

# Covid-19 Pandemic in Nigeria: The Essential Roles of Biomedical Engineers & Technologists

Journal of Bioscience & Biomedical Engineering

Review Article

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Submitted : 9 Nov 2020 ; Published : 7 Dec 2020

## Abstract

COVID-19 is a pandemic and dreadful viral disease affecting numerous countries globally including Nigeria. The virus that causes COVID-19 is mainly transmitted through droplets generated when an infected person coughs, sneezes, or exhales. These droplets are too heavy to hang in the air, and quickly fall on floors or surfaces one can be infected by breathing in the virus if he/she is within close proximity of someone infected with the Virus, or by touching a contaminated surface and then your eyes, nose or mouth. It has been discovered that the COVID-19 virus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes. The most common symptoms are fever, cough, shortness of breath, and breathing difficulties. Biomedical Equipment manpower and engineers greatly Fabricate and Design workable Infrared Thermometers, Ventilators and Respirators to detect feverish conditions, monitor and alleviate COVID-19 Patients difficulty in breathing respectively; as during the coronavirus break, some hospitals, isolation centers and healthcare providers have faced a shortage of **Infrared thermometers, respirators and ventilators**, three critical tools in fighting the infection. During this Pandemic, Nigerian Biomedical Personnel have been highly committed in the mitigation, alleviation and expertise fighting of the Scourge and its geometric confirmed cases; they, aside from design, fabrication and maintenance of vital medical equipment they provide prompt, high quality and professional engineering support in all activities related to the research, commission and installation of medical equipment during this dreadful Pandemic; their dogged determination, zeal and diligence as essential health workers cannot be over-emphasized.

## Introduction

Biomedical engineering Technology is the application of engineering principles to the fields of biology and health care. Biomedical engineers and Technologists work with doctors, therapists and researchers to develop systems, equipment and devices in order to solve clinical problems. Significantly, biomedical engineering is the application of the principles and problem-solving techniques of engineering to biology and medicine. This is evident throughout healthcare, from diagnosis and analysis to treatment and recovery, and has entered the public conscience though the proliferation of implantable medical devices, such as pacemakers and artificial hips, to more futuristic technologies such as stem cell engineering and the 3-D printing of biological organs.

Engineering itself is an innovative field, the origin of ideas leading to everything from automobiles to aerospace, skyscrapers to sonar. Biomedical engineering focuses on the advances that improve human health and health care at all levels [1].

Biomedical engineering Technology remains the application of engineering principles and design concepts to medicine and biology for healthcare purposes (e.g. diagnostic or therapeutic). This field seeks to close the gap between engineering and medicine, combining the design and problem solving skills of engineering with medical biological sciences to advance health care treatment, including diagnosis, monitoring, and therapy [2,3].

Biomedical engineers differ from other engineering disciplines that have an influence on human health in that biomedical engineers use and apply an intimate knowledge of modern biological principles in their engineering design process. Aspects of mechanical engineering, electrical engineering, chemical engineering, materials science, chemistry, mathematics, and computer science and engineering are all integrated with human biology in biomedical engineering to improve human health.

Biomedical engineers combine engineering principles with medical and biological sciences to design and create equipment, devices, computer systems, and software used in healthcare.

### Major Duties of Biomedical Engineers and Technologists

Biomedical engineers and Technologists typically do the following:

- Design biomedical equipment and devices, such as ventilators, Suction Machine, Oxygen concentrators, artificial internal organs, replacements for body parts, and machines for diagnosing medical problems
- Install, adjust, maintain, repair, or provide technical support for biomedical equipment
- Evaluate the safety, efficiency, and effectiveness of biomedical equipment
- Train clinicians and other personnel on the proper use of biomedical equipment
- Research the engineering aspects of the biological systems of humans and animals with life scientists, chemists, and medical scientists
- Prepare procedures, write technical reports, publish research papers, and make recommendations based on their research findings
- Interact with medical professionals, doctors, surgeons, therapists, patients and their careers while custom-designing and developing artificial limbs, medical devices and implants.
- Present research findings to scientists, nonscientist executives, clinicians, hospital management, engineers, other colleagues, and the public etc.

Biomedical engineers design instruments, devices, and software used in healthcare; develop new procedures using knowledge from many technical sources; or conduct research needed to solve clinical problems. They frequently work in research and development or quality assurance parastatals.

Biomedical engineers design electrical circuits, software to run medical equipment, or computer simulations to test new drug therapies. In addition, they design and build artificial body parts, such as hip and knee joints. In some cases, they develop the materials needed to make the replacement body parts. They also design rehabilitative exercise equipment.

The work of these engineers spans many professional fields. For example, although their expertise is based in engineering and biology, they often design computer software to run complicated instruments, such as three-dimensional x-ray machines. Alternatively, many of these engineers use their knowledge of chemistry and biology to develop new drug therapies. Others draw heavily on math and statistics to build models to understand the signals transmitted by the brain or heart. Some may be involved in sales.

The role of a Biomedical Engineer includes designing biomedical equipment and devices to aid the recovery or improve the health of individuals. This can include internal devices, such as stents or artificial organs, or external devices, such as braces and supports (orthotics). It can also include

creating and adapting medical equipment. It's a role that requires excellent knowledge of computing, biology and engineering, an inventive nature, and good problem solving skills.

Biomedical engineers work in teams with scientists, healthcare workers, or other engineers. Where and how they work depends on the project. For example, a biomedical engineer who has developed a new device designed to help a person with a disability to walk again might have to spend hours in a hospital to determine whether the device works as planned. If the engineer finds a way to improve the device, he or she might have to return to the manufacturer to help alter the manufacturing process to improve the design or does it himself.

The following are examples of specialty areas within the field of biomedical engineering:

Bioinstrumentation basically uses electronics, computer science, and measurement principles to develop instruments used in the diagnosis and treatment of medical problems.

Biomaterials remains the study of naturally occurring or laboratory-designed materials that are used in medical devices or as implantation materials.

Biomechanics involves the study of mechanics, such as thermodynamics, to solve biological or medical problems. Clinical engineering applies medical technology to optimize healthcare delivery.

Rehabilitation engineering is the study of engineering and computer science to develop devices that assist individuals recovering from or adapting to physical and cognitive impairments.

Systems physiology uses engineering tools to understand how systems within living organisms, from bacteria to humans, function and respond to changes in their environment.

### Coronavirus Disease Outbreak in Nigeria

The coronavirus disease (COVID-19) has been identified as the cause of an outbreak of respiratory illness in Wuhan, Hubei Province, China beginning in December 2019. As of 31 January 2020, this epidemic had spread to 19 countries with 11 791 confirmed cases, including 213 deaths. The World Health Organization has declared it a Public Health Emergency of International Concern.

The first confirmed case of Coronavirus disease in Nigeria was announced on 27 February 2020, when an Italian citizen in Lagos tested positive for the virus [4]. On 9 March 2020, a second case of the virus was reported in Ewekoro, Ogun State, a Nigerian citizen who had contact with the Italian citizen [5].

Early March, the minister of health in Nigeria, Osagie Ehanire, announced that 60 persons who had contact with the index Italian patient were under isolation, 40 persons in Ogun State and 20 in Lagos State [6].

The incubation period for COVID-19, which is the time between exposure to the virus (becoming infected) and symptom onset, is on average 5-6 days, however can be up to 14 days. During this period, also known as the “pre- symptomatic” period, some infected persons can be contagious. The most common symptoms of COVID-19 are fever, tiredness, and dry cough. Some patients may have aches and pains, nasal congestion, runny nose, or sore throat. These symptoms are usually mild and begin gradually.

On March 11, the World Health Organization declared that COVID-19, the respiratory disease caused by the novel coronavirus SARS-CoV-2, is a pandemic. With the lives of millions of people worldwide disrupted by this infectious disease outbreak, Biomedical engineers and Technologists joined the rest of the scientific community to respond to the COVID-19 challenges.

### Essential Roles of Biomedical Engineers & Technologists in Ameliorating Covid-19 Pandemic in Nigeria

However, the Coronavirus Disease-2019 (COVID-19) virus has infected more than one million people, leaving more than 50,000 people dead across the globe. The health system of many countries has been overwhelmed by the pandemic, with many losing a significant number of their health professionals in the fight against the virus. While doctors and nurses are so visible at the front lines and are being applauded for the gallant role they are playing in the recovery of hundreds of thousands of COVID-19 patients, Biomedical Engineers and Technologists are also significantly involved in various ways to curb and ameliorate the dreadful pandemic.

Biomedical Engineers from a range of industry backgrounds have been putting their normal tasks to one side to build ventilators, Respirators and PPE (Personal Protection Equipment) to help the Nigerian Centre for Disease Control (NCDC) and Nigerian COVID-19 Presidential Task Force care for the increasing numbers of patients in Intensive Care Units with COVID-19 [7].

They also essentially:

- Support in the review the medical equipment specifications and requirements under design, in terms of Specificity, accuracy, suitability and context.
- Fabricate and Design workable Ventilators and Respirators to alleviate COVID-19 Patients difficulty in breathing; during the coronavirus break, some hospitals and healthcare providers have faced a shortage of respirators and ventilators, two critical tools in fighting the infection.
- Troubleshoot problems arising in designing and developing of Pulmonological equipment and some medical devices that are faulty.
- Manage clinical trials for medical products and devices that are helpful to patients.
- Provide prompt, high quality and professional engineering support in all activities related to the research, commission and installation of medical equipment during this dreadful Pandemic
- Participate in the review and analysis of existing health

- equipment and installations (field assessments) in various Nigerian Health facility sites and Isolation Centers
- Hugely assess the probabilities for integration of the new equipment into existing medical systems to reduce the high rates of inferior equipment
- Participate in meetings and work closely with other respective medical experts to identify exact Locations and dimensions for equipment to facilitate better and efficient patient and process flows; awesome team work participation that produced plethora of good results.
- Assist in developing the schedule of the requirements, conditions, evaluation criteria and exact submission needed from the bidders before the bid solicitation.
- Assist in producing COVID- 19 needed medical equipment bill of quantities for tender purposes in terms of accuracy and content.
- Assist in preparation technical specifications for medical systems including components, products, apparatus, and services together with the expected quality of workmanship, in close coordination with the Procurement team.
- Managing and testing including field testing of clinical equipment and medical devices in hospitals and communities.
- Participate as technical evaluator of proposals for the supply of medical equipment.
- Fully assist in the development of ventilators and Respirators, thence comprehensive maintenance plan for the installed equipment.

### Ventilators- Vital Biomedical Equipment

According to the World Health Organization (WHO), some 80% of people with Covid-19 - the disease caused by coronavirus - recover without needing hospital treatment. But one person in six becomes seriously ill.

In these severe cases, the virus causes damage to the lungs, causing the body’s oxygen levels to drop and making it harder to breathe.

To alleviate this, a ventilator is used to push air, with increased levels of oxygen, into the lungs. The ventilator also has a humidifier, which adds heat and moisture to the air supply so it matches the patient’s body temperature.

Patients are given medication to relax the respiratory muscles so their breathing can be fully regulated by the machine.

Mechanical ventilators are machines that act as bellows to move air in and out of a patient’s lungs. The Biomedical Personnel or doctor can set the ventilator to control how often it puts air into one’s lungs and how much air one get air.

One seriously need a ventilator in an emergency if a condition makes it difficult to breathe on your own (called respiratory failure). Respiratory failure can be a life-threatening emergency. When a patient can’t breathe well, his/her organs cannot get enough oxygen to work. Too much carbon dioxide

may also build up in the patient's blood. This is a waste gas that is usually breathed out. Too much can damage their organs.

Many conditions and injuries that can affect one's breathing include:

- Acute respiratory distress syndrome (ARDS)
- Head injury or stroke
- Asthma
- COPD (chronic obstructive pulmonary disease) or other lung diseases
- Drug overdose
- Neonatal respiratory distress syndrome, which are breathing problems that affect newborns, especially premature babies.
- Pneumonia
- Sepsis, which is an infection in your bloodstream
- Spinal cord injuries, polio, amyotrophic lateral sclerosis (ALS) external link, myasthenia gravis external link, and other diseases or factors that affect the nerves and muscles involved in breathing
- Sudden cardiac arrest etc.

Significantly, a mechanical ventilator is an automatic machine or biomedical device designed to provide all or part of the work the body must do to move gas into and out of the lungs. The act of moving air into and out of the lungs is called breathing, or, more formally, ventilation [8,11].

The simplest mechanical device we could devise to assist a person's breathing would be a hand-driven, syringe-type pump that is fitted to the person's mouth and nose using a mask. A variation of this is the self-inflating, elastic resuscitation bag. Both of these require one-way valve arrangements to cause air to flow from the device into the lungs when the device is compressed, and out from the lungs to the atmosphere as the device is expanded. These arrangements are not automatic, requiring an operator to supply the energy to push the gas into the lungs through the mouth and nose. Thus, such devices are not considered mechanical ventilators [9].

Automating the ventilator so that continual operator intervention is not needed for safe, desired operation requires three basic components:

1. A source of input energy to drive the device;
2. A means of converting input energy into output energy in the form of pressure and flow to regulate the timing and size of breaths; and
3. A means of monitoring the output performance of the device and the condition of the patient [10].

### Respirators- Fundamental Biomedical Device in the Curb of Covid-19 Pandemic

A respirator is a masklike device, usually of gauze, worn over the mouth, or nose and mouth, to prevent the inhalation of noxious substances or the like. Health professionals wear respirators to filter out virus particles as they breathe in so they don't get infected with COVID-19 while helping people and patients [11].

The CDC specifically recommends health professionals using what are called N95 respirators. This type of respirator fits more tightly around the nose and mouth than regular medical or surgical masks. Another type of respirator is known as PAPR, short for powered air-purifying respirators, which covers the whole head and uses a blower to filter air.

In medical contexts, a ventilator is a machine that helps a patient breathe. This machine pumps oxygen into the lungs and removes carbon dioxide through a tube. The insertion of this tube into a person's windpipe (trachea) is called intubation.

The verb ventilate can refer to oxygenating the blood (i.e., supplying it with oxygen) or helping someone breathing using a mechanical ventilator.

COVID-19 is a respiratory disease, and it can cause lung inflammation (pneumonia), which makes breathing difficult for patients. That's why ventilators are needed to help treat some patients with the infection.

### Infrared Thermometers- Fundamental Biomedical Device in the Detect and Curb Of Covid-19 Pandemic

Infra-Red Thermometer is a thermometer which infers temperature from a portion of the thermal radiation sometimes called black-body radiation emitted by the object being measured. They are sometimes called **laser thermometers** as a laser is used to help aim the thermometer, or **non-contact thermometers or temperature guns**, to describe the device's ability to measure temperature from a distance. By knowing the amount of infrared energy emitted by the object and its emissivity, the object's temperature can often be determined within a certain range of its actual temperature. Infrared thermometers are a subset of devices known as "thermal radiation thermometers" [12].

A thermometer is an instrument that estimates and displays core temperature. Thermometers are ubiquitous and are used in homes, physician clinics, and hospitals. Thermometers are solely designed, maintained and troubleshooted by Biomedical Engineers and Technologists.

Thermometry is used to diagnose high-temperature conditions, such as fever and heat stroke, and low-temperature exposure. A digital thermometer uses thermistor resistance that varies with temperature. An infrared thermometer uses a pyroelectric sensor, composed of pyroelectric film and circuitry within a housing filled with dry air or nitrogen, to generate an electrical charge in response to a change in its temperature [13].

### Conclusion

The COVID-19 pandemic in Nigeria really is a worldwide pandemic scourge that influenced a huge lockdown in Nigerian Nation. It is caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). The virus is primarily transmitted from person-to-person by coming into contact with an infected person's droplets. When an infected person

coughs, sneezes or exhales, droplets are expelled and can land in another person's nose or mouth and inhaled into the lungs. The virus can be transmitted by an infected person not showing symptoms of illness.

It is worthy of note, that amongst the Serious symptoms of COVID-19 are:

High fever, difficulty breathing or shortness of breath, chest pain or pressure, loss of speech or movement; these symptoms are greatly taken care of by the use of uncommon medical equipment fabricated, designed and maintained by Biomedical Engineers, Technologists and/or Technicians.

Biomedical Equipment manpower greatly Fabricate and Design workable Ventilators and Respirators to alleviate COVID-19 Patients difficulty in breathing; as during the coronavirus break, some hospitals, isolation centers and healthcare providers have faced a shortage of **Infrared thermometers, respirators and ventilators**, three critical tools in fighting the infection. They troubleshoot problems arising in designing and developing of Pulmonological equipment and some medical devices that are faulty.

They also manage clinical trials for medical products and devices that are helpful to patients.

Their vital roles of Biomedical Personnel cannot be over emphasized during this COVID-19 Pandemic

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