Towards a Tangible Defense Against the Covid 19 Infection.

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ABSTRACT.

A simple but effective method using temperature, humidity and salinity based on scientific research reports, to control Covid 19 pandemic is described. The method involves inhalation of hot water vapors at 56 to 60 degree Celsius for five minutes, three times a day for individuals with moderate infection and ventilation with hot and humid inhalation gases at 40 to 56 degree Celsius and a relative humidity between 70% to 80% continuously or the ventilator temperature shall be adjusted to deliver hot and humid gas at suitable patient tolerable intervals for patients with severe/critical illness. For the individuals with moderate illness gargling 3% saline at 56 to 60 degree Celsius three or four times a day shall also be advised. Available literature survey shows Covid 19 virus will be killed/inactivated at 56° C. Maintain the temperature of the ICU room at 26° C.

Key words: SARS CoV -2, Covid 19, Lethal Temperature, Ventilator, Temperature & Relative Humidity for Virus Killing, Steam Inhalation & Warm Saline Gargling.

Generally, all infections are caused by micro or macro organisms. In case of micro organisms, physico-chemical parameters play an important role in both the infection as well as the survival and multiplication of the infecting organisms. Most favourable parameters are often referred to as optimum conditions, as the conditions are ideal for the organisms to grow and multiply. As the physico-chemical parameter values are varied, we also come across certain conditions, which suppress the infection or even kill the infecting organisms. The conditions which kill the organisms are called lethal conditions. In this way we can identify lethal conditions for micro organisms, whether they are bacteria or viruses. In food technology, the study of lethal temperatures for elimination of food borne pathogens is a common feature (1). Based on such results designing food processing methods to eliminate food borne pathogens, is a common practice in food manufacture.

A pathogenic micro organism can be bacteria or virus. In the case of Covid 19, the infective agent is the novel Corona Virus. In December 2019, a serious and highly contagious epidemic with Severe Acute Respiratory Syndrome caused by Corona Virus 2 (SARS -CoV-2) was reported in Wuhan, China (2 & 3). Covid 19 killed thousands of

people in China and the disease quickly started spreading not only in China but through out the world through human to human transfer (4). Initially people took it lightly and the disease SARS -CoV-2 spread like wild fire in Europe, Asia, the Americas and Africa. On 11th February 2020, WHO announced “COVID-19” as the official name of this new disease following guidelines developed earlier by the World Organization for Animal Health (OIE) and the Food and Agriculture Organization (FAO) of the United Nations. With in three months of the first report of Covid 19 from Wuhan, on 11th March 2020, the World Health Organization further reported that there are globally 118, 326 confirmed cases and 4,292 deaths due to Covid 19 and declared Covid 19 as a pandemic (5). With out any medicine against Covid 19, the whole world is trembling before this pandemic. Efforts for rapid test kits for early detection of the disease as well as development of a vaccine to contain the disease are fast progressing. Some rapid test kits for early detection of Covid 19 infection has been developed. Some of them can detect positive cases in just ten to fifteen minutes. While a positive result is indicative of exposure of an individual to SARS Cov 2, a negative result is to be retested after some days, as it may take at least seven days in some individuals for formation of antibodies at detectable levels. How ever, for the purpose of screening, several national health authorities like, the US FDA, the EU, the ICMR etc. have approved rapid test kits for Covid 19. All the positive rapid test cases are to be further confirmed by RT PCR test. Some laboratories are also attempting development of a vaccine. Such vaccines also need several trials to be under taken before actual use, which will take time. All these are indicative of a certain amount of uncertainty and shortage of test kits and huge investment for mass testing. The development of a vaccine is also likely to take at least another six months. Mass production of a successful vaccine and its use for the entire world population is yet another difficult barrier.

In the mean time the pandemic is assuming community spread in an exponential manner in several countries all over the world. The WHO Chief said in a press briefing on 1st April 2020, “Over the past 5 weeks, we have witnessed a near exponential growth in the number of new cases, reaching almost every country, territory and area. The number of deaths has more than doubled in the past week. In the next few days we will reach 1 million confirmed cases, and 50,000 deaths. The condition is critical in Italy, Spain, USA, France, UK, etc. While relatively lower numbers of confirmed cases have been reported from Africa, and Central & South America, we realize that COVID-19 could have serious social, economic and political consequences for these regions”(6).

The Corona Virus Worldometer https://www.worldometers.info/coronavirus/ on 2d April 2020, reported 9,60,063 confirmed Covid 19 cases, with 49156 deaths and 203119 recovered cases all over the world. The maximum number of deaths were in Italy followed by Spain, USA, France, China and Iran. Almost every country is under Covid 19 infection. On infection there is an incubation period of 2 to 14 days. COVID-19 typically causes flu-

like symptoms including a fever and dry cough. In some patients - particularly the elderly and others with other chronic health conditions - these symptoms can develop into pneumonia, with chest tightness, chest pain, and shortness of breath. Notably, the COVID-19 infection **rarely seems to cause a runny nose**, sneezing, or sore throat (these symptoms have been observed in only about 5% of patients) (7).

As on 20th February 2020, based on 55924 laboratory confirmed cases, “typical signs and symptoms include: fever (87.9%), dry cough (67.7%), fatigue (38.1%), sputum production (33.4%), shortness of breath (18.6%), sore throat (13.9%), headache (13.6%), myalgia or arthralgia (14.8%), chills (11.4%), nausea or vomiting (5.0%), nasal congestion (4.8%), diarrhea (3.7%), and hemoptysis (0.9%), and conjunctival congestion (0.8%). People with COVID-19 generally develop signs and symptoms, including mild respiratory symptoms and fever, on an average of 5-6 days after primary infection (incubation period 5-6 days, range 1-14 days). According to WHO, the detailed symptoms of COVID-19 are “non-specific and the disease presentation can range from no symptoms (asymptomatic) to severe pneumonia and death” (8). From this etiology of Covid 19 it is pretty clear that one to two weeks time is available from first symptoms to severe disease for management options.

Using available preliminary data, The WHO further reported that the mild cases will last for two weeks, severe and critical cases 3 to 6 weeks, time for severe disease from first symptom one week and among patients who have died, time from first symptom to death 2 to 6 weeks.

The average global death rates were alarming at 5.2%, while 21.15% got fully recovered. Remaining 74% are under various stages of treatment. Statistics revealed that the probability of death increased with age of the infected person. The probability of death was maximum (14.8%) in the age group of 80 + years, while the same was 0.2% in children and youth of age 10 to 39 years and for children (0 to 9 years) it is almost zero. Among sex, the males have a higher probability (2.8%) of death than females (1.7%). The probability of death increases with co morbidities such as asthma, diabetes, heart disease, kidney ailments, etc. (7).

Age.	Probability of death in % among confirmed cases.	Probability of death in % among all cases.
80+ years old	21.9%	14.8%
70-79 years old		8.0%
60-69 years old		3.6%
50-59 years old		1.3%

40-49 years old		0.4%
30-39 years old		0.2%
20-29 years old		0.2%
10-19 years old		0.2%
0-9 years old.		no fatalities.

In this grim situation, the look out for an effective preventive is the responsibility of all with a science background. Naturally the first search was for any physical parameter available in literature for restricting the spread and infection of the novel corona virus. There are several studies on the environmental parameters and Covid 19 spread. These studies draw up the conclusion that the Covid 19 transmissions were severe in regions where the temperatures are 3^{o} C to 11^{O} C and an absolute humidity of 3 to 9 gram per cubic meter (9, 10, 11, 12 & 13). These investigations also showed that an increase in environmental temperature by 1^{o} C decreased the spread of Covid 19 (14). Their study also gave some predictions on Covid 19 spread for the coming summer. As the environmental temperature increases in summer the Covid 19 infection rate will come down and it may reappear in next winter, when temperature and humidity will become favourable for the novel Corona virus.

Unfortunately, no attempt is made to study the lethal temperature of the novel Corona Virus or SARS CoV -2, the infective agent responsible for Covid 19. An attempt in this regard would have been rewarding, if the lethal temperature is known, provided it is bearable for the sinus, throat and lungs of human beings. Nevertheless, a search in the literature gave a silver line in a study by Lelie et.al. (15). Lelie and his team were trying to evaluate the manufacturing process for production of the vaccine against Hepatitis B virus. The vaccine they subjected to thermal processing after inoculating the vaccine with Tissue Culture Infectious Dose 50 ($TCID_{50}$) of different human infective viruses. $TCID_{50}$ is virus count required to infect 50% of the cells in the tissue culture medium. The study used 12 species of infectious viruses as inoculum in Hepatitis B vaccine evaluation, some of which were high heat resistant and some others were low heat resistant. The vaccine samples after inoculating with $TCID_{50}$ dose of each virus were separately subjected to a high temperature (103^{o} C) short time (1.5 minutes) heat treatment and a low temperature (65^{o} C) come up time (15 minute) heat treatment. The results of the low temperature come up time treatment obtained by Lelie et. el. (15) are reproduced below as it contains Mouse Hepatitis Virus (MHV), the Maurine Corona virus.

Virus name.	$TCID_{50}$ per ml before warming up.	$TCID_{50}$ per ml after warming up.
Vaccinia (poxvirus)	$10^{5.8}$	None.

EMC (picornavirus)	10^9	None.
Sindbis (togavirus)	10^{10}	None.
MHV (corona virus)	10^7	None.
Influenza (orthomyxovirus)	10^3	None.
VSV (rhabdovirus)	10^3	None.
CMV (herpes virus)	10^a	None.
HIV (lentivirus)	10^4	None.
MuLV (retrovirus)	10^4	None.

[a] Titer not known.

The Murine Corona Virus (MHV), a representative of the family of corona viruses (16), is a study subject in this group. The study clearly showed that 10^7 virus particles per ml were killed or made non infective by a 15 minutes heating process to attain 65 ^{o} C. Even though the experiment proved that the corona virus was killed by heating to 65 ^{o} C, the lethal temperature for corona virus, which can be a still lower temperature, was not clear as the object of the study was to find out a time temperature combination to eliminate human infective viruses and other representative viruses from Hepatitis B vaccine preparation.

Another study by Chan et.al. (17) revealed the effect of temperature and humidity on the survival the SARS Corona virus. The study concluded that SARS CoV can survive at least two weeks after drying at temperature and humidity conditions found in an air-conditioned environment. The virus is also stable for 3 weeks at room temperature in a liquid environment but it is easily killed by heat at 56 ^{o} C for 15 minutes. The lethality of SARS CoV at 56^o C was substantiated by WHO (18). In this study also the possibility of a still lower lethal temperature of SARS CoV is not ruled out. How ever, the study confirmed that heating at 56◦C for 15 minutes eliminated SARS CoV. Several recent studies by Ma et.al (11), Sajadi et.al. (12) and Brassey et.al. (14), on the environmental conditions causing the spread of Covid 19, has concluded that the spread of the pandemic is maximum at temperatures between 3^o C to 11^O C and the same is reduced as the temperature goes up by each degree. Obviously the SARS CoV 2 virus can be a psychrophilic, so that room temperatures are hostile for virus multiplication and spread and still higher temperatures are lethal for SARS Covid 19. Humidity also is reported to contribute to virus killing effect. Relative humidity below 20% and above 90% favour the spread of the pandemic.

Another tissue friendly parameter producing virus killing effect is salinity. There are several studies on lethal effect of salinity on viruses. In a study by Stallknecht, et.el (19) demonstrated that Avian Influenza Virus looses its infectivity at 2% salinity at a

temperature of 28^{o} C. Seo, et.al, (20) also investigated the resistance of Murine Noro Virus (MNV) and coliphage MS2, a culturable human norovirus surrogate, to temperature, salt concentration and pH. Virus inactivation was measured by plaque, real-time TaqMan reverse transcription (RT) PCR, and long-template RT-PCR assays. Both MNV and MS2 were rapidly inactivated at temperatures above 60^{o} C. Similarly, MNV tolerated low salt concentrations (0.3% NaCl) to a greater degree than high salt concentrations (3.3 to 6.3% NaCl). MNV was relatively resistant to strong acidic conditions (pH 2) and was more tolerant of slightly acidic (pH 4) and neutral (pH 7) conditions.

A study of the humidity and temperature of the inspiratory gases and expiratory gases play an important role in the success of ventilation, especially in lung infections requiring critical care. A temperature of 37^{o} C and a relative humidity of 100 % is considered good for performance of the ventilators (21). Most of the ventilators are provided with temperature and humidity control systems and operated for this criteria. Covid patients with critical breathing problems are are simple put on ventilator support in the absence of any effective medication. There are several studies stating that high humidity and temperature significantly reduce the survival of SARS CoV2 (11). There is also WHO report (18) that 10 ^{4} virus units of SARS CoV 2 can survive in virus culture medium with 1% bovine serum for at least one hour at 37 ^{o} C (after one hour, they will die) and at 56 ^{o} C die out completely in 15 minutes, based on studies at Queen Mary Hospital, The University of Hong Kong, Hong Kong, SAR China and National Institute of infectious Diseases, Tokyo, Japan. This data confirms that the temperatures between 37^{o} C and 56^{o} C are also lethal for SARS Cov 2, but the time of exposure shall be more than 15 minutes. Further Yang & Wang (22), reported Corona viruses are sensitive to heat and ultraviolet rays. According to this study the virus responsible for the present pandemic, SARS CoV -2 can be stored for several years at −80 °C and inactivated at 56 °C for 30 min (the most commonly used method to inactivate SARS-CoV-2 in the laboratory).

Evaluating the effect of humidity and temperature of inspiration gas on the trachea of the patient, Williams (24) concluded that temperatures of 43^{o} C to 45^{o} C and 100% relative humidity are safe for human trachea. The study also reported that to deliver inspiration gas at this temperature to trachea and down, the temperature of the incoming gases at the wye circuit of the ventilator shall be two or three degrees still higher. How ever studies are sparse on tolerance of higher temperatures by trachea or lung tissue and the standard practice in ventilation is 37^{o} C and a relative humidity of 75% at wye circuit of the ventilator (25). Eventually, the temperature of the inspiration gas reaching the lung tissues will be much less than the body temperature, which coupled with the significantly lower temperature of the CCU rooms will provide better survival for the SARS CoV 2.

In the study by Casanova et.al. (8) involving Murine Hepatitis Viruses (MHV) and Transmissible Gastro Enteritis Virus (TGEV), which are excellent surrogates for SARS CoV infection studies, **it was revealed that elevated temperatures of 40^{o} C and 80% Relative Humidity** both viruses were inactivated more rapidly at 40°C than at 20°C. Unlike the results at 20°C, the loss of infectivity at 40°C was more rapid at 80% RH than at 50% RH. The same study also reported that the virus inactivation is attributed to enhanced Maillard reaction occurring between the amino acids and sugar molecules in the virus particle and virus inactivation at air water inter phase, both which are less at lower temperatures and relative humidities <20% and above >80 %.

The SARS CoV 2 virus entry in human body is mainly through nostrils and mouth and the first settlement of the virus is in the para nasal sinus (the air cavities in the cranial bones of face) and the throat, which happens in the first three days of infection (23).

The virus then spread into the lungs, where severe infection causes respiratory arrest and death. The initial infection to severe disease takes at least five days to two or three weeks. As per the WHO report the first five days of infection generally brings about one or more of the typical signs and symptoms like fever (87.9%), dry cough (67.7%), fatigue (38.1%), sputum production (33.4%), shortness of breath (18.6%), sore throat (13.9%), headache (13.6%), myalgia or arthralgia (14.8%), chills (11.4%), nausea or vomiting (5.0%), nasal congestion (4.8%), diarrhea (3.7%), and hemoptysis (0.9%), and conjunctival congestion (0.8%). People with COVID-19 generally develop signs and symptoms, including mild respiratory symptoms and fever, on an average of 5-6 days after infection (mean incubation period 5-6 days, range 1-14 days) (8).

From the scientific results above an effective Covid 19 management procedure is suggested. Individuals with any one or a combination of the Covid 19 symptoms particularly fever, dry cough, fatigue, shortness of breath or head ache shall start steam inhalation for five minutes, three times a day or more frequently, till the above symptoms disappear. The temperature of steam air mix reaching the nose and throat shall be between 50 to 60^{o} C. This will expose the invading virus particles in the sinus, the throat, mouth, the larynx, the trachea and portions of the lungs to a temperature of 50^{o} C to 60^{o} C, which can kill/inactivate the viruses in the course of two or three days. Side by side 3% hot saline at 56^{o} C to 60^{o} C, can be gargled two to four times a day to kill the virus in the throat. (suitable temperature tolerable to the patient between 50^{o} C and 60^{o} C can be selected. Saline gargling will not eliminate the virus in sinus, but it will support faster recovery from the illness).

Those who are seriously ill with breathing difficulty shall be put on Active Ventilator or Heat and Humidity Ventilators with temperature and humidity control, in such a way that the inhaled air temperature shall be 40^{o} C to 56^{o} C (select the temperature subject to

patient tolerance and other clinical parameters) and the relative humidity is between 70% to 80%. The temperature application can be suitably dosed at tolerable intervals so that clinical problems of continued inhalation of hot gases can be minimized and the corona virus in the lung can be effectively controlled/eliminated. Usually the temperature of ICU rooms will be 18 to 20^{o} C, favourable for the virus multiplication. The ICU room temperature for covid patients shall be maintained at 26^{o} C or above.

For the general public the prevention and control measures recommended below by WHO and various national health authorities can be followed.

Effectiveness of entry and exit screening.
Effectiveness of the public health control measures and their socio-economic impact.
Restriction of movement.
Social distancing o School and workplace closures.
Wearing mask in general public.
Mandatory quarantine.
Voluntary quarantine with active surveillance.

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