

**A STUDY ON SAFETY MEASURES ADOPTED FOR THE TECHNICIANS
WORKING IN LABORATORY DURING COVID AT CHENNAI**

Submitted in partial fulfillment of the requirements for the award of

Master of Business Administration

by

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SCHOOL OF BUSINESS ADMINISTRATION

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with Grade “A” by NAAC | 12B status by UGC | Approved by AICTE

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April 2021

DECLARATION

I **MATHURA K 39410116** hereby declare that the project report entitled **A STUDY ON SAFETY MEASURES ADOPTED FOR THE TECHNICIANS WORKING IN LABORATORY DURING COVID AT CHENNAI** done by me under the guidance of Dr. M. JOHN BRITTO at SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, CHENNAI is submitted in partial fulfillment of the requirements for the award of Master of Business Administration Degree.

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BONAFIDE CERTIFICATE

This is to certify that this project report is the bonafide work of MATHURA K 39410116 who have done the project work entitled “**A STUDY ON SAFETY MEASURES ADOPTED FOR THE TECHNICIANS WORKING IN LABORATORY DURING COVID AT CHENNAI**” under my supervision from January 2021 to March 2021.

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ABSTRACT

The ongoing coronavirus disease 2019 (COVID-19) pandemic has presented major challenges to health care workers including laboratory professionals. Clinical laboratories play a critical role in this challenging environment by providing information to clinicians regarding prognosis, disease severity, and response to therapy apart from the diagnosis of COVID-19. Clinical chemistry laboratories inhabit central role in the management of COVID-19 through assessing the biochemical and inflammatory profile. The lab professionals at one end are at increased risk of contracting the infection while on the other end have to deal with the various challenges during the Coronavirus Disease 2019 (COVID-19) outbreak. This survey was undertaken to analyze the lab professionals' perspectives, in terms of the challenges, financial implications, fears, motivation and satisfaction from organizational processes and policies adopted, amid the COVID-19 crisis.

This alarming figure prompted us to make guidelines for bio safety procedures to protect health care workers including laboratory personnel. Infection and quarantine of health care workers cause additional burden to health care services due to shortage of manpower.

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CHAPTER 1

1.1 INTRODUCTION

It is to address the general workflow safety concerns of laboratory personnel during the COVID-19 pandemic. All laboratories should perform site-and activity-specific risk assessments to determine the most appropriate safety measures to implement for particular circumstances.

Risk assessments should include the following considerations:

- Analyse the number of people that the laboratory space can realistically and safely accommodate while maintaining social distancing.
- Assess the flow of personnel traffic. Where possible, design one-way paths for staff to walk through the laboratory space.
- Assess procedures for cleaning and sanitizing commonly equipment and areas- for example, counters, desks-to ensure clean surfaces and equipment for all users.
- Review emergency communication and operational plans, including how to protect staff at higher risk for severe illness from COVID-19.

Every institution should have a COVID-19 health and safety plan to protect employees. This plan should be shared with all staffs. Ideally, this plan would:

- Describe steps to help prevent the spread of COVID-19 if an employee is sick.
- Provide information on whom employees should contact if they become sick.
- Provide employees with accurate information about COVID-19, how it spreads, and the risk of exposure.
- Reinforce training on proper handwashing practices and other routine infection control precautions to help prevent the spread of many diseases, including COVID-19.

Ensure that employees have access to personal protective equipment (PPE), disinfectant and soap, clean running water, and drying materials for handwashing, or alcohol-based hand sanitizers that contain at least 60% ethanol or 70% isopropanol.

Social Distancing

To the extent possible, adhere to social distancing recommendations by adjusting staff schedules, adding additional shifts, or implementing non-overlapping teams to minimize personnel contact. Identify laboratory tasks and activities that can be performed with reduced or no face-to-face interactions. Examples include limiting the number of laboratory meetings that occur and, when possible, using remote collaboration tools (such as video and phone conferencing), even for those who work in the same location or building.

To the extent possible, reconfigure workspaces and locations of shared equipment to reduce crowding. Create one-directional paths and workflows. Declutter workspaces and dispose of unnecessary items to help with reconfiguration. If reconfiguration is not possible, consider placing barriers (plexiglass, partition, plastic, etc.) between computer workstations, desks, or equipment that position staff six feet apart from each other.

Minimize personnel traffic and interactions by limiting visits from vendors and other external partners; engage with them virtually whenever possible.

Face Coverings

To help slow the spread of COVID-19, CDC recommends wearing face coverings in settings where social distancing measures are challenging to maintain, like office spaces, computer workstations, and break rooms. In general, laboratory employees should wear a face covering in laboratory spaces that do not have requirements for respiratory PPE and where other social distancing measures are difficult to maintain. Any face covering that is worn inside a laboratory area where personnel work with potentially infectious material should subsequently not be worn outside of that laboratory area. Laboratory PPE are critical supplies, and employees should refrain from removing them from the laboratory for general use. Site- and activity-specific risk assessments, as well as available resources, should determine where specific facial protection, such as disposable masks, should be used.

These face coverings should not be used in place of recommended personal protective equipment (PPE).

- Face coverings are not intended to protect those who wear them and are not considered PPE.
- All staff should follow established PPE requirements for working in laboratory spaces.

Wash hands before putting on face coverings and minimize the removal while in the laboratory. The guidance below describes how to remove a face covering and replace it with a clean face covering:

- Take off the face covering carefully.
- Be careful not to touch eyes, nose, or mouth when removing a face covering.
- Untie the strings behind the head or stretch the ear loops.
- Handle only by the ear loops or ties.
- Place reusable cloth face coverings in a bag and close the bag until it can be washed.
 1. Cloth face coverings should be washed frequently.
 2. Staff are responsible for maintaining and cleaning their cloth face coverings.
- Wash hands immediately after removing.

Depending on the facility's design or configuration, additional physical barriers, such as a face shield, plexiglass, partition, or plastic barriers, may be needed to achieve social distancing goals.

Personal Hygiene and Disinfection

As more workers return to the laboratory, extra measures may be needed to ensure a clean and appropriate environment. Re-evaluate current protocols for cleaning, use of PPE, and handwashing. High-touch locations and equipment with a high frequency of handling and contact present a higher probability of contamination in the work area and should be disinfected frequently. Increasing the number of available cleaning supplies and distributing them throughout the laboratory can encourage staff to more frequently clean surfaces and equipment.

Use visual reminders, such as posters displayed throughout the laboratory environment, common areas, and restrooms, to emphasize the importance of hand hygiene and to encourage frequent handwashing. Hands should be washed regularly

with soap and water for at least 20 seconds. An alcohol-based hand sanitizer containing at least 60% ethanol or 70% isopropanol can be used when soap and water are not available. For more information, see CDC's Hand Hygiene Recommendations

1.2 INDUSTRY PROFILE



Figure.1.2 clinical laboratory

A medical laboratory or clinical laboratory is a laboratory where tests are carried out on clinical specimens to obtain information about the health of a patient to aid in diagnosis, treatment, and prevention of disease. Clinical Medical laboratories are an example of applied science, as opposed to research laboratories that focus on basic science, such as found in some academic institutions.

Medical laboratories vary in size and complexity and so offer a variety of testing services. More comprehensive services can be found in acute-care hospitals and medical center, where 70% of clinical decisions are based on laboratory testing. Doctors offices and clinics, as well as skilled nursing and long-term care facilities, may have laboratories that provide more basic testing services. Commercial medical laboratories operate as independent businesses and provide testing that is otherwise not provided in other settings due to low test volume or complexity.

DEPARTMENT

In hospitals and other patient-care settings, laboratory medicine is provided by the Department of Pathology and Medical Laboratory, and generally divided into two

sections, each of which will be subdivided into multiple specialty areas. The two sections are:

Anatomic pathology: areas included here are histopathology, cytopathology, and electron microscopy.

Medical Laboratory, which typically includes the following areas:

- **Clinical microbiology:** This encompasses several different sciences, including bacteriology, virology, parasitology, immunology, and mycology.
 - **Clinical chemistry:** This area typically includes automated analysis of blood specimens, including tests related to enzymology, toxicology and endocrinology.
 - **Hematology:** This area includes automated and manual analysis of blood cells. It also often includes coagulation.
 - **Blood bank** involves the testing of blood specimens in order to provide blood transfusion and related services.
 - **Molecular diagnostics** DNA testing may be done here, along with a subspecialty known as cytogenetics.
 - **Reproductive biology testing** is available in some laboratories, including Semen analysis, Sperm bank and assisted reproductive technology.
- Layouts of clinical laboratories in health institutions vary greatly from one facility to another. For instance, some health facilities have a single laboratory for the microbiology section, while others have a separate lab for each specialty area.

The following is an example of a typical breakdown of the responsibilities of each area:

- **Microbiology** includes culturing of clinical specimens, including feces, urine, blood, sputum, cerebrospinal fluid, and synovial fluid, as well as possible infected tissue. The work here is mainly concerned with cultures, to look for suspected pathogens which, if found, are further identified based on biochemical tests. Also, sensitivity testing is carried out to determine whether the pathogen is sensitive or resistant to a suggested medicine. Results are reported with the identified organism(s) and the type and amount of drugs that should be prescribed for the patient.

- **Parasitology** is where specimens are examined for parasites. For example, fecal samples may be examined for evidence of intestinal parasites such as tapeworms or hookworms.
- **Virology** is concerned with identification of viruses in specimens such as blood, urine, and cerebrospinal fluid.
- **Hematology** analyzes whole blood specimens to perform full blood counts, and includes the examination of Blood films. Other specialized tests include cell counts on various bodily fluids.
- **Coagulation** testing determines various blood clotting times, coagulation factors, and platelet function.
- **Clinical biochemistry** commonly performs dozens of different tests on serum or plasma. These tests, mostly automated, includes quantitative testing for a wide array of substances, such as lipids, blood sugar, enzymes, and hormones.
- **Toxicology** is mainly focused on testing for pharmaceutical and recreational drugs. Urine and blood samples are the common specimens.
- **Immunology/Serology** uses the process of antigen-antibody interaction as a diagnostic tool. Compatibility of transplanted organs may also be determined with these methods.
- **Immunoematology**, or blood bank determines blood groups, and performs compatibility testing on donor blood and recipients. It also prepares blood components, derivatives, and products for transfusion. This area determines a patient's blood type and Rh status, checks for antibodies to common antigens found on red blood cells, and cross matches units that are negative for the antigen.
- **Urinalysis tests** urine for many analysts, including microscopically. If more precise quantification of urine chemicals is required, the specimen is processed in the clinical biochemistry lab.
- **Histopathology** processes solid tissue removed from the body (biopsies) for evaluation at the microscopic level.
- **Cytopathology** examines smears of cells from all over the body (such as from the cervix) for evidence of inflammation, cancer, and other conditions.
- **Molecular diagnostics** includes specialized tests involving DNA analysis.

- **Cytogenetics** involves using blood and other cells to produce a DNA karyotype. This can be helpful in cases of prenatal diagnosis (e.g. Down's syndrome) as well as in some cancers which can be identified by the presence of abnormal chromosomes.
- **Surgical pathology** examines organs, limbs, tumors, fetuses, and other tissues biopsied in surgery such as breast mastectomies.

TYPES OF LABORATORY

In most developed countries, there are two main types of lab processing the majority of medical specimens. Hospital laboratories are attached to a hospital, and perform tests on their patients. Private (or community) laboratories receive samples from general practitioners, insurance companies, clinical research sites and other health clinics for analysis. For extremely specialised tests, samples may go to a research laboratory. Some tests involve specimens sent between different labs for uncommon tests. For example, in some cases it may be more cost effective if a particular laboratory specializes in a less common tests, receiving specimens (and payment) from other labs, while sending other specimens to other labs for those tests they do not perform.

- In many countries there are specialized types of Medical Laboratories according to the types of investigations carried out. Organisations that provide blood products for transfusion to hospitals, such as The Red Cross, will provide access to their reference laboratory for their customers. Some laboratories specialize in Molecular diagnostic and cytogenetic testing, in order to provide information regarding diagnosis and treatment of genetic or cancer-related disorders.

MEDICAL LABORATORY ACCREDITATION

Credibility of medical laboratories is paramount to the health and safety of the patients relying on the testing services provided by these labs. Credentialing agencies vary by country. The international standard in use today for the accreditation of medical laboratories is ISO 15189 - Medical laboratories - Requirements for quality and competence.

In the United States, billions of dollars is spent on unaccredited lab tests, such as Laboratory developed tests which do not require accreditation or FDA approval; about a billion USD a year is spent on US autoimmune LDTs alone. Accreditation is

performed by the Joint Commission, College of American Pathologists, AAB (American Association of Bioanalysts), and other state and federal agencies. Legislative guidelines are provided under CLIA 88 (Clinical Laboratory Improvement Amendments) which regulates Medical Laboratory testing and personnel.

The laboratory industry is a part of the broader healthcare and health technology industry. Companies exist at various levels, including clinical laboratory services, suppliers of instrumentation equipment and consumable materials, and suppliers and developers of diagnostic tests themselves (often by biotechnology companies).

Clinical laboratory services includes large multinational corporations such LabCorp, Quest Diagnostics, and Sonic Healthcare but a significant portion of revenue, estimated at 60% in the United States, is generated by hospital labs. In 2018, the total global revenue for these companies was estimated to reach \$146 billion by 2024. Another estimate places the market size at \$205 billion, reaching \$333 billion by 2023. The American Association for Clinical Chemistry (AACC) represents professionals in the field.

Clinical laboratories are supplied by other multinational companies which focus on materials and equipment, which can be used for both scientific research and medical testing. The largest of these is Thermo Fisher Scientific. In 2016, global life sciences instrumentation sales were around \$47 billion, not including consumables, software, and services. In general, laboratory equipment includes lab centrifuges, transfection solutions, water purification systems, extraction techniques, gas generators, concentrators and evaporators, fume hoods, incubators, biological safety cabinets, bioreactors and fermenters, microwave-assisted chemistry, lab washers, and shakers and stirrers.

As of 2018, the in-vitro-diagnostics (IVD) market was estimated at a global value of around \$61.22 billion, with companies: Roche Diagnostics, Abbott Diagnostics, Siemens Healthineers, Johnson & Johnson Medical Devices and Diagnostics, Beckman Coulter and BioMerieux. Many of the companies sell capital equipment and supply consumables, and the devices are also used for industrial purposes such as food testing. Molecular diagnostics is estimated at 10% of total revenue, and half of that focused on infectious disease testing. Blood transfusion diagnostics has become increasingly important with the prevalence of infectious and

chronic diseases, with companies like: Grifols S.A., Bio-Rad Laboratories, Inc., Quotient Limited, and Immucor, Inc.

Diagnostic histopathology laboratory routine practices in the light of COVID-19 pandemic

Histopathology laboratories are the designated laboratories where human tissues and cells are analysed for diagnostic, therapeutic, prognostic and forensic testing. The histopathology laboratory is fortunate in that routine Histotechnology processes often inactivate many viruses, e.g., Ebola.

The question then arises as to whether there is any evidence that these processes will have any effect on the activity of the coronavirus. Darnell et al. determined that formalin and glutaraldehyde inactivated SARS-CoV in a temperature- and time dependent manner. While incubation at 4°C inhibited the effect of these chemicals, at 37°C or room temperature, formalin significantly decreased the infectivity of the virus on day 1, while glutaraldehyde inactivated SARS-CoV after incubations of 1–2 days. Xu et al. presented the autopsy findings of a 2019-nCoV patient. Duan et al. found that several coronaviruses were made non-infectious after the following exposure times and temperatures: 90 min at 56°C, 60 min at 67°C, and 30 min at 75°C. Paraffin infiltration in most histopathology laboratories uses a temperature of 60–65°C for 2 h or more. It is; therefore, appropriate to consider that the formalin-fixed paraffin-embedded tissue block would have a low risk of coronavirus infectivity. It appears, based on the limited autopsy study by Xu et al., that only lung tissues exhibit microscopic evidence of 2019-nCoV infection whereas no viral change was noted in the liver and cardiac muscle. The few reports documenting the findings of COVID-19 show that the pathology is dominated by pulmonary findings, including pulmonary oedema and prominent proteinaceous exudates, vascular congestion, and intra-alveolar fibrinoid material and various degrees of an organization (fibroblastic plugs) corresponding to acute pulmonary injury patterns.

Diagnostic Cytology laboratory routine practices in the light of COVID-19 pandemic

Cytology samples most especially non-gynaecological and fine needle aspirate samples, on the other hand, are highly infective as these samples come fresh with no prior fixation for analysis. These measures are meant both to decrease the risk of infection to patients with routine annual and preventive health visits and elective

procedures and to increase the available capacity of the hospitals in case of a large surge of infections. From the experience with SARS, we can extrapolate that SARS-CoV-2 can be present in faecal and urine samples, in addition to peripheral blood and respiratory samples. SARS-CoV-2 may be present in samples in patients without known COVID-19, in undiagnosed patients, in pre-symptomatic patients, in patients with asymptomatic or minimally symptomatic infections, and convalescent patients, who may still be shedding the virus.

Preparatory steps that may generate aerosols or droplets include expelling aspirates from the needle or syringe, smearing the aspirated material, and potentially airdrying or heat drying the smears, in which pathologists, residents or cytoscientist may be involved during rapid on-site evaluation (ROSE). Air-drying or heat drying of smears is best performed under Class II Biosafety Cabinets (BSC).

Most cytology specimens are fixed in either formalin or alcohol solutions with over 70% alcohol, which is considered effective to destroy this virus. However additional precautions, like the use of gloves may be indicated while handling and interpreting cytological preparations processed with these fixatives. Although dipping the slides in 95% alcohol (or similar) for a couple of minutes would inactivate the virus, it would also erase the marks (“dots”) on the slides. Other surface disinfectants, especially ones with short contact times, as mentioned below, can be tried to determine the practicality of their use on cytology slides. General safe laboratory practices, especially procedures that are basic to good microbiological practices and procedures should be followed as recommended by the World Health Organization (WHO) and the CDC. This includes training all personnel in the use of protective equipment, limiting access to the laboratory, frequent hand washing, and wearing personal protective equipment (PPE). Hand washing should be performed thoroughly with soap and water for at least 20 seconds. Alternatively, an alcohol-based hand sanitizer containing at least 62% alcohol can be used, if soap and water are not available.

Diagnostic haematology and blood transfusion science laboratory routine practices in the light of COVID-19 pandemic

The haematology laboratory, is where blood and blood products are analysed. Blood is one of the samples used to check for COVID 19 infection; it is important to strictly maintain universal precautions in sample handling. A typical scenario which has played out; someone has had contact with an infected person in the past 7 – 12 days,

or has just returned from a country with a high rate of infection, he might have symptoms but decides to do home remedy – which is common in my clime--thinking it's a malaria infection, which is endemic in most parts of Africa. Being a new pathogen, there are perhaps some still unknown characteristics, which has created some level of apprehension and uncertainty in routine analysis of suspected COVID 19 samples, and also a provision of blood free of SARS-CoV-2 pathogen. Studies have shown that viral RNA can be detected in plasma and serum of patients infected with SARS-CoV at different times, after the onset of symptoms, but this isn't equivalent to the detection of intact infectious virus. With more cases of asymptomatic infections among COVID 19 cases, there is the theoretical risk of transmission; hence ensuring blood safety is a worthy consideration.

Diagnostic clinical chemistry laboratory routine practices in the light of COVID-19 pandemic

Chemical pathology laboratory or clinical chemistry involves the study of biochemical processes in the body about the disease by analysis of body fluids such as blood and urine for diagnostic and therapeutic purposes.

Most chemical pathology laboratories in a resource-limited setting receive several samples such as whole blood, plasma, serum, urine, cerebrospinal fluid, pleural fluid and stool for analysis. However, the laboratory health care workers are exposed to a varying degree of infection ranging from sample collection, handling, processing, analysis and disposal of biological samples. It becomes necessary that appropriate measures be taken by clinical laboratories to contain potentially infectious materials and forestall secondary infection and transmission. This has exposed several laboratory workers to infection in the face of COVID-19 pandemic. To this end, laboratory workers must follow GLP from the point of reception, processing, analysis, storage and disposal. This no doubt will help minimize the spread of infection to a great degree. Some measures taken as GLP in a resource-limited setting is proper to use of PPEs such as laboratory coats, hand gloves, face masks, eye shield, shoe boots, appropriate bin liners for proper disposal of highly infectious, infectious and non-infectious materials and continuing education on Quality Management Systems There is ongoing research about the pathogenic potential and risk of transmission of the novel coronavirus and diseases it causes.

Diagnostic medical microbiology laboratory routine practices in the light of COVID19 pandemic

The diagnostic microbiology laboratory is primarily involved in the diagnosis of infectious disease. It plays key roles in isolation/detection of the etiologic agent, evidence-based recommendation on antimicrobial options, monitoring the effectiveness of therapeutic regimes, surveillance of infectious agents and investigation of disease outbreaks. Various types of specimens are received, the choice of which is determined by the requesting physician and the clinical site of infection. In the light of the COVID-19 pandemic, some specimens must be deemed high risk by requesting physician, laboratory scientists, technologists and technicians. Such specimens must be collected, transported, handled with the requisite caution without prejudice to good laboratory practice (GLP) to minimize the risk of infection to the aforementioned professionals and other laboratory staff.

Invitro-fertilization (IVF) laboratory routine practices in the light of COVID-19 pandemic
Successful and consistent outcomes in human in-vitro fertilization (IVF) is vital and can be readily achieved by all IVF clinics through consideration and optimization of each procedure associated with the collection and processing of gametes, culminating in the resultant culture and transfer of healthy embryos. Laboratory safety is an important and critical component to the success of in-vitro fertilization. Therefore important that Laboratory staffs should ensure the proper use of personal protective equipment's (PPE), follow protocols for appropriate chemical hygiene plan (CHP) and use of biological safety cabinets in the in-vitro fertilization laboratory.

SAFETY MEASURES

- To ensure the lab is safe for everyone, staff should exercise extra precautions to minimize the risk of person-to-person infection and surface contamination.
- Follow the guidelines established by the occupational safety and health administration about readying workplaces for the corona virus.
- Limit close contact. Be aware of where others are in the lab, and keep as much distance as possible. Limit movements throughout the lab to essential trips.
- Institute remote working policies and stagger shifts when possible to minimize the number people in the lab at one time.
- Promote hand hygiene. Provide hand-washing stations throughout the lab and ensure that hand sanitizer is well stocked and readily available.

- Clean and disinfect frequently touched surfaces, such as equipment and cabinet handles, with products that meet the environmental protection agency criteria for use against the SARS-CoV-2 virus. Wear personal protective equipment while cleaning. Wipe down reusable PPE afterward.
- If someone working in the lab contracts covid-19, follow the protocols established by the CDC. Close off and decontaminate any areas used by the sick person with an EPA-recommended disinfectant. Engage a professional decontamination service, if necessary.
- Be sure to read all fire alarm and safety signs and follow the instructions in the event of an accident or emergency.
- Make sure you know where your lab's safety equipment- including first aid kits, fire extinguishers, eye wash stations, and safety showers- is located and how to properly use it.
- Do not chew gum, drink, or eat while working in the lab.
- Always tie back hair that is chin-length or longer.
- When working with equipment, hazardous materials, glassware, heat, and or chemicals, always wear face shields or safety glasses.
- When handling any toxic or hazardous agent, always wear the appropriate gloves.
- When performing laboratory experiments, always wear lab coat.
- Before leaving the lab always wash your hands. After performing an experiment, you should always wash your hands with soap and water.
- When using lab equipment and chemicals, be sure to keep your hands away from your body, mouth, eyes and face.

COVID HISTORY

The **COVID-19 pandemic**, also known as the **coronavirus pandemic**, is an ongoing pandemic of coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). It was first identified in December 2019 in Wuhan, China. The World Health Organization declared the outbreak a Public Health Emergency of International Concern in January 2020 and a pandemic in March 2020. As of 13 March 2021, more than 119 million cases have been confirmed, with more than 2.64 million deaths attributed to COVID-19, making it one of the deadliest pandemics in history.

Symptoms of COVID-19 are highly variable, ranging from none to life-threatening illness. The virus spreads mainly through the air when people are near each other.^[b] It leaves an infected person as they breathe, cough, sneeze, or speak and enters another person via their mouth, nose, or eyes. It may also spread via contaminated surfaces. People remain infectious for up to two weeks, and can spread the virus even if they do not show symptoms.

Recommended preventive measures include social distancing, wearing face masks in public, ventilation and air-filtering, hand washing, covering one's mouth when sneezing or coughing, disinfecting surfaces, and monitoring and self-isolation for people exposed or symptomatic. Several vaccines are being developed and distributed. Current treatments focus on addressing symptoms while work is underway to develop therapeutic drugs that inhibit the virus. Authorities worldwide have responded by implementing travel restrictions, lockdowns, workplace hazard controls, and facility closures. Many places have also worked to increase testing capacity and trace contacts of the infected. The responses to the pandemic have resulted in significant global social and economic disruption, including the largest global recession since the Great Depression. It has led to the postponement or cancellation of events, widespread supply shortages exacerbated by panic buying, agricultural disruption and food shortages, and decreased emissions of pollutants and greenhouse gases. Many educational institutions and public areas have been partially or fully closed. Misinformation has circulated through social media and mass media. The pandemic has raised issues of racial and geographic discrimination, health equity, and the balance between public health imperatives and individual rights.

Although it is still unknown exactly where the outbreak first started, many early cases of COVID-19 have been attributed to people who have visited the Huanan Seafood Wholesale Market, located in Wuhan, Hubei, China. On 11 February 2020, the World Health Organization (WHO) named the disease "COVID-19", which is short for coronavirus disease 2019. The virus that caused the outbreak is known as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), a newly discovered virus closely related to bat coronaviruses, pangolin coronaviruses, and SARS-CoV. Scientific consensus is that COVID-19 is a zoonotic virus that arose from bats in a natural setting.

The earliest known person with symptoms was later discovered to have fallen ill on 1 December 2019, and that person did not have visible connections with the later wet

market cluster. However, an earlier case of infection could have occurred on 17 November. Of the early cluster of cases reported that month, two thirds were found to have a link with the market. There are several theories about when and where the very first case (the so-called patient zero) originated.

Cases

Official case counts refer to the number of people who have been tested for COVID-19 and whose test has been confirmed positive according to official protocols. Many countries, early on, had official policies to not test those with only mild symptoms. An analysis of the early phase of the outbreak up to 23 January estimated 86 percent of COVID-19 infections had not been detected, and that these undocumented infections were the source for 79 percent of documented cases. Several other studies, using a variety of methods, have estimated that numbers of infections in many countries are likely to be considerably greater than the reported cases. On 9 April 2020, preliminary results found that 15 percent of people tested in Gangelt, the centre of a major infection cluster in Germany, tested positive for antibodies. Screening for COVID-19 in pregnant women in New York City, and blood donors in the Netherlands, has also found rates of positive antibody tests that may indicate more infections than reported. Seroprevalence based estimates are conservative as some studies show that persons with mild symptoms do not have detectable antibodies. Some results (such as the Gangelt study) have received substantial press coverage without first passing through peer review.

Analysis by age in China indicates that a relatively low proportion of cases occur in individuals under 20. It was not clear whether this was because young people were less likely to be infected, or less likely to develop serious symptoms and seek medical attention and be tested. A retrospective cohort study in China found that children and adults were just as likely to be infected.

Initial estimates of the basic reproduction number (R_0) for COVID-19 in January were between 1.4 and 2.5, but a subsequent analysis concluded that it may be about 5.7 (with a 95 percent confidence interval of 3.8 to 8.9). R_0 can vary across populations and is not to be confused with the effective reproduction number (commonly just called R), which takes into account effects such as social distancing and herd immunity. By mid-May 2020, the effective R was close to or below 1.0 in many countries, meaning the spread of the disease in these areas at that time was stable or decreasing.

Deaths

Official deaths from COVID-19 generally refer to people who died after testing positive according to protocols. These counts may ignore deaths of people who die without having been tested. Conversely, deaths of people who had underlying conditions may lead to over-counting. Comparisons of statistics for deaths for all causes versus the seasonal average indicate excess mortality in many countries. This may include deaths due to strained healthcare systems and bans on elective surgery. The first confirmed death was in Wuhan on 9 January 2020. The first reported death outside of China occurred on 1 February in the Philippines, and the first reported death outside Asia was in the United States on 6 February.

More than 95 percent of the people who contract COVID-19 recover. Otherwise, the time between symptoms onset and death usually ranges from 6 to 41 days, typically about 14 days. As of 13 March 2021, more than 2.64 million deaths have been attributed to COVID-19. People at the greatest risk from COVID-19 tend to be those with underlying conditions, such as those with a weakened immune system, serious heart or lung problems, severe obesity, or the elderly (including individuals age 65 years or older).

On 24 March 2020, the Centers for Disease Control and Prevention (CDC) of the United States, indicated the WHO had provided two codes for COVID-19: U07.1 when confirmed by laboratory testing and U07.2 for clinically or epidemiological diagnosis where laboratory confirmation is inconclusive or not available. The CDC noted that "Because laboratory test results are not typically reported on death certificates in the U.S., [the National Center for Health Statistics (NCHS)] is not planning to implement U07.2 for mortality statistics" and that U07.1 would be used "If the death certificate reports terms such as 'probable COVID-19' or 'likely COVID-19'." The CDC also noted "It is not likely that NCHS will follow up on these cases" and while the "underlying cause depends upon what and where conditions are reported on the death certificate, the rules for coding and selection of the cause of death are expected to result in COVID-19 being the underlying cause more often than not.

On 16 April 2020, the WHO, in its formal publication of the two codes, U07.1 and U07.2, "recognized that in many countries detail as to the laboratory confirmation will not be reported [and] recommended, for mortality purposes only, to code COVID-19 provisionally to code U07.1 unless it is stated as 'probable' or 'suspected'. It was

also noted that the WHO "does not distinguish" between infection by SARS-CoV-2 and COVID-19.

Multiple measures are used to quantify mortality. These numbers vary by region and over time, influenced by testing volume, healthcare system quality, treatment options, government response, time since the initial outbreak, and population characteristics, such as age, sex, and overall health. Countries like Belgium include deaths from suspected cases of COVID-19, regardless of whether the person was tested, resulting in higher numbers compared to countries that include only test-confirmed cases.

The death-to-case ratio reflects the number of deaths attributed to COVID-19 divided by the number of diagnosed cases within a given time interval. Based on Johns Hopkins University statistics, the global death-to-case ratio is 2.2 percent (2,647,229 deaths for 119,469,346 cases) as of 13 March 2021. The number varies by region.

Infection fatality ratio (IFR)

A crucial metric in assessing the severity of a disease is the infection fatality ratio (IFR), which is the cumulative number of deaths attributed to the disease divided by the cumulative number of infected individuals (including asymptomatic and undiagnosed infections) as measured or estimated as of a specific date. Epidemiologists frequently refer to this metric as the 'infection fatality rate' to clarify that it is expressed in percentage points (not as a decimal). Other published studies refer to this metric as the 'infection fatality risk'.

In April 2020, an IFR range of 0.12–1.08% was derived from non-peer-reviewed serology surveys, with the upper bound characterised as much more credible and the range indicated as from 3 to 27 times deadlier than influenza (0.04%). In June 2020, a peer-reviewed analysis of pre-serology data from mainland China yielded an overall IFR of 0.66% (with age-bracketed values ranging from 0.00161% for 0–9 years to 0.595% for 50–59 years to 7.8% for > 80 years). In July 2020, the US CDC adopted the IFR as a "more directly measurable parameter for disease severity for COVID-19" and computed an overall 'best estimate' for planning purposes for the U.S. of 0.65%.

CDC Planning Scenario IFR Range

Age group	IFR
0–19	0.002%–0.01%
20–49	0.007%–0.03%
50–69	0.25%–1.0%
70+	2.8%–9.3%

In August 2020, the WHO reported serology testing for three locations in Europe (with some data through 2 June) that showed IFR overall estimates converging at approximately 0.5–1%. A systematic review article in The BMJ advised that "caution is warranted using serological tests for epidemiological surveillance" and called for higher quality studies assessing accuracy with reference to a standard of "RT-PCR performed on at least two consecutive specimens, and, when feasible, including viral cultures. CEBM researchers have called for in-hospital 'case definition' to record "CT lung findings and associated blood tests" and for the WHO to produce a "protocol to standardise the use and interpretation of PCR" with continuous re-calibration.

In September, the CDC computed an age-bracketed 'best estimate' for the U.S. of 0.003% for 0–19 years; 0.02% for 20–49 years; 0.5% for 50–69 years; and 5.4% for 70+ years. The range of CDC estimates for each age group were as follows.

In September 2020, a Bulletin of the World Health Organization article by John Ioannidis estimated the median global IFR inferred from seroprevalence data at 0.23% overall (with rates of 0.09% in areas with low mortality, and 0.57% in areas with high mortality) and 0.05% for people < 70 years (a range of 0.00–0.31%), much lower than estimates made earlier in the pandemic.

On 6 October 2020, Dr. Mike Ryan, director of the WHO's Health Emergencies Programme announced "Our current best estimates tell us that about 10% of the global population may have been infected by this virus. Also in October, the Centre for Evidence-Based Medicine (CEBM) reported a 'presumed estimate' of global IFR at between 0.10% to 0.35%, noting that this will vary between populations due to differences in demographics. These researchers noted a decrease in IFR in England

over time; and, for the UK and Italy (the two European nations worst hit by COVID-19), attribute the rise in daily cases, stability in daily deaths, and shift of cases to a younger population to waning viral circulation, misapplication of testing, and misinterpretation of test results rather than to prevention, treatment, or virus mutation.

In November 2020, a review article in *Nature* reported estimates of population-weighted IFRs for a number of countries, excluding deaths in elderly care facilities, and found a median range of 0.24% to 1.49%.

In December 2020, a systematic review and meta-analysis published in the *European Journal of Epidemiology* estimated that population-weighted IFR was 0.5% to 1% in some countries (France, Netherlands, New Zealand, and Portugal), 1% to 2% in several other countries (Australia, England, Lithuania, and Spain), and about 2.5% in Italy; these estimates included fatalities in elderly care facilities. This study also found that most of the differences in IFR across locations reflected corresponding differences in the age composition of the population and the age-specific pattern of infection rates, due to very low IFRs for children and younger adults (e.g., 0.002% at age 10 and 0.01% at age 25) and progressively higher IFRs for older adults (0.4% at age 55, 1.4% at age 65, 4.6% at age 75, and 15% at age 85). These results were also highlighted in a December 2020 report issued by the World Health Organization.

2019

Based on the retrospective analysis, starting from December 2019, the number of COVID-19 cases in Hubei gradually increased, reaching 60 by 20 December and at least 266 by 31 December.

On 24 December 2019, Wuhan Central Hospital sent a bronchoalveolar lavage fluid (BAL) sample from an unresolved clinical case to sequencing company Vision Medicals. On 27 and 28 December, Vision Medicals informed the Wuhan Central Hospital and the Chinese CDC of the results of the test, showing a new coronavirus. A pneumonia cluster of unknown cause was observed on 26 December and treated by the doctor Zhang Jixian in Hubei Provincial Hospital, who informed the Wuhan Jiangnan CDC on 27 December.

On 30 December 2019, a test report addressed to Wuhan Central Hospital, from company CapitalBio Medlab, stated that there was an erroneous positive result for SARS, causing a group of doctors at Wuhan Central Hospital to alert their colleagues and relevant hospital authorities of the result. Eight of those doctors,

including Li Wenliang (who was also punished on 3 January), were later admonished by the police for spreading false rumours; and another doctor, Ai Fen, was reprimanded by her superiors for raising the alarm. That evening, the Wuhan Municipal Health Commission issued a notice to various medical institutions about "the treatment of pneumonia of unknown cause". The next day, the Wuhan Municipal Health Commission made the first public announcement of a pneumonia outbreak of unknown cause, confirming 27 cases enough to trigger an investigation.

The following day, on December 31, the WHO learned about a cluster of viral pneumonia cases of an unknown cause in Wuhan. An investigation was launched at the start of January 2020.

According to official Chinese sources, the early cases were mostly linked to the Huanan Seafood Wholesale Market, which also sold live animals. However, in May 2020, George Gao, the director of the Chinese Center for Disease Control and Prevention, said animal samples collected from the seafood market had tested negative for the virus, indicating the market was not the source of the initial outbreak

2020

During the early stages of the outbreak, the number of cases doubled approximately every seven and a half days. In early and mid-January 2020, the virus spread to other Chinese provinces, helped by the Chinese New Year migration and Wuhan being a transport hub and major rail interchange. On 10 January, the SARS-CoV-2 genetic sequence data was shared through GISAID. On 20 January, China reported nearly 140 new cases in one day, including two people in Beijing and one in Shenzhen. A retrospective official study published in March found that 6,174 people had already developed symptoms by 20 January (most of them would be diagnosed later) and more may have been infected. A report in *The Lancet* on 24 January indicated human transmission, strongly recommended personal protective equipment for health workers, and said testing for the virus was essential due to its "pandemic potential".

On 30 January 2020, with 7,818 confirmed cases across 19 countries, the WHO declared the COVID-19 outbreak a Public Health Emergency of International Concern (PHEIC), and then a pandemic on 11 March 2020 as Italy, Iran, South Korea, and Japan reported increasing numbers of cases.

On 31 January 2020, Italy had its first confirmed cases, two tourists from China. As of 13 March 2020, the WHO considered Europe the active centre of the pandemic. On 19 March 2020, Italy overtook China as the country with the most reported deaths. By 26 March, the United States had overtaken China and Italy with the highest number of confirmed cases in the world. Research on coronavirus genomes indicates the majority of COVID-19 cases in New York came from European travellers, rather than directly from China or any other Asian country. Retesting of prior samples found a person in France who had the virus on 27 December 2019 and a person in the United States who died from the disease on 6 February 2020.

On 11 June 2020, after 55 days without a locally transmitted case being officially reported, the city of Beijing reported a single COVID-19 case, followed by two more cases on 12 June. As of 15 June 2020, 79 cases were officially confirmed. Most of these patients went to Xinfadi Wholesale Market. On 29 June 2020, WHO warned that the spread of the virus was still accelerating as countries reopened their economies, despite many countries having made progress in slowing down the spread.

On 15 July 2020, one COVID-19 case was officially reported in Dalian in more than three months. The patient did not travel outside the city in the 14 days before developing symptoms, nor did he have contact with people from "areas of attention."

In October 2020, the WHO stated, at a special meeting of WHO leaders, that one in ten people around the world may have been infected with COVID-19. At the time, that translated to 780 million people being infected, while only 35 million infections had been confirmed.

In early November 2020, Denmark reported on an outbreak of a unique mutated variant being transmitted to humans from minks in its North Jutland Region. All twelve human cases of the mutated variant were identified in September 2020. The WHO released a report saying the variant "had a combination of mutations or changes that have not been previously observed." In response, Prime Minister Mette Frederiksen ordered for the country – the world's largest producer of mink fur – to cull its mink population by as many as 17 million.

On 9 November 2020, Pfizer released their trial results for a candidate vaccine, showing that it is 90% effective against the virus. Later that day, Novavax entered an FDA Fast Track application for their vaccine. Virologist and U.S. National Institute of Allergy and Infectious Diseases director Anthony Fauci indicated that the Pfizer

vaccine targets the spike protein used to infect cells by the virus. Some issues left to be answered are how long the vaccine offers protection, and if it offers the same level of protection to all ages. Initial doses will likely go to healthcare workers on the front lines.

On 9 November 2020 the United States surpassed 10 million confirmed cases of COVID-19, making it the country with the most cases worldwide by a large margin.

It was reported on 27 November, that a publication released by the Centers for Disease Control and Prevention indicated that the current numbers of viral infection are via confirmed laboratory test only. However, the true number could be about eight times the reported number; the report further indicated that the true number of virus infected cases *could be* around 100 million in the U.S.

On 14 December 2020, Public Health England reported a new variant had been discovered in the South East of England, predominantly in Kent. The variant, named Variant of Concern 202012/01, showed changes to the spike protein which could make the virus more infectious. As of 13 December, there were 1,108 cases identified. Many countries halted all flights from the UK; France-bound Eurotunnel service was suspended and ferries carrying passengers and accompanied freight were cancelled as the French border closed to people on 20 December.

2021

On 2 January, VOC-202012/01, a variant of SARS-CoV-2 first discovered in the UK, had been identified in 33 countries around the world, including: Pakistan, South Korea, Switzerland, Taiwan, Norway, Italy, Japan, Lebanon, India, Canada, Denmark, France, Germany, Iceland, and China.

On 12 January, it was reported that a team of scientists from the World Health Organization would arrive in Wuhan on the 14th of the month; this is to ascertain the origin of SARS-CoV-2 and determine what were the intermediate hosts between the original reservoir and humans. On the following day, two of the WHO members were barred from entering China because, according to the country, antibodies for the virus were detected in both.

On 25 January, the Brazil variant was detected in Minnesota.

On 29 January, it was reported that the Novavax vaccine was only 49% effective against the 501.V2 variant in a clinical trial in South Africa. The China COVID-19 vaccine CoronaVac indicated 50.4% effectivity in a Brazil clinical trial.

As of 13 March 2021, more than 119 million cases have been reported worldwide due to COVID-19; more than 2.64 million have died and more than 67.6 million have recovered.

COVID-19 pandemic in India

The **COVID-19 pandemic in India** is part of the worldwide pandemic of coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The first case of COVID-19 in India, which originated from China, was reported on 30 January 2020. India currently has the largest number of confirmed cases in Asia, and has the second-highest number of confirmed cases in the world after the United States with more than 10.3 million reported cases of COVID-19 infection and more than 154,000 deaths as of February 2, 2021. The per day cases peaked mid-September in India with over 90,000 cases reported per day and have since come down to below 15,000 as of 2021 January.

In July 2020, India's Ministry of Information and Broadcasting claimed the country's case fatality rate was among the lowest in the world at 2.41% and "steadily declining". By mid-May 2020, six cities accounted for around half of all reported cases in the country – Mumbai, Delhi, Ahmedabad, Chennai, Pune and Kolkata. The last region to report its first case was Lakshadweep, on 19 January 2021, nearly a year after the first reported case in India. On 10 June, India's recoveries exceeded active cases for the first time. Infection rates started to drop significantly in September, and the number of daily new cases and active cases started to decline rapidly. A Government panel on COVID-19 announced in October that the pandemic had peaked in India, and may come under control by February 2021. This prediction was based on a mathematical simulation assuming that India reaches herd immunity, the so called "Indian Supermodel". A comparison of the predicted and actual cases is available on its homepage. In a paper on an improved simulation model published February 2021 the same authors estimate the immunity of the Indian population to be close to 60% and claim that India might be the only major economy that has successfully implemented a herd immunity strategy. India has over 30 anti-COVID vaccines in various stages of development and a national vaccination drive was started on 16

January 2021. India began the world's largest Covid vaccination drive on January 16 and in 18 days the country has successfully vaccinated over 4.1 million healthcare workers.

On 12 January 2020, the WHO confirmed that a novel coronavirus was the cause of a respiratory illness in a cluster of people in Wuhan, Hubei, China, which was reported to the WHO on 31 December 2019.

On 30 January, India reported its first case of COVID-19 in Thrissur, Kerala, which rose to three cases by 3 February; all were students returning from Wuhan. Apart from these, no significant rise in transmissions was observed in February. On 4 March 22 new cases were reported, including 14 infected members of an Italian tourist group.

In March, the transmissions grew after several people with travel history to affected countries, and their contacts, tested positive. On 12 March, a 76-year-old man, with a travel history to Saudi Arabia, became the first COVID-19 fatality of India.

A Sikh preacher, who had a travel history to Italy and Germany, turned into a "super spreader" by attending a Sikh festival in Anandpur Sahib during 10–12 March. Twenty-seven COVID-19 cases were traced back to him. Over 40,000 people in 20 villages in Punjab were quarantined on 27 March to contain the spread.

On 31 March, a Tablighi Jamaat religious congregation event in Delhi, which had taken place earlier in March, emerged as a new virus super spreader event, after numerous cases across the country were traced back to it. On 18 April, the Health ministry announced that 4,291 cases were directly linked to the event.

On 2 May, in Punjab, around 4,000 stranded pilgrims returned from Hazur Sahib in Nanded, Maharashtra. Many of them tested positive, including 27 bus drivers and conductors who had been part of the transport arrangement. As of 13 May, 1,225 pilgrims had tested positive.

In July 2020, 57% of the inhabitants of Mumbai's slums had SARS CoV 2 antibodies. Since September, the number of cases in India has been falling. The Indian Supermodel initiated by the Indian government correctly predicted this development and assigned it to herd immunity.

Testing

The Union Health Ministry's war room and policy making team in New Delhi consists of the ministry's Emergency Medical Response Unit, the Central Surveillance Unit

(IDSP), the National Centre for Disease Control (NCDC) and experts from three government hospitals. They are part of policy decisions to decide how coronavirus should be tackled in the country. A cluster-containment strategy is mainly being adopted, similar to how India contained previous epidemics, as well as "breaking the chain of transmission". 15 labs across India led by the National Institute of Virology (NIV), Pune, are testing for the virus, with more labs being trained, as of early March. On 13 March, 52 labs were named capable of virus testing.

On 14 March, scientists at the National Institute of Virology isolated a strain of the novel coronavirus. By doing so, India became the fifth country to successfully obtain a pure sample of the virus after China, Japan, Thailand and the US. The Indian Council of Medical Research (ICMR) said that isolation of the virus will help towards expediting the development of drugs, vaccines and rapid diagnostic kits in the country. NIV has shared two SARS-CoV-2 genome sequences with GISAID. On 16 April, China sent 650,000 testing kits to India but their use was discontinued in view of a very low accuracy (of just 5.4%). In May, National Institute of Virology introduced another antibody test kit ELISA for rapid testing, capable of processing 90 samples in a single run of 2.5 hours.

Initial testing

Initially, the labs tested samples only from those with a travel history to 12 countries designated as high-risk, or those who had come in contact with anyone testing positive for the coronavirus, or showing symptoms as per the government guidelines. On 20 March, the government decided to also include all pneumonia cases, regardless of travel or contact history after the country saw a sharp increase in the number of cases. The first and second confirmatory tests for the virus has been made free by the government. On 9 April, ICMR further revised the testing strategy and allowed testing of the people showing symptoms for a week in the hotspot areas of the country, regardless of travel history or local contact to a patient.

The Ministry of Health said that only 10 per cent of test capacity had been used per day till 15 March, claiming that the number of tests was enough. However experts thought they were not, saying that community transmission may go undetected without adequate testing. They also wanted to add more testing centres by including private laboratories. In mid-March the government authorised accredited private labs to test for the virus.

Expansion of tests

On 17 March, the Union Ministry of Health had decided to allow private pathology labs to test for COVID-19. The ministry official claimed that by allowing private labs, the work of testing can be doubled. The ministry said that National Accreditation Board for Testing and Calibration Laboratories (NABL) accredited laboratories may soon be allowed. Once set up, a person can get COVID-19 test done at a private lab after a qualified physician in a government facility recommends it. The ICMR has appealed to the private labs to offer the tests for free as the government labs do.

On 18 March, A top health ministry official said that a Swiss private company named Roche Diagnostics has been given the Food and Drug Administration (FDA) emergency approval to conduct tests for coronavirus. The Indian regulator has given them a licence to conduct diagnostic tests of the virus on 17 March. The Drug Controller General of India (DCGI) was assessing giving another firm licence while two Indian diagnostic companies have also sought approval for the coronavirus testing kits developed by them. The government has also issued guidelines to cap the cost of sample testing by private labs at ₹4,500.

On 19 March, Ramanan Laxminarayan, director of the Center for Disease Dynamics, Economics & Policy stated that India could be facing a "tsunami of cases within a few weeks" as testing increases and the reason for the low number of confirmed cases currently is due to under-testing. He also said that according to mathematical models applied in the US or UK at least 20%–60% of the population will be affected. Applying the same models in India means that at the lower end of the estimate there could be 300 million cases of which 4–8 million could be severe.

111 additional labs for testing became functional on 21 March. On 24 March, Pune-based molecular diagnostic company Mylab Discovery Solutions became the first Indian company to have received validation for its RT-PCR tests from National Institute of Virology and the Indian Council of Medical Research (ICMR). The test takes 2.5 hours and the company is looking to price it at around ₹1,200 (US\$17), or Rs 80,000 for a 100 test kit.

In April, Institute of Genomics and Integrative Biology of Delhi had developed low cost paper-strip test that could detect COVID-19 within an hour. Each test would cost ₹500 (US\$7.00) and method could fulfill India's rapid need of testing.

On 13 April, ICMR advised pool testing in the low infection areas with a positivity rate less than 2% to increase the capacity of the testing and save resources. In this process maximum five samples are tested at once and samples are tested individually only if a pool tests positive. Andaman and Nicobar Islands and Uttar Pradesh have started doing pool testing.

On 14 April, ICMR and DGCI approved 18 new suppliers of test kits that included three Indian firms, bringing the total suppliers to 51.

On 16 April, 650,000 Rapid antibody test and RNA extraction kits were dispatched from China, and over 2 million kits were to be sent in next 15 days. On 21 April, Health department of West Bengal alleged that large number of testing kits supplied by ICMR-NICED (National Institute of Cholera and Enteric Diseases) were giving inconclusive results. ICMR-NICED admitted that there was problem in the kits and said that they are addressing the issue. While Rajasthan stopped using rapid testing kits as they were giving low accuracy of 5.4% in compared to expected 90% accuracy. Later, ICMR advised all states to stop using rapid testing kits for next two days until their on-ground teams validates these kits. Rapid antibody test kits were put on hold till further notice. The Chinese manufactures of the rapid testing kits said that the testing kits were approved by ICMR and the problem is not with the kits but with the way they were being used. However, Chinese manufacturers promised to cooperate with Indian authorities to resolve the issue. Amid this, ICMR asked states to return the faulty kits which will be sent back to the Chinese suppliers and cancelled the order of all remaining kits.

COVID 19 vaccination in india

Pune-based Serum Institute of India announced that it would apply for clinical trials of certain strains from Drug Controller General of India (DCGI) in April 2020. As per company president Adar Poonawalla, a vaccine for COVID-19 will be delivered within a year. However, it may not be effective on 20 to 30% people. Two other companies are also trying to develop a vaccine: Zydus Cadila, which is replicating viral vector and developing a DNA plasmid vaccine, and Hyderabad-based Bharat Biotech, in collaboration with US based FluGen, which is expecting the first clinical trials of a nasal vaccine by late 2020. As of late February, the Serum Institute of India had begun animal trials of vaccine candidates, followed by Zydus Cadila in March. ICMR partnered with Bharat Biotech in May to develop COVID vaccine

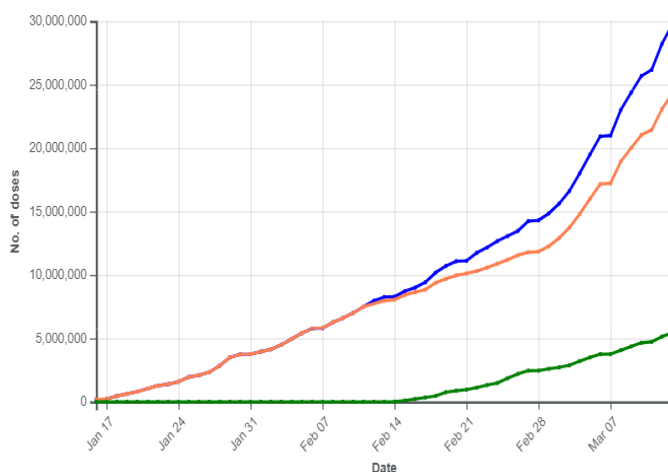
completely in India. Till May, there were over 30 candidates of COVID-19 vaccine in development in India, many of which were already in pre-clinical tests. Per reports emerged in July, ICMR was preparing to launch BBV152 COVID vaccine or Covaxin, India's first COVID-19 vaccine on 15 August following its ongoing human trials in July. Although, later deadline was cited as only meant to cut "red tape" and expected timeline of any Indian vaccine not to be before 2021. COVAXIN has been reported to have positive results on animals in building immunity against COVID-19 in pre-clinical trials. In mid-July, Zydus Cadila too had followed with human trials of its vaccine named ZyCoV-D. In early August, SII's got approval from DCGI for trial phases II & III. SII has also joined GAVI in a partnership with Bill & Melinda Gates Foundation to produce 100 million doses of vaccine for developing countries.

In September, India's science minister Dr. Harsh Vardhan announced that the first vaccine for use will be available by first quarter of 2021. 30 million health workers directly dealing with COVID patients, especially doctors and other medical personnel are supposed to be first to receive the vaccine.

Progress

Graph of cumulative doses administered across the country

■ Total vaccination doses administered across the country ■ vaccinated (1st dose only) ■ Fully vaccinated^[b]



Covid 19 vaccines with approval for emergency or conditional usage

Covishield

On 1 January 2021, the Drug Controller General of India, approved the emergency or conditional use of AstraZeneca's COVID-19 vaccine AZD1222 (marketed as Covishield). Covishield is developed by the University of Oxford and its spin-out company, Vaccitech. It's a viral vector vaccine based on replication-deficient Adenovirus that causes cold in Chimpanzees. It can be stored, transported and handled at normal refrigerated conditions (2°C-8°C/ 36°F-46°F). It has a shelf-life of at least six months.

Covaxin

On 2 January 2021, BBV152 (marketed as Covaxin), first indigenous vaccine, developed by Bharat Biotech in association with the Indian Council of Medical Research and National Institute of Virology received approval from the Drug Controller General of India for its emergency or conditional usage. However, this approval was met with some concern as the vaccine had not then completed phase-3 trials. On 3 March 2021, Bharat Biotech announced that interim results of covaxin showed the 81% efficacy. Trial was conducted on the 25,800 people in India



Tamil Nadu

The first case of the COVID-19 pandemic in the Indian state of Tamil Nadu was reported on 7 March 2020.

The largest single-day spike (6,993 cases) was reported on 27 July and Tamil Nadu now has the fifth highest number of confirmed cases in India after Maharashtra, Kerala, Karnataka and Andhra Pradesh. All 37 districts of the state are affected by the pandemic, with capital district Chennai being the worst affected.

As per the Health Department, 88% of the patients are asymptomatic while 84% of deaths were among those with co-morbidities. In June, the state saw a surge in deaths with 209 deaths (36% of the state's recorded deaths) occurring between 11 and 16 June. The initial surge in cases in the state was due to a cluster linked to a Tablighi Jamaat religious congregation event that took place in Delhi, which caused a spike in early April. Another large local cluster in Koyambedu of Chennai was identified in May.

The state government has responded to the outbreak by following a contact-tracing, testing and surveillance model. The state has 85 laboratories approved by Indian Council of Medical Research (ICMR), capable of conducting tests. The state has been under a lockdown since 25 March which was relaxed to an extent from 4 May onwards. The lockdown was further extended until 30 June with significant relaxations from 1 June. The state has enforced a stricter lockdown in four majorly-affected districts which includes Chennai and its three neighbouring districts of Chengalpattu, Thiruvallur and Kancheepuram from 19 to 30 June.

Tamil Nadu reached its peak number of active cases on 31 July with 57,968 and started to show a decline.

1.3 NEED FOR STUDY

- To focus on employees safety and health arising from chemicals and hazardous elements used at work place.
- To identify the risk of injury or illness to laboratory workers by ensuring that they have the training, information, support and equipment needed to work safely in the laboratory.

1.4 SCOPE OF STUDY

- The purpose of laboratory safety is protection of personnel, environment and laboratory facility and utility.
- Laboratory safety guidelines and rules must be prepare according to risk assessment an analysis and will be recognizing as standard safety and must respected and follow by all laboratory employees.
- Hazard waste disposal must be organized according to material safety data sheet recommendations and all hazard neutralized in order to environment pollutions.
- Health and medical surveillance regular medical checking, vaccination and immunization are important pace in laboratory safety organization.

1.5 OBJECTIVE OF THE STUDY

1.5.1 Primary objective :-

To study the safety measures adopted for the technicians working in laboratory during covid-19.

1.5.2 Secondary objective :-

- To examine satisfaction level of the respondents towards health & safety measure.
- To understand the importance of safety in the laboratory.
- To study on safety of the physical facilities in the laboratory.
- To study on how laboratory interact with hazardous substances.
- To understand the satisfactory safety measures taken by the laboratory during covid-19.

1.6 LIMITATIONS OF THE STUDY

- Open ended questions are not used.
- Due to time constrict only 116 numbers of respondents were collected.
- The study done in Chennai.
- There is no direct interact with the organisation.

CHAPTER 2

REVIEW OF LITERATURE

Lotta-maria A.H. Oksanen et al. 2020 States that purpose was to analyse the work-related exposure to SARS-CoV-2 and trace the source of COVID-19 infections in laboratories healthcare workers use of personal protective equipment and their ability to maintain social distances and follow governmental restrictions.

O. Kuzmina and s. Hoyle 2020 states that the Laboratories provide environment evolving work. The analysis of health and safety management in laboratory. The aim is to examine the challenges, from the perspective of the health and safety practitioner, researcher and academic. It is critical that health and safety in a research lab environment is practicable to those working in the labs and those that support the researchers.

Vatsala Misra et al. 2020 states that diagnostic laboratories testing different types of samples plays a vital role in treatment management. Irrespective of their size, each laboratory has to follow strict biosafety guidelines. Each sample needs to undergo a proper and well-designed processing system so that the personnel involved are not infected and also their close contacts.

Lena Jafri, Sibtain Ahmed, Imran Siddiqui 2020 states that the technicians are at risk of contracting the infection and have to deal with challenges during corona virus. The aim was to analyse the lab technicians serving at the laboratory, in terms of the challenges, fears, motivation level and satisfaction from organisation.

Kevin Odega 2020 states that all laboratory should use standard precautions. This includes, hand hygiene, and use of personal protective equipment (PPE). Safety in the medical/clinical laboratories is one of the important in laboratory procedures and medical practices. However, some determinants influence the safety of personnel, environment and sample handling, some of which are the medical procedures carried out in the lab, use of PPE, the biosafety level of the laboratory appropriate to the lab procedures and lots more.

James H Nichols, Carol A Rauch 2020 states that the biosafety practices for clinical laboratories provide protection from infectious materials such as body fluids which may contain virus. Standard precaution include hand hygiene and use of personal protective equipment, such as laboratory coats or gowns, gloves and eye protection. Routine laboratory practice for decontamination for laboratory waste is also recommended.

Abhishek Dubey, Aastha Bansal ed al. 2020 states that the health care workers of laboratory handling covid patients samples are at risk and needed to take protective measures. These healthcare workers are under physical and mental stress. The lab technicians are at forefront of managing the pandemic are at risk of contracting the disease as it highly contagious in nature.

Sergio Alejandro Gomez-Ochoa, Oscar H franco ed al. 2020 states that the healthcare workers are at increased risk of SARS-Co-2 infection due to their close contact with highly infectious patients. This could be even more problematic, considering the poor access to personal protective equipment. Limiting the possibility of designing effective preventive measures to limit the transmission of the virus within the hospital.

J Valerie Gross, Judith Mohren, Thomas C Erren 2020 states that the technicians fight impacts of SARS-Co-2 on front lines, must create safe work environment through comprehensive risk assessment, evaluation and effective implementation of counter-measures. Healthcare workers as important actors of the critical infrastructure are under considerable risk of infection and other diseases.

Kevin Odega, Ehijie Iyamah, Ephraim Ibadin, Festus Idomeh, Deborah Odega 2020 states that the due to high risk of corona virus the laboratory should minimize the risk of infection to technicians. Although extensive studies have been carried out on the novel SARS-CoV-2 on its pathogenesis, mode of infection and virulence but much is still unknown.

De Gruyter 2020 states that the challenges faced by technicians due to covid and should follow safety precautions in the laboratory. One important aspect is that corona virus may be hazardous to lab technicians. The aim is to provide a set of recommendations, adapted from official documents on biosafety levels 1 and level 2. To help minimizing the risk of developing covid-19 while working in clinical laboratories.

Abrar Ahmad Chughtai, Wasiq Khan 2020 states that the technicians at the frontline when treating infectious disease cases and at high risk of respiratory infection. Safety measures should follow such as environmental measures and use of personal protective equipment. Various infection control strategies are used to protect healthcare workers from respiratory and other infections in healthcare settings. These strategies can be broadly classified as administrative control measures, environmental control measures and the use of personal protective equipment.

Ayush Agarwal, Piyush Ranjan, Arjun Saraswat, Keerthana Kasi, Vishwesh Bharadiya ed al. 2020 states that health care workers are at increased risk of getting infected with coronavirus disease and study was done to evaluate the safety practices being followed by health care workers. Various studies have identified suboptimal handwashing, improper use and reuse of personal protective equipment, and working in high-risk department as important risk factors for infection.

Juan Pablo Appendino, Steven K Baker, Kristine M Chapman, Tamara Dykstra, ed al. 2020 states that the covid19 pandemic has had a major impact on clinical practices. Safe standards of practice are essential to protect healthcare workers while still allowing them to provide good care. To provide guidelines for safe functioning of laboratories during the covid-19 pandemic, recommendations are based on expert opinion and review of relevant published guidelines.

Packiaraj Selvajothi, MuthuPonnuswamy, Sumathy, Santiago Gnandeepam, Subramanian Kuzhali 2020 states that working during this pandemic with SARS-Co-2, one of the major issues to be focused is the laboratory personnel safety. There are possibilities of potentially infectious covid19 samples to be received in laboratories, exposing the laboratory staff to the coronavirus.

Benjamin S. Abella, Eliana L. Jolkovsky, Barbara T. Biney 2020 states that the technicians are at risk of exposure to severe acute respiratory syndrome coronavirus. Therefore, technicians should take safety precaution. Public health measures to prevent covid-19 disease have largely depended on physical distancing, use of facial covers and personal protective equipment and hand hygiene.

Orcun Zorbozan, Nergiz Zorbozan and Nevin Turgay 2021 states that aimed to perform biosafety risk assessment to determine measures to be taken against coronavirus in laboratory. Besides being a global hazard, covid-19 has become an important threat to health care workers due to transmission through aerosols. Therefore, it has a great importance of being proactive about taking biosafety measures in healthcare settings to protect healthcare workers from being infected.

Michael Kritselis, Daniel G. Remick 2020 states that the current coronavirus disease pandemic has raised concerns about the safety of laboratory personnel who handle samples in the laboratory.

While pathologists have performed autopsies on infected decedents for centuries, universal precaution protocols for limiting exposure to pathogens.

Mohammad Ali Hossain, Md Utba Bin Rashid and Mohammad Delwer Hossain Hawlader 2021 states that proper practice of personal protective equipment by healthcare workers are necessary to get protection from COVID-19 infection. The aim is to practice regarding personal protective equipment among healthcare workers.

Luigi Vimercati, Luigi De Maria, Marco Quarato, ed al. 2020 states that the prevalence of SARS-CoV-2 infection among exposed healthcare workers after preventive protocol implementation. SARS-CoV-2 represents a major hazard for technicians safety: the biological risk is higher when medical procedures are performed on the respiratory tract. To prepare for a pandemic, infection prevention measures should be focused on reducing in-hospital transmission using correct personal protective equipment, but their utilization needs to be appropriate to avoid waste.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 RESEARCH DESIGN

A research design is considered as the framework or plan for a study that guides as well as helps the data collection and analysis of data.

3.1.1 Descriptive Research Design

Descriptive research is a study designed to depict the participants in an accurate way. More simply put, descriptive research is all about describing people who take part in the study.

3.2 SAMPLING TECHNIQUE

3.2.1 Convenience sampling method

A convenience sample is one of the main types of non-probability sampling methods. A convenience sample is made up of people who are easy to reach.

3.3 SOURCES OF DATA

3.3.1 Primary data

Primary data, by contrast, are collected by the investigator conducting the research.

3.3.1.1 Questionnaire

The questionnaire tried to capture the responses of the technicians mainly on the key deliverables, derived from the survey conducted, and a few questions have been included to gauge the level of satisfaction and to gain insight into technicians expectations.

3.3.2 Secondary Data sources

Secondary data refers to data that was collected by someone other than the user. Common sources of secondary data for Journal, Books, Websites, organizational records and data that was originally collected for other research purposes.

3.4 STRUCTURE OF QUESTIONNAIRE

There are two broad types of questions open ended or open questions, and closed ended or closed questions. Open questions enable respondents to answer as they wish. Closed questions provide respondents with a list of options from which they choose.

3.5 SAMPLE SIZE

The sample size is 116.

3.6 PERIOD OF STUDY

The period of study is from January 2021 TO March 2021 which is a four months of study

3.7 ANALYTICAL TOOLS

The analytical tools used are spss for testing the hypothesis, Chi Square test in spss tool.

CHAPTER 4

DATA ANALYSIS AND INTERPRETATION

4.1 PERCENTAGE ANALYSIS

Table 4.1.1: Age of the respondents

Particulars	No.of.respondents	Percentage
21-30	86	74.14
31-40	26	22.41
41-50	4	3.45
above 51	0	0
Total	116	100

Source : primary data

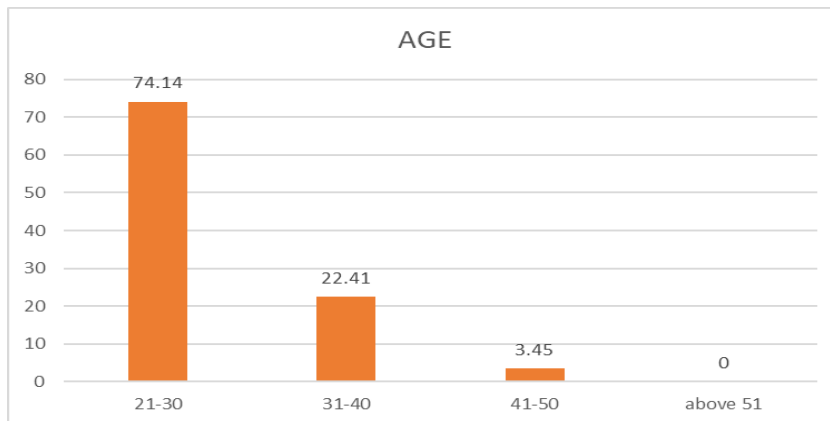


Chart 4.1.1 Age of the respondents

Interpretation

From the above table it is interpreted that the number of respondents between 21 to 30 is 74.14%, 31 to 40 is 22.41, 41 to 50 is 3.45, and above 51 is zero.

Inference

Majority (74.14%) of the respondents fall in the category of 21 to 30 years.

Table 4.1.2: Gender of the respondents

Particulars	No.of.respondents	Percentage
Male	52	44.83
Female	64	55.17
Total	116	100

Source : primary data

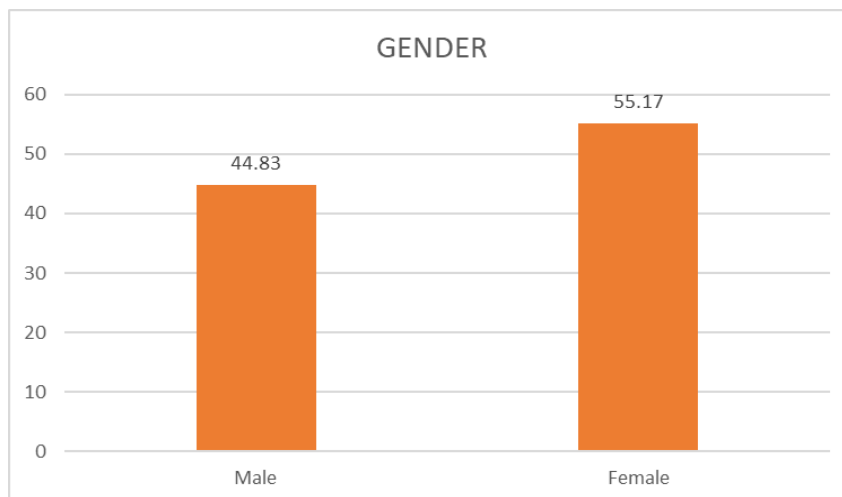


Chart 4.1.2 : Gender of the respondents

Interpretation

From the above table it is interpreted that the number of male respondent is 44.83% and female respondent is 55.17%.

Inference

Majority (55.17%) of the respondents are female.

Table 4.1.3 Marital status of the respondents

Particulars	No.of.respondents	Percentage
Single	69	59.48
Married	47	40.52
Total	116	100

Source : primary data

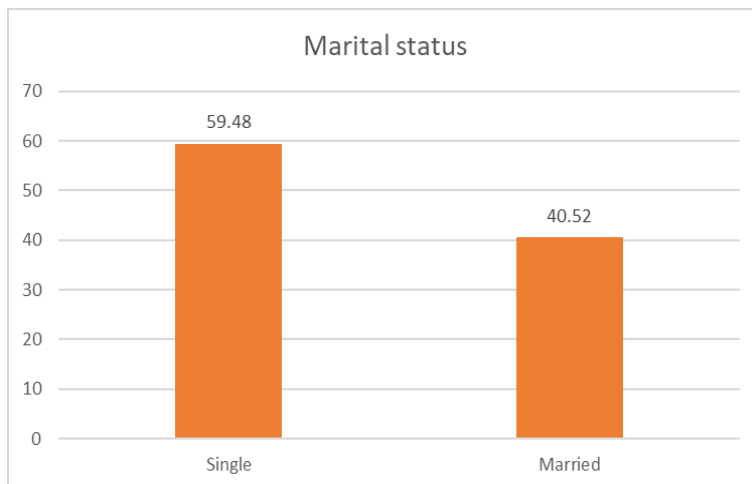


Chart 4.1.3 Marital status of the respondents

Interpretation

From the above table it is interpreted that the number of respondents were 59.48% is unmarried and 40.52% is married.

Inference

Majority (59.48%) of the respondents are unmarried.

Table 4.1.4 aware of common signs and symptoms of corona virus

Particulars	No.of.respondents	Percentage
Yes	103	89.57
No	13	10.43
Total	116	100

Source : primary data

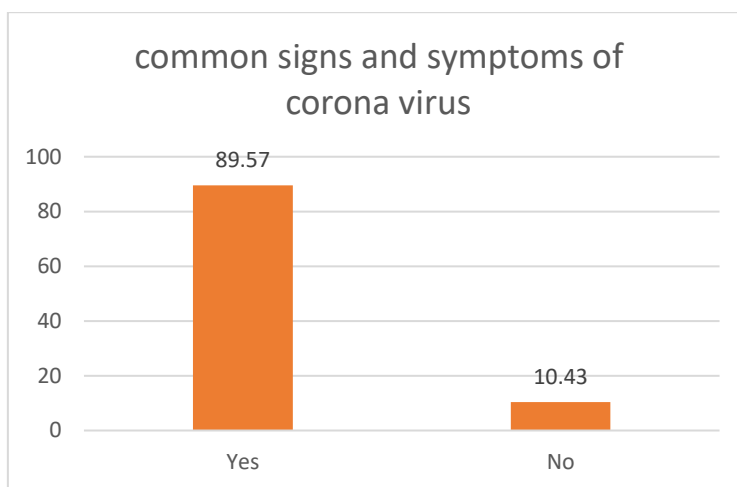


Chart 4.1.4 aware of common signs and symptoms of corona virus

Interpretation

From the above table it is interpreted that the 89.57% said yes and 10.43% said no.

Inference

Majority (89.57%) of the respondents said yes.

Table 4.1.5 Tests conducted in the laboratory per day

Particulars	No.of.respondents	Percentage
10--40	9	7.75
41-70	22	18.97
71-100	22	18.97
more than 100	63	54.31
Total	116	100

Source : primary data

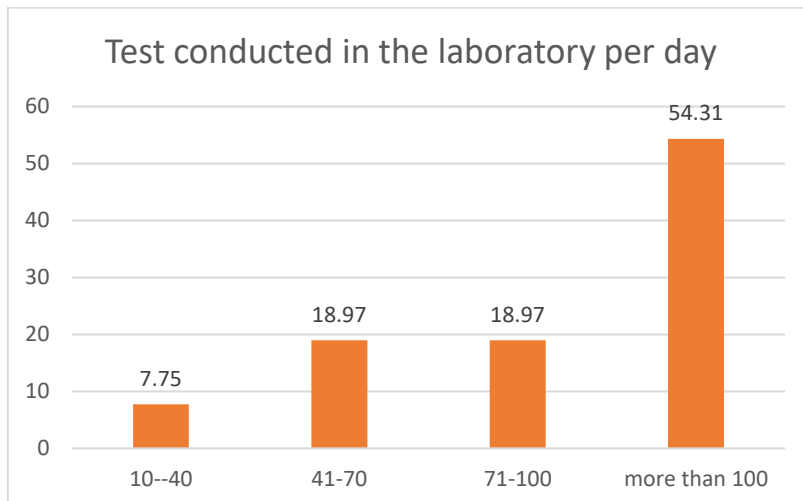


Chart 4.1.5 Tests conducted in the laboratory per day

Interpretation

From the above table it is interpreted that the number of respondents between 10 to 40 is 7.75%, 41 to 70 is 18.97%, 71 to 100 is 18.97% and more than 100 is 54.31%.

Inference

Majority (54.31%) of the respondents are more than 100

Table 4.1.6 Type of training or orientation about infection prevention and control given to your laboratory:-

Particulars	No.of.respondents	Percentage
Biohazardous waste management	1	0.86
Hand hygiene	1	0.86
Personal protective equipment	4	3.45
All of the above	110	94.83
Total	116	100

Source : primary data

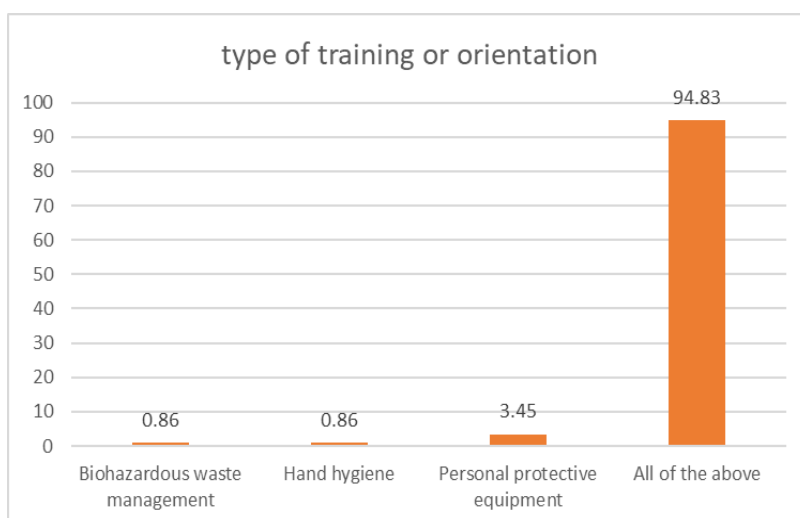


Chart 4.1.6 Type of training or orientation about infection prevention and control given to your laboratory

Interpretation

From the above table it is interpreted that the 0.86% said biohazardous waste management, 0.86% said hand hygiene, 3.45% said personal protective equipment and 94.83% said all of the above.

Inference

Majority (94.83%) of the respondents said all of the above.

Table 4.1.7 corona virus can be control

Particulars	No.of.respondents	Percentage
Yes	111	96.52
No	5	3.48
Total	116	100

Source : primary data

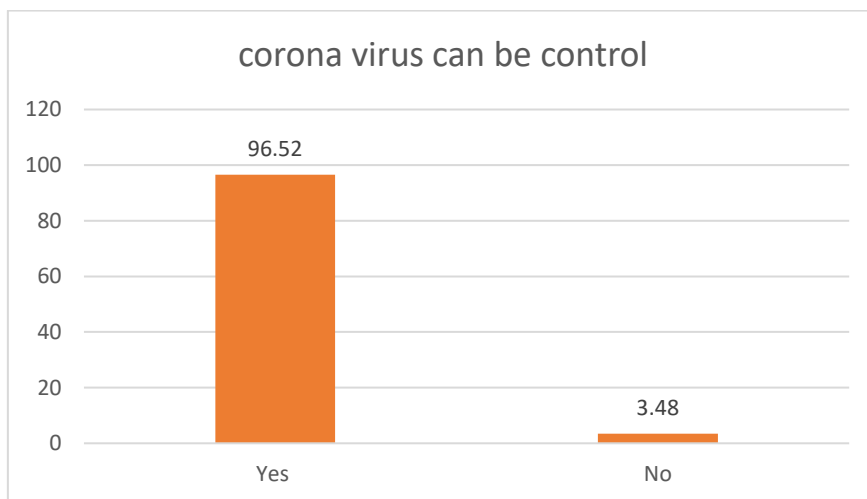


Chart 4.1.7 corona virus can be control

Interpretation:-

From the above table it is interpreted that the 96.52% said yes and 3.48% said no.

Inference

Majority (96.52%) of the respondents said yes.

Table 4.1.8 Laboratory perform temperature monitoring on staff

Particulars	No.of.respondents	Percentage
Once a day	67	57.76
Twice a day	34	29.31
More than 3 times a day	15	12.93
Total	116	100

Source : primary data

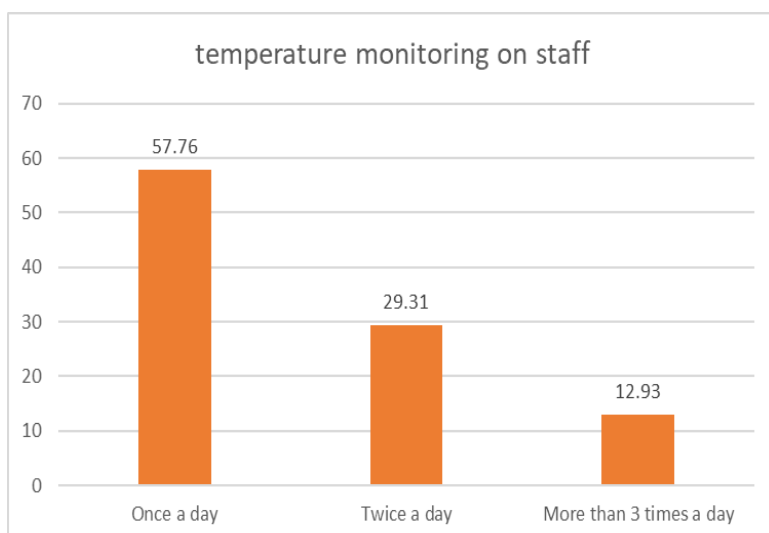


chart 4.1.8 Laboratory perform temperature monitoring on staff

Interpretation:

From the above table it is interpreted that the 57.76% of respondents said once a day, 29.31% said twice a day, 12.93% said more than 3 times a day.

Inference

Majority (57.76%) of the respondents said once a day.

Table 4.1.9 Samples packed and brought to your laboratory:-

Particulars	No.of.respondents	Percentage
Single bag	14	12.17
Two layer of plastic	32	26.96
Other	70	60.87
Total	116	100

Source : primary data

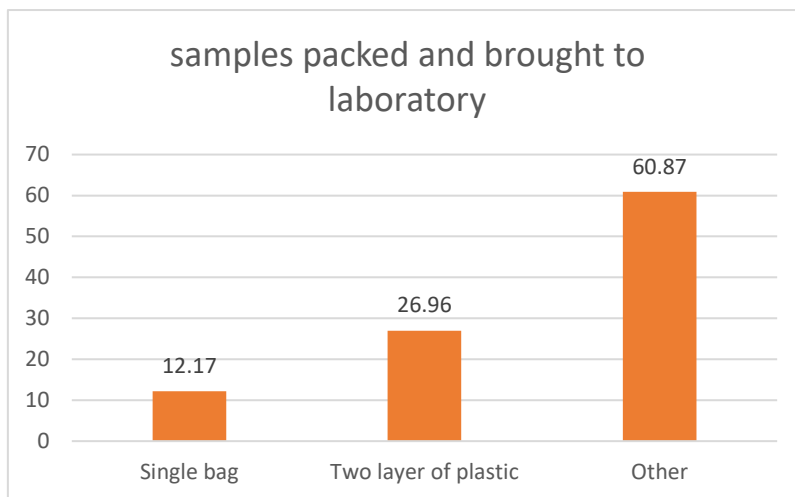


Chart 4.1.9 Samples packed and brought to your laboratory:-

Interpretation:-

From the above table it is interpreted that the 12.17% of respondents said single bag, 26.96% said two layer of plastic, 60.87% said other.

Inference

Majority (60.87%) of the respondents said other.

Table 4.1.10 Hours you work in the laboratory in a day

Particulars	No.of.respondents	Percentage
8 hours	99	85.34
9 hours	12	10.34
More than 9 hours	5	4.32
Total	116	100

source: primary data

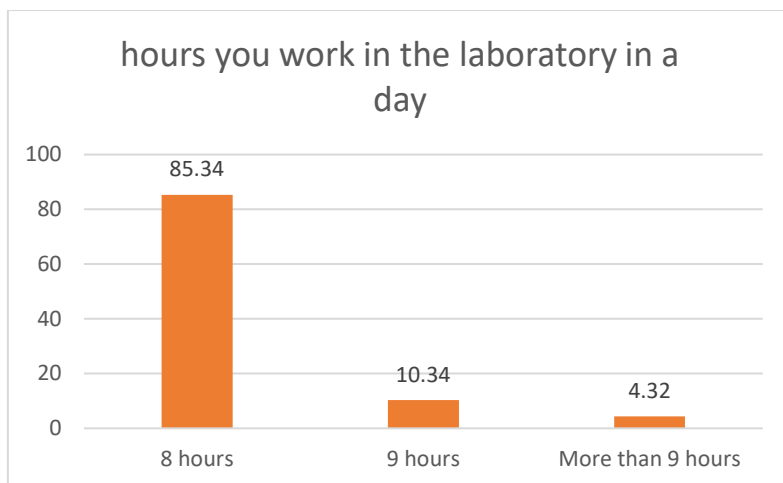


Chart 4.1.10 Hours you work in the laboratory in a day

Interpretation:-

From the above table it is interpreted that 85.34% of respondents said 8 hours, 10.34% said 9 hours and 4.32% said more than 9 hours.

Inference

Majority (85.34%) of the respondents said 8 hours.

Table 4.1.11 Rate the working environment of the organization

Particulars	No.of.respondents	Percentage
Excellent	43	37.07
Good	59	50.86
Average	14	12.07
Below average	0	0
Poor	0	0
Total	116	100

Source data: primary data

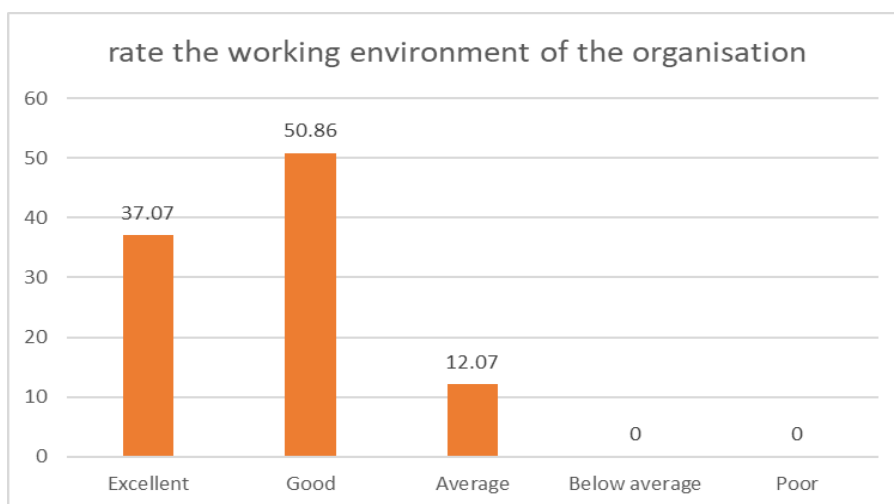


Chart 4.1.11 Rate the working environment of the organization

Interpretation:-

From the above table it is interpreted that the number of respondents said 37.07% excellent in working environment, 50.86% said good, 12.07% said average.

Inference

Majority (50.86%) of the respondents said good.

Table 4.1.12 Times they do sanitization in your laboratory

Particulars	No.of.respondents	Percentage
Once in 4 hours	45	38.79
Once in 8 hours	24	20.69
Once in a day	47	40.52
Total	116	100

source: primary data

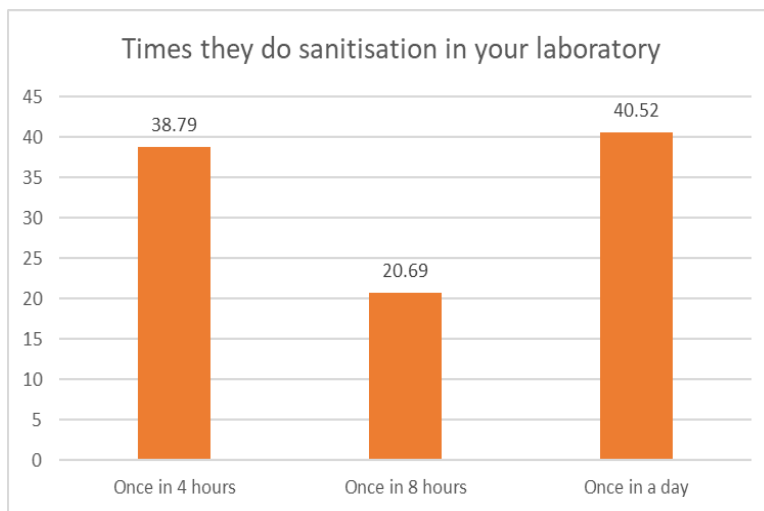


Chart 4.1.12 Times they do sanitization in your laboratory

Interpretation:-

From the above table it is interpreted that 38.79% of respondents said once in 4 hours, 20.69% said once in 8 hours, 40.52% said once in a day.

Inference

Majority (40.52%) of the respondents said once in a day.

Table 4.1.13 Wear lab coat (PPE kit) while testing

Particulars	No.of.respondents	Percentage
Yes	114	98.28
No	2	1.72
Total	116	100

Source: primary data

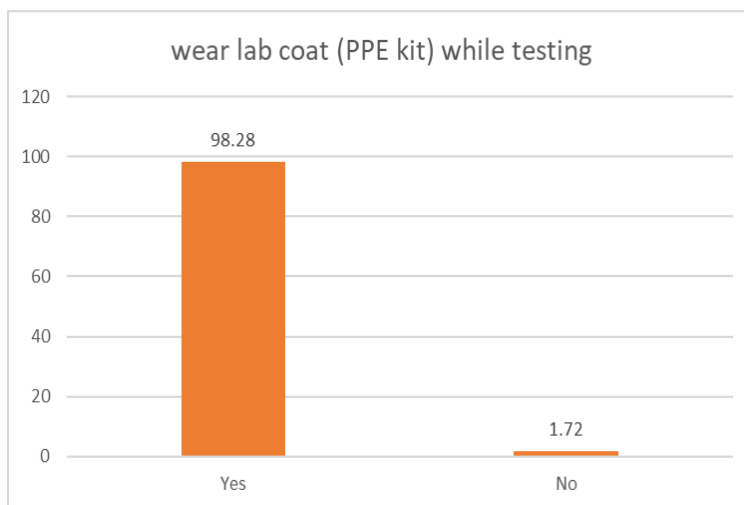


Chart 4.1.13 Wear lab coat (PPE kit) while testing

Interpretation:-

From the above table it is interpreted that the 98.28% of respondents said yes and 1.72% said no.

Inference

Majority (98.28%) of the respondents said yes.

Table 4.1.14 Wear eye protection while testing

Particulars	No.of.respondents	Percentage
Yes	72	62.07
No	44	37.93
Total	116	100

Source: primary data



Chart 4.1.14 Wear eye protection while testing

Interpretation:-

From the above table it is interpreted that the 62.07% of respondents said yes and 37.93% said no.

Inference

Majority (62.07%) of the respondents said yes.

Table 4.1.15 Types of gloves used in the laboratory

Particulars	No.of.respondents	Percentage
Latex	9	6.95
Nitrile	28	24.35
Depends on the substance being handled	79	68.7
Total	116	100

Source: primary data

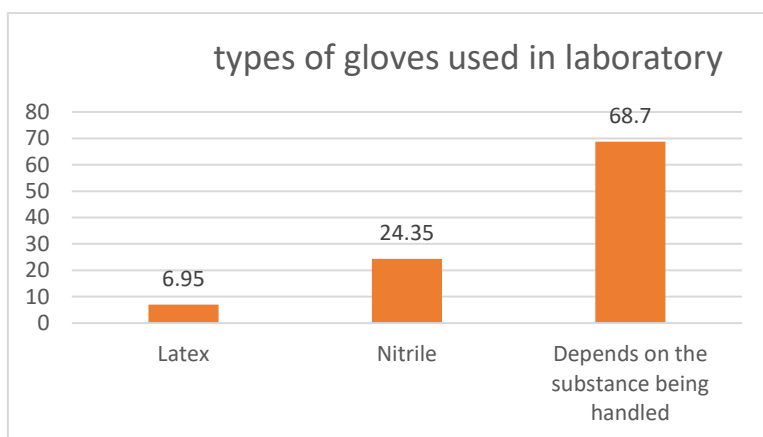


Chart 4.1.15 Types of gloves used in the laboratory

Interpretation:-

From the above table it is interpreted that 6.95% of respondents said latex, 24.35% said nitrile, 68.7% said depends on the substance being handled.

Inference

Majority (68.70%) of the respondents said depends on the substances being handled.

Table 4.1.16 Rate the facility of your laboratory

Particulars	No.of.respondents	Percentage
Excellent	42	36.21
Good	50	43.1
Average	24	20.69
Below average	0	0
Poor	0	0
Total	116	100

Source: primary data

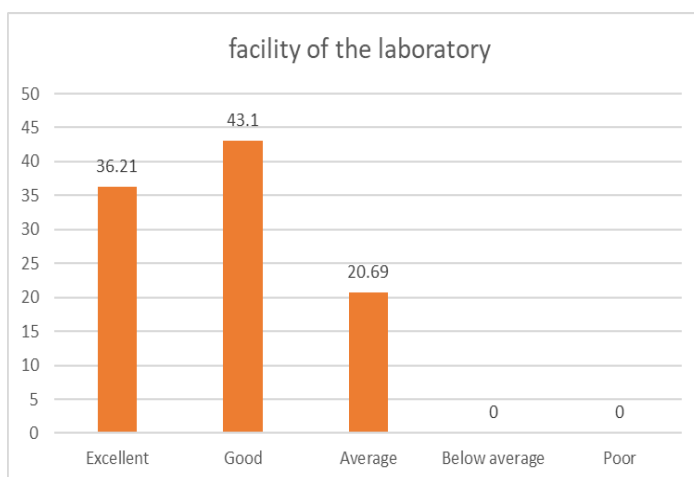


Chart 4.1.16 Rate the facility of your laboratory

Interpretation:-

From the above table it is interpreted that the number of respondents said 36.21% excellent in facility of the laboratory, 43.1% said good and 20.69% said average.

Inference

Majority (36.21%) of the respondents said good

Table 4.1.17 Steps taken to protect your health in the laboratory

Particulars	No.of.respondents	Percentage
Drinking kabasura kudineer	13	11.21
Vitamin D,C tablet	9	7.76
Protein rich foods	1	0.86
All of the above	93	80.17
Total	116	100

Source: primary data

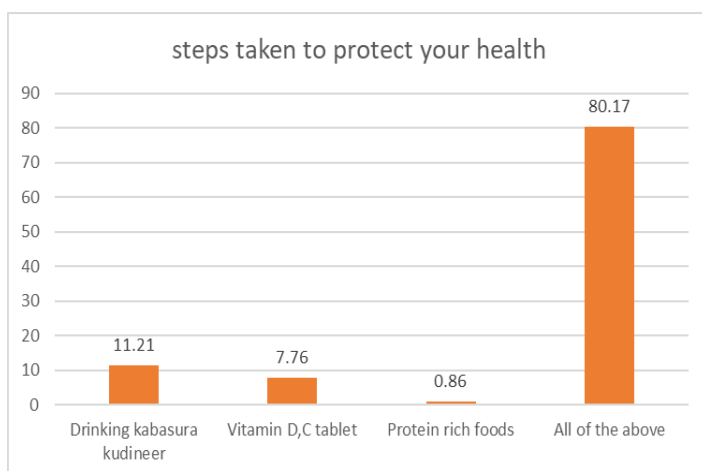


Chart 4.1.17 Steps taken to protect your health in the laboratory

Interpretation:-

From the above table it is interpreted that 11.21% of respondents said drinking kabasura kudinner, 7.76% said vitamin D,C tablets, 0.86% said protein rich foods and 80.17% said all of the above.

Inference

Majority (80.17%) of the respondents said all of the above.

Table 4.1.18 covid checkup

Particulars	No.of.respondents	Percentage
Once a month	17	14.66
Once in 6 months	4	3.44
Only when needed	95	81.9
Total	116	100

Source: primary data

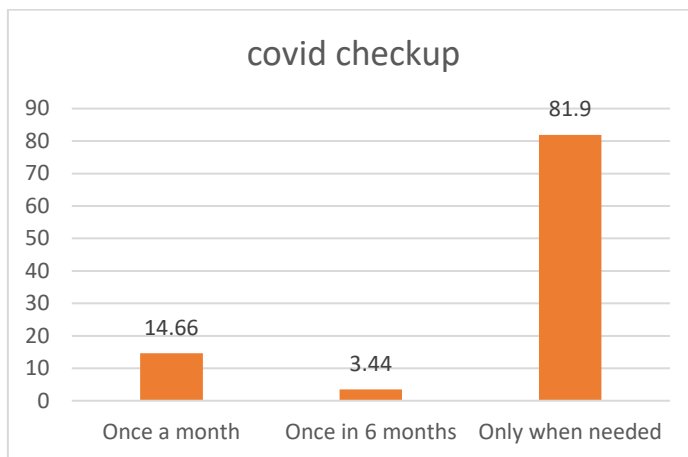


Chart 4.1.18 covid checkup

Interpretation:-

From the above table it is interpreted that 14.66% of respondents said once a month, 3.44% said once in 6 months, 81.9% said only when needed.

Inference

Majority (81.90%) of the respondents said only when needed.

Table 4.1.19 Things need to wear before beginning any test in the laboratory

Particulars	No.of.respondents	Percentage
Safety apron or lab coat	10	8.62
Goggles	1	0.86
Gloves	18	15.52
All of the above	87	75
Total	116	100

Source: primary data

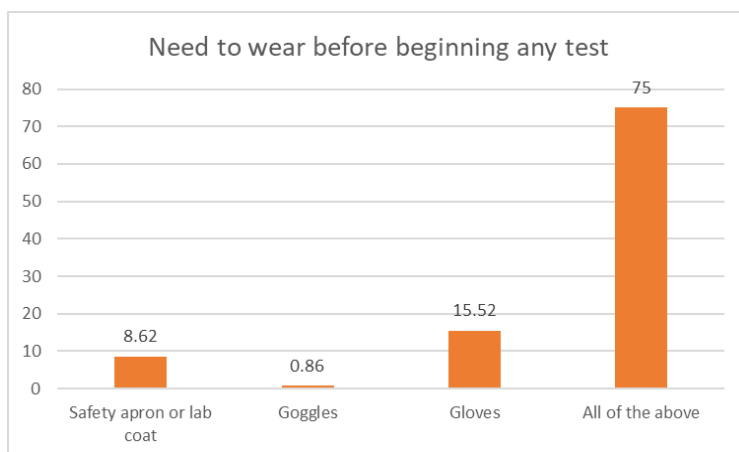


Chart 4.1.19 Things need to wear before beginning any test in the laboratory

Interpretation:-

From the above table it is interpreted that 8.62% of respondents said wearing safety apron or lab coat, 0.86% said goggles, 15.52% said gloves, 75% said all of the above.

Inference

Majority (15.52%) of the respondents said all of the above.

Table 4.1.20 Samples collect per day

Particulars	No.of.respondents	Percentage
10--40	13	11.21
41-70	18	15.52
71-100	24	20.68
More than 100	61	52.59
Total	116	100

Source: primary data

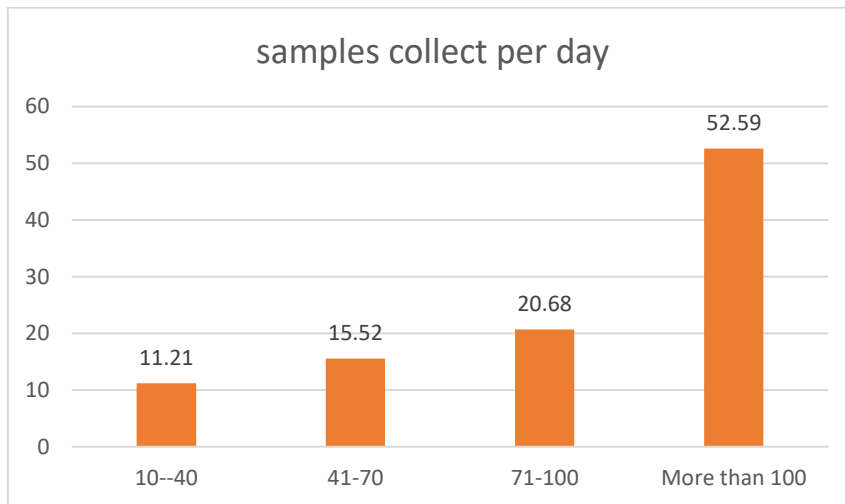


Chart 4.1.20 Samples do you collect per day

Interpretation:-

From the above table it is interpreted that the number of respondents between 10 to 40 is 11.21%, 41 to 70 is 15.52%, 71 to 100 is 20.68% and more than 100 is 52.59%.

Inference

Majority (52.59%) of the respondents said more than 100.

Table 4.1.21 Feel stress in the work place

Particulars	No.of.respondents	Percentage
Always	4	3.45
Sometimes	78	67.24
Rarely	26	22.41
Never	8	6.9
Total	116	100

Source: primary data

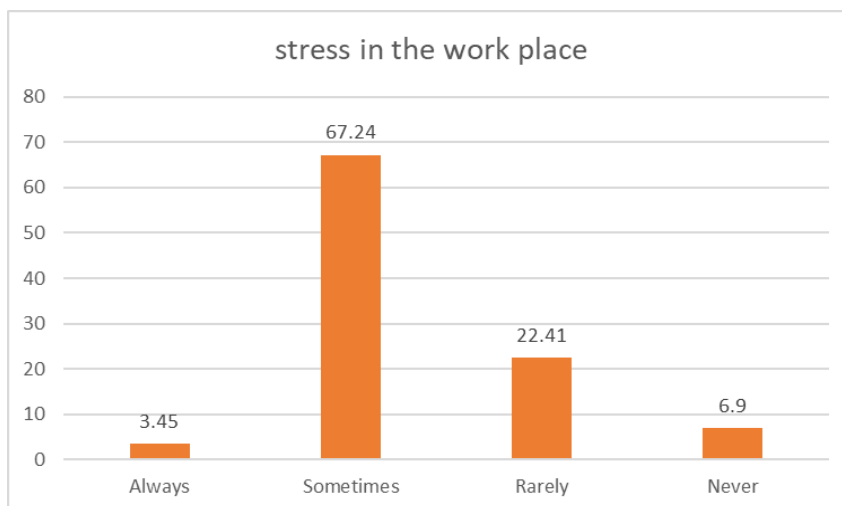


Chart 4.1.21 F eel stress in the work place

Interpretation:-

From the above table it is interpreted that 3.45% of respondents said always, 67.24% said sometimes, 22.41% said rarely and 6.9% said never.

Inference

Majority (67.24%) of the respondents said sometimes.

Table 4.1.22 Safety measures during the covid 19

Particulars	No.of.respondents	Percentage
Strongly agree	30	25.86
Agree	51	43.97
Neutral	34	29.31
Disagree	1	0.86
Strongly disagree	0	0
Total	116	100

Source: primary data

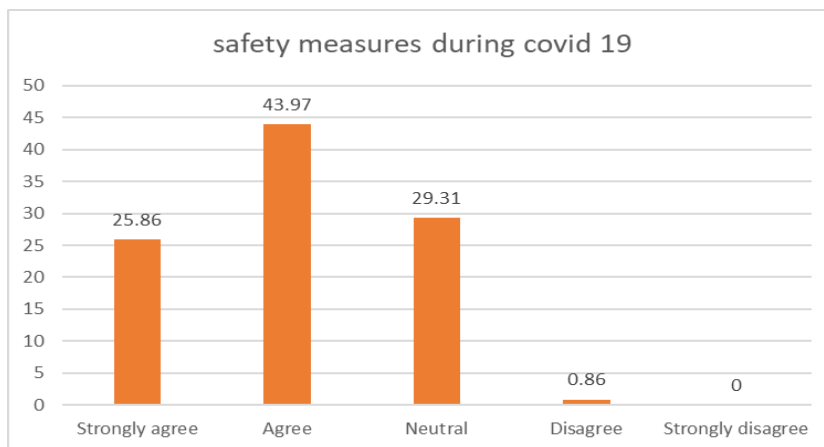


Chart 4.1.22 Satisfactory safety measures during the covid 19

Interpretation:-

From the above table it is interpreted that 25.86% said strongly agree, 43.97% said agree, 29.31% said neutral, 0.86% said disagree.

Inference

Majority (43.97%) of the respondents said agree.

Table 4.1.23 Safety of the physical facilities in the laboratory (machinery, equipment, etc)

Particulars	No.of.respondents	Percentage
Excellent	33	28.44
Good	56	48.28
Average	27	23.28
Below average	0	0
Poor	0	0
Total	116	100

Source: primary data

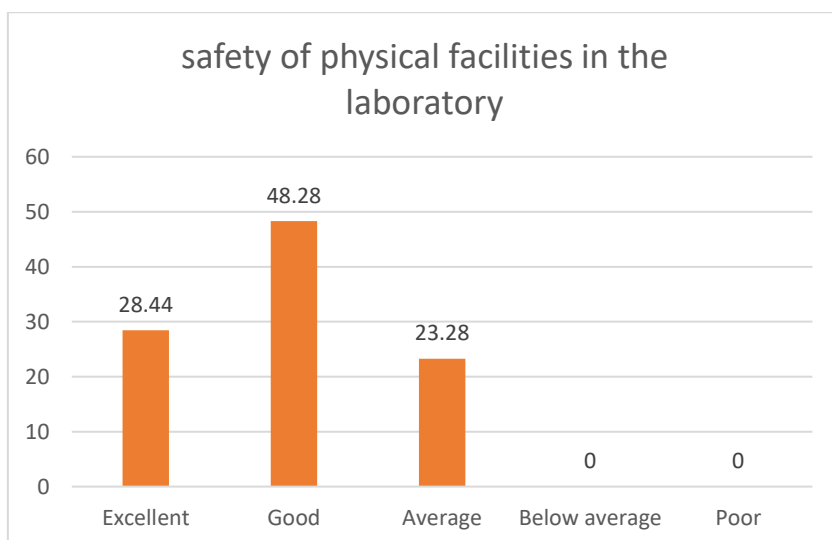


Chart 4.1.23 Safety of the physical facilities in the laboratory (machinery, equipment, etc)

Interpretation:-

From the above table it is interpreted that the number of respondents said 28.44% excellent in physical facility in the laboratory, 48.28% said good and 23.28% said average.

Inference

Majority (48.28%) of the respondents said good.

Table 4.1.24 Interact with hazardous substances such as chemicals, flammable liquids and gases

Particulars	No.of.respondents	Percentage
Never	16	13.91
Once a year	2	0.87
Every 6 months	4	3.48
Every 3 months	9	7.83
Every week	19	16.52
Every day	66	57.39
Total	116	100

Source: primary data

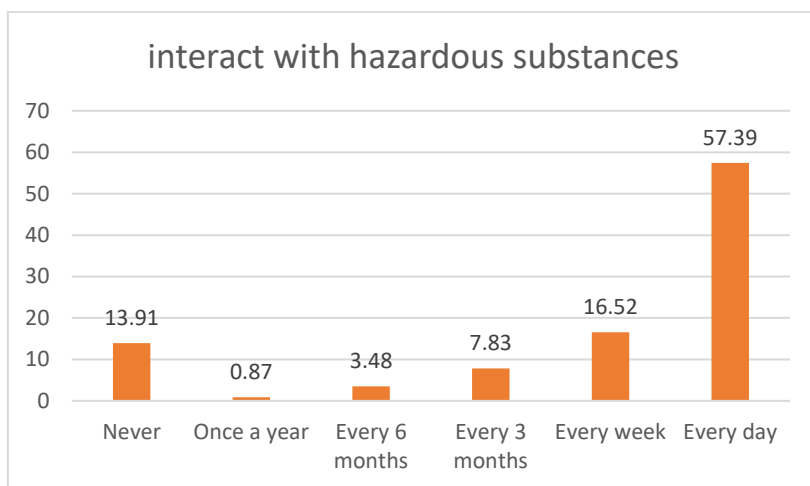


Chart 4.1.24 Interact with hazardous substances such as chemicals, flammable liquids and gases

Interpretation:-

From the above table it is interpreted that 13.91% of respondents said never interact with hazardous substances, 0.87% said once a year, 3.48% said every 6 months, 7.83% said every 3 months, 16.52% said every week, 57.39% said every day.

Inference

Majority (57.39%) of the respondents said everyday.

Table 4.1.25 Motivates you to do the work in the laboratory during covid 19

Particulars	No.of.respondents	Percentage
Responsibility of work	35	30.43
Salary increment	20	16.52
Safety measures	27	23.48
All of the above	34	29.57
Total	116	100

Source: primary data

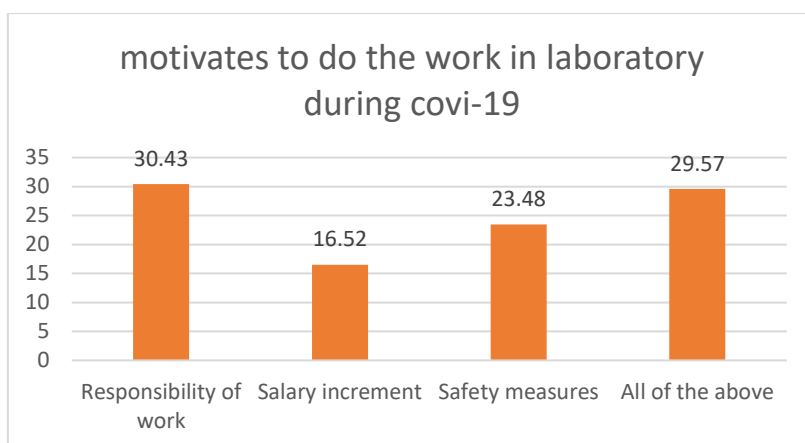


Chart 4.1.25 Motivates you to do the work in the laboratory during covid 19

Interpretation:-

From the above table it is interpreted that 30.43% of respondents said responsibility of work, 16.52% said salary increment, 23.48% said safety measures, 29.57% said all of the above.

Inference

Majority (30.43%) of the respondents said responsibility of work.

4.2 Chi-square

Table 4.2.1: Table showing the significant difference between how you interact with hazardous substances and age

Null hypothesis (H_0) – there is no significant difference between how you interact with hazardous substances and age

Alternate hypothesis (H_1) – there is significant difference between how you interact with hazardous substances and age

Case Processing Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
2. Age * 26. In your laboratory, how often do you interact with hazardous substances such as chemicals, flammable liquids and gases?	116	100.0%	0	0.0%	116	100.0%

Chi-Square Tests				
		Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square		20.079 ^a	12	.066
Likelihood Ratio		17.285	12	.139
N of Valid Cases		116		

a. 16 cells (76.2%) have expected count less than 5
The minimum expected count is .03.

Source: primary data

Interpretation

Since p value is less than 0.5, we accept the alternate hypothesis and reject the null hypothesis. Therefore, there is significant difference between how you interact with hazardous substances and age

Table 4.3: Table showing the significant difference between safety of physical facility in the laboratory and gender.

Null hypothesis (H_0) – there is no significant difference between safety of physical facility in the laboratory and gender.

Alternate hypothesis (H_1) – there is significant difference between safety of physical facility in the laboratory and gender.

Case Processing Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
3. Gender * 25. How do you rate the safety of the physical facilities in the laboratory (machinery, equipment, etc)	116	100.0%	0	0.0%	116	100.0%

Chi-Square Tests				
		Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square		6.639 ^a	2	.036
Likelihood Ratio		6.699	2	.035
N of Valid Cases		116		
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 12.10.				

Source: primary data

Interpretation

Since p value is higher than 0.05, we accept the null hypothesis and reject the alternate hypothesis. Therefore, there is no significant difference between safety of physical facility in the laboratory and gender.

CHAPTER 5

FINDINGS, SUGGESTIONS AND CONCLUSION

5.1 Findings of the study

1. Majority (74.14%) of the respondents fall in the category of 21 to 30 years.
2. Majority (55.17%) of the respondents are female.
3. Majority (59.48%) of the respondents are unmarried.
4. Majority (89.57%) of the respondents said yes aware of aware of common signs and symptoms of corona virus.
5. Majority (54.31%) of the respondents said more than 100 tests are conducted in laboratory per day.
6. Majority (94.83%) of the respondents said all of the above type of training or orientation about infection prevention and control given to the laboratory.
7. Majority (96.52%) of the respondents said yes corona virus can be control.
8. Majority (57.76%) of the respondents said once a day laboratory perform temperature monitoring on staff.
9. Majority (60.87%) of the respondents said other samples packed and brought to the laboratory.
10. Majority (85.34%) of the respondents said 8 hours work in the laboratory in a day.
11. Majority (50.86%) of the respondents said good working environment of the organisation.
12. Majority (40.52%) of the respondents said once in a day times they do sanitization to the laboratory.
13. Majority (98.28%) of the respondents said yes wear lab coat (PPE kit) while testing.
14. Majority (62.07%) of the respondents said yes wear eye protection while testing.
15. Majority (68.70%) of the respondents said depends on the substances being handled type of gloves used in the laboratory.

16. Majority (36.21%) of the respondents said good facility of the laboratory.
17. Majority (80.17%) of the respondents said all of the above steps taken to protect health in the laboratory.
18. Majority (81.90%) of the respondents said only when needed get a covid check up.
19. Majority (15.52%) of the respondents said all of the above things need to wear before beginning any test in the laboratory.
20. Majority (52.59%) of the respondents said more than 100 samples collect per day.
21. Majority (67.24%) of the respondents said sometimes feel stress in the workplace.
22. Majority (43.97%) of the respondents said agree laboratory has taken satisfactory safety measures during covid-19.
23. Majority (48.28%) of the respondents said good safety of physical facilities in the laboratory (machinery, equipment, etc)
24. Majority (57.39%) of the respondents said everyday interact with hazardous substances such as chemicals, flammable liquids and gases.
25. Majority (30.43%) of the respondents said responsibility of work motivates the work in the laboratory during covid-19.

5.2 Suggestions

- Limit close contact. Be aware of where other are in the lab, and keep as much distance as possible.
- Promote hand hygiene. Provide hand washing station throughout the lab and ensure that hand sanitizer is well stocked and readily available.
- Clean and disinfect frequently touched surfaces, such as equipment and cabinet handles. Wear personal protective equipment while cleaning. Wipe down reusable PPE afterward.
- If someone working in the lab contracts covid-19, follow the protocols established by the Centres for Disease Control and Prevention (CDC).
- Wash your hands frequently, especially after contacting commonly touched surfaces. Use soap and water, and wash for at least 20 seconds.
- Don't touch your face if you haven't washed your hands.
- Stay home if you feel sick. Avoid any contact with sick people.

5.3 Conclusion

Laboratory staff, like all health care workers, are at risk for infectious diseases because of working with infectious material. Prevention of spread of the disease amongst the technicians in the laboratories is also important. Clinical laboratories are an intersection point for infected materials. For this reason, biosafety should be considered in all laboratory processes. The biosafety measures that clinical laboratories should take are outlined according to the risk group of microorganisms likely to be encountered, in the biosafety guidelines. Face masks and gloves were the most commonly used PPE to protect from infections. The pandemic has affected the routine work of the clinical laboratory and has manifested in the form of test restriction. Temperature monitoring and splitting staff into teams can reduce the risk of transmission within the laboratory environment. Each laboratories should asses their risk category and then reframe their working methods and ensure safety of their personal. Adopting standard precautions along with maintaining a good personal hygiene, proper physical distancing, safe handling of laboratory samples, appropriate use of personal protective equipment and in the correct method, proper biomedical waste disposal and all shortcuts can reduce the risk of transmitting covid-19 to the laboratory personnel.

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APPENDIX – I (Questionnaire)

1. Name _____
2. Age
(a) 21-30 (b) 31-40 (c) 41-50 (d) above 51
3. Gender
(a) male (b) female
4. Marital status
(a) single (b) married
5. Name of the organisation _____
6. Have you aware of common signs and symptoms of corona virus?
(a) yes (b) no
7. How many tests are conducted in the laboratory per day?
(a) 10-40 (b) 41-70 (c) 71-100 (d) more than 100
8. What type of training or orientation about infection prevention and control given to your laboratory?
(a) biohazardous waste management (b) hand hygiene (c) personal protective equipment (d) all of the above
9. Is corona virus can be control?
(a) yes (b) no
10. Does your laboratory perform temperature monitoring on staff?
(a) once a day (b) twice a day (c) more than 3 times a day
11. How are samples packed and brought to your laboratory?
(a) single bag (b) two layer of plastic (c) other
12. How many hours you work in the laboratory in a day?
(a) 8 hours (b) 9 hours (c) more than 9 hours
13. How do you rate the working environment of the organisation?
(a) excellent (b) good (c) average (d) below average (e) poor
14. How many times they do sanitization in your laboratory?
(a) once in 4 hours (b) once in 8 hours (c) once in a day
15. Do you wear lab coat (PPE kit) while testing?
(a) yes (b) no
16. Do you wear eye protection while testing?
(a) yes (b) no

17. What types of gloves are used in your laboratory?
(a) latex (b) nitrile (c) depends on the substance being handled
18. How do you rate the facility of your laboratory?
(a) excellent (b) good (c) average (d) below average (e) poor
19. What are the steps taken to protect your health in the laboratory?
(a) drinking kabasura kudineer (b) vitamin D, C tablet (c) protein rich foods (d) all of the above
20. How often do you get a covid check-up?
(a) once a month (b) once in 6 months (c) only when needed
21. What things do you need to wear before beginning any test in the laboratory?
(a) safety apron or lab coat (b) goggles (c) gloves (d) all of the above
22. How many samples do you collect per day?
(a) 10-40 (b) 41-70 (c) 71-100 (d) more than 100
23. How often do you feel stress in the work place?
(a) always (b) sometimes (c) rarely (d) never
24. Does the laboratory has taken satisfactory safety measures during the covid 19?
(a) strongly agree (b) agree (c) neutral (d) disagree (e) strongly disagree
25. How do you rate the safety of the physical facilities in the laboratory (machinery, equipment, etc)?
(a) excellent (b) good (c) average (d) below average (e) poor
26. In your laboratory, how often do you interact with hazardous substances such as chemicals, flammable liquids and gases?
(a) never (b) once a year (c) every 6 months (d) every 3 months (e) every week (f) every day
27. What motivates you to do the work in the laboratory during covid 19?
(a) responsibility of work (b) salary increment (c) safety measures (d) all of the above

Safety Measures Adopted for the Technicians Working in Laboratory during COVID-19 at Chennai

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Abstract: *The ongoing coronavirus sickness 2019 (COVID-19) pandemic has given major challenges to health care employees together with laboratory professionals. Clinical laboratories play a crucial role during this difficult surrounding by providing info to clinicians concerning prognosis, sickness severity, and response to medical care except for the diagnosing of COVID-19. Clinical chemistry laboratories inhabit central role within the management of COVID-19 through assessing the organic chemistry and inflammatory profile. The workplace professionals at one finish area unit at exaggerated risk of catching the infection whereas on the opposite finish ought to take care of the varied challenges throughout the Coronavirus sickness 2019 (COVID-19) occurrence. This survey was undertaken to investigate the workplace professionals' views, in terms of the challenges, monetary implications, fears, motivation and satisfaction from structure processes and policies adopted, amid the COVID-19 crisis. This alarming figure prompted U.S. to form tips for bio safety procedures to guard health care employees together with laboratory personnel. Infection and quarantine of health care employees cause further burden to health care services thanks to shortage of men.*

Keywords: COVID-19, laboratory

1. Introduction

It is to deal with the overall work flow safety issues of laboratory personnel throughout the COVID-19 pandemic. All laboratories ought to perform site-and activity-specific risk assessments to see the foremost acceptable safety measures to implement for specific circumstances. Risk assessments ought to embody the subsequent considerations: Analyse the quantity of individuals that the laboratory house will realistically and safely accommodate whereas maintaining social distancing. Assess the flow of personnel traffic. wherever doable, style unidirectional ways for workers to steer through the laboratory house. Assess procedures for cleansing and sanitizing normally instrumentation and areas-for example, counters, desks-to guarantee clean surfaces and instrumentation for all users. Review emergency communication and operational plans, together with a way to defend employees at higher risk for severe sickness from COVID-19. Every establishment ought to have a COVID-19 health and safety arrange to defend workers. This arrange ought to be shared with all staffs. Ideally, this arrange would: Describe steps to assist stop the unfold of COVID-19 if associate worker is sick. Provide info on whom workers ought to contact if they become sick. Provide workers with correct info concerning COVID-19, however it spreads, and also the risk of exposure. Reinforce coaching on correct handwashing practices and alternative routine infection management precautions to assist stop the unfold of the many diseases, together with COVID-19. make sure that workers have access to private protecting instrumentation (PPE), disinfectant and soap, clean running water, and drying materials for handwashing, or alcohol-based hand sanitizers that contain a minimum of hour plant product or seventieth isopropyl alcohol.

2. Review of Literature

James H Nichols, Carol A Rauch 2020 states that the biosafety practices for clinical laboratories provide protection from infectious materials such as body fluids which may contain virus. Standard precaution includes hand hygiene and use of personal protective equipment, such as laboratory coats or gowns, gloves and eye protection. Routine laboratory practice for decontamination for laboratory waste is also recommended.

Lotta-maria A.H. Oksanen et al. 2020 States that purpose was to analyse the work-related exposure to SARS-CoV-2 and trace the source of COVID-19 infections in laboratories healthcare workers use of personal protective equipment and their ability to maintain social distances and follow governmental restrictions.

O. Kuzmina and s. Hoyle 2020 states that the Laboratories provide environment evolving work. The analysis of health and safety management in laboratory. The aim is to examine the challenges, from the perspective of the health and safety practitioner, researcher and academic. It is critical that health and safety in a research lab environment is practicable to those working in the labs and those that support the researchers.

Abhishek Dubey, Aastha Bansal et al. 2020 states that the health care workers of laboratory handling covid patients samples are at risk and needed to take protective measures. These healthcare workers are under physical and mental stress. The lab technicians are at forefront of managing the pandemic are at risk of contracting the disease as it highly contagious in nature.

Sergio Alejandro Gomez-Ochoa, Oscar H franco ed al. 2020 states that the healthcare workers are at increased risk of SARS-Co-2 infection due to their close contact with highly infectious patients. This could be even more problematic, considering the poor access to personal protective equipment. Limiting the possibility of designing effective preventive measures to limit the transmission of the virus within the hospital.

Objective of the study

- To examine satisfaction level of the respondents towards health & safety measure.
- To understand the importance of safety in the laboratory.
- To study on safety of the physical facilities in the laboratory.
- To study on how laboratory interact with hazardous substances.
- To understand the satisfactory safety measures taken by the laboratory during COVID-19.

3. Data Analysis and Interpretation

Chi-square

Table showing the significant difference between how you interact with hazardous substances and age

Null hypothesis (H_0) – there is no significant difference between how you interact with hazardous substances and age

Alternate hypothesis (H_1) – there is significant difference between how you interact with hazardous substances and age

Case Processing Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
2. Age * 26. In your laboratory, how often do you interact with hazardous substances such as chemicals, flammable liquids and gases?	116	100.0%	0	0.0%	116	100.0%

Chi-Square Tests			
	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	20.079 ^a	12	.066
Likelihood Ratio	17.285	12	.139
N of Valid Cases	116		
a. 16 cells (76.2%) have expected count less than 5. The minimum expected count is .03.			

Source: primary data

Interpretation

Since p value is less than 0.5, we accept the alternate hypothesis and reject the null hypothesis. Therefore, there is significant difference between how you interact with hazardous substances and age

Table showing the significant difference between safety of physical facility in the laboratory and gender.

Null hypothesis (H_0) – there is no significant difference between safety of physical facility in the laboratory and gender.

Alternate hypothesis (H_1) – there is significant difference between safety of physical facility in the laboratory and gender.

Case Processing Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
3. Gender * 25. How do you rate the safety of the physical facilities in the laboratory (machinery, equipment, etc)	116	100.0%	0	0.0%	116	100.0%

Chi-Square Tests			
	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.639 ^a	2	.036
Likelihood Ratio	6.699	2	.035
N of Valid Cases	116		
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 12.10.			

Source: primary data

Interpretation

Since p value is higher than 0.05, we accept the null hypothesis and reject the alternate hypothesis. Therefore, there is no significant difference between safety of physical facility in the laboratory and gender.

4. Suggestion

- Promote hand hygiene. offer hand laundry station throughout the research laboratory and make sure that hand sanitizer is well equipped and without delay out there.
- Clean and clean often touched surfaces, like instrumentation and cupboard handles. Wear personal protecting instrumentation whereas clean-up. Wipe down reusable PPE after.
- If somebody operating within the research laboratory contracts covid-19, follow the protocols established by the Centres for malady management and bar (CDC).
- Wash your hands often, particularly once contacting unremarkably touched surfaces. Use soap and water, and wash for a minimum of twenty seconds.

5. Conclusion

Laboratory employees, like all health care workers, unit at risk for infectious diseases thanks to in operation with infectious material. bar of unfold of the malady amongst the technicians among the laboratories is to boot necessary. Clinical laboratories unit associate purpose for infected materials. For this reason, safety got to be thought-about altogether laboratory processes. the protection measures that clinical laboratories got to take unit written in line with the danger cluster of microorganisms ostensibly to be

encountered, among the protection tips. Face masks and gloves were the foremost ordinarily used PPE to protect from infections. The pandemic has affected the routine work of the clinical laboratory and has manifested among the variability of take a glance at restriction. Temperature observation and ripping employees into teams can reduce the danger of transmission at intervals the laboratory atmosphere. each laboratories got to asses their risk category then reframe their in operation ways that and guarantee safety of their personal. Adopting commonplace precautions in conjunction with maintaining a good personal hygiene, correct physical distancing, safe handling of laboratory samples, applicable use of personal protective instrumentality and among the proper methodology, correct drugs waste disposal and each one shortcuts can reduce the danger of transmission covid-19 to the laboratory personnel.

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