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Editorial

Fungal infections: The ignored threat requiring a global response

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Among the four groups of organisms causing human infectious diseases, certain pathogens rightfully command our attention. Bacteria and viruses tend to receive much attention and priority in the public health discourse, in the differential diagnoses considered by clinicians and also in the medical curricula at all the levels. Important reasons for this include their ability to cause debility & death, pandemic potential, their ubiquitous presence, wider availability and ease of diagnosis, and practicality of control through vaccines. Amidst all this, fungal diseases are ignored as they are relatively silent and insidious threat. From superficial infections that mainly cause discomfort or cosmetic issues to life-threatening invasive mycoses, fungi represent a significant and growing global health burden. Even today, the diagnosis of fungal diseases is often by exclusion. The treatment of mycoses is expensive and often unsuccessful. Now, it is the right time that we recognize that awareness of fungal diseases among the medical community, policy makers, and the general public is no longer a matter of academic interest but a critical public health necessity.

1. Significant Burden of Mycoses

The global burden of fungal infections is a grossly underestimated public health crisis. The estimates done recently indicate that serious fungal diseases affect to the tune of 6.5 million people per year, which lead to a staggering mortality of 3.8 million, with roughly 2.5 million of these deaths being directly attributable to the fungal infection.[1] This mortality estimate is higher than that of malaria and tuberculosis in some geographical regions. The true burden is likely to be much higher due to widespread underdiagnosis of mycoses. In spite of such burden, fungal infections receive a considerably less funding and attention. Invasive aspergillosis, that affects over 2 million people annually with a high mortality rate, and candidiasis, which causes nearly a million deaths annually are the major contributors to this burden.[2] Chronic fungal diseases also contribute significantly to morbidity and mortality, with conditions such as chronic pulmonary aspergillosis, fungal asthma, dermatophytoses, etc.[3] The economic impact is also considerable, with a conservative estimate of the annual economic burden in the United States alone exceeding $19 billion due to healthcare costs and lost productivity.[4] This data highlights an imminent need for greater awareness, improved diagnostics, and more effective treatment for mycoses.

The increasing burden of fungal infections is documented. The increasing immunocompromised population due to medical advancements is one of the causes for rise of invasive fungal infections (IFIs). People at a higher risk of fungal infections include those on corticosteroid or immunosuppressant therapy such as post-organ transplantation, severe autoimmune diseases, or those receiving chemotherapy, and living with HIV/AIDS. Along with the COVID-19 pandemic, the incidence of

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mucormycosis soared as a complication of steroid therapy and caused significant mortality. Furthermore, the geographic distribution of environmental fungi is changing due to climate change, exposing new populations to endemic mycoses like coccidioidomycosis, which is now expanding beyond its traditional range.[5] The emergence of drug-resistant fungal pathogens, such as multi drug resistant *Candida auris*, with outbreak potential in healthcare facilities, and azole-resistant *Aspergillus fumigatus*, highlights the urgent need for robust surveillance and new therapeutic strategies.[3]

2. Fungi are ignored by Doctors, Public, and Policymakers

Despite the increasing incidences, morbidity and mortality, fungal pathogens remain on the sidelines of the global health agendas. This neglect stems from several interlaced factors. For the public, fungal infections are often trivialized, associated primarily with common conditions like jock itch, thrush etc. The notion of a fungus as a systemic, fatal pathogen is foreign to most. This lack of public awareness, in turn, makes the policymakers and funding agencies turn their eyes more towards the other “popular diseases”. When there is no public demand for action, there is little pressure and in turn little political will to allocate resources for fungal diseases.

This neglect is also reflected within the medical education and the medical community. In many parts of the world, medical school curricula allocate least amount of time to mycology compared to all other sections of medical microbiology (Bacteriology, Virology and Parasitology). The medical students graduate with this gap in education. This translates to a lack of suspicion and a high rate of misdiagnosis. Invasive fungal infections, often mimic bacterial or viral illnesses, presenting with non-specific systemic symptoms such as fever, cough, or fatigue. Without a proper awareness and experience, the clinicians may ignore fungi as potential case, resulting in administering inappropriate antibiotics, delaying life-saving antifungal therapy and contributing to treatment failure and higher mortality. A survey conducted in adults in the US in 2019 found that more than two-thirds of respondents had never heard of any of the six major invasive fungal diseases.[4] These glaring facts emphasize the existence for profound public awareness deficit that can be linked to the medical community's own knowledge gaps.

3. Challenges in Diagnosis and Treatment

Unlike bacterial infections that can often be cultured rapidly, fungal cultures take time to grow, are labor-intensive, and often have low sensitivity. Availability of fungal diagnostic methods in microbiological laboratories is limited. Very few laboratories, especially in low and middle-income countries offer molecular or rapid diagnostic methods (fungal seromarkers) and antifungal susceptibility testing (AFST). For several fungi clinical breakpoints for interpretation of the AFST is also lacking.[6]

Treating fungal infections is equally difficult. The number of effective antifungal drug classes is small compared to antibacterial agents. The few available drugs, such as amphotericin B and azoles, can have significant side effects and are often ineffective against emerging resistant strains. This limited antifungal arsenal, coupled with a slow drug development pipeline, leaves clinicians with few options when faced with resistant infections. The concept of antifungal stewardship is still in its infancy, and the overuse of prophylactic antifungals in high-risk patients contributes to the development of resistance.

4. Fungal Disease Awareness Week

In recognition of these critical issues, global organizations lead by the Centers for Disease Control and Prevention (CDC) have initiated the Fungal Disease Awareness Week (FDAW), an annual event conducted in September aimed at bridging the gap in knowledge and improving patient outcomes. FDAW is a concentrated effort to "Think Fungus" in clinical practice.[7] The initiative provides a platform for disseminating information, sharing case studies, and promoting educational materials for both healthcare providers and the public. By dedicating a specific week to this topic, FDAW helps to catalyze conversations, encourage professional development, and underscore the importance of early diagnosis and appropriate treatment. It serves as a reminder that fungal infections are not just a footnote in medical texts but a present and future threat that requires proactive engagement. In countries like India these campaigns have been limited to few regional centers or being specific to a particular fungal disease like the “Fungus free frocks” or the “Hello skin” chat box.

5. The Need for a One Health Approach to Combat Fungal Infections

The One Health Approach, that underscores an integrated approach to tackle infections that are interconnected to human, animal, and environmental health, is apt for addressing fungal infections. Many fungi are widely distributed in the environment and acquired directly from the environmental sources such as soil and vegetation by humans and animals. Many serious human fungal diseases are transmitted from the animals.[8] As in case of antibacterials, several antifungals are widely used for nontherapeutic purposes in agriculture, thus driving the development of antifungal resistance in environmental fungi like *Aspergillus fumigatus.* Such practices tend to create drug resistant "superbugs" that can then cause difficult-to-treat, often life-threatening infections in humans.[9] Events like climate change, deforestation, and environmental neglect further disrupt ecosystems, altering the prevalence of pathogenic fungi. Addressing this requires a unified effort from human and veterinary medicine, environmental scientists, and

agricultural experts as envisaged in the One Health approach. Such collaborative, cross-disciplinary approach is essential to comprehend, predict, and mitigate the multifaceted threat posed by fungi.

6. Effective Methods to Create Awareness

A multi-pronged strategy to address the gap in awareness is need of the hour. It should be tailor-made to target different audiences to be effective. For the general public, public health campaigns should utilize accessible platforms like social media, infographics, and short videos to demystify fungal infections and highlight key symptoms. Irrational use and over-the-counter medication of antifungals, often along with unnecessary steroids and antibacterials should be discouraged. Patient stories and survivor testimonials can be impactful in conveying the message. For healthcare professionals, awareness must be built into medical education from the ground up, with a greater emphasis on mycology in curricula and continued professional development. Clinical case-based learning, accredited webinars, and point-of-care diagnostic algorithms can help clinicians to "think fungus" when faced with non-responsive symptoms. Competency-based medical education system currently available for medical graduate and post-graduate courses in India has ample scope to implement these. Partnerships between academic institutions, professional societies, and public health agencies are crucial to developing and disseminating these educational resources. Campaigns like the CDC's "Think Fungus" initiative, which provides diagnostic tools and educational materials, are excellent examples of this targeted approach.[7]

7. Conclusion

The poor emphasis given to fungal diseases has resulted in a global health crisis that is often not evident to the very systems designed to combat it. Scientific community must advocate for the integration of mycology into core medical and public health curricula globally. There is a need to invest in rapid and accessible diagnostic methods that can enable clinicians to make timely, life-saving decisions. Researchers and policymakers must collaborate to develop new antifungal agents, robust surveillance networks and also devise effective stewardship protocols to track emerging resistance in fungi. A collective effort to target all stake holders at multiple level is need of the hour.

8. Conflict of Interest

None.

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