Ministry of Education and Science of Ukraine
Ternopil Ivan Puluj National Technical University

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(full name of faculty)
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QUALIFYING PAPER

for the degree of

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topic: **Using Information Technology for the COVID-19 Pandemic Response in the Benin Republic**

Submitted by: fourth year student IV , group ICH-42
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Ternopil
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« » 2022

ASSIGNMENT

for QUALIFYING PAPER

for the degree of bachelor
(degree name)

specialty 122 – Computer Science
(code and name of the specialty)

student Bakari Sam-Sam
(surname, name, patronymic)

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Introduction. Section 1. Analysis of the Covid-19 Challenges and Solutions 1.1. Pandemic COVID-19 1.2.Internet of things and internet of medical things 1.3. IoMT devices used for COVID-19 response Section 2. Hardware and software solutions for the COVID-19 response in the Benin Republic 2.1. Usability of drones during the COVID-19 2.2. Usability of robots 2.3. Unmanned vehicles 2.4 Bluetooth and GPS technology Section 3.Occupational safety and labour protection 3.1. Occupational safety 3.2. Basics of labor protection. Conclusion. References. Appendix

5. List of graphic material (with exact number of required drawings, slides)
1. Title slide 2. Daily New Cases in Benin 3. Architecture of Internet of medical things 4. Remote patient monitoring architecture 5. A step-up process chart for using IoT during COVID-19 pandemic 6. Use of IoMT for disease management 7. Telemedicine as an integration of IT 8. Final slide

6. Advisors of paper chapters

Chapter	Advisor's surname, initials and position	Signature, date	
		assignment was given by	assignment was received by
Occupational safety and labour protection	Lazaryk V.V, PhD, Assoc. Prof		

7. Date of receiving the assignment 20.12.2021

TIME SCHEDULE

LN	Paper stages	Paper stages deadlines	Notes
1	Acquaintance with the task for qualification work	21.12.2021	*Done*
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	related to the project	31.12.2021	*Done*
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4	Analysis of issues and IT solutions for	04.01.2022 –	
	COVID-10 pandemic responses in Benin	25.01.2022	*Done*
5	Writing of the first section	26.01.2022 –	
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6	Writing of the second section "Hardware and software	04.04.2022 –	
	solutions for the COVID-19 response in the Benin Republic"	25.04.2022	*Done*
7	Writing of the section "Occupational safety	26.04.2022 –	
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13	Defense of qualifying work	06.07.2022	

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ANNOTATION

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Key words: COVID-19, pandemic, internet of things, internet of medical things, point-of-care devices, usability, robots

Qualifying paper is dedicated to analysis of information technologies of the COVID-19 response in Benin republic and give the recommendations for improvements.

The goal of the paper is to consider the issues caused by COVID-19 in Benin republic, analyse possible information technology solutions and recommendations for the improvements.

In the first section of the qualification work the analysis of the subject area is performed, the review of COVID-19 notions and issues has been analysed, possible solutions based on internet of things and internet of medical things have been considered.

In the second section of the qualification work hardware and software solutions for the COVID-19 response in Benin republic has been analised in detail, including GPS, robots, telemedicine, special software etc. The recommendations for the improvements are given in the paper.

The section "Occupational safety and labour protection" identifies the main psychological risk factors that lead to accidents, and considers the requirements of ergonomics for the organization of the workplace of the PC operator.

LIST OF SYMBOLS, UNITS, ABBREVIATIONS AND TERMS

MERS – Middle East respiratory syndrome

SARS – severe acute respiratory syndrome

IoT – Internet of things

WWW – World Wide Web

IoMT – Internet of medical things

ECG – electrocardiogramm

RPM – Remote patient monitoring

OSH – Occupational safety and health

OSHA – Occupational Safety and Health Administration

ILO – International Labour Office

CONTENTS

INTRODUCTION

Actuality of theme. Emergency management of infectious disease outbreaks is critical for publical health threats. Currently, controls for the COVID-19 outbreak are an international concern and become a crucial challenge in many different countries over the world. This thesis of bachelor degree is analysis of significant information technology applications in control responce of COVID-19 by consideratuon the prevention, preparedness, response, and also recovery actions phases of our crisis. This rpaper was conducted carefully using databases MEDLINE PubMed, Embase, and also IEEE, and Google Scholar databases which are important in the world.

The purpose and tasks of the study. The qualification work is devoted to the consideration of the utilization of information technologies, and also systems and other applications in the conditions of a pandemic.

The first section of the final paper deals with the problems and challenges caused by the COVID-19 pandemic. Information on the use of information technologies in the conditions of an epidemic are provided. The considered problems which are caused by the unreliability of data used in the papers. In the second section of the current work, the problem of using IT during the COVID-19 pandemic response in Benin have been considered. First of all, the relation of systems to integrated devises was investigated. The different datasets for processes of exchange of experience in the conditions of the pandemic is taken into account.

The main tasks of the bachelor project is:

- To analyze the subject area related to COVID-19 pandemic.
- To justify the software which can be used to response in Benin.
- To consider hardware to pandemic response in Benin republic.

The practical significance of the results obtained. The analysis has been conducted can be used to improve COVID-19 response reccomendation in Benin.

SECTION 1. ANALYSIS OF THE COVID-19 CHALLENGES AND SOLUTIONS

1.1 Pandemic COVID-19

The COVID-19 pandemic has had a huge impact on the hospital systems, businesses, the schools and the economy. Telemedicine, remote work and the online education are becoming relevant to help society slowing down the spread of the coronavirus [1]. The pandemic has generated a increase in the big number of requests for the use of innovative technologies to fight the damage caused by COVID-19 in various areas of human life [2].

A family of viruses, seven of which are known to infect people. They get their name from the crown like spikes the coronas that appearing on the viruses under a microscopes. Coronaviruses could cause the common cold (which can also be caused by other viruses, such as rihinoviruses), as well as dangerous illnesses such as severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS). SARS CoV-2, the coronavirus virus first discovered on December 2019, causes the disease now known as COVID-19.

It is the coronavirus, which first infected humans in 2002, that really reached epidemic proportions before it was actually contained — there have been no outbreaks since 2003. SARS causes fever, headache, and body aches, a dry cough, hypoxia (the oxygen deficiency), and usually pneumonia. SARS and SARS CoV-2 are related genetically, but actually the diseases they cause are different.

The new real coronavirus that causes COVID-19, which is considered to have started in animals and spread to human life. Animal to person spread was suspected after the real initial outbreak in December among all people who had a link to a really large seafood and live animal store in Wuhan, China. While no one knows actually how SARS-CoV-2 spread from an animal (and what type of animal) to the human, SARS-CoV-2 is a betacoronavirus, meaning it originated in bats [3].

Just as the human immunodeficiency virus (HIV) causes acquired immunodeficiency syndrome (AIDS), the coronavirus SARS-CoV-2 causes COVID-19. The symptoms of COVID-19 include cough, terrible fever, and shortness of

breath. While the disease now appears to cause mild to moderate illness in the most people, in others it caused life-threatening pneumonia and finally death. Doctors and researchers continue to do research more about the disease, so actual information about symptoms, prevention, and treatment may change as more data available.

When a disease and the virus that causes it begins to spread, epidemiologists (who are considered the basic scientists of public health) take notice, looking for the frequency, patterns, and causes associated with it. Below are definitions of a few of those epidemiological terms that you may hear or see reported in the news, especially as they relate to COVID-19.

An epidemic that has spread over several countries or continents, impacting many people. Pandemics typically happen when a new virus spreads easily among people who—because the virus is new to them have little or no pre-existing immunity to it. COVID-19, which was declared a pandemic by the WHO in early March, is the first pandemic known to be caused by the emergence of a new coronavirus.

The CDC recognizes six stages to a pandemic it starts with an investigation phase, followed by recognition, initiation, and acceleration phases, which is when it peaks. Then, comes a deceleration phase, when the rate of infection decreases. Finally, there is a preparation phase, where the pandemic has abated, and public health officials monitor virus activity and prepare for possible additional waves of infection. Different countries and various sections of the same country can be in different phases of the pandemic at the same time. The U.S. is currently in the acceleration phase.

Circulation of a disease among people in a certain area with no clear explanation of how they were infected they did not travel to an affected area and had no close link to another confirmed case. This is sometimes referred to as community transmission. In late February, a woman in California became the first patient confirmed in the U.S. who could not confirm how she got COVID-19.

Although scientists are still learning about COVID-19 as more data becomes available, the virus is thought to be spread mainly from person-to-person contact, as well as when a person touches a surface or object that has the virus on it and then

touches the mouth, nose, or possibly eyes. What follows are some key words used in news outlets to discuss transmission of COVID-19.

The time between when a person is infected by a virus and when he or she notices symptoms of the disease. Estimates of the incubation period for COVID-19 range from 2-14 days, but doctors and researchers may adjust that as more data becomes available.

A form of direct transmission, this is a spray containing large, short-range aerosols (tiny particles suspended in air) produced by sneezing, coughing, or talking. Droplet transmission occurs in general and for COVID-19 when a person is in close contact with someone who has respiratory symptoms. “Although now there is the understanding that we may all spray droplets when we talk or breathe,” says Dr. Meyer. “You don’t necessarily have to cough or sneeze, it’s just that the coughing and sneezing propel the droplets further.”

When a patient is a carrier of an illness but does not show symptoms. People are thought to be most contagious for COVID-19 when they are most symptomatic, according to the CDC, although researchers are still investigating how its spread might be possible at other times, including during the incubation period (called “pre-symptomatic transmission”) and even after symptoms have resolved.

A key strategy for slowing the spread for COVID-19. Washing hands with soap and water for at least 20 seconds is one of the most important steps to take to protect against COVID-19 and many other diseases.

Putting physical distance between yourself and other people. This means avoiding groups of people (parties, crowds on sidewalks, lines in a store) and maintaining distance (approximately 6 feet) from others when possible. This is a key strategy for avoiding COVID-19 infection and to flatten the curve.

A vaccine triggers the immune system to help it build immunity to a disease. The immune system already has the capacity to react to diseases by producing substances called antibodies that remain in the body to fight them in the future. With a vaccine, you don’t have to get the disease to develop immunity the vaccine triggers the same process by providing the body with a tiny amount of a germ that has been

weakened or killed, but small enough that it won't make you sick. Vaccines are introduced to the body via injection, mouth, or a nasal spray.

The National Institute of Allergy and Infectious Diseases (NIAID) is investigating a vaccine to protect people against COVID-19. An experimental vaccine, called mRNA-1273, has been developed by NIAID scientists and their collaborators at the biotechnology company Moderna, Inc. It could take at least a year before this or any other vaccine is available for the new disease.

1.2 Internet of things and internet of medical things

IoT is also known as the Internet of Everything or the Industrial Internet. It is a new technology paradigm, which comprises a network with machines and devices that can efficiently interact with each other. IoT has gathered major attention from many industries all over the world and is expected to be an integral part of future technology.

IoT is becoming popular for many reasons. The most important reasons being the wide availability of broadband Internet, the reduced cost of hardware, and an enormous amount of people using smartphones, wearables capable of collecting data, and other "smart" products (see figure 1.1).

Figure 1.1 – Internet of things current area

IoMT combines medical devices and applications to connect the information technology systems of healthcare by using various networking technologies. IoMT is making its place in society at a fast pace with a big percentage of global healthcare organizations already making use of it.

IoMT is a smart platform, which makes use of smart sensors, smart devices, and innovative communication protocols in order to examine the biomedical signals and subsequently diagnosing the disease of patients without much human involvement. Figure 1.2 shows a brief architecture of IoMT.

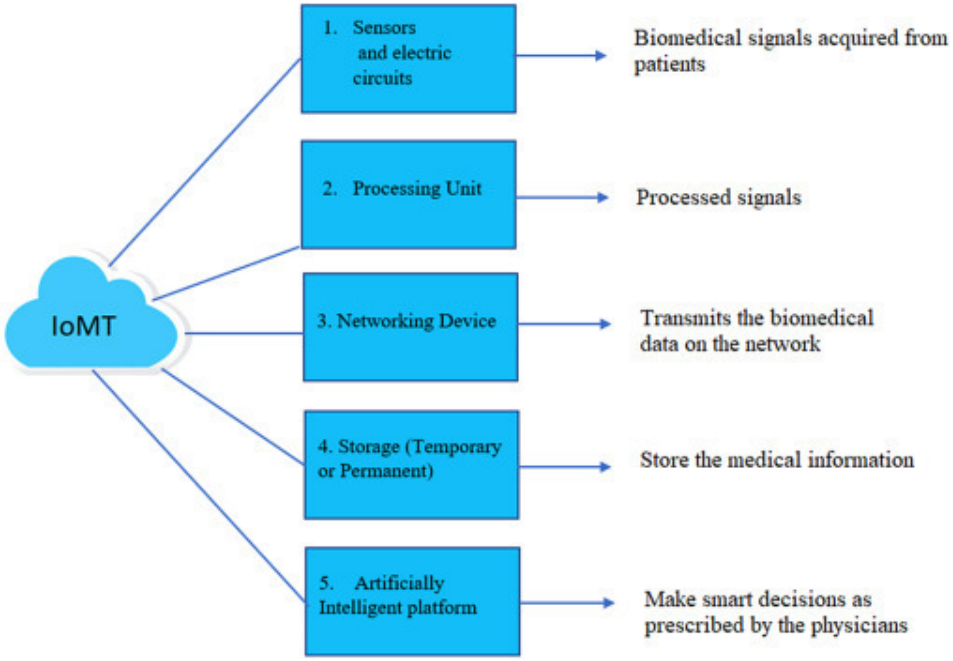

Figure 1.2 – Architecture of Internet of medical things

IoMT may find its applications in the following: remote monitoring of patients, order tracking for medications, transmitting the medical information monitored by the wearables to the concerned healthcare professionals.

1.3 IoMT devices used for COVID-19 response

In this section we consider the classification of the internet of things devises which can be used to COVID-19 response in Benin Republic.

1.3.1 Wearables devises

Wearables are further classified in to two categories.

Fitness wearables. These are the lifestyle devices, which are normally worn by the patients. Patient's health is monitored by collecting the data based on his physical activities by making use of built-in sensors. Some common examples of these wearables are bands, wrist watches, and necklaces (fig. 1.3).

Figure 1.3 – Fitness wearables for COVID-19 monitoring

Clinical grade wearables. This category includes the IoT devices, which have been certified and approved by the regulatory authority. These are mostly prescribed by doctors and used at a clinic or in home in order to monitor and improve chronic conditions in specific diseases. Examples include smart belts (Active protect), which are especially designed to detect falls in elderly patients and chest straps (Qardio Core), which can record the ECG (see figure 1.4).

(A) Active protect (B) Qardio core

Figure 1.4 – Clinical grade wearables for COVID-19 monitoring

The devises we have considered play a grate role for monitoring patient desoases and also for monitoring COVID-19 issues in Benin Republic and also in other countries.

1.3.2 Remote patient monitoring devises

Remote patient monitoring (RPM) has enabled the physicians to monitor and manage patients in a nontraditional manner. RPM collects the health data from individuals in one location, which can be a patient's home and then transmits this information electronically to healthcare providers who might be in a different location so that they can make their assessments and provide recommendations.

This approach saves time and provides services while ensuring patient's comfort. It can be used to send reminders and revised medical plans to patients based on their physical activities. According to IHS (Information Handling Services), more than four million patients will monitor their health conditions remotely by 2020. Some famous examples include remote blood sampling devices, continuous glucose monitoring device, and affordable surgical robots (see fig. 1.5).

Point-of-care devices are diagnostic devices that can be found in doctors' offices, hospitals, and mostly in patients' home. They are used to acquire diagnostic results while they are with the patient or close to the patient. Common examples are devices used to test glucose and cholesterol levels, pregnancy testing, oximeter, tests for drugs of abuse, etc. The most prominent advantages of these devices include portability, convenience, and speed.

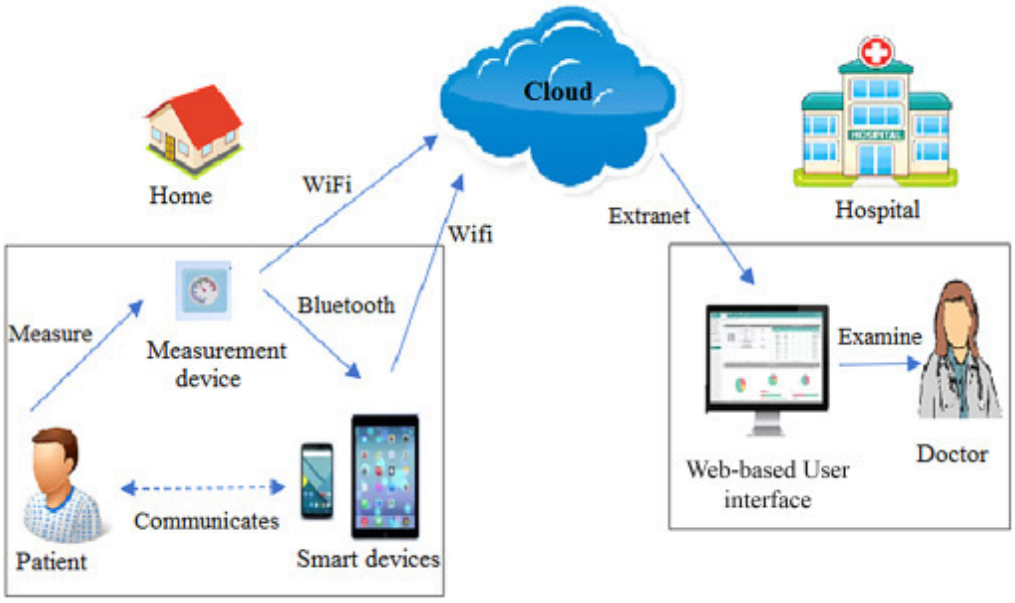

Figure 1.5 – Remote patient monitoring architecture

This architecture play a grate role for the COVID-19 remote patient monitoring using the modern informative technologies and communications.

1.3.3 Internet of medical things application for healthcare system

The unprecedented outbreak of the novel coronavirus also known as COVID-19 poses a major global challenge. As the treatment of the disease is still under way, an optimal approach will be to find an efficient mechanism of disease diagnosis and management. A healthcare system based on the IoT can help achieve the goal. On the figure 1.6 you can see the general structure.

Figure 1.6 – A step-up process chart for using IoT during COVID-19 pandemic

The standard testing method being used currently for COVID-19 screening is the reverse real-time PCR assay (rRT-PCR). It is a time-consuming, molecular-based test, which on the average needs 4–6 h to deliver the results. It also requires trained specialists and a well-resourced laboratory. This eventually puts a limit on the number of tests that can be conducted, which is not satisfactory in such critical circumstances. Hence, alternative rapid diagnostic tools are urgently needed.

In such a situation, a promising technique can be the point-of-care (POC) devices that employ lateral flow immunoassay (LFIA) technology to detect COVID-19 in human serum. This technology relies on the fact that after the COVID-19 infection, IgG and IgM antibodies against SARS-CoV-2 can be detected in human blood and their levels in the blood can offer an insight into the disease stage and its growth. With an increase in the number of cases worldwide, numerous POC LFIA devices have come to the front as rapid diagnostic tools.

In the current pandemic situation, the number of COVID-19 patients is increasing at an alarming rate, which calls for an efficient monitoring and surveillance system for impactful patient tracing.

IoT can play a vital role during this pandemic in context to contact tracing, cluster identification, and compliance of quarantine.

It is critically important to identify infected individuals in crowded places, which is being done mostly by using infrared thermometers. However, it does not seem to be much efficient as first, thermometer might not cover all the people in crowd and second, it might lead to the spread of virus as it has to be done by a health officer, who is examining many people standing in a queue and anyone among them can be infected. Hence, an alternative technology is required and IoT seems to be promising in this regard.

With the rapid spread of COVID-19, the whole world has implemented strict lockdown measures to reduce the spread of disease. According to an estimate, approximately 10 billion people have been self-quarantined at home. On the other hand, essential medical supplies and equipment have been on high demand. In order to seek medical help, the citizens, some of whom can be potential patients, must leave their homes, which contradicts the efforts being done for isolation and quarantine.

Also, due to the lack of proper isolation wards, the health community has prompted the patients with minor or suspected symptoms to stay in their homes.

Additionally, the lack of isolation wards and proper medical devices has prompted the medical community to encourage those with mild or suspected symptoms to remain at home. In such critical situation, IoMT can be used as a medical podium not only to aid the affected individuals to get the suitable healthcare facilities at home but also to create an extensive disease management database for governments and healthcare organizations.

Figure 1.7 shows such a platform where the process of disease management will follow the several steps.

Figure 1.7 – Use of IoMT for disease management

On the first step individuals who are experiencing insignificant symptoms do not have to be in the hospital. Instead, they can acquire the diagnostic and healthcare requirements such as thermometers, masks, gloves, sanitizers, and POC kits used for detecting and monitoring COVID-19 and medications at their homes. After that, patients can then use the Internet to upload their regular health status to the IoMT platform from where their details will be broadcasted to the closest hospitals, Centre for disease control (CDC), and local health agencies.

SECTION 2. HARDWARE AND SOFTWARE SOLUTIONS FOR THE COVID-19 RESPONSE IN THE BENIN REPUBLIC

In the current section we are going to consider the modern technologies which are used for the COVID-19 pandemic response in the Benin republic. We will also consider the technologies that can be recommended as the high level solutions.

2.1 Usability of drones during the COVID-19 pandemic

The involvement of drones in military operations has increased since late 1990s. But civilian drones with commercial-grade low-cost technology are also getting popular and have already been used for various rescue tasks and natural disasters around the world. In this section, we will present the possible ways that can be helpful in fighting and disaster, or disease spread specifically during COVID-19. The first country to face the wrath of COVID-19 has made great use of drone technology to counter its spread. Taking that as an inspiration, countries around the world have joined forces with numerous researchers and innovators in an attempt to find ingenious ways of using drones to fight any future or current pandemic at the best.

Drones can be used to facilitate access to medical care in demoted communities. Demoted communities lack infrastructure and proper transportation. Therefore, drones are particularly helpful in such communities to help in the delivery of necessary health services and supplies in a time-effective manner. Drones travel faster than any manned vehicle and hence can overcome topographic challenges that would be very challenging to overcome by other forms of transportation.

As the person with COVID-19 is contagious, medicines and food can be transferred to the person in isolation. An example of autonomous drone is Beyond visual line of sight (BVLOS) [24]. These drones can fly far beyond visual line of sight while maximizing production, reducing costs and risks, and ensuring site safety and security, hence protecting the human workforce in times of a pandemic [25].

They can also be used for consumer-related missions like package delivery, as demonstrated by Amazon Prime Air, and critical deliveries of health supplies.

Drones with camera as payload are being used mainly for surveillance other than hobbyist photography. They can be ideal for crowd surveillance due to their feature to provide current location bird eye or aerial view in no time. That is why many countries around the world are deploying drones for crowd surveillance especially during COVID-19 pandemic.

Surveillance drones added with temperature sensor can updated about body temperature of peoples in any community area. Countries including China and India have also adopted the drone technology for crowd surveillance. The drones deployed are equipped with surveillance cameras that can effectively monitor sensitive areas in the city and allow the police to handle any unwarranted situation promptly.

In addition to crowd surveillance, drones can prove to be highly useful for broadcasting important information, particularly in areas that lack open channels for communication. In California, Florida, and New Jersey, officials have used drones to get messages to homeless communities or notify and warn people about social distancing. The police authority in Madrid, Spain, used a drone equipped with a loudspeaker to inform people of the guidelines put in place regarding the state of emergency that was imposed European countries are also getting benefit from drones; many countries have deployed drones for making public announcements for public awareness during pandemics to stop spread of diseases or disasters.

Drone technology is benefiting people where there is need to avoid direct contact with viruses and bacteria. Using drones, disinfectants can be sprayed in contaminated areas. Increase of demand has been observed for spraying drones in agricultural lands during last decade. The Spanish military has recently adopted the use of agricultural drones made by DJI, a leading Chinese drone manufacturer, to spray disinfecting chemicals over public spaces [8]. On average, these spraying drones have a load capacity of 16 L and can disinfect one-tenth of a kilometer in an hour.

2.2 Usability of robots in COVID-19 pandemic response

Robots are smart machines and remained helpful during current COVID-19 pandemic. Robots can easily be deployed as frontline warrior in medical units due to less risk of contagious disease spread from the patients who are suffering.

Additionally, ultraviolet (UV) disinfection method (method to disinfect the areas from contagious diseases) is easily achieved with robots through preprogrammed procedures; hence, limiting the transfer of the disease via contaminated surfaces in hospitals or isolation centers. The autonomous disinfecting robots with very little or no human contact are recommended as compared to the manual decontamination, which involves the cleaning staff and may risk their lives.

Many countries all over the world took advantage from robot technology for not only mitigating the spread of COVID-19 disease but also for the sake of monitoring social and emotional health of patients and people in isolation. Other than the above-mentioned services, a few more helpful features of robots during the disaster are concluded below.

Delivery. Robots are deployed during COVID-19 pandemic to deliver medicines, medical equipment, and serving food in medical units to avoid contact with patients directly, hence giving relief to medical staff. A Kerala-based Indian startup named Asimov Robotics has developed a three-wheeled robot that can be used to perform all these tasks while assisting patients in isolation wards

Social distancing. Robots with cameras are helpful to keep check in public, if social distancing is being followed or not. In addition, guiding public about preventive measures should be observed in public especially in affected areas.

Disinfecting. As discussed earlier, robots are safer for disinfecting equipment and places of concern. A Danish robotics company has developed multiple disinfection robots, which disinfect effected area or equipment by UV light radiation. The UV rays tear apart strands of virus' DNA, hence making it harmless. The company named UVD has delivered its robots in China, healthcare markets in Europe, and United States. Their claim is that the robots can operate for about 2.5 h and disinfect about nine or ten rooms on a single charge [3].

Emotional support. Many countries during pandemic underwent into strict lockdowns for months. Prolonged isolation affects mental health of people in negative way. Special robots are developed to share the emotions of people in isolation. These robots are virtually controlled by doctors to keep check of patient's health condition.

Medical procedures and surgeries. The contagious nature of COVID-19 put many medical experts at added risk while performing regular procedures and surgeries. As the virus easily spreads through mouth and droplets, the dentist, oncologist, and ENT surgeons [13] stand at front of the danger zone. Although, general-purpose procedures were postponed during the pandemic by almost every country effected but still emergencies need special attention. Robotic surgeries are already being successfully done in different medical fields far before the pandemic crisis. Even with personal protective equipments (PPEs), physical distancing is the key to avoid virus spread. Consequently, during pandemic nonautonomous robots can prove to be safer alternative where close contact through patient's mouth and nasal cavity become necessity.

The overview of different tasks done by robots in industries is compiled below on the figure 2.1.

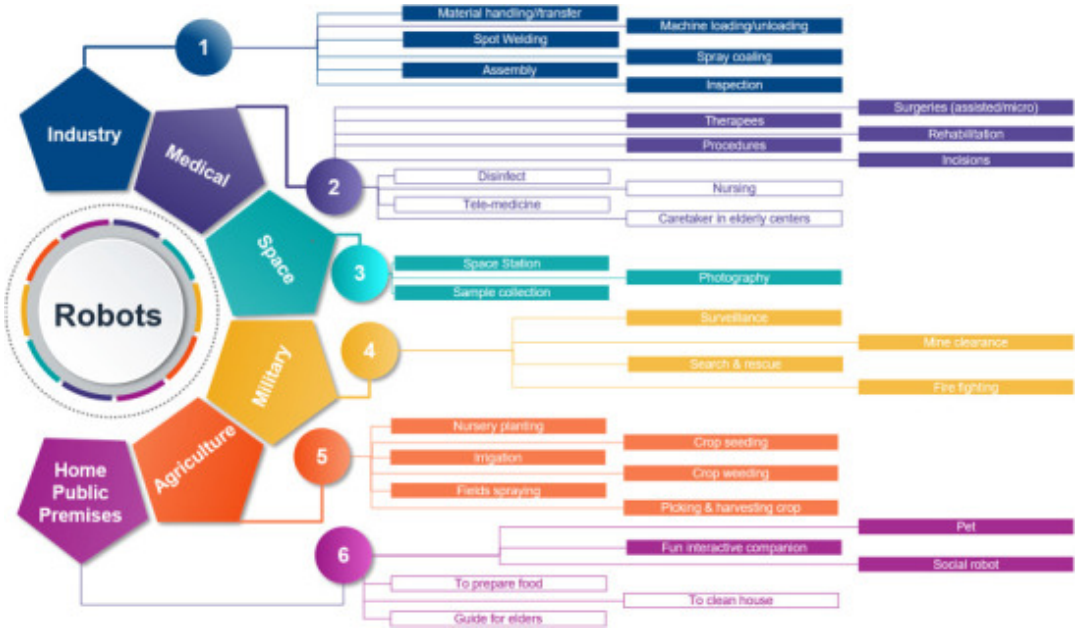

Figure 2.1 – Use of robots for disease management

As a conclusion I can say that using robots for the COVID-19 response in the Benin republic has become one of the most important solutions no decrease the level of desease outbraking.

2.3 Unmanned vehicles

Unmanned vehicles are without involvement of any human driver aboard. They can cover far-flung and difficult areas, impossible by any human driven vehicle. As compared to traditional vehicles, they have additional features of high safety, reliability, intelligence, and efficiency because of small size.

Unmanned vehicles are without involvement of any human driver aboard. They can cover far-flung and difficult areas, impossible by any human driven vehicle. As compared to traditional vehicles, they have additional features of high safety, reliability, intelligence, and efficiency because of small size.These vehicles can either be remote-controlled, remote-guided vehicles or autonomous, which are capable of sensing and navigating on their own. These autonomous driverless vehicles work according to the paths defined by installed sensors to sense surrounding environment or obstacles on the way with the help of intelligent software. The destination is fed by the software installed in these vehicles or at control station.

The vehicle and equipment that operate with little or no operator intervention are always an attraction because they save the labor cost in commercial areas and remove the direct involvement of operator specifically during dangerous applications. During the disaster or any global health crisis like COVID-19 pandemic, AVs can be of great help. They can ease the stress on existing delivery mechanisms while mitigating the spread of virus spread. During 2016, a company JD.com, an e-commerce company, began testing the country's first developed self-driving vehicle for domestic usage. The other companies in market soon joined this race to compete each other. During the pandemic, China led the charge in the use of AVs. Beijing-headquartered White Rhino Auto Company, in alliance with UNIDO's Investment and Technology Promotion Office (ITPO), dispatched two autonomous

delivery vehicles from Beijing to the Guanggu Field Hospital in the Hubei Province of China.

These UVs proved to be very useful during pandemic; hence, they can serve in various ways. These tasks may include delivering medical supplies within hospitals, distributing meals and medicines in isolation centers, on demand groceries delivery home-to-home during lockdowns, decontaminate infected surroundings, awareness announcements in large gatherings, and much more.

2.4 Bluetooth and GPS technology

Bluetooth technology is a short-range technology that operates in UHF radio waves spectrum (ultra-high frequency 300 MHz–3 GHz). Mainly, it is used to deploy low-cost, low-power, and short-time wireless connections between desktops, laptops, and Bluetooth devices like mobile phones, printers, digital cameras, headsets, keyboards, and even a computer mouse. This cutting-edge technology uses globally available radio frequency band between 2.402 and 2.480 GHz, which is dedicated for industrial, scientific, and medical use. In a nutshell, Bluetooth technology unplugs your digital peripherals and makes cable clutter a thing of the past.

The Bluetooth technology is very helpful for proximity calculation and preferred over other technologies because of its least invasive nature. With this technology, it is easy to monitor relative distance between two nodes without getting actual location of devices.

GPS is a navigation system that uses satellites to provide positioning, navigation, and timing (PNT) services to its users.

During COVID-19, governments can make use of the GPS technology for tracking the current and the historical location of positive patients. This will eventually help in backtracking other potential COVID-19 patients.

Some common uses of GPS during COVID-19 pandemic are represented below, taking into account our recommendation to use them for the COVID-19 response in Benin republic.

Mobile applications. During this deadly pandemic, many countries have released different versions of mobile applications leveraging GPS in order to identify the COVID-19 patients and help control the spread of virus. Most of these applications are downloadable for free using individuals' mobile numbers. Once launched, it will categorize the users as safe or unsafe using different criterions such as existence of virus symptoms, or international travel history. The GPS location of the suspected cell phone users will be stored in the database. This information can be later used for various purposes such as (1) to alert a safe user if he meets a suspected virus victim and (2) to send the GPS location of the victim to the healthcare officials if any emergency help is needed.

Smart helmets. Many countries are making use of smart helmets equipped with built-in GPS modules, optical camera, and infrared thermal camera for screening the suspected COVID-19 carriers. The infrared camera scans the given area for any high temperature. Once an individual with a high temperature is detected, the optical camera captures the face of the suspected individual. The GPS module then determines the position coordinates and after tagging it, a notification is sent to assigned smart mobile through a GSM, which will be subsequently used for various purposes mentioned above.

Smart ambulance system. Another efficient approach to combat the effects of COVID-19 can be the use of Smart Ambulance System, which is an integration of GPS and GSM. The GPS component is used to identify the location of the patient and the ambulance, whereas the GSM is used for data transmission. This system consists of an end-to-end smart health application. Once an emergency request is generated by a registered GSM mobile user facing extreme virus symptoms, such a system can track the location of the patient using the GPS embedded in the mobile, identify the nearest hospital with available beds, and urgently send them smart ambulances equipped with major requirements of a critical COVID-19 patient such as oxygen cylinder, oximeters, and other instruments for measuring the vitals. The timely delivery of patient to the hospital is extremely important. The ambulance is also equipped with (1) GPS module to determine updated ambulance location so that the paramedics can select the ambulances, which are already in the same route as the

patient and for calculating the shortest/fastest possible route to the selected hospital; (2) GSM module in order to transmit any essential information to the paramedics' database or the hospital. It will be even better if the time for patient's transportation can be utilized to gather major medical information about him/her and transmit it to the hospital using GSM in order to enable them to make prior emergency arrangements.

Controlling the coronavirus spreading is the key factor to mitigate COVID-19 disease. So far, many advancements and inventions in the technology have been done, in order to reduce direct virus exposure in societies, decontamination of suspected places, and effected surveillance of masses. Before looking further at possibilities to control virus spread, it is important to dig down to the level of coronavirus transmission biological details. The virus may enter the body through mouth, nose, and eyes, if a person with prior COVID-negative exposes to exhaled droplets of an infected person, touched the contaminated surface, aerosol, and possibly through fecal–oral contamination.

2.5 Telemedicine technology for COVID-19 response

A very recent development that is ushering in the field of medical science is telemedicine. Telemedicine refers to the practice of remote patient care when the healthcare provider and patient are not physically present with each other. It offers the following advantages:

– with telemedicine, a patient can consult a specialist anywhere on the globe;

– it reduces the workload of overburdened hospital staff;

– in case of disease outbreaks, it lessens the chances of disease speed from the patient to the healthcare personnel;

– it can prove to be a lifesaver in emergency situations requiring immediate critical care;

– from the perspective of patients, it means a shorter waiting time and hence a faster recovery.

It also enables people in rural parts of a country with unsatisfactory medical services have a quicker and easier access to healthcare.

Figure 2.2 shows the basic idea of telemedicine. It is an integration of various technologies discussed above in order to make the healthcare facilities available at patient's doorstep.

Figure 2.2 – Telemedicine as an integration of information technologies for the COVID-10 response

2.6 NHS COVID-19 application

The NHS COVID-19 app is an important part of the 'Test Trace Protect program' made in BENIN to control the spread of COVID-19. The app is used, alongside traditional contact tracing, to notify users if they come into contact with someone who later tests positive for coronavirus.

The app allows people to report symptoms, order a coronavirus test and it helps the NHS trace individuals that may have coronavirus.

The app is helping the NHS understand if the virus is spreading in a particular area, and so local authorities can respond quickly to stop it spreading further.

The app does this while protecting a user's anonymity. Nobody, including the government, will know who or where a particular user is.

The app is available for download from the Apple app store or Google Play store. By downloading and using the app, you can help keep your family and friends safe.

Let us consider how this application help user under COVID-19 pandemic conditions.

The app detects and logs other nearby app users using random unique IDs. If any of those users later test positive for coronavirus (COVID-19), you will receive an exposure alert with advice on what to do. If you are under 18, you are advised to show this alert to a trusted adult.

When you first register for the app, you will be asked for the first half of your postcode. You can check the app every day to see whether where you live has become a high-risk area for coronavirus. If it is, you will also receive a notification to let you know. This will help you make daily decisions to protect yourself and those you love.

If you feel unwell, you can use the app to check if your symptoms could be related to coronavirus (COVID-19).

If you have coronavirus symptoms, the app will take you to a website where you can book a test to see if you have coronavirus or not.

If you have been advised by the app to self-isolate, the app provides a countdown timer so that you can keep track of how long you need to self-isolate. When you reach the end of your self-isolation period, the app will send you a notification reminder with a link to the latest advice for you.

You may be entitled to a payment of £500 under the Test, Trace, Protect self-isolation support scheme. Find out more information about how to apply through the COVID-19 app, on NHS COVID-19 app support.

The NHS COVID-19 app uses your smartphone's existing "Exposure Logging" feature to work out if you have spent time near other app users who have tested positive for coronavirus (COVID-19). For this to work, your Bluetooth needs to be turned on: this will not drain your battery as the app uses "Bluetooth Low Energy". It uses your postcode district to tell you if your area is at risk. When you download the app, you will be asked to share the first 4 letters and digits of your

postcode with NHS Wales. A postcode district generally contains about 8,000 addresses. This means that your specific location cannot be identified.

At the and of our thesis we represent the figure 2.3 with data visualization of daily new cases in Benin.

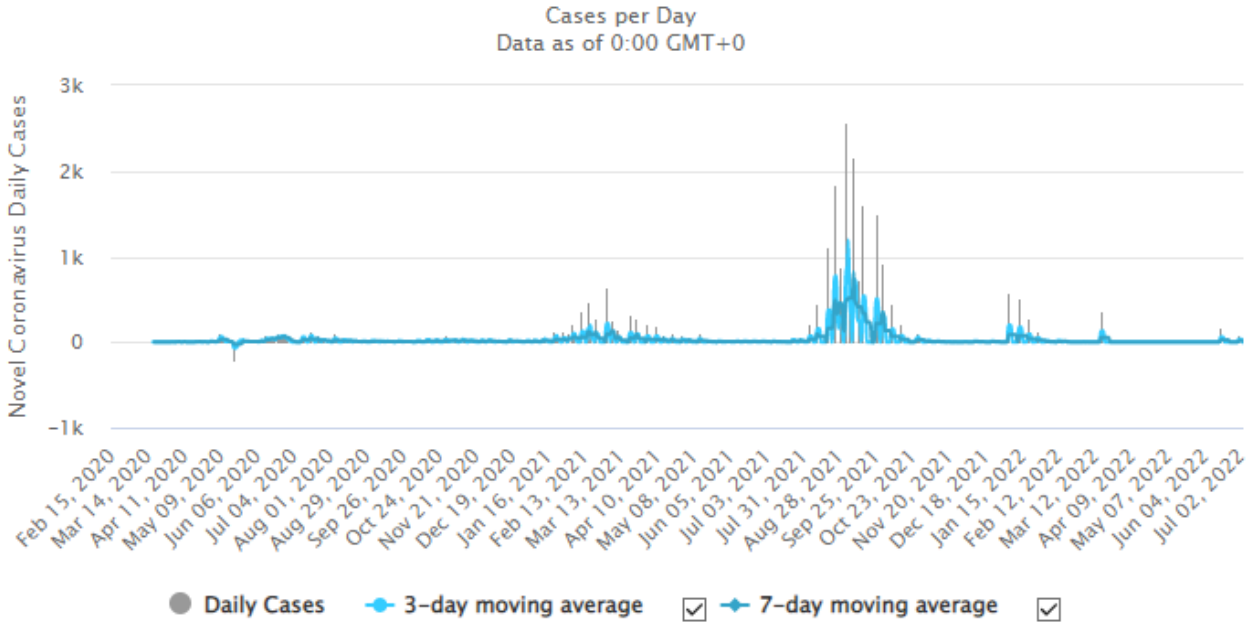

Figure 2.3 – Daily New Cases in Benin

The dataset has been taken from the https://www.worldometers.info/coronavirus/country/benin/. Also 3-day moving average and 7-day moving average are represented to illustrate the average tendency of COVID-19 pandemic in the Benin Republic.

The information technology which have been considered in the thesis were the key importance for the response in the country, and they were very effective and helpful.

SECTION 3. OCCUPATIONAL SAFETY AND LABOUR PROTECTION

3.1 Occupational safety

Workplace safety is an important part of any job and requires that everyone in the company adhere to the safety guidelines and policies in place. Carefully following appropriate safety guidelines can go a long way toward preventing workplace injuries. Here are some ways you can work to stay safe on the job.

Always be alert to what's happening in your surroundings; remember that your safety is your responsibility. Understand the particular hazards related to your job or workplace, and keep clear of potentially hazardous areas or situations. Be awake and attentive on the job, and be particularly aware of machinery. Avoid going to work under the influence of alcohol or drugs, which can compromise your concentration, coordination, judgment, motor control and alertness.

Use correct posture to protect your back while at work. If you sit at a desk, keep your shoulders and hips in line and avoid hunching over. Use correct form when lifting objects and avoid twisting and stooping. The following tips provide information about lifting correctly:

– Use both hands to lift or carry a heavy object.

– Adopt a proper lifting stance by putting the strain on your legs, keeping your back.

– Wear a back brace for heavy work.

– Test the weight before picking up the item.

– Lift items smoothly and slowly.

– Move your feet instead of your back when traveling or turning with a heavy object.

– Hold the load close to your body.

– Ask for help to move loads that are too heavy for you.

Feeling tired and burned out makes you less likely to be aware of your surroundings and is a common cause of workplace injuries. Regular breaks help you

stay fresh and alert on the job. It is particularly important to take short breaks when you have a task that requires repetitive movements over a long period of time.

Always take the proper precautions when operating machinery or using tools. Taking shortcuts is a leading cause of workplace injuries. Use the appropriate tool for the job, and use it in the right way. When using tools and machinery, put safety first with the following tips:

– Only use machinery you are trained and authorized to use.

– Keep tools clean and in good working order.

– Organize tools and always return them to their proper place.

– Make sure the machine operator sees you, don't approach from a blind spot or from behind.

– Only perform tasks you have been properly trained to perform.

– Never leave machinery unattended while it is running.

– Always obey operating instructions.

– Never remove or tamper with safety guards.

– If something seems wrong, immediately stop the machine and get assistance.

– Communicate with those around you.

– Never walk in front of heavy equipment.

– Read and follow all labels and instructions.

– Don't tamper with hazardous items, including cords, switches and electric controls.

– Wear appropriate and compact clothing; loose, billowing clothing and accessories can easily get caught in moving parts.

– Never place fingers or other objects into moving machinery.

– Turn off equipment before moving, cleaning, adjusting, oiling or un-jamming.

Always know where emergency exits are located and keep the path to them clear. You should also have clear access to emergency shutoffs on machinery.

If you notice a potential safety hazard or risk, report it to your supervisor immediately so they can address the situation.

3.2 Labor protection management

The need to improve the conditions of labour that exist “involving such injustice, hardship and privation to large numbers of people as to produce unrest so great that the peace and harmony of the world are imperiled”, as stated in the Preamble to the ILO Constitution, was the underlying motivation for the ILO’s creation in 1919. Almost 90 years later, the ILO Declaration on Social Justice for a Fair Globalization, 2008, reaffirmed the importance of the constitutional objectives of the ILO and stressed the need to develop and enhance measures of labour protection, including “healthy and safe working conditions; and policies in regard to wages and earnings, hours and other conditions of work, designed to ensure a just share of the fruits of progress to all and a minimum living wage to all employed and in need of such protection”.

Labour protection is grounded in the ILO’s founding values that labour is not a commodity and that improving conditions of work is central to social justice, countries’ prosperity and universal and lasting peace.

As set out in the ILO Declaration on Social Justice for a Fair Globalization, social protection comprises two pillars: social security and labour protection. At its 100th Session (2011), the International Labour Conference held a recurrent discussion on social protection (social security); this year, the theme of the recurrent discussion will be social protection (labour protection). Labour protection and social security are complementary and together are intended to provide most of the protection those workers, and their families, need.

In line with the guidance provided by the Governing Body at its 320th Session (March 2014), this year’s recurrent discussion will focus on four policy areas: wage policies; working-time arrangements; occupational safety and health (OSH); and maternity protection. These policy areas were at the heart of the ILO’s founding in 1919. They are central to the employment relationship and are important determinants of the competitiveness and innovativeness of enterprises. Almost a century later, they are more than ever a chief concern of ILO constituents.

This recurrent discussion will allow the ILO's tripartite constituents to review the evolving realities and needs of Members as regards labour protection, as well as the related action taken by ILO member States and the Organization in recent years. The discussion is a timely occasion for assessing the relevance and effectiveness of responses, while considering options for the future, bearing in mind the outcomes of the recurrent discussions on the other strategic objectives and the forthcoming 100th anniversary of the Organization.

3.3 Work-related diseases caused by inhalation of asbestos dust

Asbestosis is widespread scarring of lung tissue caused by breathing asbestos dust. Asbestos can cause serious disease when inhaled over a long period. Minute asbestos fibers are taken up by the lung cells. Unlike many ordinary dust particles, they cannot be removed by the lung. Because the fibers are small, thin, and narrow, they can penetrate the deepest lung tissues, where they remain permanently. Continued exposure can increase the amount of fibers that remain in the lung, causing one of several diseases to develop even two to three decades after exposure. These diseases include asbestosis, lung cancer, mesothelioma, and some less common conditions. Asbestosis is the most common form of asbestos-related lung disease. Smoking increases the risk of developing illness from asbestos exposure.

Symptoms of asbestosis appear gradually only after large areas of the lung become scarred. The scarring causes the lungs to lose their elasticity. The first symptoms are a mild shortness of breath and a decreased ability to exercise. Smokers who have chronic bronchitis along with asbestosis may cough and wheeze. Gradually, breathing becomes more and more difficult. In about 15% of people with asbestosis, severe shortness of breath and respiratory failure develop. People with a noncancerous asbestos effusion may have difficulty breathing because of fluid accumulation. Pleural plaques cause only mild breathing difficulty resulting from stiffness of the chest wall. Mesothelioma is a form of cancer caused by exposure to asbestos. Persistent pain in the chest and shortness of breath are the most common symptoms of mesothelioma.

The term “asbestos” is a generic name given to a fibrous variety of six naturally occurring minerals that have been used for decades in thousands of commercial products. Asbestos is a commercial name given to a group of minerals that possess high tensile strength, flexibility, resistance to chemical and thermal degradation, and electrical resistance. These minerals have been used in many products, including insulation and fireproofing materials, automotive brakes and textile products, and cement and wallboard materials.

Asbestos has over 3,000 uses, including insulation for boilers and pipes, automobile brake linings, and, until recently, insulating hair dryers. An estimated 30 million tons have been used in the United States since 1900. Most products made today do not contain asbestos. Those few products made which still contain asbestos that could be inhaled are required to be labeled as such. However, until the 1970s, many types of building products and insulation materials used in homes contained asbestos. Refer to the EPA Asbestos website listed under references for more information.

Naturally occurring asbestos (NOA) includes fibrous minerals found in certain types of rock formations. NOA can take the form of long, thin, separable fibers. Natural weathering or human disturbance can break NOA down to microscopic fibers, easily suspended in air. There is no health threat if NOA remains undisturbed and does not become airborne. Covering NOA with clean soil or planting grass reduces exposure.

Asbestos is a well recognized health hazard, and is highly regulated by the government. When disturbed, the asbestos minerals have a tendency to separate into microscopic-size particles that can remain in the air and are easily inhaled. Although the use of asbestos and asbestos products has dramatically decreased, they are still found in many residential and commercial settings and continue to pose a health risk to workers and others. The more a person is exposed to asbestos fibers, the greater the risk of developing an asbestos-related disease. People who regularly work with asbestos are at the greatest risk of developing lung disease, and can develop several types of life-threatening diseases, including lung cancer. Asbestosis is a much more

common consequence of asbestos exposure than cancer. Between 1999 and 2004, there were 3,211 deaths due to asbestosis in the United States.

An estimated 1.3 million workers in the construction and general industry face significant exposure to asbestos on the job. Shipbuilders, textile and construction workers, home remodelers, workers who do asbestos abatement, and miners who are exposed to asbestos fibers are among the many workers at risk. The heaviest exposures are in the construction industry, especially during the removal of asbestos during renovation or demolition. Workers exposed to deteriorating, damaged, or disturbed asbestos-containing products such as insulation, fireproofing, acoustical materials, and floor tiles have an increased risk of exposure. Workers can also be exposed to asbestos during manufacturing of asbestos products (such as textiles, friction products, insulation and other building materials) and during automotive brake and clutch repair work.

Although the general public has become more aware of the risks of asbestos, people who have no occupational exposure have a very low risk of developing asbestos-related lung disease. However, secondhand exposure may occur among family members of exposed workers and among people who live close to mines. Persons living in buildings that have undergone renovation and repair without proper control of asbestos-containing materials or dust may also experience an increased risk of disease.

A thorough history, including a detailed work history over the patient’s lifetime, physical exam, and diagnostic tests, is needed to evaluate asbestos-related disease. Chest x-rays are the best screening tool to identify lung changes resulting from asbestos exposure. Lung function tests and CAT scans also assist in the diagnosis of asbestos-related disease.

If diagnosis or screening is being done for a worker covered by the Coal Workers' X-Ray Surveillance Program as mandated by the Federal Mine Safety and Health Act of 1977, regulations mandate that all physicians who participate in the examination and/or classify chest radiographs under the Act must utilize the ILO System and Standard Films. This may also apply for asbestos-exposed workers covered by U.S. Department of Labor regulations, or for other medical screening,

surveillance, research, or compensation programs. B Reader approval is granted to physicians with a valid U.S. state medical license who demonstrate proficiency in the classification of chest radiographs for the pneumoconiosis using the International Labour Office (ILO) Classification System.

Asbestosis is a serious, progressive, long-term non-cancer disease of the lungs. It is caused by inhaling asbestos fibers that irritate lung tissues and cause the tissues to scar. The scarring makes it hard for oxygen to get into the blood. Symptoms of asbestosis include shortness of breath and a dry, crackling sound in the lungs while inhaling. Most treatments for asbestosis ease symptoms rather than cure the disease. Oxygen therapy relieves shortness of breath. Draining fluid from around the lungs may make breathing easier. Occasionally, lung transplantation has been successful in treating asbestosis. Asbestosis is not necessarily fatal. While asbestosis is not cancer, it may lead to cancer. If the patient smokes, he or she should stop because smoking significantly increases the risk of developing lung cancer in people with underlying asbestosis. Some patients can die from severe forms of the disease or from complications, such as pneumonia.

Lung cancer causes the largest number of deaths related to asbestos exposure. People who work in the mining, milling, manufacturing of asbestos, and those who use asbestos and its products are more likely to develop lung cancer than the general population. The most common symptoms of lung cancer are coughing and a change in breathing. Other symptoms include shortness of breath, persistent chest pains, hoarseness, and anemia.

Asbestos also causes cancer in the pleura, called mesothelioma, or in the membranes of the abdomen, called peritoneal mesothelioma. In the United States, asbestos is the only known cause of mesothelioma. Smoking is not a cause of mesothelioma. Mesotheliomas most commonly occur after exposure to crocidolite, one of four types of asbestos. Amorite, another type, also causes mesotheliomas. Chrysotile probably causes fewer cases of mesotheliomas than other types, but chrysotile is often contaminated with tremolite, which does. Mesotheliomas usually develop 30 to 40 years after exposure and can occur after low levels of exposure. Mesotheliomas are invariably fatal within 1 to 4 years of diagnosis. Chemotherapy

and radiation therapy do not work well, and surgical removal of the tumor does not cure the cancer. Other treatment is focused on controlling pain and shortness of breath in an effort to preserve as much quality of life as possible.

Diseases caused by asbestos inhalation can be prevented by minimizing asbestos dust and fibers in the workplace. Because industries that use asbestos have improved dust control, fewer people develop asbestosis today, but mesotheliomas are still occurring in people who were exposed as many as 30 to 50 years ago. Asbestos-containing materials in a home are typically only a concern if the materials are going to be removed or the home renovated, in which case they should be removed by workers trained in safe removal techniques.

Smokers who have been in contact with asbestos can reduce their risk of lung cancer by giving up smoking and should probably have a chest x-ray annually. Pneumococcal and influenza vaccination are recommended for people who have been in contact with asbestos to help protect against infections to which workers may be more vulnerable.

Worker exposures to asbestos hazards are addressed in specific U.S. Occupational Safety and Health Administration (OSHA) standards for the construction industry, general industry and shipyard employment sectors. These standards reduce the risk to workers by requiring that employers provide personal exposure monitoring to assess the risk and hazard awareness training for operations where there is any potential exposure to asbestos. Airborne levels of asbestos are never to exceed legal worker exposure limits. Where the exposure does, employers are required to further protect workers by establishing regulated areas, controlling certain work practices and instituting engineering controls to reduce the airborne levels. The employer is required to ensure exposure is reduced by using administrative controls and provide for the wearing of personal protective equipment. Medical monitoring of workers is also required when legal limits and exposure times are exceeded.

CONCLUSION

The current pandemic has drastically affected every aspect of our life. It has changed peoples' way of viewing different things. The whole world is on the lookout for best alternates of the available technological solutions. All the technologies discussed in this chapter are for prevention, mitigation, and restoration from aftermath of the disease spread.

IoMT has made a sizeable contribution in current pandemic. It is a promising technology that has shown potential in the collection, analysis, and effective transmission of health data to the concerned departments. Therefore, it is a choice of preference to be deployed for disease monitoring and management during this deadly pandemic. Drones have changed the entire concept of how things are delivered. Similarly, robots are replacing humans. UMVs are approaching to places where traditional man driven vehicles are unable to reach. Bluetooth and GPS are being deployed to look out for disease carriers in the surroundings.

IoMT, drones, and robots have joined hands together for the advancement of telemedicine field, which can be used for spreading limited clinical resources across a wide geographic area. It improves quality of care and access during the ongoing pandemic. All these technologies are on the way of maturing to help us fight against the deadliest pandemics in Benin Republic.

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