**ENGINEERING STRATEGIES FOR HANDLING COVID-19 FOR ENVIROMENTAL HEALTH AND ECONOMIC HEALTH AND ECONOMIC SUSTAINABILITY**

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**ABSTRACT**

**Bioinformatics** is an interdisciplinary field that develops methods and software tools for understanding biological data. As an interdisciplinary field of science, bioinformatics combines computer science, statistics, mathematics, and engineering to analyze and interpret biological data.

Bioinformatics is considered both an umbrella term for the body of biological studies that use computer programming as part of their methodology, as well as a reference to specific analysis "pipelines" that are repeatedly used, particularly in the field of genomics. Common uses of bioinformatics include the identification of candidate genes and nucleotides (SNPs). Often, such identification is made with the aim of better understanding the genetic basis of disease, unique adaptations, desirable properties (esp. in agricultural species), or differences between populations. In a less formal way, bioinformatics also tries to understand the organisational principles within nucleic acid and protein sequences. This principle is a factor used to determine viruses and also used to fight them.

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CHAPTER ONE

**HISTORY OF ENGINEERING IN MEDICINE**

The history of the IEEE EMBS runs hand in hand with the history of Biomedical Engineering both as a scientific discipline and as a profession. The conferences and publications led by IEEE EMBS, amongst other activities were a mirror of the evolution of Biomedical Engineering over the years and they equally contributed to shape Biomedical Engineering as we view it today. The IEEE EMBS provides a testimony of how a broad and diverse scientific community that comes from many diverse areas such as medicine, engineering, physics and chemistry and shares common purposes and interests can successfully work under the same designation of biomedical engineers. This account is a review of the history of Biomedical Engineering and the development of the IEEE EMBS since the inception of its predecessors, the AIEE Committee on Electrical Techniques in Medicine and Biology and the IRE Professional Group in Medical Electronics

**WHAT IS BIOMEDICAL ENGINEERING**

**Biomedical engineering** (**BME**) or **medical engineering** is 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. Also included under the scope of a biomedical engineer is the management of current medical equipment within hospitals while adhering to relevant industry standards. This involves making equipment recommendations, procurement, routine testing and preventive maintenance, a role also known as a Biomedical Equipment Technician (BMET) or as clinical engineering.

Biomedical engineering has recently emerged as its own study, as compared to many other engineering fields. Such an evolution is common as a new field transitions from being an interdisciplinary specialization among already-established fields, to being considered a field in itself. Much of the work in biomedical engineering consists of research and development, spanning a broad array of subfields (see below). Prominent biomedical engineering applications include the development of biocompatible prostheses, various diagnostic and therapeutic medical devices ranging from clinical equipment to micro-implants common imaging equipment such as MRIs and EKG/ECGs, regenerative tissue growth, pharmaceutical drugs and therapeutic biologicals.

**CHAPTER 2**

**ELECRTRICAL/ELECTRONIC ENGINNERING IN MEDICINE**

There are different strategies that can be put in place for the enhancement of environmental health and to help in curbing pandemics, in the case of the coronavirus(COVID-19) due to the complexity of the virus it tends to affect the respiratory ducts living patients docile due to the lack of air caused by fibrosis however electronics engineering can be implemented in the case of ventilation process, machines can be built to help in assisting respiration an example of thus electrical machines is a ventilator

**WHAT IS A VENTILATOR**

A **ventilator** is a machine that provides mechanical ventilation by moving breathable air into and out of the lungs, to deliver breaths to a patient who is physically unable to breathe, or breathing insufficiently. Modern ventilators are computerized microprocessor controlled machines, but patients can also be ventilated with a simple, hand-operated bag valve mask. Ventilators are chiefly used in intensive care medicine, home care, and emergency medicine (as standalone units) and in anesthesiology (as a component of an anesthesia machine).

Ventilators are sometimes called respirators, a term commonly used for them in the 1950s (particularly the "Bird respirator”). However, in contemporary hospital and medical terminology, a respirator is a protective face mask

**FUNCTION OF A VENTILATOR**

In its simplest form, a modern positive pressure ventilator consists of a compressible [air](https://en.wikipedia.org/wiki/Air) reservoir or turbine, air and [oxygen](https://en.wikipedia.org/wiki/Oxygen) supplies, a set of valves and tubes, and a disposable or reusable "patient circuit". The air reservoir is pneumatically compressed several times a minute to deliver room-air, or in most cases, an air/oxygen mixture to the patient. If a turbine is used, the turbine pushes air through the ventilator, with a flow valve adjusting pressure to meet patient-specific parameters. When over pressure is released, the patient will exhale passively due to the [lungs](https://en.wikipedia.org/wiki/Lung)' elasticity, the exhaled air being released usually through a [one-way valve](https://en.wikipedia.org/wiki/One-way_valve) within the patient circuit called the patient manifold.

Ventilators may also be equipped with monitoring and alarm systems for patient-related parameters (e.g. pressure, volume, and flow) and ventilator function (e.g. air leakage, power failure, mechanical failure), backup batteries, oxygen tanks, and remote control. The pneumatic system is nowadays often replaced by a computer-controlled [turbo pump](https://en.wikipedia.org/wiki/Turbopump).

Modern ventilators are electronically controlled by a small [embedded system](https://en.wikipedia.org/wiki/Embedded_system) to allow exact adaptation of pressure and flow characteristics to an individual patient's needs. Fine-tuned ventilator settings also serve to make ventilation more tolerable and comfortable for the patient. In Canada and the United States, [respiratory therapists](https://en.wikipedia.org/wiki/Respiratory_therapists) are responsible for tuning these settings, while biomedical technologists are responsible for the maintenance. In the United Kingdom and Europe the management of the patient's interaction with the ventilator is done by [critical care](https://en.wikipedia.org/wiki/Critical_care_nursing) nurses.

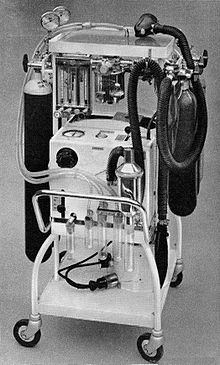
The patient circuit usually consists of a set of three durables, yet lightweight plastic tubes, separated by function (e.g. inhaled air, patient pressure, exhaled air). Determined by the type of ventilation needed, the patient-end of the circuit may be either noninvasive or invasive.

Noninvasive methods, such as continuous positive airway pressure (CPAP) and [non-invasive ventilation](https://en.wikipedia.org/wiki/Non-invasive_ventilation), which are adequate for patients who require a ventilator only while sleeping and resting, mainly employ a nasal mask. Invasive methods require [intubation](https://en.wikipedia.org/wiki/Intubation), which for long-term ventilator dependence will normally be a [tracheotomy](https://en.wikipedia.org/wiki/Tracheotomy) cannula, as this is much more comfortable and practical for long-term care than is larynx or nasal intubation.

**HISTORY OF VENTILATORS**

The history of mechanical ventilation begins with various versions of what was eventually called the [iron lung](https://en.wikipedia.org/wiki/Negative_pressure_ventilator), a form of noninvasive negative pressure ventilator widely used during the [polio](https://en.wikipedia.org/wiki/Poliomyelitis) epidemics of the twentieth century after the introduction of the "Drinker respirator" in 1928, improvements introduced by [John Haven Emerson](https://en.wikipedia.org/wiki/John_Haven_Emerson) in 1931, and the [Both respirator](https://en.wikipedia.org/wiki/Both_respirator) in 1937. Other forms of noninvasive ventilators, also used widely for polio patients, include [Biphasic Cuirass Ventilation](https://en.wikipedia.org/wiki/Biphasic_Cuirass_Ventilation), the rocking bed, and rather primitive positive pressure machines.

In 1949, John Haven Emerson developed a mechanical assister for anaesthesia with the cooperation of the anaesthesia department at [Harvard University](https://en.wikipedia.org/wiki/Harvard_University). Mechanical ventilators began to be used increasingly in anaesthesia and intensive care during the 1950s. Their development was stimulated both by the need to treat polio patients and the increasing use of [muscle relaxants](https://en.wikipedia.org/wiki/Muscle_relaxant) during anaesthesia. Relaxant drugs paralyse the patient and improve operating conditions for the surgeon but also paralyse the respiratory muscles.

[](https://en.wikipedia.org/wiki/File:East-Radcliffe_Respirator_Wellcome_L0001305.jpg)

An East-Radcliffe respirator model from the mid-twentieth century

In the United Kingdom, the East Radcliffe and Beaver models were early examples. The former used a [Sturmey-Archer](https://en.wikipedia.org/wiki/Sturmey-Archer) bicycle [hub gear](https://en.wikipedia.org/wiki/Hub_gear) to provide a range of speeds, and the latter an automotive [windscreen wiper](https://en.wikipedia.org/wiki/Windscreen_wiper) motor to drive the bellows used to inflate the lungs.[[5]](https://en.wikipedia.org/wiki/Ventilator#cite_note-pmid13320798-5) Electric motors were, however, a problem in the operating theatres of that time, as their use caused an explosion hazard in the presence of flammable anaesthetics such as [ether](https://en.wikipedia.org/wiki/Diethyl_ether) and [cyclopropane](https://en.wikipedia.org/wiki/Cyclopropane). In 1952, Roger Manley of the [Westminster Hospital](https://en.wikipedia.org/wiki/Westminster_Hospital), London, developed a ventilator which was entirely gas-driven and became the most popular model used in Europe. It was an elegant design, and became a great favourite with European anaesthetists for four decades, prior to the introduction of models controlled by electronics. It was independent of electrical power and caused no explosion hazard. The original Mark I unit was developed to become the Manley Mark II in collaboration with the Blease company, which manufactured many thousands of these units. Its principle of operation was very simple, an incoming gas flow was used to lift a weighted bellows unit, which fell intermittently under gravity, forcing breathing gases into the patient's lungs. The inflation pressure could be varied by sliding the movable weight on top of the bellows. The volume of gas delivered was adjustable using a curved slider, which restricted bellows excursion. Residual pressure after the completion of expiration was also configurable, using a small weighted arm visible to the lower right of the front panel. This was a robust unit and its availability encouraged the introduction of positive pressure ventilation techniques into mainstream European anesthetic practice.

The 1955 release of [Forrest Bird](https://en.wikipedia.org/wiki/Forrest_Bird)'s "Bird Universal Medical Respirator" in the United States changed the way mechanical ventilation was performed, with the small green box becoming a familiar piece of medical equipment.[[6]](https://en.wikipedia.org/wiki/Ventilator#cite_note-AboutBird-6) The unit was sold as the Bird Mark 7 Respirator and informally called the "Bird". It was a [pneumatic](https://en.wikipedia.org/wiki/Pneumatics) device and therefore required no [electrical power](https://en.wikipedia.org/wiki/Electrical_power) source to operate.

In 1965, the Army Emergency Respirator was developed in collaboration with the Harry Diamond Laboratories (now part of the [U.S. Army Research Laboratory](https://en.wikipedia.org/wiki/United_States_Army_Research_Laboratory)) and [Walter Reed Army Institute of Research](https://en.wikipedia.org/wiki/Walter_Reed_Army_Institute_of_Research). Its design incorporated the principle of fluid amplification in order to govern pneumatic functions. Fluid amplification allowed the respirator to be manufactured entirely without moving parts, yet capable of complex resuscitative functions. Elimination of moving parts increased performance reliability and minimized maintenance. The mask is composed of a [poly(methyl methacrylate)](https://en.wikipedia.org/wiki/Poly(methyl_methacrylate)) (commercially known as [Lucite](https://en.wikipedia.org/wiki/Poly(methyl_methacrylate))) block, about the size of a pack of cards, with machined channels and a cemented or screwed-in cover plate. The reduction of moving parts cut manufacturing costs and increased durability.

The bistable fluid amplifier design allowed the respirator to function as both a respiratory assistor and controller. It could functionally transition between assistor and controller automatically, based on the patient's needs. The dynamic pressure and turbulent jet flow of gas from inhalation to exhalation allowed the respirator to synchronize with the breathing of the patient.

Intensive care environments around the world revolutionized in 1971 by the introduction of the first SERVO 900 ventilator (Elema-Schönander). It was a small, silent and effective electronic ventilator, with the famous SERVO feedback system controlling what had been set and regulating delivery. For the first time, the machine could deliver the set volume in volume control ventilation.

Ventilators used under increased pressure (hyperbaric) require special precautions and few ventilators can operate under these conditions. In 1979, Sechrist Industries introduced their Model 500A ventilator which was specifically designed for use with [hyperbaric chambers](https://en.wikipedia.org/wiki/Hyperbaric_chamber).

**PRINCIPLE OF VENTILATORS**

**Breathe in, breathe out**

The principal function of a ventilator is to pump or blow oxygen-rich air into the lungs; this is referred to as “oxygenation”. Ventilators also assist in the removal of carbon dioxide from the lungs, and this is referred to as “ventilation”.

One basic type of ventilator is the Bag Valve Mask (BVM). The BVM, also known as the Ambu Bag, is operated manually by a person squeezing a self-inflating bladder. This is an essential tool for ambulance crews, first responders and critical care units. It is light, compact and easy to use.

However, in situations where a steady and controlled air exchange (oxygen in, carbon dioxide out) is needed, mechanical ventilators are required. These look like a quintessential medical product.

**CHAPTER 3**

**IMPORTANCE OF COMMUNICATION, CONNECTIVITY(5G) AND ROBOTICS IN HANDLING A PANDEMIC**

The world is considered a global village, due to the ease of access to information and connectivity but it also isn’t the only reason the world is a global village. Other examples of why the world can be considered a global village is trade, ease of transportation thus factors can be detrimental in a case of a pandemic especially if the virus is easily transmitted, various precautions can be taking to reduce the impact of such pandemics like social distancing and basic hygiene but such measures aren’t enough. For the safety of the health workers and citizens connectivity and robotics comes into play.

**WAYS 5G AND ROBOTICS CAN BE APPLIED IN THE MEDICAL FIELD**

**Remote surgery and patient care**

Many believe that 5G will revolutionize how medical staff perform surgery and administer medical treatments. These innovations include “tele-presence,” where a surgeon watch a real-time operation and can provide expert support, and “tele-surgery,” where the doctor actually operates the surgical device remotely.

4G networks are not suitable for these types of applications because the lag time between input and output can sometimes be as long as 2 seconds—a delay long enough to prove devastating in an operating room.

5G, on the other hand, aims to reduce latency to an almost instantaneous 2 milliseconds between devices.

Further, as 5G services expand for the medical field, it may no longer be necessary for patients to be transported a specific clinic or specialist. Instead, they can undergo a remote consultation, saving both doctor and patient time and making it possible for individuals who struggle to receive care to be more appropriately treated.

Recently, the first laparoscopy surgical procedure—in which a fiber-optic instrument is inserted through the abdominal wall—was performed at the Skolkovo Innovation Center in Moscow using 5G. The procedure, which involved the use of a laparoscope and 4K camera connected to the 5g network, resulted in the successful removal of a cancer tumor.

**Medical data**

Finally, 5G promises to transform medical field by drastically increasing the amount and quality of valuable medical data that can be gathered and processed at high speed. From medical records to larger image files from MRI or CAT scans, a single patient can generate hundreds of gigabytes of data each day. The transfer of this data can be hugely aided by the implementation of a 5G, improving care by reducing the time it takes to reach a diagnosis and to begin treatment.

In addition, surgeons can receive real-time data from their patients during surgery, and medical specialists will all be able to work together from across the world.

**Pathology and diagnoses**

A few weeks ago, [Samsung Medical Center (SMC) and Korean telecom KT Corporation announced their partnership to develop 5G medical services](https://www.prnewswire.com/news-releases/kt-and-samsung-medical-center-to-build-5g-smart-hospital-300989452.html) to support the development of smart hospitals, including improving pathology services, or the study of a disease or ailment’s causes and effects.

KT has built an enterprise-dedicated 5G network at SMC, which includes a 5G-powered digital pathological analysis. According to the companies, the digital pathological analysis is a world-first example of using 5G technology for on-site medical problems.

Previously, diagnostic pathology at the Korean hospital involved sending tissues taken from the patient during surgery to pathologists in an adjacent room, a process that required roughly 20 minutes and made on-site group analyses a challenge.

Now, doctors will be able to utilize the high speed and low latency of the 5G network to efficiently and quickly access pathological data obtained during surgery, as well as access relevant materials and files from anywhere in the world, which ensures better medical services. Obtaining this information quickly is critical in determining the conditions of patients during a procedure.

In China, [ZTE and China Telecom are claiming to have developed China’s first 5G remote diagnosis of the new coronavirus pneumonia](https://www.rcrwireless.com/20200127/5g/zte-china-telecom-complete-5g-remote-diagnosis-new-coronavirus) backed up with the latest 5G technology.

The pneumonia-like virus was first reported in Wuhan, China, on December 31, 2019, and has subsequently spread to various other countries, causing worldwide concern.

Since the outbreak, ZTE and China Telecom have been moving quickly. First, the two built interconnected 5G indoor base stations on January 25, connecting the conference room for remote diagnosis and treatment in West China Hospital to the remote diagnosis and treatment system; and then, completed the construction, optimization, speed test and commissioning of the 5G indoor distribution system at another core point of the remote diagnosis and treatment system the following day.

In arrangement with the Sichuan Health and Health Commission, the 5G remote consultation system will access 27 hospitals that have accepted and treated patients. ZTE will then build China’s first 5G remote diagnosis coronavirus infection system covering the Sichuan province, city and county to provide a single network for remote diagnosis in front-line hospitals.

**Staff-patient communication**

[AT&T is working with The Lawrence J. Ellison Institute for Transformative Medicine of USC to open a “smart” facility](https://www.prnewswire.com/news-releases/uscs-ellison-institute-leverages-state-of-the-art-wireless-networks-to-build-next-generation-smart-facility-that-enhances-connections-between-researchers-and-patients-300981677.html) to further advance the multidisciplinary cancer research ecosystem. One of the partnerships goals is to use the telecom’s 5G network to ‘revolutionize the communication between researchers and patients.’

According a press release, the pair will accomplish this by equipping the building with multi access edge computing (MEC), artificial intelligence (AI) and various other technology from AT&T to power the facility for cancer research, treatment and wellness education.

The solution will include a distributed antenna system (DAS), 5G using millimeter wave spectrum, multi-access edge computing and an IoT platform,.

Some of the specific ways 5G can be expected to improve patient experience is the implementation of connected sensors that will track patient-staff interactions to be analyzed in an effort to provide better outcomes and immersive and personalized experiences for patients.

CONCLUSION

In this report I have successfully been able to outline ways engineering can be effective in the medical field and how connectivity will support growth in a modern society as time passes development becomes a key factor in the growth of an economy and as a people, health is the biggest factor to consider in any developing society, as the world fights this pandemic we hope to see a change in the mentality of leaders and citizens of nations to focus on the development of alternatives to help in our day to day growth and health.

We all have a role to play to making this a possibility.

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