Project Title

Development of a UVC Sterilisation Unit for N95 Mask

Project Lead and Members

Project lead: not indicated

Project members: not indicated

Organisation(s) Involved

Tan Tock Seng Hospital, Institute of Bioengineering & Bioimaging, iNOVA

Healthcare Family Group(s) Involved in this Project

Healthcare Administration

Applicable Specialty or Discipline

Infectious Diseases

Project Period

Start date: not indicated

Completed date: not indicated

Aims

Aim is to enhance equipment safety for ground staffs as they are required to wear the N95 masks for a prolonged period of time. With a sterilization unit, users will be able to sterilize their N95 maskes between breaks and shifts.

Background

The project was initiated during the COVID-19 pandemic to address the need for personal sterilization units for ground staff who wear N95 masks for extended periods. UV sterilization was identified as a promising method due to its effectiveness and low health risk.

Methods

The project involved collaboration with TTSH, Institute of Bioengineering & Bioimaging (IBB), and iNOVA. Bio-efficacy testing was conducted on bacteria strains using a UVC prototype, and modifications were made to improve the prototype's performance.

Results

The UVC prototype achieved significant log reduction for B. Subtilis but was ineffective for Pyrogenes. The BFE test showed no change in mask filtration efficiency after multiple UVC cycles.

Conclusion

The project was aborted due to the inability to achieve the desired sterilization effectiveness and resource inefficiencies.

Project Category

Care & Process Redesign

Product Development, Proof of Concept

Keywords

Covid-19 pandemic, personal sterilization unit, N95 mask, Pyrogenes bacteria

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Tan Tock Seng HOSPITAL
National Healthcare Group

Development of a UV-C Sterilisation Unit for N95 Mask

Project Background/Reason for Action

An idea developed during the COVID-19 pandemic – Can a **personal sterilization unit** for ground staff be introduced to enhance equipment safety as they are required to wear the N95 masks for a prolonged period of time. With a sterilization unit, users will be able to sterilize their N95 masks between breaks and shifts.

The sterilisation unit will also mitigate stress on the N95 mask supply due to the ability to prolong mask usage within Infection Control guidelines.

With research on sterilization methods, It is shown that UV Sterilization is one of the most promising methods for its effectiveness with little health risk.

Project Collaborators

Collaborating parties

1. TTSH

- Kaizen Office as the Principal Investigator team with support from Infection Control and Facilities. Provide the requirements and specifications of the sterilisation unit.

2. Institute of Bioengineering & Bioimaging (IBB), A*STAR research entities

- as the testing agency for bio-efficacy testing for 2 bacteria strains on 3M 1870+ N95 and mask integrity test post UVC sterilization using the sterilization prototype unit

3. iNOVA

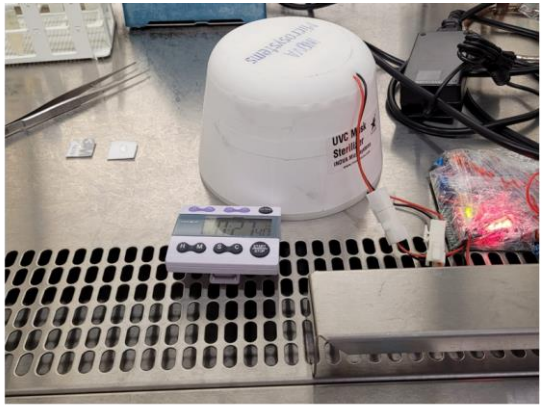
- provides the engineering expertise and production capability. Work with Kaizen on the prototype design and development of the sterilisation unit

Bio-Efficacy Testing Process

1

2 squares are cut from the N95 (1870+) mask

2



The 2 cut out squares is stained with the bacteria solution before placing back on the mask

3

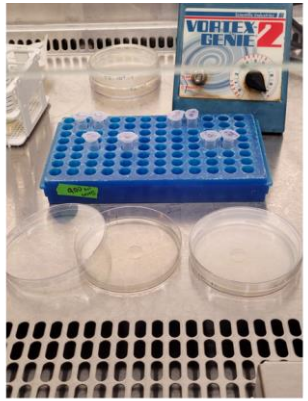
The stained N95 mask is placed into the UVC prototype

4

After sterilisation i.e. exposed to the UVC Leds, the cut out squares stained with the bacteria solution is placed in media and vortex

(Exposure time: 5, 15 and 30mins respectively)

5



The vortexed media is serially diluted before being plated on agar plates for counting of the colonies

Bio-Efficacy Test Results

Results of Bio-Effiacy testing for B.Subtilis and Pyrogenes bacteria

- UVC prototype achieved a 1.8, 3.0 and 4.3 (i.e. >99.99% deactivation) log reduction at 5, 15 and 30 minutes of UVC exposure time respectively.
- However, there was no significant bacteria colonies reduction observed for Pyrogenes despite adding 4 additional UVC LEDs as part of the iterative testing (from 5 to 9)
- Both aforementioned results were comparable to the control study i.e. a commercially bought UVC bag (which is almost twice as expensive as our projected final production per unit cost for the UVC device)

Bacterial Filtration Efficiency (BFE) Test

- The BFE of the 3M 1870+ before and after 15 times of 30min UVC cycles was conducted
- Based on the results obtained, there was no change in the BFE for the 3M 1870+ mask that had been subjected to 15 cycles of 30min/cycle.

Project Status - Aborted

Upon discussion with TTSH Infection Control, the project was aborted due to the following reasons:

1. The sterilisation had failed to reach a 6 Log reduction i.e. 99.9999% to be considered highly effective for staff safety
2. The sterilisation was ineffective for the common Pyrogenes bacteria
3. It would not be resource effective (time and cost) to develop a collapsible form based on user needs

Key Challenges Encountered

1. **Trial and error/iterative testing process which took longer than expected**
   - Initial prototype only achieved <2 Log reduction i.e. (<89% deactivation)
   - Modifications were made to the prototype and retested for Bio-efficacy
   - Thus far, 2 modifications have been made to alter the UVC LEDs placement and also to increase the number of UVC LEDs
2. **Need to pace with A*Star IBB manpower resourcing and other conflicting priorities**
   - This project is a collaboration with A* Star IBB and not a procured service. In fact, they have been very accommodating with our requests to modify the test protocols i.e. increase more tests to include 30 minutes exposure and also to test the commercially bought UVC bag

THANK YOU