COVID19 Disinfection – Cohort Review on Infected Surfaces

John Peter Smiles CIH, CSP
Assistant General Manager
Chola MS Risk Services Limited, Chennai

1.0 Abstract:

SARS-COV-2 enters host cell through human cell receptor ACE2 the same as SARS-COV-1, but with higher affinity. The rapid increase of infectious case is found to be more contagious than SARS-COV-1 or MERS-COV. Arriving at a conclusion on use of appropriate disinfection has been a challenge towards prevention and protection of SARS-COV-2 infection. This article compares clinical severity between SARS-COV-2 & SARS-COV-1, studies done on the viral surface stability and exposure of such virus to various disinfectants.

2.0 Clinical severity between SARS-COV-2 and SARS-COV-1:

SARS-COV-2 virus which causes COVID-19 belongs to beta Coronavirus similar to SARS-COV-1 and MERS-COV. SARS-COV-2 possess a coronavirus structure with spike protein in the membrane envelope. The S protein of SARS-COV-2 (Spikes found around the virus envelope) interacts with ACE 2 receptor on the host cell the same as SARS-COV-1 virus specifically into the epithelial alveolar cells. Another factor to consider is the R through (R_O) which is 1.4 to 2.5 for SARC-COV-2 virus. R_O for SARS-COV-1 is close to 0.4 which is almost very less compared to SARS-COV-2. The high R_O associates with high diffusible infection with low incubation period. The potential latent infection could cause more clinical delinquent concerning over occupational respiratory diseases. Population with higher affinity between ACE 2 receptor and SARS-COV-2 may be more prone to COVID-19. SARS-COV-2 has it's envelop with a lipid bilayer. Lipid viruses are the least resistant microorganism to germicidal chemicals. It is generally inferred through various studies that disinfection should minimize the viability of SARS-COV-2 on surfaces and in the air.

3.0 Viral Stability:

3.1.1 SARS-COV-2 viral transmission includes Direct (cough, sneeze and droplet) and Contact (Contact with oral, nasal and eye membranes). A recent surface stability study published in The New England Journal of Medicine compared SARS-COV-2 with SARS-COV-1 through an aerosol generation process. Inoculum and Conditions maintained at 105 $TCID_{50}$/ml, 21 – 23^{0}C, 40% RH, Surface deposits of 50µL. SARS-COV-2 virus was found in aerosol during the entire 3 hours of the study with a reduction in infectious titer from $10^{3.5}$ to $10^{2.7}$ $TCID_{50}$ (TCID50 is 50% Tissue Culture Infectious Dose). This result was similar with SARS-COV-1 from $10^{4.3}$ to $10^{3.5}$ $TCID_{50}$ per ml. SARS-COV-2 remained active on surface up to 72 hours and in aerosol for about 3 hours. Time of Limit of Detection was $10^{0.5}$ $TCID_{50}$ per ml of medium for plastic, steel and cardboard, $10^{1.5}$ $TCID_{50}$ per ml of medium of copper corresponding to plastic 4 days with half-life of 6.8 hours, Stainless steel 4 days with half-life of 5.6 hours, Cardboard 2 days and Copper 8 hours. The study indicates credible evidence for transmission of infectious disease by the contaminated surface and air.

3.1.2 University of Hong Kong carried out a study which cultured 5 µL droplet SARS-COV-2 virus (~7·8 log unit of TCID50 per mL) pipetted on a surface and left at room temperature (22°C) with a relative humidity of around 65% probed on various different objects. It was evident that the virus remained identifiable on the outer layer of surgical mask on day 7. It also documents a note that biphasic decay of infectious SARS-COV-2 found in samples recovered from smooth surfaces.

3.1.3 Study conducted in Wuhan hospital was typically to collect swab sampling on potentially contaminated objects of Intensive Care Unit and general COVID-19 ward to find the plausibility of fomite transmission. Samples on aerosolized air from indoor air and air outlet were assessed for SARS-COV-2 exposure. The results from the third study found positive for SARS-COV-2 virus on frequently touched objects, shoes soles of the working staffs, floors of the ICU and wards. Results were also found positive in the aerosol samples eluting higher probability of infection transmission through aerosol not limited to droplet viral transmission.

There is no defined threshold established on the safe exposure levels for this virus or threshold on viral load or the minimum detection limits or reliable established sample collection and analytical method. SARS-COV-2 genome is predominantly 70 % to 80% similar with SARS-COV-1. With the reviewed three recent studies it is evident that SARS-COV-2 can be found contaminated on surfaces and in aerosol samples, under subjected conditions.

4.0 Disinfection studies:

4.1.1 Study conducted on SARS-COV-1 in early 2005 found SARS-COV-1 to persist on surface for up to 96 hours and dried SARS-COV-1 retained its infectivity up to 6 days. Eight commercial products were tested on SARS-COV-1. Four were alcohol based hand disinfectant primarily on varied concentration of iso-propanol, n-propanol, ethanol with base material such as Sterillium, mecetronium etilsulphate. Three of the other commercial products surface disinfectant had a base of Benzalkonium Chloride, lauryl amine, glutaraldehyde, didecyldimonium chloride and monoperpthalate. The instrument disinfectant was base of glutaraldehyde and (ethylenedioxy) dimethanol was also included in the study. The results of the study inferred all four alcohol based hand rubs below limit of detection with reduction factor of greater than 4.3 irrespective of the presence and type of organic load within 30 seconds. The three surface disinfectant also inactivated SARS-COV-1 to below limit of detection with reduction factor of greater than 3.8 within 30 min. Instrument disinfectant also showed similar results at various concentration of 2% at 60 min, 3% at 30 min and 4% at 15 min regardless on the type of organic load. The study summarized that all the disinfectant subjected for study were found to be active over SARS-COV-1 regardless on the type of organic load. However on current situation, disinfectant specified on the study needs to be verified with EPA list N.

4.1.2 University of Hong Kong revealed its study results of disinfectants over SARS-COV-2 virus. 15 µL of SARS-COV-2 culture (approx. 7.8 log unit of $TCID_{50}$ per ml) was exposed to 135 µL of various disinfectants. Disinfectants with working concentration such as Household bleach (1:49), Household bleach (1:99), Hand soap solution (1:49), Ethanol (70%), Povidone-iodine (7.5%), Chloroxylenol (0.05%), Chlorhexidine (0.05%), Benzalkonium chloride (0.1%) were subjected to the study. Studies were done in three independent triplicates. SARS-COV-2 was exposed to the above said disinfectants at 5 min, 15 min and 30 min. Only one of the Hand soap solution triplicate reactions was positive in the $TCID_{50}$ assay. With the exception of a 5 min incubation with hand soap, no other virus incubation were detected after a 5 min incubation at room temperature of 22 deg C.

4.1.3 Recent study at NIH's Rocky Mountain Laboratories in Montana, tested decontamination on sections of N95 exposed to SARS-COV-2 virus. Various decontamination techniques such as Vaporized Hydrogen Peroxide, 70% ethanol spray, Dry heat of 70 deg C and Ultra Violet light were used. The results concluded that ethanol spray damaged the integrity of respirator's fit and seal after two decontamination session and was not recommended for decontamination of respirators. UV and Heat treatment for at least 60 minutes showed fit and seal problems after three decontamination sessions. The study suggest UV and Heat treatment for potential two respirator reuse. Vaporized Hydrogen Peroxide experienced no failures and no virus could be detected after 10 minute treatment, suggesting they could be reused three times.

4.1.4 A study documented in Auckland proposed five disinfection steps for reuse of PPEs including N95 FFP, eye wear and Poly-Propylene gowns. Ultra Violet Germicidal irradiation (UVGI) was the preferred choice. The study estimated a minimum applied UVC dose for effective deactivation of SARS-COV-2 on N95 filtering face piece to be around 1,000 mJ/cm^2. The disinfection of PPE steps involved were (1) **Inspection & Sorting** – Soiled and damaged PPE to be discarded, intact PPE to be stored. (2) **Storage** – sorted PPE to be stored for 4 days without direct contact at approx. 20^{0}C and 40 – 50 % RH. (3a) **UVGI** – After 4 days of storage, N95 and other PPEs treated in UVGI chamber at an applied dose of 2,000 mJ/cm^2 on wearer-facing and outer side. (3b) **Heat treatment** at 60^{0}C for 90 minutes at 40-50 % RH. (3c) **Clinical Disinfection** – eye wear to be disinfected with high grade disinfectant through soaking or using wipes. (4) **Re-Inspection & Sorting** – Intact PPE to be packed specifying 'PPE- for REUSE, PPE Derived from Disinfection and number of disinfection cycle'. N95 FFP shall be discarded after 5th re-use. (5) **Fit Test** - Mandatory fit test required (at least Qualitative Fit Test).

ACGIH Threshold Limit Value on human exposure to UVC 0f 254 nm wave length (emission lines of mercury discharge spectrum) is 6.0 mJ/cm^2 and Relative Spectral Effectiveness is 0.500. Effective Irradiance E_{eff} to be obtained from the supplier of the UVC device to calculate allowed exposure duration per day which needs to be communicated to the users and appropriate protective measures to be taken.

5.0 Summary:

Considering lipid bilayer of SARS-COV-2 virus which has the least resistant to germicidal chemicals, chemical disinfectant are found to be more effective in disinfection. However, other operating challenges pertaining with chemical disinfectants such as chemical compatibility toward Material of Construction of the surface to be disinfected, electrocution, ignition hazard and continuous occupancy of infectious room shall be considered for other alternate disinfectants. Energy sensitive disinfecting method such as Ultra Violet (UVC) light shall be considered specifically on disinfection of air and other surfaces (not on human body surface) were germicidal chemicals cannot be applied based on well documented applied Dose, Effective Irradiance and ensuring human exposure below the threshold time duration.

6.0 Reference:

a) European Review of Medical and Pharmacological Science: Difference and similarities between Severe Acute Respiratory Syndrome (SARS)-Coronavirus (CoV) and SARS-COV-2

b) New England Journal of Medicine: Aerosol and surface stability of SARS-COV-2 compared with SARS-COV-1

c) LKS Faculty of medicine, University of Hong Kong: Stability of SARS-COV-2 in different environmental conditions

d) Aerosol and surface distribution of SARS-COV-2 in hospital wards, Wuhan, China, 2020

e) Efficacy of various disinfectants against SARS coronavirus, 2005

f) NIH study validates decontamination methods for re-use of N95 respirators

g) Derraik et al. – SARS-COV-2 evidence & double – hit PPE reuse protocol

Disclaimer:

Views, thoughts, opinion expressed in this article on 25th April 2020 belongs solely and personally to the author, and not necessarily, to the views of author's current or previous employer, organization, and committee or other groups or individuals. Anyone using this document should understand the documents limitation and rely on his / her professional judgment, as appropriate. He / she shall remain updated on SARS-CoV-2 virus, local government disinfection methodology, as well as adhere to local regulations and advisories.