ASSIGNMENT-6

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3 5 Solutions to Covid-19 provided by Biomedical Engineers

Bioengineering (BE) technology has significant influence on the healthcare environment. This has grown steadily particularly since the medical practice has become more technology based. We have tried to assess the impact of bioengineering in tackling the COVID-19 pandemic. The use of bioengineering principles in healthcare has been evaluated. The practical implications of these technologies in fighting the current global health pandemic have been presented. There has been a shared drive worldwide to harness the advancements of bioengineering to combat COVID-19. These efforts have ranged from small groups of volunteers to large scale research and mass production. Together the engineering and medical fields have worked to address areas of critical need including the production and delivery of personal protective equipment, ventilators as well as the creation of a viable vaccine. The fight against COVID-19 has helped highlight the work and contributions of so many professionals in the bioengineering fields who are working tirelessly to help our health services cope. Their innovation and ingenuity are paving the way to successfully beat this virus. We must continue to support these fields as we evolve our health systems to deal with the challenges of healthcare in the fu-

ture.

4 Treatment mechanisms

5 Oxygen

The first form for mild respiratory insufficiency is usually the supply of extra oxygen through a nasal cannula or a more intrusive face mask. Most of the time, the oxygen comes in the form of cylinders, either small for portability or large for stationary patients and longer-term supply.

Oxygen concentrators represent an attractive alternative to tanks although this is not typically in use while caring for COVID-19 patients in hospital settings. Oxygen concentrators extract oxygen from the air on demand and supply it directly to the patient. Concentrators come in a variety of sizes from a portable shoulder bag form factor, to higher capacity stationary machines for patients who need oxygen 24/7.

Variants of oxygen supply include high flow nasal oxygen (HFNO) which delivers warmed and humidified oxygen, to avoid the drying of airways, at high flow rates - typically tens of litres/min) at body temperature and up to 100

6 Continuous Positive Airway Pressure (CPAP)

The next step up in treating COVID-19 patients is Continuous Positive Airway Pressure (CPAP)

which is initially intended to prevent airways collapse in sleep apnoea patients, but has been shown to be beneficial to COVID patients if applied early enough in the progression of the disease.

A well-fitted face mask is an essential component of a CPAP system and as such it is quite intrusive. CPAP is only appropriate for patients who are capable of some breathing strength as CPAP effectively opposes some resistance to expiration. Variants exist that either automatically adjust the level of pressure to the patients breathing characteristics (APAP) or have different levels of pressure for inspiration and expiration (BiPAP). CPAP usually supplies (filtered) air to the patient but most masks have a port for supplementing the supply with oxygen.

7 Ventilators

Patients who cannot breathe spontaneously need to be put on a ventilator. Ventilators are capable of replacing the breath function and patients in an advanced state of respiratory distress are usually intubated and sedated at the beginning of the treatment.

Ventilators are capable of replacing the breath function and patients in an advanced state of respiratory distress are usually intubated and sedated at the beginning of the treatment. They are complex systems providing the healthcare professionals with a lot of flexibility to adapt the as-

sisted breathing settings and to be able to wean recovering patients off the ventilator gradually.

Modern ventilators are typically closed loop pressure controlled and capable of detecting spontaneous breathing to synchronise assistance for recovering patients. They also enable the control of the composition of the gas the patient breathes from normal air to 100

8 Ventilator Challenge UK

In March 2020, pandemic modelling predicted that the UK could have an insufficient number of ventilators to cope with the upsurge of patients in intensive care units (ICU) requiring them. The Government launched the Ventilator Challenge, a nation-wide call to industry and academia to help mitigate the potential shortfall.

This saw a lot of consortia being formed developing new CPAP and more or less featured new ventilator designs or looking for ways to scale up the production capacity of existing ventilator models already manufactured and approved in the UK.

Ultimately, the need was thankfully less than initially anticipated, the production scale up efforts were sufficient and none of the new designs were put through the emergency approval process. This remains a fantastic demonstration of what the country's engineering community is capable of when faced with such a challenge.

9 Patient monitoring

An essential element of the ICU equipment is the monitoring equipment that keeps track of some of the patient vitals especially when they are ventilated and sedated but also during their recovery phase to ensure the regime of ventilation is optimised for their condition. Ventilators already provide their set of patient parameters, but usually patient monitors are separate devices as they continue to be useful after the patient can resume breathing on their own unassisted.

One of the key parameters for COVID-19 patient is the amount of oxygen in their bloodstream (SpO2), measured by pulse oximetry which uses optics within a finger clamp. Pulse oximetry tends to be used for the duration of the patient's stay in ICU.

Modern patient monitors provide many more patient parameters all the way to breathing waveforms to enable clinicians to fine tune their care of the patients.