## Review Article

# Mask for All – Physical & Immunological Barrier of COVID 19 !

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The COVID-19 pandemic which started in late 2019 is still continuing unabated, rather with resurgence of cases in certain areas globally. Even with the emergency use authorization of several vaccines and extensive vaccination programs, we are yet to bring the pandemic to its knees. The present scenario has more than ever highlighted the importance of face masks in controlling the infection and transmission of the SARS CoV2 virus. In this review article, we discuss the evidence available to date to support the use of masks as a protective barrier to limitvirus entry. We also discuss how masks indirectly help stimulate protective immune responses and provide a comparative glimpse on the characteristics of various masks.

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The whole world is now waiting eagerly to be vaccinated against SARS-CoV2 virus. A few vaccines are already being used by several countries to vaccinate their citizens while many others are in advanced stages of development. A vaccine is a product that stimulates a person's immune system to produce immunity to a specific disease and protects the person from that disease[1]. Vaccination is a form of active immunization. Vaccine is a biologic in the form of an antigen, as a whole, killed (inactivated) organism; attenuated (live) organism; or a specific protein or peptide constituent of an organism which is responsible for active immunity against infectious diseases, cancers and a few auto-immune diseases[2]. A face mask is obviously not a vaccine as per definition. In a lighter sense, it generally shows an immense preventive role in COVID 19 pandemic. Masks reduce transmission of COVID 19 infection, decrease viral load and in turn trigger both T cell and B cell immunity. It is neither a biologic, antigen (whole, killed or inactivated organism), live attenuated organism nor a protein or peptide constituents of organism; mask is a protective barrier which limits virus entry and indirectly helps stimulate protective immune responses.

***Editor's Comment :***

- Masks reduce transmission of COVID 19 infection, decrease viral load and in turn trigger both T cell and B cell immunity
- Adherence to the universal face-covering policy helps to mitigate the spread of SARS-CoV-2.
- Along with its use, proper storage, cleaning and disposal of masks are essential to make them as effective as possible.

On April 3, 2020 the Centre for Disease Control, USA (CDC) had recommended cloth face coverings due to frequency of asymptomatic transmission. They had used the slogan – "protect others". This slogan was updated on September, 2020 in California – "protect yourself and others".

Table 1 suggests that use of any type of mask is probably going to decrease viral exposure and infection risk on a population level. Use of mask in outdoor and in specific indoor cases should be mandated by the Government till any new conflicting evidences are generated.

Table 1 — *Level of Exposure and Wearing Mask*[3]

| COVID 19 Carrier | Risk of Spread | Healthy Person |
|---|---|---|
| Without Mask | High | Without Mask |
| Without Mask | Moderate | With Mask |
| With Mask | Low | Without Mask |
| With Mask | Extremely Low | With Mask |
| With Mask | No Risk (with 6 ft Social Distancing) | With Mask |

## Evidences :

In a study with 9850 health care workers it was found that 1271 (12.9%) had positive results for SARS-

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CoV-2. During the pre-intervention period (not using universal mask) it was observed that the SARS-CoV-2 positivity rate increased exponentially from 0% to 21.32%, with a weighted mean increase of 1.16% per day and a case doubling time of 3.6 days (95% CI, 3.0-4.5 days). During the intervention period, with initiation of universal mask usage, the positivity rate decreased linearly from 14.65% to 11.46%, with a weighted mean decline of 0.49% per day. The net slope change was 1.65% (95% CI, 1.13%-2.15%; P<0.001). There were more declines per day compared with the pre-intervention period. Results of this study support universal masking as part of a multipronged strategy in health care settings to reduce infection[4].

In another report it was found that 139 clients of a salon were exposed to two symptomatic hair stylists with confirmed COVID-19. The stylists and the clients wore face masks. There were no reported cases of secondary symptomatic cases. Among 67 clients tested for SARS-CoV-2, all test results were negative[5]. It was concluded that adherence to the universal face-covering policy helps to mitigate the spread of SARS-CoV-2.

## A Few Important Statements :

*"Handwashing, physical distancing and use of mask in public and work places will help us to overcome this difficult time" — Prof (Dr) Balaram Bharghava DG-ICMR*

*"These facemasks are the important, powerful public health tool we have ... I might even go so far as to say that this face mask is more guaranteed to protect me against COVID than when I take a COVID vaccine." CDC Director, Sept 16*

*"Well, if people are not wearing masks, then may be we should be mandating it" — NIAID Director, October 23, 2020*

## Mask, A Double Edged Sword to Fight against COVID-19 ?

It is important to explore the right answer to COVID 19 pandemic, to find whether some agents can reduce the transmission rate and decrease morbidity. Universal mask usage can efficiently address these two issues. Universal mask use can decrease both infectivity and severity of COVID 19 virus infection. Different epidemiological studies suggest that approximately 40-45% of infected persons with SARS-CoV-2 virus remain asymptomatic. These studies suggest that the virus might have greater potential to spread silently among man. Asymptomatic persons can transmit SARS-CoV-2 to others for longer than 14 days. The absence of COVID-19 related symptoms in persons infected with SARS-CoV-2 might not necessarily signify an absence of harm[6]. Depending on the type, masks can be used for either protection of healthy persons or to prevent onward transmission (source control).

## Types of Masks :

Medical masks are recommended for all health workers and in clinical settings, for those who are symptomatic, anyone awaiting COVID-19 test results or who are tested positive and the caregivers of these patients[7].

Universal masking in health facilities is defined as the requirement for all persons (staff, patients, visitors, service providers and others) to wear a mask at all times except for when eating or drinking[8].

Recommendation of medical mask also includes people aged >60 yrs, people with severe chronic comorbidities like chronic respiratory disease, cardiovascular disease, cancer, obesity, DM and immune compromised patient.

Non-medical, fabric masks or cloth mask can be used by the general public under the age of 60 and who do not have underlying health conditions. It should meet three essential parameters-filtration, breathability and fit[7,8].

Medical masks (also known as surgical mask) are composed of three layers of synthetic non-woven materials, configured to have filtration layers sandwiched in the middle. They are available in different thickness and have various levels of fluid resistance and filtration. They are single use disposable masks[8].

Respirators (also known as filtering face piece respirators - FFP) are available at different performance levels such as FFP2, FFP3 (EU Standard), N95, N99 (NIOSH certified). Such masks have high fluid resistance and provide protection to the wearer from droplet of infectious material emitted during coughing/sneezing/talking[9].

Medical masks and respirator masks are similar in terms of protective value. However respirators are specific for certain procedures because they have a tightly fitted component to them.

WHO does not recommend masks or respirators with exhalation valves.

Along with its use, proper storage, cleaning and disposal of masks are essential to make them as effective as possible (Table 2).

## Masks Reduce Virus Inoculum :

90-95% viral particles filtered via N95 masks and 65-85% viral particles are filtered via cloth or surgical masks, if used properly. Less viral inoculum leads to an advantageous position for hosts. Reduced viral

Table 2 — *Comparative characteristics of different types of face masks*[10]

| | Multilayered Cloth Mask | Medical Mask | N95/N99 Mask |
|---|---|---|---|
| Filtration efficacy | 50-70 % | 99% particles >0.3 µm; 75% particles <0.3 µm | 99.9% particles >0.3 µm; 85 % particles <0.3 µm |
| WHO recommendation for use | General public use | People at high risk of COVID-19, those with COVID-19 and healthcare workers | People at high risk of COVID-19, those with COVID-19 and healthcare workers |
| Reusability | Yes | No | Cautious reuse due to availability constraints |
| Washing/ treatment methods before reuse | Washed daily or immediately after use with soap and warm water | Single use | Can be cautiously reused hydrogen peroxide, dry heat pasteurization, ultraviolet irradiation and moist heat |

inoculum could be responsible for less viral disease. LD50 is defined as the virus dose at which 50% exposed hosts die. This is generally determined via experiments in which a range of doses are injected to animals to calculate a dose-mortality curve. Many animal studies have shown dose-response for other viruses. Increase in virus inoculum is directly proportional to virus related morbidity and mortality. In Syrian hamster model study, micro-CT analysis had revealed that severity of the pulmonary abnormalities is related to the degree of infectious dose of SARS COV-2[11]. Upper respiratory tract viral RNA replication, distinct lung pathology and post viral fatigue were observed most consistently in the high virus inoculum dose group in ferret model of SARS-CoV-2 infection[12]. As masks can reduce virus inoculum, it will reduce the infection associated morbidity and mortality. In golden Syrian hamster SARS-CoV-2 model it was found that non-contact transmission was 66.7% (10/15) of exposed naive hamsters. Surgical mask partition had significantly reduced transmission to 25% (6/24, P = 0.018) and surgical mask partition for challenged index hamsters had shown significantly reduction in transmission to only 16.7% (2/12, P =0.019) of exposed naive hamsters. Intervention with surgical mask partition had shown lower clinical scores, milder histopathological changes, and lower viral nucleocapsid antigen expression in respiratory tract tissues[13]. Though human studies are rare due to valid ethical reasons; a few studies support this hypothesis. Challenge studies[14-16] have been conducted in human volunteers by injecting wild-type influenza A at different doses. It was found that higher doses are associated with more severe disease manifested by more severe cough and shortness of breath.

## Lessons from 1918 – 1919 Influenza Pandemic :

The second wave of pandemic generally produces less severe pathology due to development of immunity but the influenza pandemic of 1918 was an exception. Scientists postulated that exposure to higher infectious dose with 2nd wave after May 1st, 1918 was associated with higher mortality[17]. So before the start of the second wave of COVID 19 pandemic, it is extremely important to strengthen preventive measures so that history is not repeated.

## Interesting Evidences :

In one study conducted among health care workers it was found that most infections had occurred at the early stage of the epidemic, when there were lacks of protective measures[18]. Another study suggested that social distancing can reduce the speed of the spread of SARS-CoV-2 in a cohort of young, healthy soldiers. This study had suggested that social distancing and other preventive measures can induce an immune response by colonizing in nasal passages. Dose of viral inoculum during infection or mode of transmission may determine the clinical course of COVID-19. Out of 354 soldiers, 30% fell ill from COVID-19. They were infected prior to the implementation of social distancing. In a group of 154, no soldiers were suffering from COVID-19, where infections appeared after implementation of social distancing. Despite the detection of viral RNA in the nose and virus-specific antibodies within this group, no soldiers were suffering from any symptoms[19]. The question which arises is whether we are getting more asymptomatic carriers due to the use of masks. Cruise ships experiences are good experiments in this case as they are closed settings. In one study, researchers had conducted statistical modelling on publicly available data to analyze the asymptomatic proportion among the COVID-19 cases on board the Diamond Princess cruise ship. Their estimated asymptomatic proportion was 17.9% (95%CI: 15.5–20.2%)[20]. Another Japanese study had shown similar results. They had shown asymptomatic COVID 19 patients were 33.3% (95% CI: 8.3–58.3%) among the Japanese citizens who were evacuated from Wuhan[21]. After an Argentine ship had an outbreak, they gave surgical masks to all the passengers and N95 masks to all crew members. It was found that 128 out of 217 passengers and staff eventually tested positive for SARS-CoV-2, but majority

of the positive patients (81%) remained asymptomatic[22]. Another study in a pediatric hemodialysis unit had shown a high prevalence of subclinical seroconversion while using masks. Two out of 11 health care workers who were involved in caring for two patients with subclinical seroconversion developed SARS-CoV-2 antibodies. Health care workers had not developed any symptoms. All seroconversions were associated with no symptoms.[23] Different media reports also point to the fact that usage of masks reduces the disease severity while increasing the proportion of asymptomatic COVID 19 patients. It was reported that 95% asymptomatic cases out of the total people affected in outbreaks in Oregon seafood plant and Arkansas Tyson chicken plant after issuing mandatory mask regulation. Initially there were more illness and sufferings among the workers[24]. In a SEIR model [susceptible (S), exposed (E), infectious (I) and recovered (R)], it was shown that social distancing would reduce 50% of infection whereas masking would decrease infection in 80% of the population. This model had also suggested that universal masking at 80% adoption would be responsible for 60,000 deaths but a strict lockdown would result in 1,80,000 deaths. At only a 50% adoption rate of masking was not shown to be sufficient to prevent continued spread and eventually results in 2,40,000 deaths. That study group had also suggested that replacing the strict lockdown with social distancing without masking results in exponential COVID 19 infection spread.[25]

## Mask & Immunity :

Host immune responses play major role in pathogenesis in viral infections. High doses of viral inoculum can devastate innate immune defenses which can lead to dysregulation of innate immunity. Dysregulated immunity has increased severity of viral infection[26]. Use of mask in an appropriate way can reduce viral load and may be beneficial for patient by preventing disease severity. Asymptomatic or patients with mild infection would experience strong T-cell & memory B-cell immunity. CD4+ and CD8+ T cells, along with other factors, help in producing a coordinated immune response, first resolving an acute viral infection and then producing protection against reinfection. There is a certain difference noted between immune response directed against SARS-CoV-2 versus SARS-CoV-1. Immune response after SARS-CoV-2 represents broader spectrum compared to SARS-CoV-1. T cell mediated immunity is largely specific for spike protein. In a study it was shown that the breadth and magnitude of the T cell response is greater in more severe COVID 19 patients. But the proportion of the T cell response that is related with CD8+ (rather than CD4+) T cells is higher in mild infections[27]. This finding is consistent with findings in another study. This study had shown higher percentage of activated and proliferating CD8+ T cells production in mild as compared to severe COVID-19[28]. These findings emphasize the protective role for SARS-CoV-2-specific CD8+ T cells. In infected lung in mild COVID 19 patients, a greater proportion of clonally expanded CD8+ T cells were found[29].

## Conclusion :

Mass vaccination would take time to reach every corner of the world. Available vaccines are developed in a compressed timeline which raises questions on their safety and efficacy. We do not have any data regarding their long-term safety. Appropriate use of masks, which is cheap and accessible, could be an effective way to fight against this epidemic. Resource constrained countries should adopt universal mask use protocol as a strict regulatory policy. A behavioral change with effective health education is extremely important in this perspective. Mankind has faced challenges of COVID 19 pandemic very recently but there are many more challenges like air pollution, threats of other non-communicable diseases like tuberculosis etc., where policies for universal, appropriate mask usage would help mankind approach these problems holistically.

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