

Application of Nanoscience in the Diagnosis of Covid19 with “KJ’s Covid Tracker” – A New Innovation.

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Abstract

This Covid 19 (Coronavirus Disease 2019) pandemic has really challenged the medical fraternity as well as scientists all over the world. All are trying to find a permanent solution for this dreaded RNA virus which is resistant to most of the drugs. It has cost a heavy burden on valuable human lives and economy of the world. The SARS-CoV-2 (Severe Acute Respiratory Syndrome-Coronavirus-2) is a new respiratory virus that needs immediate diagnosis. To prevent the infection during the contact with COVID 19 affected persons and aerosol spread, we are protecting with face masks and eye protection with shield or specs. Currently, all SARS-CoV-2 detection measures make use of RT-PCR test, and its results are generally reported as either positive or negative, which tells us if a person is infected or not. It's important to know that the RT-PCR test does not provide the additional measure of the viral load in the sample. So, we felt that the diagnosis of COVID 19 must be made simple, painless and with less chance of cross infection of spread to the doctors, nurses, paramedics and all the frontline warriors. In this study we introduce the non-invasive technique to identify the COVID-19 using nanopotential of the skin and the other blood parameters.

Key words: Zetapotential, Non-invasive, KJ's Covid Tracker, SARS-CoV-2, COVID 19, Pandemic.

Introduction

The SARS-CoV-2 is a respiratory virus, which was first reported in the city of Wuhan, China in late December 2019. There now more than 117 million cases of COVID-19 affecting 219 countries and caused 2.61 million deaths as of 25th August 2020. It is a highly infectious and contagious pathogen more infectious than toximar SARS. The most common symptoms of COVID-19 are fever, dry cough and tiredness. Other symptoms include headache, sore throat, diarrhoea, anosmia or ageusia. To start with the symptoms

the severity of the disease varies from mild to moderate. Only of every 5 people who gets COVID-19 becomes severe form of COVID manifestations and develops difficulty in breathing. Aged persons having common comorbidities like high blood pressure, heart and lung disease, diabetes are at risk of developing severe illness. All the organs and systems are involved in COVID 19 infection. Prominently lung, liver, brain and in some patient's kidney also gets affected. Our previous work on preventing blood clotting and microbial colonization in the prosthetic valve using Nano technology and it's physico chemical effects lead us to the study of Nanopotential/ Zeta potential. The Number of nanoparticles Vs the biological effects, the anticoagulant and antimicrobial effect reached a peak at 10,000 ablation pulses. After that the anticoagulant effect reduces when the ablation pulses are increased to 12,500 and attains a plateau thereafter. The antimicrobial effect decreases after 10,000

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Received: January 2021

Accepted: February 2021

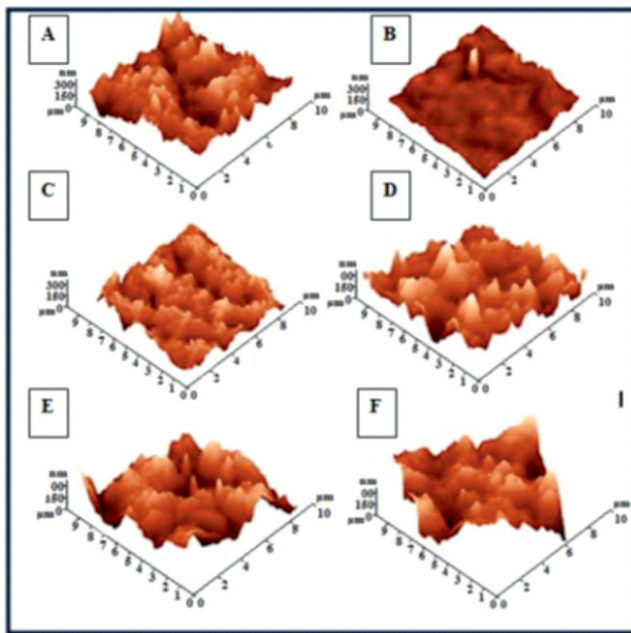


Figure 1: Representative AFM image of (A) non coated Pyrolytic Carbon, Silver Nanoparticles deposited on Pyrolytic Carbon: (B) 5,000 ablation pulses, (C) 7,500 ablation pulses, (D) 10,000 ablation pulses, (E) 12,500 ablation pulses, and (F) 15,000 ablation pulses

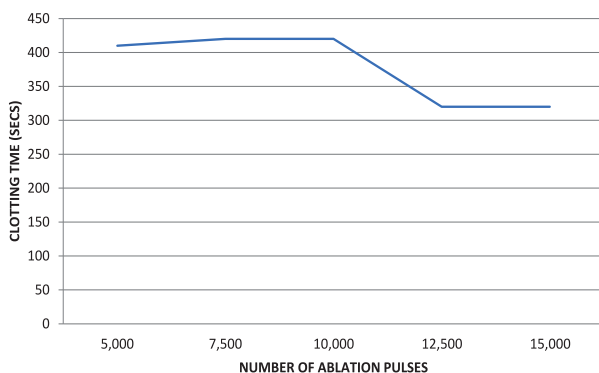


Figure 2: Representation of Anti-coagulation effect of Copper Nanoparticles deposited on Pyrolytic carbon.

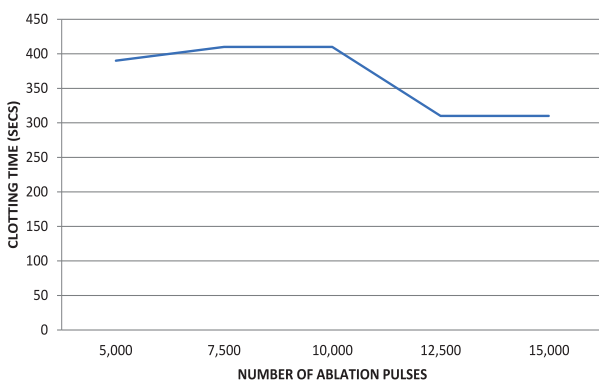


Figure 3: Representation of Anti-coagulation effect of Silver Nanoparticles deposited on Pyrolytic carbon.

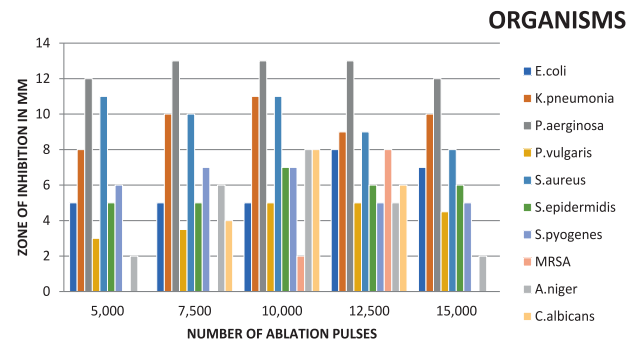


Figure 4: Representation of Antimicrobial effect of Silver Nanoparticles deposited on Pyrolytic carbon.

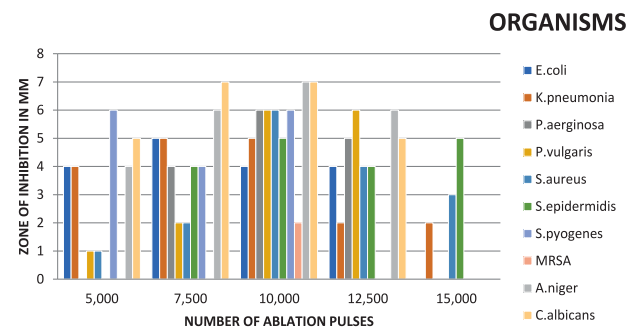


Figure 5: Representation of Antimicrobial effect of Copper Nanoparticles deposited on Pyrolytic carbon.

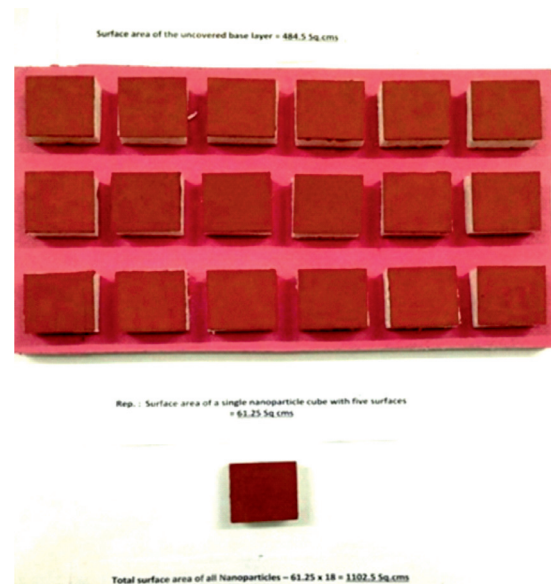


Figure 6: Physical model of Nanoparticles cubes deposited at intervals between each other on the uncovered base.

ablation pulses and reduces thereafter. This has been demonstrated with graphs using the data obtained from our previous work [7].

We had attempted to draw a physical model to decipher the mismatch between the number of nanoparticles Vs the biological effects.

Presuming the Nanoparticle model as a cube, the physical model is made by fixing the nanoparticle model with interval from each other on the uncovered base layer. The length and the width of the uncovered base surface was taken as 28.5 cms and 17 cms respectively. The measurement of one side of a model nanoparticle cube was 3.5 cms. The number of nanoparticle cube models taken were 18. The sixth surface i.e., the surface fixed to the uncovered base was not taken for calculation (**Figure S1**).

The surface area of the intervals between the nanoparticle cube models was calculated as follows:

The surface area of the uncovered base layer = 484.5 sq.cms.

The area of the sixth surface fixed to the uncovered base layer- $3.5 \times 3.5 = 12.25$ sq.cms.

The area of the sixth surface of all the 18 nanoparticle cube models- $12.25 \times 18 = 220.5$ sq.cms.

The surface area of the cube with five sides - $3.5 \times 3.5 + 1.3 \times 4 = 30.5$ sq.cms.

Hence, the surface area of the intervals between the nanoparticle cube models- $484.5 - 220.5 = 264$ sq.cms.

Therefore, the total surface area of the nanoparticle cube models fixed on the uncovered surface- $1102.5 + 264 = 1366.5$ sq.cms. i.e., 2.8 times greater than the uncovered base layer's surface area. This suggests that there will be an increase in the physicochemical effect which will lead to the increase in antibacterial, antifungal and anticoagulant effects of the mechanical valve used for heart valve replacement surgery.



Figure 6: The Physico chemical effect of the Nano particle in a cube model

This work of measuring physico chemical effect of Nano particles lead us to the study of zetapotential of the nanoparticles and on the surface of the human tissue also.

Hence, we tried to apply the Nanopotential in the diagnosis of Covid 19.

SARS CoV-2 VIRUS

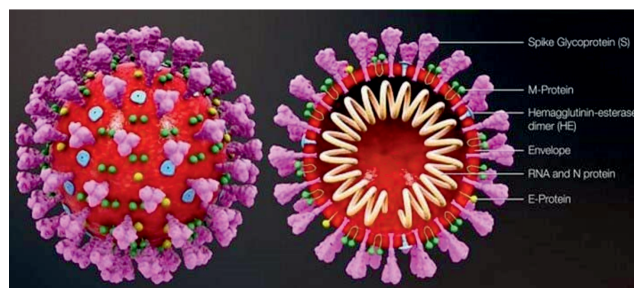


Figure 7: 3D model of the SARS CoV-2 Virus

Coronavirus are a group of related RNA viruses that cause diseases in mammals and birds. In humans and birds, they cause respiratory tract infections that can range from mild to severe and death. Birds covid19 virus has 88% of genetic similarity with human covid19 virus. Mild illness in humans include some cases of common cold while more lethal varieties can cause SARS, MERS (Middle East Respiratory Syndrome) and COVID-19.

The stages of coronavirus replication include binding to a host cell surface receptor, cell entry, virion uncoating, transcription synthesis, translation of replicase proteins, virions assembly and release of mature virions into the extracellular space, where the cycle can begin again. The virion is an enveloped particle surrounded by a protein shell called capsid. It is made up of spike, envelope, membrane, nucleocapsid proteins.

Pathological changes in various organs of human body

In Lungs Diffuse alveolar damage, Lymphocyte Infiltration, Giant/Hyper plastic pneumocytes, Intra-alveolar fibrin deposition, Exudate formation, viral particles within pneumocytes, Hyaline membrane formation were noted.

In Liver Hepatocyte degeneration, congestion of hepatic sinuses, Fibrosis of portal tracts, Leukocyte infiltration in the portal tracts, Alteration of vascular structure, Atypical arrangement of intrahepatic blood vessels were noted.

In Spleen Reduction of cell composition, Atrophy of white pulp, Neutrophil and plasma infiltration, Atrophy of corpuscles, Fibrosis of sinuses, Reduction or absence of lymphoid follicle were noted.

In Brain Haemorrhagic white matter, Axonal injuries, Leukocytic infiltration, ADEM (Acute disseminated encephalomyelitis) like appearance were noted.

In skin Perivascular inflammatory infiltration, Acantholytic suprabasal clefts, dyskeratotic and ballooning herpes- like keratinocytes, keratinocytes necrosis, Mucin Deposition in dermis and hypodermis are seen. The Skin biopsy of the Covid 19 patient in Fig. 8 & 9 describes the Capillary sized vessels lined by plump endothelial cells with scant

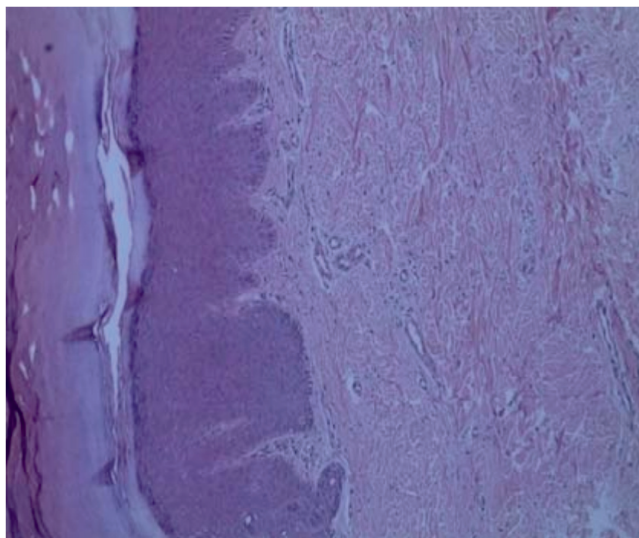


Figure 8: Skin Biopsy of Covid 19 Patient in low power magnification

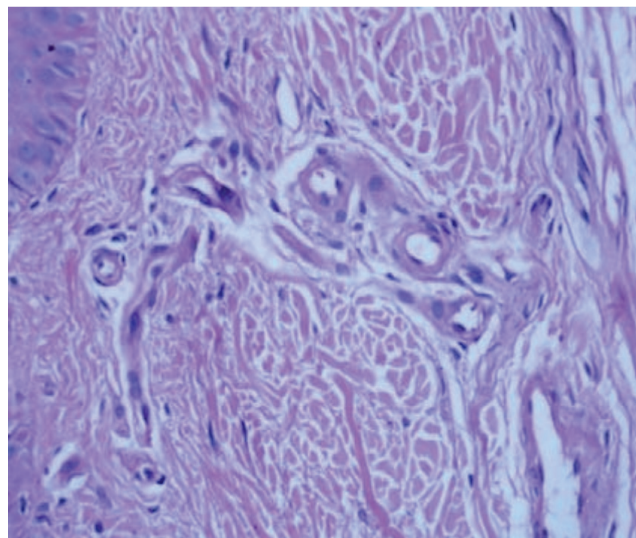


Figure 9: Skin Biopsy of Covid19 Patient in high power magnification

perivascular lymphocytic infiltrate in the dermis [1].

Materials and Methods

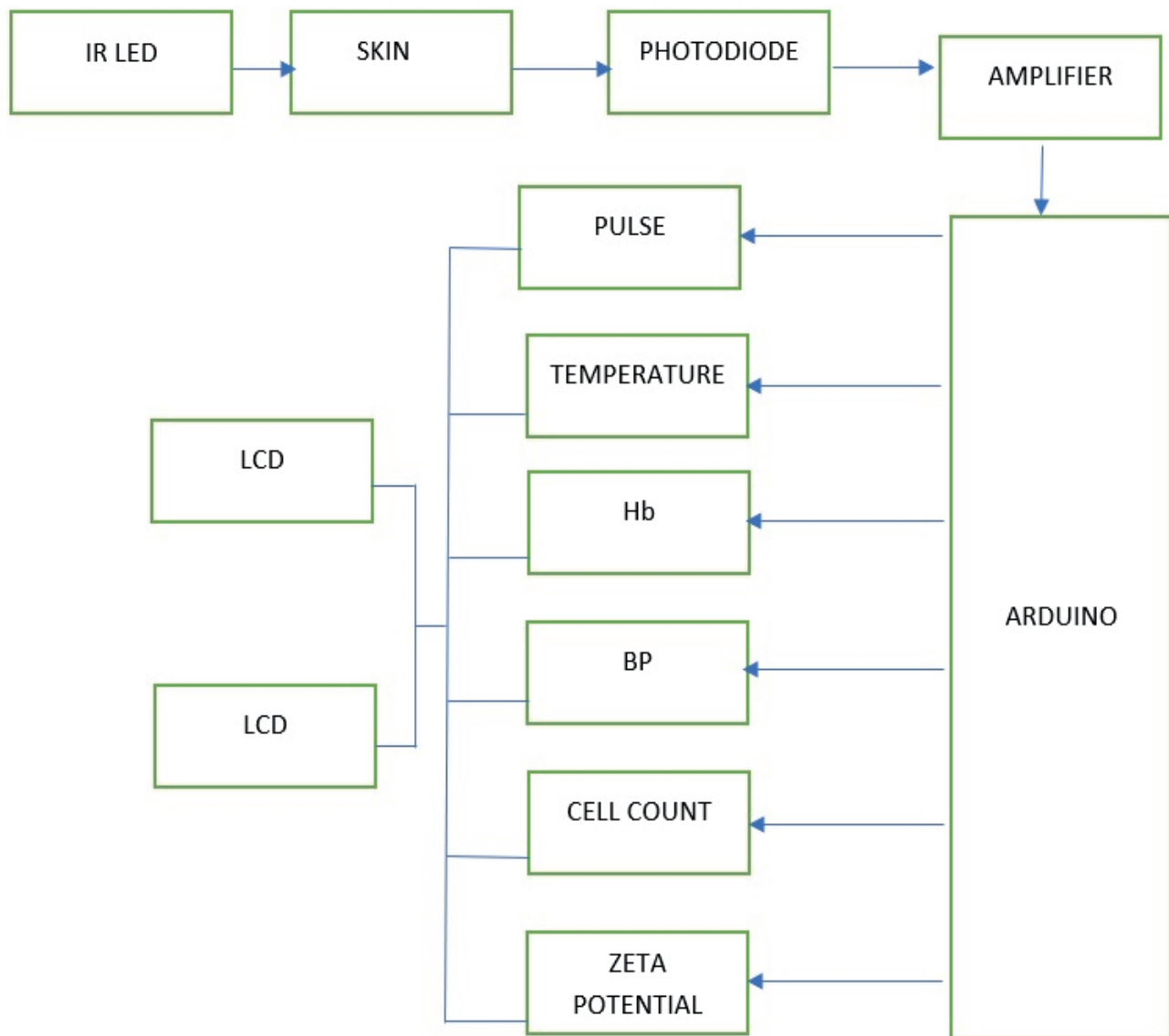
In COVID infected patient's leucopenia, lymphopenia and eosinopenia are seen, temperature raise, increase in pulse rate, low oxygen saturation were noted [3]. Blood & nasopharyngeal swab samples collection for RT-PCR, X-ray, Ultrasound, CT chest, liver, heart, lung will conform the diagnosis. The sample collections & processing of all the above diagnostic tests which involves time and high chances of the frontline workers getting infected. Here we introduce the application of nano potential or zeta potential for the diagnosis of Covid 19. Zeta potential/ nano potential is the electrical potential of the Surface of the human tissue. It is measured in Volts and millivolts. We measured Zeta potential from the skin of COVID infected patients and normal control and that there is a substantial difference in zeta potential is noted. The normal range of zetapotential of a healthy individual ranges from +22 to +24 millivolt. The zetapotential of the SARS CoV-2 is found to be -25mV. The zeta potential of the therapeutic drug of Covid 19-Remdesivir is +30mV. KJ's Covid tracker works when the person with the plastic gloved hand touches the device, it records certain data like zeta potential, pulse rate, temperature, respiration, blood pressure, oxygen saturation, Hemoglobin, total White Blood Cell count, Total Red Blood Cell count, Total Platelet count and differential count of white blood cells [2]. The device can be connected to the computer, laptop or mobile phones to view the results. The crucial diagnosis pointer is the nano potential or zeta potential is measured from the skin which is much lower in Covid19 infected patients. By collecting all these data non-invasively, one could come to a conclusion whether the patient is affected or not. All the patients subjected to the study are well informed about the procedure and then consent form is obtained. Infants,

Children and Patients having skin inflammations and injuries on the hands were not included in the study. This comparative study was conducted in two major government hospitals in Chennai after getting the ethical clearance. Total Number of patients were 489 in number with 293 males and 196 females aging from 35 years to 70 years and the control was 80 cases (40 males and 40 females). The results of RT-PCR and hematological parameters from the laboratory were collected and compared with the results of KJ's Covid tracker. Both the results were analysed statistically.

We have used biosensors to measure zeta potential, Pulse, Temperature, Spo2, Respiration, BP, Blood cell counts, Total Platelet count, Hb, Smell and Taste using Arduino Software. They are entirely non- invasive and radiation free.



Figure 10: KJ's Covid tracker



Block diagram of KJ's Covid tracker



Figure 11: Working model of KJ's Covid tracker

KJ COVID TRACKER REPORT	
Name:	
zeta potential 23.2	
COVID NEGATIVE	
BP	: 124/86
Temp	: 98
pulse	: 100
Spo2	: 99
Hb	: 15.5
TOTAL RBC(Millions/cumm)	: 4.7 [NORMAL RANGE 4.7 TO 6.1 %]
TOTAL WBC(micro/liter)	: 13249 [NORMAL RANGE 4500 TO 11000 %]
PLATELET(micro/liter)	: 295000 [NORMAL RANGE 150000 TO 400000]
DIFFERENTIAL COUNTS:	
NEUTROPHIL(%)	: 51% [NORMAL RANGE 40 TO 60 %]
EOSINOPHIL(%)	: 1% [NORMAL RANGE 0 TO 6 %]
BASOPHIL(%)	: 1% [NORMAL RANGE 0 TO 3 %]
LYMPHOCYTE(%)	: 38% [NORMAL RANGE 20 TO 40 %]
MONOCYTE (%)	: 5% [NORMAL RANGE 2 TO 8 %]

Figure 12: Result Format of KJ's Covid tracker

Results

Both the results are compared and statistically analysed. The statistical significance of KJ's Covid tracker with the current diagnostic methods was found to be extremely significant as its P value obtained is 0.0001 and its standard deviation is 20.8. The zeta potential of the healthy individuals were ranging from +22 mV to +24mV and zeta potential of the Covid infected patients was found to be much lower than the controls. Hence, we considered the zeta potential of the controls as normal values and asymptomatic patients and patients with mild to severe infected patients ranging from +15mV to +5mV as covid positive values. **The accuracy of the zetapotential and the RT-PCR was found to be 100%.** The accuracy of the haematological parameters of both laboratory and the KJ covid tracker was found to be 97.8%. The overall accuracy of KJ's Covid tracker with the current diagnostic methods of Covid 19 was found to be 98.2%.

Conclusion

This device is Simple, cost effective, Painless, non-invasive, radiation free with results obtained on the screen within 5-7 seconds, and the accuracy is found to be 98.2% and less chance of cross infection. It mainly prevents cross infection for the frontline workers. The factory workers and any major political, religious or scientific gatherings could be screened at the entry point and it is very useful for the professionals who are in public life like doctors, lawyers etc. come into contact with the cross section of the society.

Acknowledgement

This case study was supported by K. J. Hospital Pvt Ltd, we thank Dr. Sugathan, Professor, Department of dermatology, Calicut Medical College and Dr. Mamtha George, Assistant Professor, Department of Pathology, Calicut Medical College, Calicut for providing us the details skin biopsy of Covid19 infected patient. We also thank our colleagues Mr. Vikraman and Mr. Lakshmanan, Sonographers of K. J. Hospital for helping in the designing of the KJ's Covid tracker.

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Conflict of interest:	All authors declare no COI
Ethics:	There is no ethical violation as it is based on voluntary anonymous interviews
Funding:	CSR Funds from K. J. Research Foundation
Guarantor:	Dr. K. Jagadeesan will act as guarantor of this article on behalf of all co-authors.

