4. CONCLUSION

In this current paper, the pervasiveness of hospital acquired infections was reported in relation to Internet of Health Things for COVID-19 pandemic health risk management. Even though the healthcare workforces have comprehensive knowledge of hospital acquired infections, uncompromising response should be exerted in identifying and resolving the health menace. Systematic surveillance of the hospital acquired infections is straightaway desirable in order to condense hospital infectious spreading and improve the quality of life of patients and healthcare employees together with healthcare delivery system performances. The future healthcare system suggests an astounding opportunities, connecting humans and scientific innovations, which the current digital society believed will improve the level of healthcare solutions and performances of the Medicare in such manner that had not been witnessed or seen before. Internet of Healthcare Robots will generally takeover some certain classified jobs within the health sector and hopefully will outperform humans in some certain scenarios, offering cheaper treatment services and perform faster and repetitively manipulate several processes better than any known human being.

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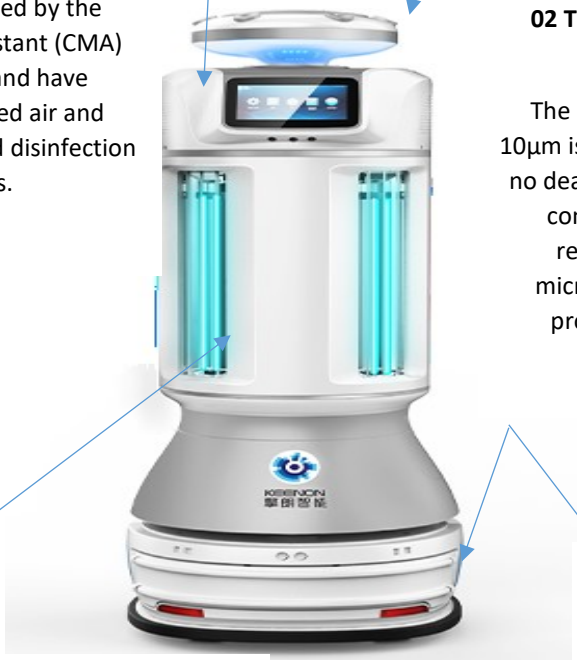
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**Appendix: Figure 1 and Table 1**

**01 The UV Disinfecting Robots autonomous certification module**

The UV disinfecting robots in this category has been approved, inspected and certified by the Certified Medical Assistant (CMA) certification body and have satisfactorily achieved air and surface sterilization and disinfection expectations.



**02 The autonomous UV robot spray and disinfection module**

The ultra violet dry spray particles within 10μm is satisfactory and constant, and there is no dead corner. The disinfectant spray result conforms to the disinfection technical requirement while the killing rate of microorganisms (virus, fungus, bacteria, protozoa) in the air is relatively 99%.

**03 Completely autonomous positioning and navigational**

The current Industrial brand of new composite positioning of UV robots and navigation technology to achieve long-term stable operational in complex hospital environments.

**04 The UV autonomous sterilization module**

The UV robot irradiance ultraviolet lamp satisfied the prerequisites of the GB19258 and the technical requirements for disinfection, as the irradiance concentration of each lamp is 200μW/cm² .

**Figure 1. Biotechnology Application: The 5G IoTs UV Autonomous Robot for Hospital Disinfection**

**Table 1: Specifications of the UV autonomous IoTs Robot for hospital disinfection**

| **Size** | *500*500*1350mm* | **Maximum Speed** | *0-0.8m/s* |
|---|---|---|---|
| **Capacity** | *15L* | Network Interface | *WIFI/5G/4G/Bluetooth* |
| **Spray parameters** | *The amount of spray is 2-4L/h, the spray substance is lower than 10μm* | Battery Life | *DC 48V 15Ah* |
| **No. of ultrasonic atomization** | *6sets of ultra-dry mist atomization* | Rated Power | *150W* |
| **Applicable Disinfectant** | *Hydrogen peroxide , hypochlorous acid* | Standby current | *<0.5A* |
| **No. of UV groups** | *4 short-wave UV lamp* | Standby time | *≈24h* |
| **UV irradiance intensity** | *>200μW/cm²* | Battery life | *≈4h* |
| **Product weight** | *70kg* | Life span | |

The **Table 1** gives the operational description of the IoTs UV robot module operation empowered for autonomous cross-floor disinfection and epidemic prevention services for lowering the scourge of hospital acquired infections(HAIs) in the ongoing COVID-19 global healthcare challenges.