Review Article

Wearable devices and mHealth: The significant applications in COVID 19 Pandemic

ABSTRACT:
Wearable devices (WDs) and mHealth (Mobile Health) give you the healthcare services, overcoming geographical, temporal or even organizational obstacles. Wearable technologies will have non-encroaching and sovereign devices that collect save and examine physiological information that will certainly help to improve patient health. It has been used so far for fitness purposes. But with increasing demand by patients and health care workers, wearable devices have also been developed to monitor patient health-related issues. It collects and analyses data. In some scenarios makes a sensible decision and provide a suitable response to the users. Now a day, mobile applications have also proven effective in the field of medicine with the motto of giving personalized treatment to disease control. Advanced technology in wearable gadgets has become a great aspect of our day-to day life in addition to the health care industry.
A global pandemic that the world is facing in the form of COVID19 has come up with the importance of clinical research and technologies which help to tackle COVID 19 infection worldwide in an exceptional manner. While expected results have been found on effective use of wearable devices and mHealth systems to study the structure of COVID 19 and upcoming infectious ailment. The objective of this review is to test permitting technologies and structures with diverse utility to deal with the COVID 19 disaster. This review acknowledges the researchers of the wearable devices and mHealth systems which proved their significance in the present pandemic. Also, this review explains the exceptional tracking devices, which include heart rate, temperature and oxygen monitoring that, are used to diagnose COVID 19 patients.

KEYWORDS: mHealth, wearable devices, wearable technology, COVID19

Introduction:

mHealth (mobile health) is defined by the World Health Organization as "scientific and public health exercise supported by using cellular devices, consisting of cellular phones, patient tracking gadgets, private digital assistants, and other wireless devices." mHealth is an abbreviation of mobile Health for the practicing of medicine and public health that is assisted by mobile devices. mHealth is used for practice of public fitness practice supported through mobile device. It includes various high-quality apps referenced for use in mobile communication devices together with cell phones, computer systems, tablets, Personal Digital Assistant (PDA) for fitness care and records. Wearable devices are the small digital gadgets implanted in an object that connect to the actual gadget and have algorithm functionality. It applies to protecting a device through clothing and wearable accessories (eg. glasses, contact lenses, watches) or additional devices (eg. pocket tool to measure steps) [1].

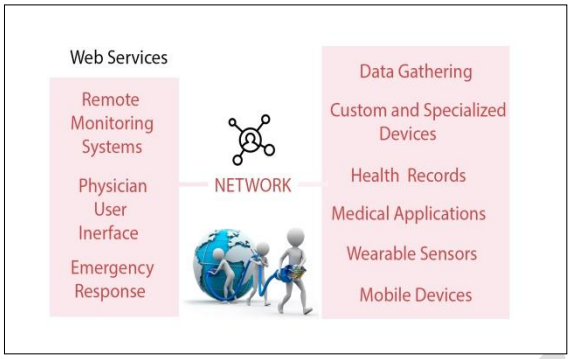

Figure 1: Typical architecture of mHealth service

Services of mobile Health (mHealth):

mHealth provides facilities with the help of internet and web services through the various technologies such as mobile apps, mobile devices, wearable sensors, etc. for interaction between the patient and doctor. M-fitness is the new innovative technology. It monitors health-related conditions every time, and everywhere, phenomenal to geological, temporal, as well as central boundaries.

The typical architecture of the mHealth services shown in figure 1. mHealth technology and their parallel strength as a utility have a robust effect on everyday medical management tracking, detecting and give warning structures, physiological and organizational statistics collection, file preservation, health related schemes, scientific records perceptions, monitoring structures, drug counterfeiting, and robbery.

Normal mHealth offerings designs utilize the internet and net facilities to offer an actual extensive inter-linkage among the physicians and sufferers. Medical doctors or sufferers can easily get information for the equal clinical document at any moment and everywhere via patient's personal pc, tabs, or telephone. Affected person can connect to the medical doctor in emergency condition, as well as, it can get entry to medical catalogue or consultations in any case and region [2].

Functions of mHealth:

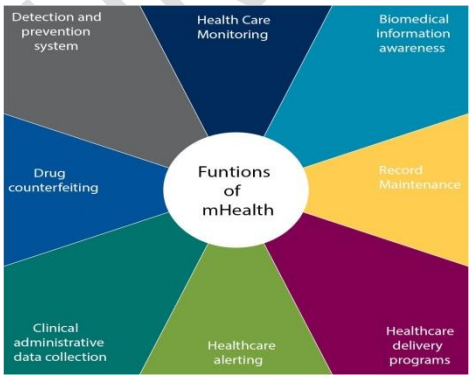

Figure 2: Functions of mHealth

mHealth provide vital functions shown in figure 2 such as detection, and prevention system, healthcare monitoring, biomedical information awareness, record maintenance, healthcare delivery programs, healthcare altering, clinical administrative data collection, drug counterfeiting etc. which clearly signifies its important in COVID 19 pandemic. It monitors the user's health with the help of various apps likes My Fitness Pal, Fit plan apps.

There are different apps provide the information related to the biomedical field and helps in spreading awareness like Medscape app. It maintains the records of users and provides security and privacy. Deliver the healthcare programme using

different apps likes Health Kart, Midlife, etc. It alerts the users by providing notifications eg. In COVID19 pandemic, "AarogyaSetu" app detects the infected patients and alerts other people. It collects clinical data of patients and provides it from time to time whenever it is needed using various apps. It prevents drug counterfeiting by scanning the benchmark already given to medical products. It detects the uncommon symptoms of users and provides a solution.

Challenges in Wearable Devices:

Figure 3: Challenges in wearable devices

Wearable technology have various challenges such as data qualification and validation, Killer apps, software architecture, sensors, changes in model, technological dependence, power management, privacy, personal area network etc. for its effective implementation.

Also, Wearable devices are used to monitor the health parameters of patients on a continuous basis.

Wearable devices utilise sensors for this purpose. This contribution, however, is only advantageous if the devices are constantly monitored and recalibrated by health professionals. A wearable gadget that provides health coaching feedback based on inaccurate data that has not been calibrated would undoubtedly mislead the user. In other circumstances, such as for people with chronic diseases, the implications might be harmful, if not fatal [3].

Types of Wearable Devices in mHealth [4, 5, 6]:

In recent years, wearable technology has been almost largely utilised for fitness applications, driven by customers' growing desire to analyze their own health. There are various types of wearable devices in mHealth shown in below Table 1. These devices can save the lives of people, if they are used effectively. It includes different watches, jewellery, garments, etc. Smart watches are capable of much more than merely showing the time. It delivers users notifications about their calls, texts, emails, and social media updates, among other things. Smartwatches are made up to look like jewellery, with a focus on females. When a user's phone is out of reach, these jewels alert them to text messages, calls, or emails. Wearable Clothing incorporates smart technological equipment to provide an innovative and trendy look. Likewise, all devices provide useful and unique features to the users.

Table 1. Types of Wearable Devices and their uses

Sr. No.	Types of Wearable Devices	Uses
1	Smart Watches	• Fitness and Wellness Purpose • Mobile Functions
2	Smart Eye Wear	• Provide Display Screen • Video Collaboration
3	Smart Jewellery	• Near-field Communication • Health Oriented • Action Oriented
4	Smart Garments	• Health Oriented • Athletics and Military Applications • Used in Covid 19 as a multifunctional monitor
5	E-Patches	• Monitoring • Diagnostics • Fitness and Sport • Used in diabetics for measuring blood glucose level
6	Smart Bands	• Health Oriented • Regular Vitals Tracking • Fitness focused

Wearable technology, such as activity trackers, smartwatches, and smart clothes, has seen a rise in popularity in the previous few years. Users and producers are starting to employ a range of devices for a number of purposes. Wearable technology allows us to track our fitness levels, see text messages more quickly, and track our whereabouts using GPS. Also, many of the devices that enable us to do so are hands-free and portable, so we don't have to take them out of our pockets. In following Table 2, advantages and disadvantages of devices are discussed.

Table 2 Advantages and disadvantages of wearable devices

Wearable devices	Advantages	Disadvantages
Smart Watches and bands	• Notifications are easily accessible • Calls are never missed • Healthcare monitoring with customized data	• Short battery power • Sometimes gives false information • Tiny display • Costly and soon outdated

Smart Jewellery	• Simple to carry • Gives modern outlook to user	• Small display • Harmful rays may produce • Some Jewellery may not waterproof • Expensive
Smart Garments	• Convenient • Health oriented	• Expensive • Generate skin problem
Smart eyewear	• Blocks UV rays • Simple to use and maintain • Vision and color filter • Functions as a projector display	• Costly • Complicated installing • usage of electricity • Not used often

Wearable Devices Used in Covid 19:

Due to COVID19, the capacity of the healthcare system all over the world is under pressure and exhausted, which increases physiological stress on the patient's health. That's why; some emerging companies are working on it and finding some relevant solution in the form of wearable devices. People use various devices to monitor their oxygen levels, heart rate, etc.

Coronavirus disease 2019 (COVID19) has come out as a virulent disease creating critical conditions which lead to loss of life. As present day virus related pathological examination and immunization are slow to appear, we see a need of extra vigorous disease detection and tracking related to humans and subsequently fitness all over the population, which can be provided through sensors that human, can wear and use as wearable devices and mHealth. During application of this generation of devices which has been used for corresponding diseases related to physical health i.e. physiological metrics to daily residing and the daily activities of humans, the interpretation of this generation in the direction related to the prediction of the occurrence of COVID19 remains a need. While used together with predictive structures, users of wearable devices are probably alerted, even as modifications in their metrics suit those related to COVID19. A smartphone app that collects information from smart watches and trackers, in addition to self-said signs and symptoms. Diagnostics are trying out consequences and feature assessed whether symptom and sensor facts can differentiate COVID19 properly to avoid emergency instances in symptomatic people.

WDs during the current era perform a great function in our day to day existence and the industry related to health. The current COVID19 widespread has taken the arenas of health protection system via wonder. Wearable gadgets can probably aid in those concerns by way of supplying actual-time far-off tracking, signs and symptoms prediction, contact tracing, and so on. The gadgets are explained based totally on the facility provided by them, their working processes and correspondence analysis in their advantages and disadvantages with price. A relative deliberation with probably destiny traits too interested in making choice of best technology for coronavirus infected patients. Its miles forecasted that wearable gadgets are only able to offer primary therapy that may address the widespread of coronavirus.

The wearable gadgets have to be enhanced for subsequent motives: (i) to observe remotely the health of coronavirus infected sufferers or self-isolated patients who are taking treatment in private room. (ii) to predict the danger of the prone people who come under the critical region concerning coronavirus. The primary observation will help in reduction of the cause drastically. (iii) to lower the spread rate of infectious coronavirus among many of the doctors,

caring staff, medical institution control staff, and sufferers of different illnesses, as wearable gadgets permit the doctors and caring staff to check on patients in real-time [7].
The rescue-suited wearable structures for supporting an infected person affected by the radical COVID19 virus can extensively distinguish into two most important classes: symptoms monitoring systems for COVID19 and pneumothoracic (respiratory) support systems for COVID19. Figure 4 shows the different devices used in COVID19. At the same time, recognizing capability of corona virus sufferers with the aid of tracking fitness indicators consisting of respiratory rate (RR), arterial blood pressure, SpO2 inside the blood, frame temperature, and so on. Respiratory support systems with ventilators, Continuous Positive Airway Pressure (CPAP) structures, and oxygen therapy etc. aid coronavirus infected sufferers in their recovery method.

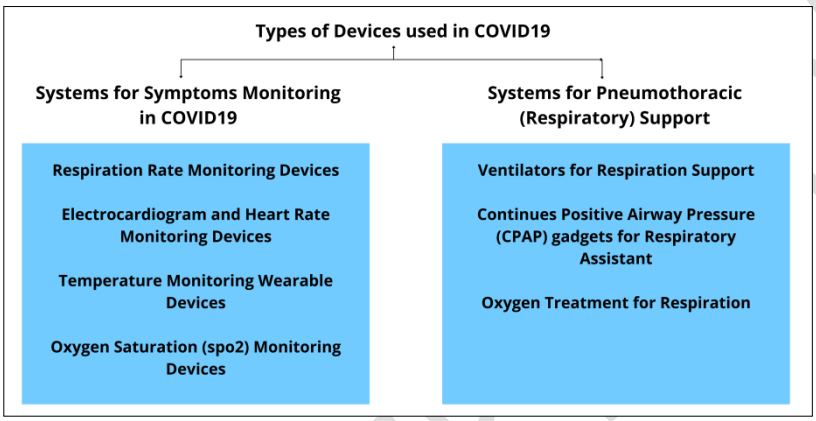

Figure 4: Different devices used in COVID19

A. Systems for Symptoms Monitoring in COVID19:

The word wearable technology indicates the shrewd gadgets that are worn on the frame for evaluating, comparing as well as shifting exclusive form of information. The wearable devices perform a huge function in observation of COVID19 symptoms to guide the infected peoples by means of this crucial virus [8].
There are three signs which can be taken into consideration as number one coronavirus symptoms: (i) respiration problem (ii) high body temperature and (iii) throat infection that can be frequent to every scientific proof of COVID19. Generally the individual inflamed through COVID19 possess respiration rate (RR) ≥ 20 per minute, body temperature ≥ 38°C, heart rate > 100 beats/ minute. Subsequently, its miles vital to evaluate respiration, CVS (cardiovascular system) monitoring and testing of further variables together with body temperature, SpO2 level. With the help of these wearable devices, the vital evaluation, tracking and testing of variables are executed more without difficulty, efficiently as well as value efficaciously.
The technology which can be evolved for fundamental signs and symptoms monitoring for COVID19 infected sufferers are described as follows.

1. Wearable Devices for Respiration Rate Monitoring:

Respiration rate (RR) is an essential factor in examining the development of infection. Exchange and peculiarities in RR are not simpler connecting with respiratory situation; however, additionally do pose hints for patients with critical conditions in retaining equilibrium of RR. Collectively with oxygen saturation, frame temperature and pulse rate, respiration rate is considered best in examining the seriousness of respiratory disorder. eg. a person infected with extreme breathing misery has an RR of more than 30 breaths/min that could change into acute respiratory distress syndrome (ARDS). Looking at current COVID19 situations, respiration rate is the crucial parameter as the virus implies various conditions on

the lungs. The respiratory harm as a result of COVID19 reduces the general efficiency of the lungs which leads to an expanded respiration rate remunerate. Remarkable expanded respiration rate isn't as usual in instances of different spreading ailments inclusive of common bloodless and influenza due to the effect on top respiratory pathway. It's troubling, but the way of time the patient is tachypneic, the disease may have reached an extreme condition [9]. Actual time and resuming evaluation of respiration rate could be extremely critical in tracking any modern day circumstances, development and treatment of sufferers infected by the corona virus. A committee of scientists has proposed wearable gadgets which might be installed on the chest or may be placed on the body to measure the respiratory rate, and also these gadgets are effective in examining corona virus patients. Researchers have already proposed wearable gadgets which might be installed on the chest or placed on the pores and skin to measure the RR and these devices are beneficial for monitoring COVID 19 patients [10].

Some great consequences have been shown by accelerometer-based totally wearable sensors, triboelectric sensors and wearable pressure gauge sensors being used to measure the respiration rate. However, patients might not feel relaxed carrying those styles of devices. The respiration rate can be estimated via tracking the different factors such as humidity, frame temperature, CO_2 etc. with the help of these gadgets. Scientists have developed a number of wearable gadgets which are used as a thermistor for nasal and oronasal, sensors for humidity or moisture checking and CO_2, which detects the exchange of CO_2, humidity or temperature among respiration mechanisms. This technology is based on the air flow sense technique. In this case, Liu Y. and his colleagues introduced a respiration rate machine primarily based upon heat transmission, which is utilized for detecting epidermal respiratory tract infection. Dai J. and his colleagues introduced a polyelectrolyte humidity device in the form of sensors as well as a CO_2 sensor which connects to face masks that's extensively utilized during the COVID19 pandemic. Still, the device might not be acceptable to sufferers as the action of sensors can additionally affect perfection [11]. Respirations Rate is also calculated with the help of Electrocardiograph as well as photoplethysmogram (PPG) that may effortlessly acquire by wearable gadgets. Charlton PH and his colleagues present a device for measuring respiratory rate with electrocardiograph and photoplethysmogram that elevated the measuring perfection. Subsequently, this generation of devices might be more organized for COVID19 patients to screen their respiratory rate all through this present pandemic [12].

2. Electrocardiogram and Heart Rate Monitoring Devices:

COVID19 can notably affect coronary heart and characteristics; it affects the cardiovascular system harm that additionally in irreversible harms. Viral infection due to COVID19 will increase clinical stress at a frame that normally shows the growth in coronary arterial blood pressure. An electrocardiogram is a robotic monitoring machine that helps in increasing the electrical and physical activity of a heart. It monitors the patterns and actions of the cardiac muscles. Electrocardiograph and its extract heart rate can give precious fact in monitoring non-infected people with cardiovascular disease, prognosis of cardiovascular disease chance evaluation of corona virus treatment. Corona virus complex with the aid of cardio-vascular damage may additionally be pondered through electrocardiograph change. Electrocardiograph defect along with S and T section increase arterial blood pressure where suggested in sufferers through corona virus with diagnosis of electrocardiograph is efficient need for corona virus with QT extend cure [13].

Moreover, wearable established electrocardiograph diagnosing rather than trendy important signals examine with the aid of scientific experts can highly decrease contamination via decreasing group of workers to sufferers contact. Sticky electrocardiograph spots are the maximum usual wearable electrocardiograph diagnosis procedure. Electrocardiograph

diagnosis spot is tiny wireless compressed gadgets are clean as well as secure easy to handle. It monitors the electrocardiograph for plenty time of the gadgets, a tiny gadgets track with the data noting and reminiscence deposits data. Relying on the gadgets there may be average time period starting from specific time.

The FDA (Food and Drug Administration) has authorized many products which might be helpful to patients suffering from COVID19. MCOT patch by Biotelemetry, US are utilized for ECG monitor in patients. Later, management of the medication, Atrial Traumatic Inflammation (AF) turned into diagnosed some time as well as time-to time interference with the aid of suitable treatment intended to relieve AF promoted reversion to sinus rhythm [10]. In addition, the BardyDx CAM patch is reported for the tracking QT interval in the body of sufferers through COVID19 which manage the hydroxychloroquine [14].

Quy VN. et al. developed a tool, piezoresistive sensors, which are used to monitor heart beat change. The video display in this tool provides units of heart rate in actual time. This device is highly precise and cheap where it may be used by patients who suffer from COVID19 [15]. Another researcher Shahshahani A. and his colleagues submitted an ultrasound wearable device sensor used for heart rate tracking. However, the piezoresistive tool is put at the right angle to coronary for reaching superior accuracy. The video display in this tool provides actual heart rate. In addition to this, it provides ECG movement also which may be beneficial to patients suffering from COVID19 [16].

Devices for monitoring the fitness which may screen metrics of an affected person together with arterial blood pressure, movement of pupil, temperature of body and SpO2% are provided by the Tamilselvi and his colleagues [17].

3. Temperature Monitoring Wearable Devices:

Temperature dimensions are much critical factor for detection of COVID19 and already it has been broadly utilized by several nations as a right way to check tourists or residents infected from COVID19. Even as quarantine people with fevers can stop transference to some extent, this approach of temperature monitoring is not always sufficient as COVID19 may be transmitted before a fever develops. Now days, the body temperature is constantly tracked using wearable devices such as TempTraq Qardio CORE, Oura ring, VivaLNK Fever Scout, etc. Liu B. and his colleagues suggested a device which recorded blood sugar levels, heartbeat, frame temperature, ECG, etc. as well as a few more physiological parameters. This device is tiny, convenient to handle, as well as this device is specifically designed for personal use of COVID 19 patients or at home [18].

Song C and his colleagues introduced a device primarily formed on a couple of synthetic neural networks in which it displays units of body temperature in a short time [19].

In this pandemic of COVID19, children and infants are also getting infected by the virus. Zakaria and his colleagues invented an Internet of Things (IoT) device which tracks the temperature of the body. This device is mainly useful for infants. This device is tiny and light weight. This device is utilized to monitor the temperature of a toddler's body continuously [20]. An additional IoT tool named Health Companion, which uses wearable computing proposed by Kulkarni and his colleges. It monitors the temperature and pulse. The objective of this tool is to collect exceptional parameters of the human body which helps the users to reveal their physical circumstances and helps the doctors to inspect the sufferers' illness intently. This device can be used for fever tracking at some stage of illness. The device additionally alerts users about excessive fever [21].

4. Oxygen Saturation (spo2) Monitoring Devices:

Oxygen saturation is the small part of oxygen-saturated hemoglobin as compared to the total hemoglobin in the blood. Oxygen saturation is a sign of respiration features as well as the general physical state of the human body. The coronavirus damages vital organ and produces

hypoxia. This happens step by step like lungs inflammation in which air sacs are getting inflamed by inflammatory fluid substances. The normal level of oxygen saturation in a healthy human is 95% to 100%. If this normal level gets disturbed, this leads to health issues and respiratory system related clinical conditions. Oxygen saturation is a crucial sign for detecting COVID19 in patients. The level of SpO2 may fall, if the patients have breathing problems or other health related problems. SpO2 is a crucial element in COVID19 patients for monitoring the development of infection in COVID19 sufferers. Further, SpO2 levels are very low in patients who are in critical condition and at high levels of corona infection [22].
As per the WHO (World Health Organization) guidelines, oxygen saturation in patients, more than 94% is at low level of risk and can be cured at home also. Patients having an oxygen saturation range below 93% are at high levels of risk and recommended hospitalization in ICU. Patients having oxygen saturation below 90% are in very critical condition and may lead to death. Therefore, constant tracking of oxygen saturation levels are very important to detect the proportional increase of infection and become aware of failure in specific critical instances.
The oxygen saturation monitors with the help of pulse oximeter gadgets. This device is based on photo plethysmography (PPG). It monitors, if any modifications are there in the arterial blood quantity by absorbing light. They include twin LED (Light Emitting Diode) which is typically purple, and an infrared detector. The way of illuminate light by the pulse oximeter on finger tips. The detector locates wavelengths which are reflected from finger tips (Frame Elements). Oxygen saturation is finally calculated using this device [23].
Jarachi D and his colleagues introduced pulse oximeter devices which are used to detect pulse rate variability as well as SpO2 estimation. These devices are also in the form of wrist-worn devices and give accurate results [24]. Xue J. et al introduced a device which continuously detected SpO2 and the body temperature at actual This tool can be used for COVID 19 infected person as its strength intake could be very low and compact in size [25]. Phuoc Son L. et al evolved a SpO2 device based on reflection theory of light from the frame element for actual time monitoring. This device is tiny, easy to handle, having vicinity tracker as well as IoT guide. With help of this tool physicians can detect the SpO2 level of patients who are suffering from COVID19 [26].
Rostami M. and his colleagues introduced a machine based on a telemedicine system for patients who suffer from Obstructive Sleep Apnea (OSA). With the help of this device, patients can track SpO2 levels in actual time. It observes the apnea episodes in patients suffering from Obstructive Sleep Apnea. It assists them in recording their result. These machines are pretty much and beneficial for the far-off tracking of SpO2 stage in COVID19 sufferers [27]. As well as oxitone 1000 M, which is the first FDA accepted wrist worn sensor pulse oximeter used for detecting SpO2 levels and giving the right results. SpO2 dimensions blunders between 3% for this device. This tool can also work on the different sites of the body, e.g. on the head or within the chest.

B. Systems for Pneumothoracic (Respiratory) Support:

Numbers of machines are there which help to recover the breathing parameters in a COVID19. Structures which might be advanced on the basis of wearable generation of devices used for breathing guide of COVID19 sufferers are mentioned as below.

1. Ventilators for Respiration Support:

In COVID19 situation, lacks of ventilators are observed. Therefore, open source positive pressure ventilation devices (OSPPVD) are used in hospital wards. This ventilator was developed in line with healthcare experts and in place of recreating current technology [28]. Many respiratory support machines for COVID 19 are much more priced. As a result of this, cost of the structure, prior research modification with smooth improvement, simple, new as well as transportable ventilator for patients is needed. The put forward ventilators are

designed according to the right clinical requirements, which include IEC62304, ISO5367 and ISO80601. This system provides the inspiration and expiration rate of patients who suffered from COVID19 through LCD (liquid crystal display) screen [29].

2. Continues Positive Airway Pressure (CPAP) gadgets for Respiratory Assistant:

The CAPA gadgets can reduce the chances of COVID19 virus infection from one person to another. For the completion of breathing cycle CPAP is used. It continuously provides high quality airway pressure.

CPAP gadgets have been approved for COVID19 patients and have been used by countries such as China and Italy. The gadget requires no assistance from health care workers. The CPAP gadget has been proved to be a powerful and non-invasive tool for COVID19 patients [30]. The Helmet tool, Pressure Support Ventilation (PSV) and CPAP gadgets provide additional respiration support and restrict the spread of COVID19 virus into the air. The helmet is reusable which is made up of a plastic hood on a tough plastic ring which has multi-size silicon PVC. This has been designed in a way that gets adjusted with the neck's dimensions [31].

3. Oxygen Treatment for Respiration:

High Float Nasal Cannula (HFNC) is used as a respiratory assist in patients infected by COVID19. After the application of the HFNC respiratory support system, the severely affected COVID19 patients have been discharged from the intensive care unit (ICU). This machine enables the patients to get into an inclined position three times a day, due to which the patient's condition gets improved, as the oxygen saturation level starts getting at normal [32].

Conclusion:

The established and included wearable technology has made it simple to handle and monitor many physiological parameters correctly. Wearable devices and mHealth systems are convenient to detect and record disease development in viral infections. The impact of this technology is very extensive and essential in pandemics. It can be benefited to a person who is home quarantine and consequently, it helps in decreasing the burden of medical and paramedical fraternity. COVID 19 pandemic is an alarming and critical situation for all human beings worldwide, and it needs a spark of discussion for publicly or individually sponsored research well beforehand to tackle a sudden pandemic which manifest in the destiny as well as inventive application in present, to control the obstacles and provide contemporary control of healthcare structures. Even though wearable devices show amazing capacity in managing infectious diseases like COVID 19. There is absolute confidence that wearable technology can be the simplest systems, if public awareness is created. Wearable devices manufacturers can think about the intended use of their devices, user population and devices awareness plan in early-stage of product development and they can develop the strategy to get regulatory approval as early as possible.

Wearable devices technology and eHealth systems give extremely beautiful capability for supporting in improvement to control the viral diseases like COVID 19 as well as an earlier mentioned demanding pandemic situation to permit extra massive selection stays an essential subject.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the

advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

References:

1. Mesut Cicek. Wearable technologies and its future applications. 2015 International Journal of Electrical, Electronics and Data Communication, ISSN: 2320-2084 Vol. 3, Issue- 4.
2. Bruno M.C. Silva, Joel J.P.C. Rodrigues, Isabel de la Torre Díez , Miguel López-Coronado, Kashif Saleem. Mobile-health: A review of current state in 2015. 2015. Journal of Biomedical Informatics, 56, 265–272. doi:10.1016/j.jbi.2015.06.003
3. Tahri Sqalli M and Al-Thani D. Evolution of Wearable Devices in Health Coaching: Challenges and Opportunities. 2020. Frontiers Digital Health 2:545646. doi: 10.3389/fdgth.2020.545646
4. Technicals: Technology Articles and Updates- https://technicles.com/ (Assessed on March 2, 2022)
5. Smart clothing Technology- https://www.businesspally.com/smart-clothing-technology/ (Assessed on March 2, 2022)
6. Pros and cons of smart eyewear- https://www.thehomehacksdiy.com/the-pros-and-cons-of-smart-glass/ (Assessed on March 2, 2022)
7. Xiaorong Ding, David Clifton, Nan Ji, Nigel H. Lovell, Paolo Bonato, Wei Chen, et al. Wearable Sensing and Telehealth Technology with Potential Applications in the Coronavirus Pandemic. 2021. IEEE Reviews in Biomedical Engineering, Vol. 14; 14:48-70. doi: 10.1109/RBME.2020.2992838
8. Arons MM, Hatfield KM, Reddy SC, Kimball A, James A, Jacobs JR, et al. Presymptomatic SARS-CoV-2 infections and transmission in a skilled nursing facility. 2020. N Engl J Med. 382:2081–90. https://doi.org/10.1056/NEJMo a2008 457
9. Chu M, Nguyen T, Pandey V, Zhou Y, Pham HN, Bar-Yoseph R, et al. Respiration rate and volume measurements using wearable strain sensors. 2019. NPJ Digit Med. 2:8. https://doi.org/10.1038/s4174 6-019-00833
10. Liu Y, Zhao L, Avila R, Yiu C, Wong T, Chan Y, et al. Epidermal electronics for respiration monitoring via thermo-sensitive measuring. 2020. Mater Today Phys; 13:100199. https://doi.org/10.1016/j.mtphy s.2020.100199
11. Dai J, Zhao H, Lin X, Liu S, Liu Y, Liu X, et al. Ultrafast response polyelectrolyte humidity sensor for respiration monitoring. 2019. ACS Appl Mater Interfaces; 11:6483–90. https://doi. org/10.1021/acsam i.8b189 04.
12. Charlton PH, Birrenkott DA, Bonnici T, Pimentel MAF, Johnson AEW, Alastruey J, et al. Breathing rate estimation from the electrocardiogram and photoplethysmogram: a review. 2018. IEEE Rev Biomed Eng.2018; 11:2–20 https://doi.org/10.1109/RBME.2017.2763681
13. Jia He, Bo Wu, Yaqin Chen, Jianjun Tang, Qiming Liu, Shenghua Zhou, et al. Characteristic Electrocardiographic Manifestations in Patients With COVID-19. Mar 2020. Canadian Journal of Cardiology, https://doi.org/10.1016/j.cjca.2020.03.028
14. James Gabriels, MD, Moussa Saleh, MD, David Chang, MD, Laurence M. Epstein, MD. Inpatient use of mobile continuous telemetry for COVID-19 patients treated with hydroxychloroquine and azithromycin, HeartRhythm Case Report. 2020. vol. 6, no. 5, pp. 241–243, https://doi.org/10.1016/j.hrcr.2020.03.017

15. Quy VN, Xuan Duy DT, Kien DT, Tu VH, Sun Q, Roy VAL, et al. Wearable device for monitoring heart rate based on low-cost Piezoresistive sensor. 2019. In: 2019 8th International Conference on Modern Circuits and Systems Technologies (MOCAST). IEEE, pp. 1–4, DOI: 10.1109/mocast.2019.8741734
16. Shahshahani A, Bhadra S, Zilic Z. A piezo transducer based flexible hybrid sensor for health monitoring. 2018. In: 2018 International Flexible Electronics Technology Conference (IFETC). IEEE, pp. 1–2, DOI:10.1109/IFETC.2018.8583998
17. Tamilselvi V, Sribalaji S, Vigneshwaran P, Vinu P, GeethaRamani J. IoT based health monitoring system. 2020. In: 2020 6th International Conference on Advanced Computing and Communication Systems (ICACCS). IEEE, pp. 386–389.
18. Liu B, Zhang Y, Liu Z. Wearable monitoring system with multiple physiological parameters. 2008 In: 2008 5th International Summer School and Symposium on Medical Devices and Biosensors. IEEE, pp. 268–271.
19. Song, C, Zeng, P, Wang, Z, Zhao, H, & Yu H. Wearable Continuous Body Temperature Measurement Using Multiple Artificial Neural Networks. 2018. IEEE Transactions on Industrial Informatics, 1–1. doi:10.1109/tii.2018.2793905
20. Zakaria NA, Mohd Saleh FNB, Razak MAA. IoT (internet of things) based infant body temperature monitoring. 2018 In: 2018 2nd International Conference on BioSignal Analysis, Processing and Systems (ICBAPS). IEEE, pp. 148–153.
21. Kulkarni C, Karhade H, Gupta S, Bhende P, Bhandare S. Health companion device using IoT and wearable computing. 2016. In: 2016 International Conference on Internet of Things and Applications (IOTA). IEEE, pp. 152–156.
22. Yufang Shi, Ying Wang, Changshun Shao, Jianan Huang, Jianhe Gan, Xiaoping Huang. COVID-19 infection: the perspectives on immune responses. 2020. Cell Death & Differentiation. vol. 27, pp. 1451–1454, doi: 10.1038/s41418-020-0530-3
23. Joren Buekers, Jan Theunis, Patrick De Boever, Anouk W Vaes, Maud Koopman, Eefje VM Janssen , et al. Wearable finger pulse oximetry for continuous oxygen saturation measurements during daily home routines of patients with chronic obstructive pulmonary disease (COPD) over one week: Observational study. 2019. JMIR mHealth uHealth, vol. 7, no. 6, doi: 10.2196/12866
24. Jarchi D, Salvi D, Velardo C, Mahdi A, Tarassenko L, Clifton DA. Estimation of HRV and SpO2 from wrist-worn commercial sensors for clinical settings. 2018. In: 2018 IEEE 15th International Conference on Wearable and Implantable Body Sensor Networks (BSN). IEEE, pp. 144–147 doi:10.1109/BSN.2018.8329679
25. Xue J, Huang Y, Du X, Wu X, Wu K, Zeng W, et al. Design of a wearable device for monitoring SpO2 continuously. 2015. In: 2015 IEEE 12th Intl Conf on Ubiquitous Intelligence and Computing and 2015 IEEE 12th Intl Conf on Autonomic and Trusted Computing and 2015 IEEE 15th Intl Conf on Scalable Computing and Communications and Its Associated Workshops (UIC-ATC-ScalCom). IEEE, pp. 1253 1257
26. Phuoc Son L, Thi Anh Thu N, & Trung Kien N. Design an IoT wrist-device for SpO2 measurement. 2017. In: 2017 International Conference on Advanced Technologies for Communications (ATC). IEEE, pp. 144–149. doi:10.1109/atc.2017.8167605
27. Rostami M., & Janghorbani A. Design and implementation of telemedicine system for Spo2 monitoring. 2014. In: 2014 22nd Iranian Conference on Electrical Engineering (ICEE). pp. 1945–1949. doi:10.1109/iraniancee.2014.6999860
28. Sorbello M, El-Boghdadly K, Di Giacinto I, Cataldo R, Esposito C, Falcetta S, et al. The Italian coronavirus disease 2019 outbreak: recommendations from clinical practice. 2020. Anaesthesia. 2020; 75:724–32. doi:10.1111/anae.15049

29. El Majid B, El Hammoumi A, Motahhir S, Lebbadi A, El Ghzizal A. Preliminary design of an innovative, simple, and easy-to-build portable ventilator for COVID 19patients. 2020. Euro-Mediterr J EnvironIntegr, 5:23. doi:10.1007/s41207-020-00163-1
30. Mahase, E. Covid-19: Mercedes F1 to provide breathing aid as alternative to ventilator. 2020. BMJ, m1294. doi:10.1136/bmj.m1294.
31. Arulkumaran N, Brealey, D, Howell D, Singer M. Use of non-invasive ventilation for patients with COVID-19: a cause for concern, The Lancet Respiratory Medicine. 2020. Lancet Respir Med. 8:e45 doi: 10.1016/s2213-2600(20)30181-8
32. Guan L, Zhou L, Le Grange JM, Zheng Z, & Chen R. Non-invasive ventilation in the treatment of early hypoxemic respiratory failure caused by COVID-19: considering nasal CPAP as the first choice. 2020 Critical Care, 24(1). doi: 10.1186/s13054-020-03054-7