SUMMER TRAINING

at

Camomile Healthcare Ventures
Chennai

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A report
on

Mucormycosis among Covid-19 Patients

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MBA HOSPITAL AND HEALTH MANAGEMENT
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ACKNOWLEDGEMENT

Covid pandemic was totally unpredictable. We have learnt a lot of lessons during this pandemic. The summer training period coincided with Corona Virus pandemic, which provided us the health professionals a great opportunity to learn.
It was a great experience working with Camomile Healthcare Ventures in such times of crisis.

My overall development and professional experience were boosted up during this time. I would like to acknowledge my sincere thanks to IIHMR, Jaipur for designing the curriculum in such a way where we could gain enough knowledge related to the health scenario and then apply the concepts accordingly by providing us with two months training opportunity.

I extend my sincere thanks to **Mr. Raghava Rao** , Co-founder , Camomile Healthcare Ventures for giving me the opportunity to do a project in such times.

I would like to express my deepest gratitude to **Dr. Neha Kumar**, Engagement Manager , Camomile Healthcare Ventures for providing us support and making us acquaint with the knowledge from different departments working under the organization.

My sincere thanks to my mentor **Dr. Arindam Das**, Associate Professor, IIHMR University for providing me guidance and keeping me on the right path which helped me in completing the project work.

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ABBREVIATIONS

CX Designers – Customer Experience Designers

EBIDTA – Earnings before Interest taxes, Depreciation, and Amortization

CSR – Corporate Social Responsibility

GMCs – Government Medical Colleges

BBCI – Bhubaneshwar Borooah Cancer Institute

HIV/AIDS – Human Immunodeficiency Virus / Acquired Immuno Deficiency Syndrome

ICU – Intensive Care Unit

ICMR – Indian Council of Medical Research

CAPA – Covid-19 Associated Pulmonary Aspergillosis

DKA – Diabetic Ketoacidosis

About the Organization

Camomile Healthcare is a leading healthcare advisory and transformation organization that leverages deep industry expertise, leading-edge analytics, technology and strategy to create solutions for organizations that work in the real world. Camomile is the most trusted data driven healthcare consulting organization.

MISSION
Camomile help organizations make distinctive, lasting, and substantial improvements in their performance, by providing them with the information they need to make data-driven decisions.

Their journey started in year 2016 with a single-minded mission to make healthcare efficient and process driven. Camomile created the tools, standards and processes that will help achieve mission so that helping hospitals to be value-driven and patient-centric.
After speaking to hospitals and healthcare entrepreneurs about the requirement for these services and three months into the operations, Camomile signed up their first client. That was the beginning for them and there was no looking back. The first few months itself proved that Camomile's offering is much needed by all types of healthcare facilities and healthcare initiatives.

The Pain Point
Healthcare organisations/Hospitals are capital intensive projects involving outlays of Rs. 100-Rs. 750 crores per project. One in two hospitals is saddled with poor planning, systems or infrastructure, leading to enormous waste of invested capital, delays in execution or a compromised infrastructure that is inefficient to operate. Another change driver is the digital explosion, leading to a rapidly changing patient behavior and regulatory environment.

Solution Created by Camomile
Camomile healthcare sensed the tremendous need to provide data backed advisory services that will help create efficient hospitals to provide patient centric care. Camomile created one of the best healthcare consulting companies.

- Putting together a terrific team to start with, the founders and specialist teams come with the experience of planning and operating large hospitals and health systems.

- Identifying the right technology and automation tools that will help achieve efficiencies and scale.
- Future-proofed the hospitals through design thinking at every stage of the hospital establishment and operations. From identifying the right services mix to architecture, information technology, processes and human resources.

  More importantly, enabling a culture of innovation that will continuously look for value unlocking opportunities and make them available to the healthcare sector. Consulting with the best healthcare organization.

Significant Strides

Today Camomile healthcare is a leading healthcare consultancy and transformation services organization that leverages deep industry
expertise, leading-edge analytics, technology and strategy to create solutions for organizations that work in the real world.

Having started operations in 2016, today, Camomile Healthcare works with companies around the world and across the healthcare ecosystem- from hospitals to payors and digital healthcare and beyond. We now help clients with everything from opportunity discovery to commercialization.

Collaborating with clients from the private, public and not-for-profit sectors to identify their highest-value opportunities, address their most critical challenges, and transform their enterprises. Camomile have been involved with over 12,000 beds from their own inception and bring exceptional value to partners and clients through original ideas, research and solutions.

Vision

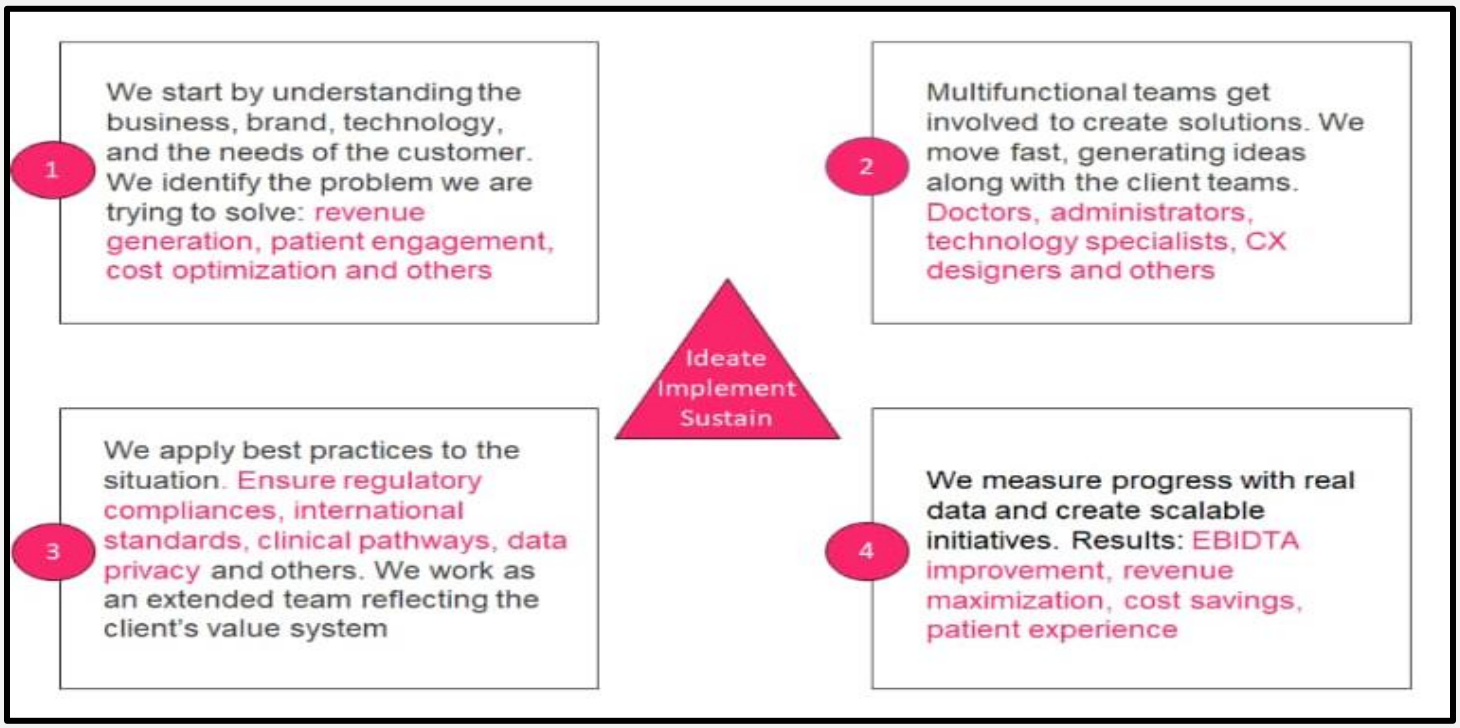
Our vision is to be the industry's most-respected, future-focused, data-driven provider of end to end healthcare solutions. By partnering with our clients, we will improve access, efficiency and affordability for delivery of healthcare today and in the future.

Values

- Observe highest ethical standards
- Maintain an independent perspective
- Deliver sustainable value and excellence to our clients
- Conduct business with absolute integrity
- Advocate a caring meritocracy for employees, partners and clients.

Approach

Tried and tested process that is adapted based on needs of client. It's intensely collaborative and work closely in partnership with our clients. Here's an overview of process and what you can expect during each phase:



Capabilities

Leverage our deep industry expertise, leading-edge analytics, technology and strategy to create solutions for organizations that work in the real world.

1. **Hospital Planning**
   Hospital planning services helps navigate hurdles and successfully commission your project within the targeted time and cost. Camomile brings the extensive experience of working with over 60 hospitals and 12,000 beds.

   Healthcare systems are very complex entities. They require seamless integration of various functions and personnel to offer patient-centric care. To enable them to fulfill their role pertains to the times, hospitals must be planned for the present and the future. The task of hospital consulting and planning involves a great deal of research, meticulous forethought, developing plans with a great level of detail and creating systems to manage and ensure smooth operation and workflow of various activities and teams while adhering to safety and quality standard protocols and meeting strict budget and timeline constraints. The end output is a healthcare facility that is truly capable of delivering quality healthcare and meets the client's mission and vision.

Hospital consulting also involves helping existing healthcare facilities to scale up their operations, expand into new verticals and improve the quality of care being provided.
Camomile brings its deep industry expertise to transform our client's vision into reality. Our hospital consulting experts come from diverse backgrounds and adopt a multi-disciplinary approach in helping clients achieve their objectives.

2. **Digital Health**
   Providing digital health strategy, product design, implementation and technology integration services to enable your hospital to stay laser focused on the current and emerging needs of patients and health professionals.

   Every healthcare organization today has to embrace e-patients by improving their digital health capabilities. This transformation needs an understanding of the domain and its constraints as well as the expertise of modern technologies that can automate sub-processes to unleash efficiency and effectiveness.
   Digital health makes quality healthcare highly accessible and cost-efficient. It facilitates efficient data collection from patients, healthcare professionals and the organization's processes. This data is then optimally used to improve the accuracy of diagnosis, enhance the patient's progress and make clinical decision-making easier and more reliable. The use of digital health tools also leads to better patient empowerment- giving patients more control over their health and the means for healthcare professionals to provide a more personalized and effective treatment. Camomile's digital health practice helps clients go 'Meaningfully digital- Achieving real business outcomes at the lowest possible cost'
   All this is possible because Camomile Healthcare has a strong team of doctors, nurses, data scientists, technologists, business consultants, healthcare leaders whose multi-disciplinary expertise helps clients make the best use of the latest available technology and resources, to design and implement healthcare solutions that are innovative, effective and improve patient outcomes.

3. **Operations excellence in Healthcare**
   Excellence involves continuously delivering consumer value. Camomile helps keeping only value generating processes at every level and thereby achieve the best financial and clinical outcomes.

   Gone are the days where just clinical leadership was the key differentiator in healthcare. To lead and be at the forefront of the healthcare sector, organizations not only need great value-creating services for the consumers but also value-generating processes to deliver it.

   Camomile offers services to manage your hospital, prescribe metrics to monitor performance, help set goals and manage talent to achieve operational excellence. We have two primary goal-oriented services.

4. **Public Health**
   Helping organizations conceptualize, pilot and scale transformative public health initiatives that solve real problems and maximize true impact. Camomile served as technical partners to governments, multilateral organizations, CSR arms of large corporations and other philanthropic bodies.

Operationalizing the most ambitious public health projects
Camomile Healthcare continues to play a vital role in many ambitious public health projects undertaken by the largest philanthropic groups and governments around the world. Leverage deep domain expertise across the spectrum of research, operations, and implementation to maximize the impact of our clients' programs.
Camomile consists of doctors, public health researchers, consultants, former bureaucrats who help clients see through implementation hurdles like stakeholder buy-in, partnerships, funding, regulations and others to navigate the least resistant path towards maximum impact.

5. **Compliance and Regulations consulting**
Camomile is healthcare's trusted partner for comprehensive regulatory and compliance advisory services. Helping your business minimize risk and stay profitably compliant.

Providing advisory and solutions to the ever-increasing demands of compliance across the various facets of hospital and healthcare technology verticals. Many hospital licenses, permits, approvals and other legal documents are required to meet regulatory demands and protocols set up by the government and other regulatory bodies. Moreover, these regulations and compliances are constantly changing, and hence need to be reviewed and updated by the hospital's or organization's management, on a periodic basis. Accreditation by the country's healthcare regulatory body and other globally renowned regulatory bodies goes a long way in communicating a high level of healthcare quality being provided in a particular facility.
Specialist teams of highly experienced business consultants, lawyers, legal advisors and operational experts assist clients in acquiring and maintaining the required hospital licenses and meet the regulatory requirements and approvals, thus allowing them to stay "profitably compliant."

WORKS

- Healthcare model evaluation for a large real estate group in North India.
- Building an oncology focused digital solution.
- Regulatory and Hospital compliance consulting for an innovative healthcare delivery model.
- Comprehensive IT solution to strengthen cancer care services at the GMCs in Maharashtra.
- Developing a truly world class medical university.
- IT infrastructure planning and implementation for cancer hospitals.
- Hospital consulting for acquisition of a large hospital in Mumbai.
- Hospital planning, implementation support, and cost transformation for a 500-bed tertiary care facility.
- Strategic healthcare consulting to build maternal health capacity in India.
- Strengthening public health cancer capabilities of Karnataka.
- Cancer care for 50 million population through a public private partnership.
- Post-merger integration of Dr. B. Barooah Cancer institute.
- Business and infrastructure due diligence of one of the largest hospital chains in India.
- Acquisition and transformation of a leading cancer hospital in National Capital Region (NCR).
- Management control of BBCI by TATA Memorial Hospital.
- Upgrading a 90 bedded cancer centre in Northeastern India.

MODE OF DATA COLLECTION

- Data taken from organization Website.
- Understanding organization with the help of organization mentor.

PROJECT REPORT

MUCORMYCOSIS AMONG COVID-19 PATIENTS

OBJECTIVE- To find the factors leading to Mucormycosis among Covid-19 patients.

METHODS -

Secondary Research

- All review articles taken from Pub Med and Google Scholar published before 20/06/2021.

ELIGIBILITY CRITERIA

Title and Abstracts taken from suitable studies were inspected and articles were reviewed. Articles and abstracts included –

- Studies analyzing Mucormycosis cases reported in India.
- Studies analyzing cause of increasing cases of Mucormycosis among Covid patients in India.
- Case studies done on patients suffering.
- Studies analyzing Rhino-orbital Mucormycosis.
- Studies analyzing treatment factors among Black fungus cases.

DATA EXTRACTION

Data was extracted from all selected articles and were compared for consistency of data extractions. The following information came out regarding Mucormycosis and it's spread among Covid-19 patients , awareness for prevention, symptoms, and treatment.

SELECTED LITERATURE

Seven articles identified from original set: removing duplicates, reviewed all articles and those articles did not relate to the Spread of Mucormycosis among Covid-19 patients, it's knowledge, prevention were excluded because they did not compare their knowledge was not relevant to the required articles.

One article focused on the case study performed on a cohort, Three articles focused on the prevalence and factors causing the infection, Three articles were focused on the prevention , prevalence and treatment of the infection – Mucormycosis.

DATA ANALYSIS

All study was analyzed as well as compared to find the prevalence, prevention and treatment of the Mucormycosis infection among Covid-19 patients.

HIGHLIGHTS

- Increasing cases of Rhino Orbital Mucomycosis in India.
- More than 41,000 cases reported so far in India.
- Deadly Black fungal disease already claimed more than 3,000 lives in India.
- More than 72 Million cases of diabetes in adult population in India , and many tested covid positive.
- More than 50% covid patients treated with Corticosteroids.

INTRODUCTION

Year 2020 brought so many uncertainties and so is year 2021. Covid-19 pandemic has claimed 4,08,792 lives so far and around 3,08,73,900 confirmed cases in India. Almost everyone's life was affected in a way or other with Covid situation. With the onset of second wave from March 2021 , another deadly fungal infection cases started reporting in Covid patients. This infection is detected as **Mucormycosis** or **Black Fungus.**
Though the infection is very rare generally , but some factors caused huge rise in black fungus cases from April onwards. There has been a huge surge of this deadly fungal infection among Covid-19 patients , which adds to India's pandemic woes , attacking vulnerable patients.
This rare but fatal fungal infection is caused by an aggressive and an invasive group of molds called Mucoromycetes. The fungal molds are present in air and the infection can spread when someone breathes in the spores.

It is not Corona virus that is causing this rare fungal infection, but it's adverse effects. It effects people with compromised immune system. These may be people with diseases like diabetes, cancer, HIV/AIDS or deadly Corona virus infection that weakens our immune system.
Diabetes not only increases the risk of severe Corona virus, but it also increases the conditions for fungal infection to thrive in patients. Corona virus and corticosteroids makes the matter worse by suppressing the immunity of a person. Steroids used to diagnose lung inflammation in Covid-19 patients maybe a trigger for this disease. Prolonged use of humified oxygen , contaminated humidifiers and long stay inn ICU during treatment can also cause this fatal black fungal infection.

Black fungus , the deadly infection , spreads rapidly from nose and sinuses to the eyes, face, brain and jaw. Rhino orbital mucormycosis is another kind of black fungal infection that spreads as rapidly as infection involving nose and sinuses. Rhino Orbital Cerebral Mucormycosis affects brain and muscles of human body. Sometimes it may lead to paralysis.
If left untreated , this fungal infection can be deadly for corona patients suffering from uncontrolled Diabetes , prolonging ICU stays.

Mucormycosis was first reported in State of Gujarat during the first week of May,2021 among recovered Corona patients. Then the cases started rising in other states also , like Karnataka, Maharashtra, Uttarakhand, Telangana, Madhya Pradesh, Andhra Pradesh, Haryana, Bihar and other states. Many of these states declared Black fungus as an **epidemic**.
ICMR and Union Health Ministry issued an advisory for screening, diagnosis and management of Mucormycosis on May 9, 2021.
Common name "**Black Fungus"** is in reference to the blackening characteristics of the disease.
It was reported 32% in age group 18-45 , 42% in age group 45-60 and 24% in 60+ age group. Mortality rate is 54% for black fungus infection. Kerala, Karnataka, Maharashtra and Tamil Nadu are the only states reporting more than 100 deaths daily. Whereas the active cases are concentrated in Maharashtra, Kerala, Tamil Nadu, West Bengal, and Odisha.

Many other kinds of fungal infection were reported after Black fungus in India. These infections were equally fatal but the no. of Black fungus cases were reported more than other strains.

DISCUSSION

The current Covid-19 scenario is worrisome, though the daily reporting of Corona cases is decreasing but with increased gatherings of people due to the relaxations given by state governments , there is fear of third wave among health experts. The impact of second wave of covid infection has been different from the first in symptoms, severity and infectiousness. During this second wave of Covid-19 many Black fungal infection cases were reported in India. More than 3,000 people have died of this deadly infection so far. Many states are still reporting more than 100 cases daily.

There is no medicine for corona virus , and in this situation earlier , Glucocorticoids and Remdisivir were the only drugs proven beneficial for the treatment of severe Covid-19. Widely available and inexpensive Glucocorticoids reduced mortality among hypoxemic patients with Covid-19. These steroids were seen increasing the blood sugar level among patients.

The Glucocorticoids and diabetes increased the risk of secondary infection among covid-19 patients called as Covid-19 Associated Pulmonary Aspergillosis (CAPA) received much attention. The use of such immunomodulatory drugs increases the risk of infections in Covid-19 patients.

Pre-existing Diabetes Mellitus was observed in 80% of Mucormycosis cases. Diabetes Mellitus suppresses the immunity of a person. While concomitant DKA was reported in 14.9% of cases.

DKA is a serious complication observed in diabetes patients which occurs in body when it produces high level of blood acids called Ketones. This condition gets developed when our body cannot produce enough amount of Insulin.

Mainly two kind of mucormycosis infection was observed among Covid patients in India.

1. Infection involving nose and sinuses.
2. Rhino-Orbital-Cerebral Mucormycosis

Rhino-Orbital-Cerebral Mucormycosis is a kind of fungal infection of the orbital tissues by the fungus called Mucor -Class Phycomycetes.

The infection develops on the skin as the fungus enter our skin through a cut, scrape, burn, or other type of skin infection. Mucormycosis is observed among patients who are recovering or who have recovered already from Corona virus. Moreover, a person whose immune system is week and not functioning well are more prone to this fungal infection. It is known that Covid-19 is affecting our immune system adversely. Alongwith, intake of drugs like dexamethasone, steroids suppress our immunity. Due to such factors, Covid patients suffer a renewed risk of failing the battle against attacks mounted by organisms such as mucormycetes.

With these factors, contaminated oxygen humidifiers and therapies in ICU, are also much prone to fungal infection. The chance of recovery totally depends on early diagnosis and treatment.

From the review of research papers, it was observed that Diabetes Mellitus was the most common risk factor. Some other subjects showed glucocorticoids as risk factor. Mucormycosis developed 10-14 days post-hospitalization in recovered Covid patients. Mucormycosis infection is rare but ignorance and serious infection can complicate the course of severe Covid-19.

The spores of mucormycosis inoculate the paranasal sinuses and nasopharynx with subsequent spread to the orbit and intracranial cavity in persons with decreased cellular and humoral defenses.

Early diagnosis with appropriate antimicrobial therapy saves both sight and life. The present Covid-19 pandemic has witnessed a resurgence of cases of Rhino-Orbital Mucormycosis.
According to some health experts , and survey conducted , it was observed that Mucormycosis was more vulnerable and fatal in males than females.

Symptoms
Mucormycosis starts with skin infection in the air pockets which are present behind our forehead, nose, cheekbones, and in between the eyes and teeth. Then, it may spread in eyes, lungs, and brain. It can cause blackening or discoloration around nose, blurred vision or double vision with pain, chest pain, pleural effusion and breathing difficulties.

Other symptoms can show-

- Headache
- Nasal Congestion with black discharge from nose.
- Redness and pain around eyes and nose.
- Coughing out blood.
- Sinusitis
- Loosening of teeth and jaw.
- Facial numbness or swelling on cheeks with pain.

Though ICMR advised that not all cases showing symptoms blocked nose should be considered as sinusitis after Covid-19. There should be proper procedure for detection of the fungal infection.

A CASE STUDY
According to a case study done on a cohort of 8 patients, it was observed Diabetes Mellitus was the most common factor among the patients suffering from Mucormycosis. In one case diabetes was undiagnosed. Acute respiratory distress syndrome due to Covid-19 was observed in seven cases. Two subjects presented with symptoms suggesting Mucormycosis post Covid-19 , while the others developed mucormycosis during the treatment of Covid-19. One of the subject among the cohort was 55-year old man with prolonged diabetes mellitus , hypertension, and ischemic cardiomyopathy with fever, cough and progressive breathlessness. Blood sugar monitoring was irregular. The patient also had renal disease and was receiving hemodialysis maintenance treatment for one year.
After testing positive for Covid-19 , he was started on intravenous dexamethasone -6mg once a day for 14 days. He was also given Remdesivir.
Supportive care included, oxygen supplementation, thromboprophylaxis for venous thrombosis and hemodialysis. After 14 days, the patient showed improvement after therapy.
But three days later, patient complained cough, expectoration and burning micturition. The urine sample collected showed growth of fungal infection. The chest radiography confirmed the presence of fungal infection. The patient was diagnosed with anti-fungal medicines and liposomal amphotericin B for pulmonary mucormycosis.
The patient started showing improvement and he was discharged 54 days after hospitalization. The patient received liposomal amphotericin B for 25 days after discharge.

CAUSE OF MUCORMYCOSIS RAVAGING COVID-19 PATIENTS IN INDIA

This huge surge has been attributed to the improper use of steroids to treat corona patients and poorly managed diabetes. The problem does not lie in the drug but in how it is prescribed. Prolonged use of higher doses is a clearer risk factor for invasive fungal infection.
Also, India has an epidemic of type 2 diabetes, a significant proportion of patients with diabetes are diagnosed late in the illness. Around 54% of diabetic patients in India were Covid positive.
Along with these, unhygienic practices during the lack of oxygen concentrators also caused increase in no. of cases of Mucormycosis.

TREATMENT
This fatal black fungus begins with a skin infection, but it can reach to the different parts of the body also. Control over **Hyperglycemia** and early treatment is done with **Liposomal Amphotericin B** and may be **surgery**. Treatment involves removal of all dead and infected tissue. Surgery might result in removal of upper jaw or sometimes even the eye. Treatment involving cure involve 4-6 weeks of therapy with intravenous anti-fungal drugs.
Patients who are diabetic and are covid positive need to take care of themselves very much.
Over-dosage of steroids and self-medication could be fatal and hence patients should take appropriate doses of drugs and take the drugs as prescribed by the doctors only.

To prevent the disease one must keep these things in mind:

- To monitor levels of blood sugar after discharge from hospital.
- Judicious use of corticosteroids in diabetic patients.
- Use of sterile and clean humidifiers and oxygen concentrators during oxygen therapy.
- Anti-fungal therapy and extensive surgical debridement.

CONCLUSION

Mucoromycetes spores inoculate in the paranasal and nasopharynx cavity causing Mucormycosis , commonly known as “Black Fungus” in persons diagnosed with Covid-19. Covid-19 does not cause the fatal fungal infection , however it has created some unique situation where all the aspects of management are getting compromised. Firstly, Glucocorticoids were aggravated by most effective therapy as observed for severe Covid-19 , coexisting with ARDS and multiorgan disfunction with Diabetes Mellitus and other factors. These all caused a fair scenario for existence of Mucormycosis.

The “Unholy Trinity” of **Diabetes Mellitus** , excess use of **Corticosteroids** for treatment of Covid-19 and Covid-19 itself appears to increase the risk of Mucomycosis.
These all factors leads to the decrease in the immune system of a person. Black fungus is a rare but extremely fatal fungal infection. Many states in India have already declared it as epidemic in their region.

Mucormycosis can affect adversely the health of a person and during the treatment one may lose their eye, nose or maybe upper jaw. One must be aware of the symptoms of Black Fungus. Delay in the treatment can be fatal as immunity of a person is already very weak due to Covid-19 and other factor like use of steroids for diagnosing Corona , unhygienic practices , contaminated humidifiers during oxygen therapy.

The physicians should recommend judicious use of glucocorticoids for their patients. Thus, the use of glucocorticoids in mild Covid cases should be avoided. Patients should know that early diagnosis and timely management of the deadly fungal infection is necessary to to improve outcomes in pulmonary Mucormycosis.

REFRENCES

- PIB (Government of India)
  PIB. (n.d.). PIB. https://pib.gov.in/PressReleseDetailm.aspx?PRID=1718501

- ICMR Website
  Indian Council of Medical Research | Government of India. (n.d.). Icmr. Retrieved July 12, 2021, from https://main.icmr.nic.in/

- Prakash, H., Ghosh, A. K., Rudramurthy, S. M., Singh, P., Xess, I., Savio, J., Pamidimukkala, U., Jillwin, J., Varma, S., Das, A., Panda, N. K., Singh, S., Bal, A., & Chakrabarti, A. (2018). A prospective multicenter study on mucormycosis in India: Epidemiology, diagnosis, and treatment. Medical Mycology, 57(4), 395–402. https://doi.org/10.1093/mmy/myy060

- A;, S. A. K. S. R. J. S. R. M. (n.d.). *Mucormycosis in COVID-19: A systematic review of cases reported worldwide and in India*. Diabetes & metabolic syndrome. https://pubmed.ncbi.nlm.nih.gov/34192610/.

- Agrawal, G., Ravani, S., Leuva, P., Modi, P., & Amin, K. (2021). Rise of the phoenix: Mucormycosis in COVID-19 times. Indian Journal of Ophthalmology, 69(6), 1563. https://doi.org/10.4103/ijo.ijo_310_21

- Rocha, I. C. N., Hasan, M. M., Goyal, S., Patel, T., Jain, S., Ghosh, A., & Cedeño, T. D. D. (2021). COVID-19 and mucormycosis syndemic: double health threat to a collapsing healthcare system in India. Tropical Medicine & International Health. Published. https://doi.org/10.1111/tmi.13641

- Gandra, S., Ram, S., & Levitz, S. M. (2021). The “Black Fungus” in India: The Emerging Syndemic of COVID-19–Associated Mucormycosis. Annals of Internal Medicine. Published. https://doi.org/10.7326/m21-2354

- Mahalaxmi, I., Jayaramayya, K., Venkatesan, D., Subramaniam, M. D., Renu, K., Vijayakumar, P., Narayanasamy, A., Gopalakrishnan, A. V., Kumar, N. S., Sivaprakash, P., Sambasiva Rao, K. R., & Vellingiri, B. (2021). Mucormycosis: An opportunistic pathogen during COVID-19. Environmental Research, 111643. https://doi.org/10.1016/j.envres.2021.111643

- Pal, R., Singh, B., Bhadada, S. K., Banerjee, M., Bhogal, R. S., Hage, N., & Kumar, A. (2021). COVID-19-associated mucormycosis: An updated systematic review of literature. Mycoses. Published. https://doi.org/10.1111/myc.13338

- Mehta, S., & Pandey, A. (2020). Rhino-Orbital Mucormycosis Associated With COVID-19. Cureus. Published. https://doi.org/10.7759/cureus.10726