Indian Journal of Hospital Infection

(A Peer-Reviewed and Refereed Journal)

Volume 6 Number 2 July - December 2024

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Wound Assessment using a Smartphone-based Application: Imitomeasure in Electric Burns

Kanav Gupta[1], Ravi Kumar Chittoria[2], Padmalakshmi Bharathi Mohan[3], Jacob Antony Chakiath[4], Sushil Nepali[5]

How to cite this article:

Kanav Gupta, Ravi Kumar Chittoria, *et al.*, Wound Assessment using a Smartphone-based Application: Imitomeasure in Electric Burns. RFP Ind. Jr. Hosp. Inf., 2024,6(2): 43-45.

Abstract

Wound dimensions can be measured using various methods, including photographs, comparisons, rulers, or grids. Modern smartphones, equipped with high-quality cameras, are now more accessible and affordable, offering new opportunities in medical applications. Specialized smartphone apps have contributed numerous benefits in healthcare, particularly for wound measurement. One such app, Imitomeasure, has been developed specifically to measure wound dimensions without direct contact. This non-contact approach reduces the risk of infection compared to traditional methods using rulers or tape. Studies assessing the effectiveness of Imitomeasure have shown it to be highly effective for measuring wound dimensions. In this research, the wound size on the scalp was measured using the Imitomeasure app on a smartphone.

Keywords: Imitomeasure application, electric burns, wound dimension, measurement

INTRODUCTION

Newer smartphones have high quality affordable cameras making them ideal for various healthcare applications. Smartphone-based applications, like Imitomeasure, are found to be valuable for assessing patient wounds. These apps offer a non-contact method, reducing the risk of infection spread compared to traditional physical methods like rulers or measuring tapes. In this case report, an electrical burn wound on a patient's scalp was assessed using the Imitomeasure application.

MATERIALS AND METHODS

Informed written consent was obtained from the patient, and permission for this study was taken from the departmental ethics committee.

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Received on: 05.11.2024

Accepted on: 03.02.2025

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The patient was an 8-year-old boy presenting with electrical burns that caused scalp ulceration. He had no known comorbidities at the time of admission, and daily wound care was provided. The initial treatment involved hydrotherapy with normal saline, followed by the application of Silver Solution and Superoxidised Aqua Gel. Collagen sheets were then applied to the wound, with further packing done with negative pressure wound therapy. Continuous regulated oxygen therapy was administered in conjunction with negative pressure wound therapy. The patient's wound was assessed using the Imitomeasure app.

This study was conducted on an Android phone with the free Imitomeasure app from the Play Store.

The app installation process involves the following steps:

1. Search for "Imitomeasure" in the Apple or Google Play Store and the app is installed.
2. The app provides two modes: Calibration mode and Manual mode.
3. For Calibration mode, print the calibration markers available in the app, and use this printout when taking pictures.
4. For Manual mode, select the area where the wound is located, then capture photos of the wound.
5. After taking the photo, outline the wound and click "Measure" to calculate the wound area.

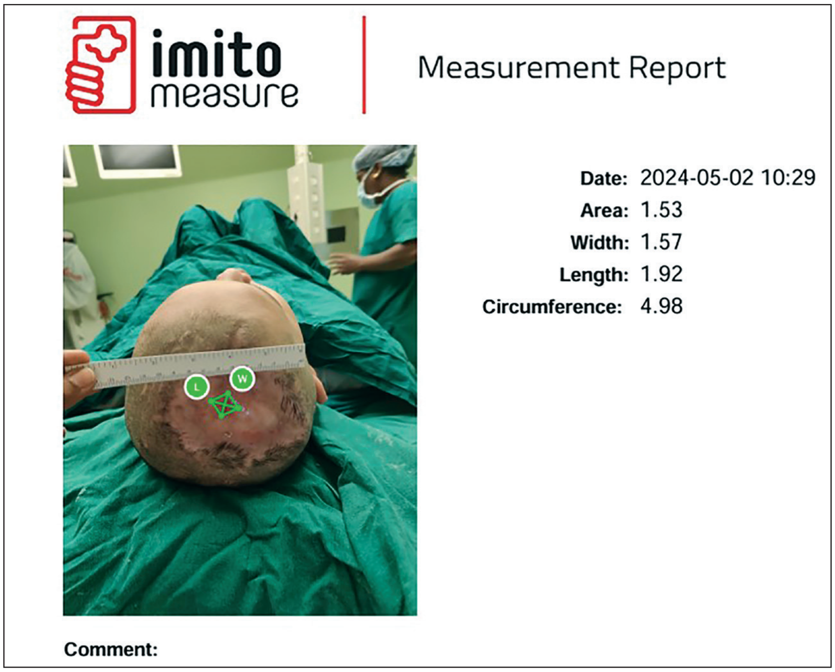

Fig. 1: Figure showing area, width, length and circumference of a burns wound over scalp region using Imitomeasure app

RESULTS

The Imitomeasure application provides nearly accurate wound dimensions without touching the wound, and can be used to monitor the progression of the wound condition from the start of treatment throughout the healing process.

DISCUSSION

Assessing wound parameters, such as wound dimensions, is essential for tracking wound healing progress. Various dressing materials and techniques are used to enhance healing, and the effectiveness of these methods can be evaluated by observing changes in wound size. Regularly measuring wound dimensions provides insight into whether the wound is healing (seen as a decrease in size) or worsening (seen as an increase in size).

Traditionally, clinicians measure wound dimensions with rulers or measuring tapes, but these methods risk contaminating the wound. A non-contact method for measuring wound dimensions would thus be advantageous. Imitomeasure is an affordable and highly effective mobile application which by just using the smartphone cameras accurately measures wound dimensions without direct contact.

In this study, the wound of a patient with a burn injury on the scalp region was assessed using the Imitomeasure app, with results showing high accuracy. Confirming this accuracy through larger-scale studies could support the universal adoption of this application as a valuable tool for monitoring wound healing.

CONCLUSION

In this study, the wound of a patient with electric burn injury on the scalp was assessed using the Imitomeasure application. Larger studies using this application are required to furthur validate its benefits and reliability, establishing it as a valuable tool for wound monitoring.

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Volume 6 Number 2, July-December 2024

Bacterial and Fungal Biofilms: Formation, Impact, and Techniques for Control

Sayan Bhattacharyya

How to cite this article:

Sayan Bhattacharyya, Bacterial and Fungal Biofilms: Formation, Impact, and Techniques for Control. RFP Ind. Jr. Hosp. Inf., 2024,6(2):47-51.

Abstract

Background: Biofilms are communities of microcolonies of bacteria or fungi and exopolymeric matrix. They render the cells refractory to antibiotics and also shield them from the immune system. There are many methods to detect biofilms in vivo and in vitro.

Aim: To collate available information about bacterial and fungal biofilms.

Objectives: To search available information from scientific literature.

Material: Thorough literature search using MeSH (Medical subject headings) terms.

Result: Many methods are documented for detecting bacterial and fungal biofilms. Biofilm progression is via many stages and many methods are three to control biofilm formation.

Conclusion: Biofilms render microbes drug resistant and efforts should be made to prevent and control their formation.

Biofilms are communities of microcolonies of bacteria or fungi and exopolymeric matrix. They render the cells refractory to antibiotics and also shield them from the immune system. There are many methods to detect biofilms in vivo and in vitro.

Keywords: Biofilms, bacteria, EPS.

Key message: Biofilms can be produced by bacteria and fungi in vivo as well as in vitro. There are many methods to control biofilm formation.

INTRODUCTION

Biofilms are communities of microorganisms, including bacteria and fungi, that adhere to surfaces and form complex structures encased in a self-produced extracellular matrix[1]. These biofilms are found in a wide variety of environments, ranging from natural habitats like rivers and oceans to medical settings like implants and catheters. Bacterial and fungal biofilms represent

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Received on: 13.12.2024 **Accepted on:** 03.02.2025

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a significant challenge in both environmental and clinical contexts due to their resilience to antibiotics, antifungals, and immune system defenses. Nowadays they have assumed great importance with regards to antimicrobial therapy.

Formation and Characteristics of Biofilms

Bacterial Biofilms: Bacterial biofilm formation begins with the attachment of planktonic (free-living) bacteria to a surface. This attachment can be reversible or irreversible, depending on the bacterial species and the surface properties. Initially, the formation of bacterial biofilms is a multi-step process starting with reversible attachment to surfaces aided by intermolecular forces and hydrophobicity[2]. Then it progresses to extracellular polymeric substances (EPS) production which enables the cells to permanently adhere to any surface[2]. Once adhered, bacteria begin to proliferate and produce an extracellular polymeric substance (EPS) that generally consists of polysaccharides, proteins, and DNA. These extracellular components provide structural stability and protect the bacterial cells from hostile environments. The biofilm matures through different stages, including microcolony formation, maturation, and eventual dispersion of cells to colonize new areas.

Fungal Biofilms: Fungal biofilm formation shares similarities with bacterial biofilms but has unique characteristics. Fungi, particularly pathogenic species like *Candida albicans*, form biofilms that are composed of yeast and hyphal forms, contributing to a highly dynamic and heterogeneous structure[3]. Fungal biofilms are particularly prevalent in medical devices, such as catheters, dentures and prosthetic valves, and can lead to persistent infections that are difficult to treat. The EPS produced by fungi also serves as a protective layer against antifungal drugs and the host immune response. Fungal biofilm formed in vivo, are more fragile and consequently, the chances of throboembolism is significantly more in comparison with bacterial biofilms, when formed over native (vegetations) or prosthetic heart valves.

Factors Influencing Biofilm Formation

The formation of bacterial and fungal biofilms is influenced by several factors which can be described as under:

a. ***Surface properties:*** Hydrophobic or rough surfaces tend to encourage biofilm formation. Medical implants, for example, are prone to biofilm growth due to their surface characteristics. Catheters also suppoirt growth of biofilms.
b. *Environmental conditions:* Factors such as nutrient availability, temperature, Oxygen, pH, and osmolarity can significantly affect the growth of biofilms[4].
c. *Genetic factors:* Specific genes regulate biofilm formation. In bacteria, genes responsible for quorum sensing (a form of cell-to-cell communication) play a crucial role in the maturation of biofilms. In fungi, the regulation of hyphal growth and yeast-to-hyphal transition is critical and pivotal for biofilm development.
d. *Interactions with host immune response:* Biofilms protect microorganisms from the host immune system by limiting the penetration of immune cells and antibodies, as well as protecting the microbes from antibiotics[5]. This resistance makes infections more persistent.

Clinical Significance: Bacterial and fungal biofilms are major contributors to chronic infections, particularly in the healthcare settings. They can form on medical devices, such as catheters, prosthetic devices, and heart valves, leading to device-related infections. We have seen that biofilm formation occurs readily even in OPD isolates. Some of the most problematic biofilm-forming bacteria include *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Escherichia coli*, while *Candida* albicans and Aspergillus species are the most common fungal biofilm formers.

Antimicrobial Resistance: Biofilms are inherently more resistant to antimicrobial agents than planktonic cells. This resistance is due to several mechanisms, including the limited diffusion of drugs through the EPS matrix, the metabolic slow-down of cells in the biofilm, and the presence of persister cells that are dormant and highly resistant to antibiotics and antifungals. Upregulated efflux pumps in biofilms may also contribute to drug resistance. The overuse of antibiotics in clinical settings has contributed to the emergence of multidrug-resistant strains, making biofilm-related infections particularly difficult and cumbersome to treat.

Chronic Infections: Biofilm-associated infections tend to be often chronic and recurrent, because the biofilm provides an ideal niche for pathogens to survive despite hostile conditions. In conditions like cystic fibrosis, chronic wound infections, and endocarditis, biofilms complicate the treatment and eradication of infections, leading to prolonged patient suffering and higher healthcare costs.

Techniques for in-vitro visualization of biofilms:

a. *Test-tube method:* This is an old, easy and qualitative method to detect biofilms. Here bacterial cells are grown in test tube containing Peptone water with glucose, and tested later by washing and staining the inner wall of the test tube with crystal violet or Safranine[6]. Results are noted visually.

b. *Microtitre plate method:* Here specific liquid media are used for growing biofilms, and then the wells are washed, dried, stained with alcoholic safranine and observed under inverted microscope, and their optical density is also noted in a spectrophotometer[7].

c. *Congo Red agar method:* Congo red agar (CRA) method is a qualitative assay for detection of biofilm-producing microorganism, as a result of color change of colonies inoculated on CRA medium. It was described by Freeman et al. The CRA medium is constructed by mixing 0.8 g of Congo red and 36 g of sucrose to 37 g/L of Brain heart infusion (BHI) agar. After an incubation period of 24 hours at 37°C, morphology of colonies that undergo different colors is differentiated as biofilm producers or not. Black colonies with a dry crystalline consistency indicate biofilm producers, whereas colonies which retain pink colour are non-biofilm producers[8].

d. *Confocal laser scanning microscopy:* Confocal laser scanning microscopy (CLSM) is a high-resolution technique which allows 3-dimensional visualisation of biofilm architecture. In combination with a live/vital or dead stain, it can be used to quantitatively estimate biofilm viability on both transparent and opaque surfaces[9].

For bacteria generally Peptone water with 1% glucose is used to test biofilms in vitro. For testing biofilms of yeasts, YPD or yeast extract-peptone-dextrose, and for molds, Phosphate buffered saline with fecal calf serum is used. Figure 1 below illustrates test tube method of biofilms.

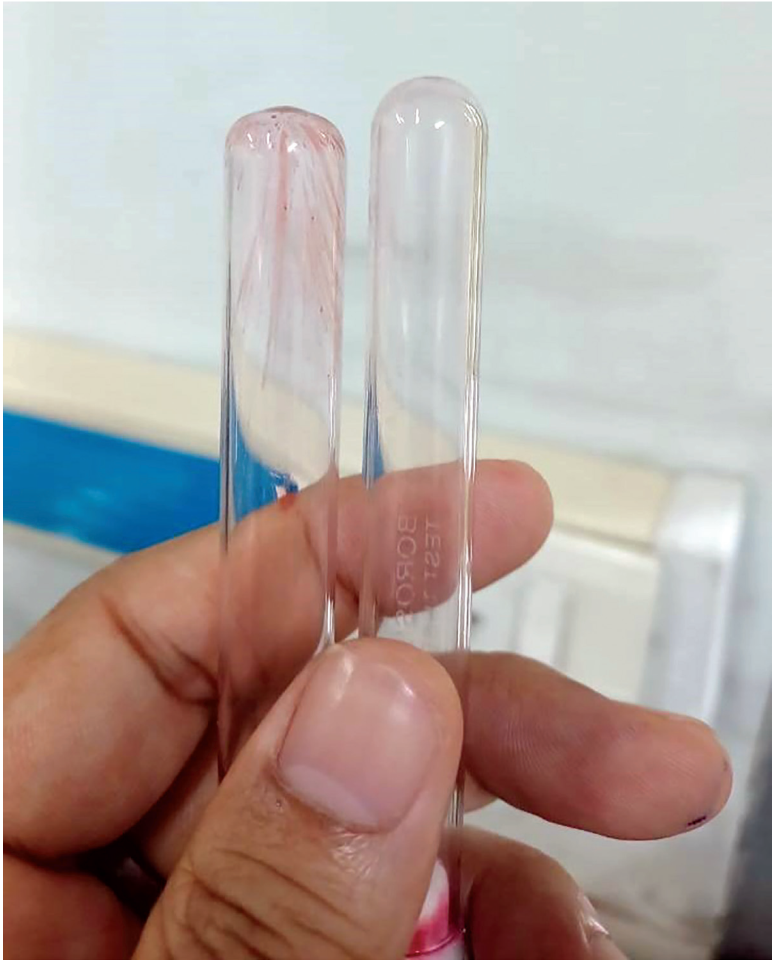

Fig. 1: Test tube method of biofilm formation [using Safranine]

Strategies for Biofilm Control: Efforts to manage biofilm-related infections should focus on preventing biofilm formation, disrupting established biofilms, and overcoming their resistance mechanisms.

a. Prevention of Biofilm Formation:

Preventive strategies involve the use of surface coatings and antimicrobial agents that inhibit the initial attachment of microorganisms. For example, medical devices can be treated with anti-adhesive coatings or embedded with antimicrobial substances like Silicone. Some novel materials, such as silver nanoparticles or chitosan-based coatings, have shown promise in reducing biofilm formation on surfaces[10].

b. Biofilm Disruption and Eradication:

Once biofilms have formed, disrupting their structure is a significant challenge. Several approaches have been explored for this, like:-

a. *Enzymatic treatments:* Enzymes such as DNases, proteases, and polysaccharide-degrading enzymes can break down the extracellular matrix, making the biofilm more susceptible thereafter to antibiotics and antifungal agents.
b. *Ultrasound and electrical fields:* Physical methods like ultrasound or electrical fields can disrupt tge biofilm integrity and then enhance the penetration of antimicrobial agents.
c. *Quorum sensing inhibitors:* Targeting the bacterial communication system (also known as quorum sensing) has shown enormous promise in disrupting microbial biofilm formation by preventing the coordination of biofilm-producing genes.
d. *Combination Therapy:* Combination therapy, which involves the use of antibiotics or antifungals in conjunction with biofilm-disrupting agents, is a promising approach to treating biofilm-related infections. This approach aims to both reduce biofilm thickness and prevent the formation of new biofilms, improving the efficacy of traditional antimicrobial treatments.

Prevention

Biofilm formation can be prevented, however, by using indwelling devices coated with silver or silver salts or silicone. Chemical modifications are the main strategy which are being contemplated now for biofilm elimination on indwelling medical devices. In one such approach, catheters are coated with antimicrobial agents such as antibiotics, biocides like chlorhexidine or with ion coatings with silver and to a lesser extent with zinc. These interfere with the attachment and expansion of immature biofilms[10].

Future Directions

Ongoing research into biofilm biology is essential for developing more effective strategies to control bacterial and fungal biofilms. Key areas of focus include:

a. The development of novel anti-biofilm agents that target the EPS matrix or inhibit biofilm-associated genes.
b. The use of nanoparticles, bacteriophages, and natural compounds as biofilm disruptors.
c. Personalized medicine approaches, which consider the specific biofilm-forming capabilities of pathogens in individual patients.
d. Advances in imaging techniques, which allow for better visualization and understanding of biofilm structures and dynamics.

CONCLUSION

Bacterial and fungal biofilms pose significant challenges in both clinical and environmental contexts. These biofilm communities exhibit remarkable resistance to traditional antimicrobial agents, thus making infections harder to treat and eradicate. Understanding the mechanisms of biofilm formation and the factors that contribute to their persistence is crucial for developing more effective treatment protocols. As research continues to evolve, new strategies, including biofilm-disrupting agents, combination therapies, and advanced coatings, may hold promise for combating biofilm-associated infections and improving patient outcomes.

Conflict of Interest: There are no conflicts of interest.

Funding: There is no funding.

Ethics Declaration: There are no ethical issues involved.

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Review Article

RFP Indian Journal of Hospital Infection
Volume 6 Number 2, July-December 2024

Viruses in the Modern Era: Challenges and Societal Impacts Ahead

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How to cite this article:

Syed Douhath Yousuf, Gowhar Rashid, Manzoor Ahmad Raina, Syed Mudassar, Viruses in the Modern Era: Challenges and Societal Impacts Ahead. RFP Ind. Jr. Hosp. Inf., 2024,6(2):53-63.

Abstract

Viruses have profoundly shaped human history, presenting unique challenges and far-reaching impacts on society. This article explores the multifaceted roles viruses play in the modern world, from their influence on public health to their implications for global economies, ecosystems, and technological innovation.The article delves into the evolving threats of viral pandemics, the emergence of new pathogens, and the role of climate change and globalization in facilitating their spread.It also highlights advancements in virology, such as vaccine development and antiviral therapies, alongside the ethical, social, and economic dilemmas these advancements introduce. By examining the interplay between viruses and society, this article underscores the critical need for robust preparedness, interdisciplinary research, and global collaboration to mitigate the risks and harness the opportunities presented by viral phenomena in our interconnected world.

Keywords: Viral infections, Pandemic, Epidemic, Vaccines, Viral outbreak.

INTRODUCTION

The global landscape of infectious diseases has been dramatically altered by the emergence of novel viruses, posing a significant threat to public health, global security, and economic stability. As the world becomes increasingly interconnected, the speed and scale at which infectious diseases can spread have grown exponentially, underscoring the urgent need to understand, monitor, and mitigate the risks associated with emerging viruses. Viruses play a complex and dual role in present society, acting as both a threat to public health and a catalyst for scientific advancement(1).

1. Viruses as a Threat to Public Health

Viruses are among the leading causes of morbidity and mortality worldwide. Viruses pose a significant threat to public health, as they are highly infectious pathogens capable of causing widespread illness, epidemics, and pandemics(2). These microscopic organisms can mutate rapidly, enabling them to evade the immune system and existing medical interventions such as vaccines and antiviral drugs. Diseases caused by viruses,

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Received on: 28.01.2025 **Accepted on:** 11.03.2025

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such as influenza, HIV, and emerging threats like COVID-19, have had devastating impacts on global health, economies, and healthcare systems. The ability of viruses to spread through various modes, including respiratory droplets, bodily fluids, and vectors like mosquitoes, increases their potential to cause outbreaks in densely populated and interconnected communities. Effective public health strategies, including vaccination programs, early detection, robust surveillance, and global cooperation, are essential to mitigate the threat viruses pose to human health and well-being[3].

A. Endemic and Pandemic Diseases

(i) **Influenza:** Seasonal flu viruses lead to millions of cases and hundreds of thousands of deaths annually.The constant evolution of influenza strains makes vaccine development a continuous challenge. The influenza virus, a highly contagious respiratory pathogen, remains a significant public health concern worldwide due to its ability to cause seasonal epidemics and occasional pandemics. Belonging to the Orthomyxoviridae family, influenza is classified into four types—A, B, C, and D—with types A and B being the primary culprits of human illness. The virus mutates rapidly through antigenic drift and shift, enabling it to evade immunity and occasionally give rise to novel strains with pandemic potential. Symptoms range from mild respiratory discomfort to severe complications, particularly in vulnerable populations such as the elderly, young children, and those with underlying health conditions. Annual vaccination is the most effective prevention strategy, though antiviral medications can aid in treatment. The influenza virus underscores the need for continued research, surveillance, and public health initiatives to mitigate its impact and prevent future outbreaks[4].

(ii) **HIV/AIDS:** Although advancements in antiretroviral therapies have improved patient outcomes, HIV(Human Immunodeficiency Virus) remains a major global health issue, particularly in low-income countries. HIV is a chronic, life-threatening virus that attacks the immune system, specifically targeting CD4 cells, which are crucial for immune defense. Left untreated, HIV progressively weakens the immune system, leading to AIDS (Acquired Immunodeficiency Syndrome), the most advanced stage of the infection. Transmitted through blood, sexual contact, and from mother to child during childbirth or breastfeeding, HIV has affected millions globally since its discovery in the early 1980s. While there is no cure, antiretroviral therapy (ART) has transformed HIV into a manageable chronic condition, allowing individuals to live long, healthy lives with proper treatment. The virus also carries a significant social stigma, which has posed barriers to testing, treatment, and prevention efforts. Ongoing research into vaccines, cure strategies, and preventive measures remains critical to controlling and ultimately eradicating HIV/AIDS worldwide[5].

(iii) **COVID-19(SARS-CoV-2):** The COVID-19 pandemic disrupted societies globally, causing widespread illness, death, and socioeconomic upheaval. Variants of concern continue to challenge vaccination and containment efforts. COVID-19, caused by the novel coronavirus SARS-CoV-2, emerged in late 2019 and rapidly escalated into a global pandemic, profoundly affecting every aspect of life. Characterized by its high transmissibility and potential for severe respiratory illness, the virus placed unprecedented strain on healthcare systems and led to millions of deaths worldwide. Governments implemented drastic measures, including social distancing, and mask mandates, to curb its spread. The pandemic disrupted global economies, halted travel, and accelerated the adoption of digital technologies, transforming how people work, learn, and interact. It also highlighted critical issues, such as healthcare disparities, vaccine accessibility, and the importance of international collaboration in combating global health crises. COVID-19 serves as a stark reminder of humanity's vulnerability to infectious diseases and the need for robust preparedness and research to address future challenges[6].

Lockdown strategies during the COVID-19 pandemic were implemented globally to curb the spread of the virus and protect healthcare systems from being overwhelmed. These strategies typically involved restrictions on movement, the closure of non-essential businesses, schools, and public spaces, and mandates for remote work. Governments encouraged or enforced stay-at-home orders, limiting public gatherings and imposing curfews in some regions. While these measures effectively reduced transmission rates, they also had significant social and economic repercussions, including job losses, mental health challenges, and disruptions to education. Balancing public health priorities with economic and social impacts became a key challenge, prompting adaptations such as phased reopenings, targeted lockdowns, and increasedreliance on digital infrastructure for work, education, and communication[7].

B. Re-emerging Viruses

(i) **Dengue and Zika**

Dengue and Zika viruses, both transmitted primarily by *Aedesaegypti* mosquitoes, are significant public health threats in tropical and subtropical regions. Dengue virus causes dengue fever, characterized by high fever, severe headaches, joint pain, and in severe cases, life-threatening complications like dengue hemorrhagic fever and dengue shock syndrome.

Zika virus, while often causing mild symptoms such as fever, rash, and conjunctivitis, is particularly dangerous for pregnant women as it can lead to congenital Zika syndrome, causing microcephaly and other severe birth defects in infants.

Both viruses highlight the challenges posed by vector-borne diseases, including the role of climate change in expanding mosquito habitats and the lack of specific antiviral treatments. Preventative measures, such as mosquito control programs, public awareness campaigns, and ongoing research into vaccines and treatments, are critical in reducing the global burden of these disease[8].

(ii) **Measles**

Measles is a highly contagious viral disease caused by the measles virus, a member of the *Paramyxoviridae* family. It spreads through respiratory droplets and can infect up to 90% of unvaccinated individuals exposed to an infected person. Symptoms typically begin with high fever, cough, runny nose, and conjunctivitis, followed by a characteristic red, blotchy rash. While often self-limiting, measles can lead to severe complications, including pneumonia, encephalitis, and death, particularly in young children and immunocompromised individuals. Despite the availability of a safe and highly effective vaccine, measles outbreaks persist in regions with low vaccination coverage, often exacerbated by misinformation about vaccine safety. Measles remains a stark reminder of the importance of vaccination programs and global efforts to achieve herd immunity to prevent its resurgence[9].

(iii) **Hendra Virus**

Hendra virus is a rare but serious virus that primarily affects horses and can be transmitted to humans, often with fatal consequences. It was first identified in 1994 in Hendra, Queensland, Australia, when several horses fell ill and died, with a small number of human cases following. The virus is part of the Henipavirus genus and is carried by flying foxes (fruit bats), which are believed to be the natural reservoir. Human infections are typically associated with close contact with infected horses, leading to symptoms such as fever, headaches, respiratory distress, and encephalitis. While Hendra virus infections in humans are rare, the severity and potential for fatal outcomes make it a major public health concern, particularly in regions where horses and bats are in close proximity. Research into vaccines and treatments for Hendra virus has intensified in response to its zoonotic potential and the risk it poses to both animal and human populations[10].

C. High-Fatality Viruses

(i) ***Ebola and Marburg***

Ebola and Marburg viruses, both members of the *Filoviridae* family, are highly lethal pathogens responsible for severe hemorrhagic fevers in humans and primates. Transmitted through direct contact with infected bodily fluids, contaminated surfaces, or animals, these viruses cause rapid disease progression marked by fever, muscle pain, vomiting, diarrhea, and in severe cases, internal and external bleeding. Ebola, first identified in 1976, has caused numerous outbreaks, with the 2014–2016 West Africa epidemic being the largest, while Marburg virus, first detected in 1967, has resulted in smaller but equally deadly outbreaks. Both viruses have high mortality rates, ranging from 25% to 90%, depending on the outbreak and medical response. Effective prevention hinges on early detection, strict infection control measures, community education, and, in the case of Ebola, the use of newly developed vaccines. Ongoing research is critical to improving treatments and containment strategies for these devastating diseases[11].

(ii) ***Nipah Virus***

With a high fatality rate and potential for person-to-person transmission, Nipah remains a critical area of concern with 40-75% mortality rate.Nipah virus (NiV), a zoonotic pathogen belonging to the *Paramyxoviridae* family, is an emerging global health threat due to its high mortality rate and potential for human-to-human transmission. First identified during an outbreak in Malaysia in 1998, the virus is primarily transmitted to humans through direct contact with infected animals, such as fruit bats (natural reservoirs) or pigs, as well as contaminated food or fluids. Nipah infection can cause a range of symptoms, from mild respiratory illness to severe encephalitis, leading to coma or death in severe cases. With no specific antiviral treatments or vaccines currently available, management relies on supportive care and strict infection control measures. Frequent outbreaks in South and Southeast Asia underscore the need for robust surveillance, early detection, and research into preventive measures, as well as public awareness to mitigate the risk of spillover events[12].

2. Social and Economic Impacts

Viruses significantly influence societal and economic structures, often creating long-term challenges.Viral outbreaks have profound social and economic impacts, often disrupting daily life and global stability. On a social level, they can cause widespread fear, stigma, and isolation as communities implement quarantines, social distancing, and other public health measures to control the spread. Education systems are often disrupted as schools close, and healthcare systems become overwhelmed, leading to delayed or inaccessible care for other medical needs. Economically, viral outbreaks can result in massive job losses, reduced productivity, and financial instability as businesses shut down and supply chains are interrupted. Tourism, trade, and industries reliant on global connectivity often suffer significant losses. Governments and households face increased financial burdens due to healthcare costs and recovery efforts. Long-term consequences may include increased poverty, inequality, and a slower pace of economic growth, making it essential to invest in preparedness and resilience to reduce the societal and economic toll of future outbreaks[13,14].

A. Health Disparities

The burden of viral diseases disproportionately affects low-income and marginalized communities, exposing global inequities in healthcare access and resource distribution. Health disparities caused by viruses highlight the unequal impact infectious diseases have on different populations, often exacerbating existing health inequalities. Marginalized groups, including racial and ethnic minorities, low-income communities, and individuals with pre-existing health conditions, are particularly vulnerable to viral infections. Factors such as limited access to healthcare, lack of vaccination, crowded living conditions, and systemic inequities in healthcare systems contribute to these disparities.For example, during the COVID-19 pandemic, Black and Latino communities experienced higher infection rates and more severe outcomes, including hospitalization and death, compared to white populations. Addressing these disparities requires improving healthcare access, increasing education on prevention, and ensuring that resources are equitably distributed to those most at risk[15,16].

B. Economic Costs

Viral outbreaks disrupt industries, from healthcare and education to travel and trade. For instance, COVID-19 led to global economic losses estimated in the trillions of dollars. Virus 5 outbreaks can lead to significant economic losses, disrupting industries, global supply chains, and everyday economic activities. As businesses close or reduce operations due to health concerns or government-imposed restrictions, industries such as travel, hospitality, and retail are particularly hard-hit. Job losses and reduced wages lead to lower consumer spending, which further slows down economic growth. The broader economy may face recessions, with stock markets experiencing volatility and businesses scaling back on investments. In addition, healthcare costs surge as resources are redirected toward managing the outbreak. Governments often need to implement emergency relief packages, which strain public finances. The long-term impact can be felt for years, as economies struggle to recover and rebuild from the effects of a viral crisis[17,18].

C. Mental Health

Prolonged pandemics, fear of infection, and economic uncertainty contribute to widespread mental health issues, including anxiety, depression, and post-traumatic stress. The fear of contracting the virus, along with isolation due to lockdowns and social distancing measures, can lead to increased feelings of loneliness and depression. For many, the constant media coverage and information overload contribute to heightened anxiety. Those already dealing with mental health conditions may experience exacerbated symptoms, while others may develop new mental health struggles, including post-traumatic stress disorder (PTSD), insomnia, and panic attacks. The economic hardships and loss of jobs further add to the psychological burden, leading to a sense of hopelessness or despair. Additionally, the loss of loved ones or uncertainty about the future can deepen emotional distress. Addressing mental health during a pandemic requires both immediate psychological support and long-term strategies to help individuals cope with the ongoing challenges(19).

3. Advances in Science and Medicine

Despite their destructive potential, viruses have driven significant scientific and medical advancements. The rapid progression of science and medicine has played a pivotal role in combating viral threats. Key advancements include:

A. Vaccine Technology

The rapid development of mRNA vaccines during the COVID-19 pandemic represents a ground-breaking shift in vaccine technology, paving the way for vaccines against other viruses. The outbreak of viruses like COVID-19 has accelerated advancements in vaccine technologies, leading to innovative approaches in vaccine development. One major breakthrough has been the development of mRNA vaccines, which allow for faster production and greater flexibility in response to emerging viruses. These vaccines, such as those developed by Pfizer-BioNTech and Moderna, work by instructing cells to produce a protein that triggers an immune response. Viral vector vaccines, another advancement, use harmless viruses to deliver genetic material that prompts immunity, as seen in the AstraZeneca and Johnson & Johnson vaccines. The pandemic has also spurred improvements in vaccine distribution and storage technologies, making vaccines more accessible globally and enhancing their effectiveness in diverse environments(20, 21).

B. Antiviral Therapies

The outbreak of viral pandemics has led to significant advances in antiviral therapies, expanding treatment options for a range of infections. Researchers have developed novel antiviral drugs that target specific stages of the viral lifecycle, such as protease inhibitors and polymerase inhibitors, which have proven effective against viruses like HIV, Hepatitis C, and SARS-CoV-2. The rapid development of antiviral treatments for COVID-19, such as Remdesivir and Paxlovid, has demonstrated the potential for swift therapeutic innovation in response to emerging threats. Additionally, advances in monoclonal antibody therapies have provided effective tools for treating and preventing viral infections by mimicking the immune response. The global focus on antiviral research has also led to improved drug delivery systems and combination therapies that enhance the effectiveness of treatments and reduce the development of resistance(22).

C. Virology and Genomics

Advances in genomics have enabled real-time tracking of viral mutations, informing public health responses and guiding vaccine updates. The outbreak of viral infections has spurred significant advances in virology and genomics, enhancing our ability to understand and combat viruses. The rapid sequencing of viral genomes, as seen with the SARS-CoV-2 virus, has revolutionized how quickly we can identify and track emerging pathogens. Advances in next-generation sequencing technologies have enabled scientists to map the genetic makeup of viruses with unprecedented speed and accuracy, improving diagnostic capabilities. These advancements have also paved the way for the development of targeted therapies and vaccines, by providing deeper insights into how viruses mutate and interact with host cells. Furthermore, genomic surveillance networks have become vital tools in tracking viral spread, identifying new variants, and informing public health responses globally(23, 24).

D. Virus-Based Innovations

Viruses are used as tools in gene therapy, oncolyticvirotherapy (targeting cancer cells), and vaccine development for non-viral diseases.

(i) **Genomic Technologies**

High-throughput sequencing has revolutionized our ability to detect and characterize novel pathogens swiftly. Technologies like CRISPR have enabled precision diagnostics and therapeutic interventions, allowing for targeted treatments of viral infections(25).

(ii) **mRNA Vaccine Platforms**

The development of mRNA vaccines for COVID-19 demonstrated unprecedented speed and effectiveness, paving the way for similar approaches against other pathogens. This platform allows for rapid adjustments to vaccines in response to viral mutations, addressing evolving strains[26].

(iii) **Artificial Intelligence (AI) in Disease Modelling**

AI tools are now widely used for predictive modelling, helping to identify outbreak patterns and optimize intervention strategies. Machine learning algorithms facilitate the analysis of vast datasets, enabling the discovery of potential drug targets and the optimization of public health responses[27].

(iv) **Broad-Spectrum Antiviral Agents**

Research into drugs effective against multiple virus families is underway, potentially providing a first line of defense against novel pathogens.These antivirals target conserved viral mechanisms, reducing the time needed for drug development during outbreaks[28].

(v) **Nanotechnology in Drug Delivery**

Advances in nanotechnology have enabled precise delivery of antiviral agents, improving their efficacy and minimizing side effects. Nanoparticles are also being explored for use in diagnostics and vaccine delivery[29].

(vi) **Improved Surveillance Tools**

Portable diagnostic kits, wearable health monitors, and mobile labs have enhanced real-time surveillance capabilities. Integration with digital health platforms ensures faster reporting and response to emerging threats[30].

(vii) **Synthetic Biology**

Synthetic biology enables the creation of novel vaccines and therapeutic compounds by engineering microorganisms or biomolecules. This field also aids in understanding virus-host interactions, improving our ability to design effective interventions[31].

(viii) **Telemedicine and Remote Monitoring**

Digital health technologies have expanded access to healthcare, particularly during outbreaks when physical contact must be minimized.Remote monitoring of patients supports early intervention and reduces strain on healthcare facilities[32].

(ix) **Public-Private Partnerships in Research**

Collaborative efforts between governments, academia, and industry have accelerated the translation of scientific discoveries into practical solutions. Initiatives like CEPI (Coalition for Epidemic Preparedness Innovations) have played a crucial role in funding vaccine development[33].

4. Societal Behaviour and Misinformation

During a virus outbreak, societal behaviour and misinformation can significantly influence the trajectory of the crisis. Fear and uncertainty often amplify the spread of misinformation, leading to the circulation of false remedies, conspiracy theories, and exaggerated risks. This can undermine public health efforts, as individuals may disregard official guidelines, such as wearing masks or getting vaccinated, in favour of unproven alternatives. Panic buying and stigmatization of affected communities can further exacerbate social tensions and disrupt the equitable distribution of resources. Conversely, collective responsibility, trust in credible sources, and widespread adherence to preventive measures can mitigate the outbreak's impact. Clear communication and combating misinformation are thus crucial in fostering informed societal behaviour and curbing the spread of both the virus and harmful falsehoods[34].

A. *Vaccine Hesitancy*

Misinformation has fuelled resistance to vaccines, leading to the resurgence of preventable diseases like measles and polio in certain regions. Vaccine hesitancy fuelled by misinformation poses a significant threat to public health, especially during disease outbreaks. Misinformation spreads rapidly through social media and other platforms, often promoting unfounded fears about vaccine safety, effectiveness, and necessity. Myths about vaccines causing severe side effects, altering DNA, or being part of conspiratorial agendas can erode public trust in immunization programs. This hesitation delays herd immunity, prolongs the outbreak, and increases the vulnerability of high-risk populations. Addressing vaccine hesitancy requires transparent communication, community engagement, and the active debunking of false claims. Equipping people with accurate, evidence-based information helps build confidence in vaccines and underscores their critical role in saving lives and controlling infectious diseases[35].

B. *Hygiene and Public Health Awareness*

The COVID-19 pandemic emphasized the importance of basic hygiene practices, such as handwashing and mask-wearing, in preventing viral transmission. Hygiene and public health awareness play a pivotal role in controlling the spread of viruses during outbreaks. Simple practices such as regular handwashing, using sanitizers, covering coughs, and wearing masks can significantly reduce transmission rates. Public health campaigns emphasizing these behaviors, along with guidelines on physical distancing and symptom monitoring, help individuals understand their responsibility in protecting themselves and others. Raising awareness about early detection, isolation protocols, and the importance of seeking medical attention fosters a proactive approach to containment. Effective communication tailored to diverse communities ensures widespread compliance, creating a collective shield against the virus and reducing the strain on healthcare systems[36].

C. Global Collaboration

Viral outbreaks have underscored the importance of international collaboration in disease surveillance, research, and response. Global collaboration is essential during a virus outbreak, as no nation can effectively combat a pandemic in isolation. Coordinated efforts among governments, international organizations, and healthcare institutions enable the sharing of critical resources, such as vaccines, medicines, and personal protective equipment, ensuring that even resource-limited regions have access to essential tools. Collaborative research accelerates the development of treatments and vaccines by pooling expertise, data, and funding across borders. Organizations like the World Health Organization (WHO) play a central role in disseminating accurate information and standardizing responses to the crisis. Moreover, global solidarity fosters the exchange of best practices and lessons learned, empowering nations to implement effective containment strategies. By working together, the international community can reduce disparities, curb the spread of the virus, and mitigate its far-reaching social and economic impacts[37].

5. Factors Driving the Emergence of New Viruses

A. Globalization and Urbanization

Globalization and urbanization are key factors driving the emergence and spread of new viruses. Increased global connectivity through travel and trade accelerates the cross-border movement of pathogens, turning localized outbreaks into global threats within days. Urbanization amplifies this risk by concentrating large populations in densely populated areas, where close contact and inadequate sanitation provide ideal conditions for viral transmission. Rapid deforestation and habitat destruction often driven by urban expansion bring humans into closer contact with wildlife, increasing the chances of zoonotic diseases spilling over. Markets selling live animals, which are common in some urban areas, further amplify the risk of novel pathogens jumping species. Addressing these challenges requires integrated approaches, including monitoring high-risk environments, improving urban infrastructure, and enhancing global surveillance systems to mitigate the emergence of new viruses[38].

B. Climate Change

Climate change is a significant factor driving the emergence of new viruses by altering ecosystems and disrupting the natural balance between humans, animals, and pathogens. Rising global temperatures and shifting weather patterns affect the habitats and behaviors of wildlife, leading to increased interactions between species that might not otherwise come into contact. This heightened interspecies interaction creates opportunities for zoonotic diseases—those that jump from animals to humans—to emerge. Additionally, climate change facilitates the expansion of disease-carrying vectors like mosquitoes and ticks into new regions, spreading viruses such as dengue, Zika, and Lyme disease to previously unaffected populations. Melting permafrost and ice caps may even release ancient pathogens that have been dormant for centuries. Addressing the link between climate change and viral emergence requires global efforts to reduce greenhouse gas emissions, conserve biodiversity, and strengthen public health infrastructure to monitor and respond to new threats[39].

C. Deforestation and Habitat Disruption

Deforestation and habitat disruption are critical factors driving the emergence of new viruses by increasing human exposure to wildlife and their pathogens. When forests are cleared for agriculture, urban development, or logging, the natural habitats of animals are destroyed, forcing them to migrate closer to human populations. This heightened interaction facilitates the spillover of zoonotic diseases viruses that jump from animals to humans such as Ebola, Nipah, and coronaviruses. Fragmented ecosystems also weaken natural biodiversity, which often acts as a buffer against disease transmission, allowing certain host species to thrive and spread pathogens more easily. Additionally, activities like hunting, wildlife trade, and the establishment of livestock farms in deforested areas further amplify the risk of viral outbreaks. Addressing these challenges requires sustainable land-use practices, habitat conservation, and improved monitoring of wildlife-human interactions to minimize the risk of future pandemics[40].

D. Antimicrobial Resistance and Health System Gaps

Antimicrobial resistance (AMR) and gaps in health systems are significant factors driving the emergence and spread of new viruses. Overuse and misuse of antibiotics and antivirals in humans, animals, and agriculture contribute to the development of resistant pathogens, which can complicate the treatment of viral co-infections and weaken overall public health defences. Health system gaps, such as inadequate disease surveillance, limited access to healthcare, and underfunded public health infrastructure, further exacerbate the problem by delaying the detection and response to emerging threats. In regions with weak health systems, outbreaks can spread unchecked, increasing the likelihood of viruses mutating and becoming more dangerous. Strengthening health systems globally, promoting responsible antimicrobial use, and investing in research and development are critical steps to address these interconnected challenges and reduce the risk of future pandemics[41, 42].

6. Challenges in Managing Emerging Viral Threats

A. Surveillance and Early Detection

Current surveillance systems are often fragmented and under-resourced, particularly in low- and middle-income countries. Delayed detection hampers timely responses to contain outbreaks[43].

B. Vaccine and Therapeutic Development

The development of vaccines and antiviral therapies is a time-intensive and costly process. Viruses with high mutation rates, such as influenza and SARS-CoV-2, complicate vaccine design and efficacy[44].

C. Misinformation and Public Perception

The spread of misinformation can undermine public trust in health interventions and hinder effective outbreak management. Social media platforms have been a double-edged sword, providing both valuable information and avenues for misinformation[45].

D. Global Inequities in Health Resources

Disparities in healthcare access and resources exacerbate the impact of viral outbreaks in vulnerable populations. Ensuring equitable distribution of vaccines and treatments remains a significant challenge[46].

7. Preparing for Future Viral Threats

Viruses will continue to emerge and evolve, necessitating proactive measures to mitigate their impact on society. The increasing frequency of viral outbreaks demands a proactive approach to future threats. Key measures include:

A. Strengthening Health Systems

Strengthening health systems is essential for preparing for future viral threats and mitigating the impact of pandemics. Robust health systems must prioritize early detection and rapid response by investing in advanced disease surveillance technologies, laboratory capacity, and data-sharing frameworks. Expanding healthcare infrastructure, including sufficient hospital beds, medical supplies, and well-trained personnel, ensures readiness for surges in demand during outbreaks. Strengthening primary healthcare and promoting universal health coverage enable equitable access to preventive measures, vaccines, and treatments, reducing the spread of infections in vulnerable populations. Public health campaigns that foster trust and community engagement play a vital role in ensuring adherence to safety protocols. Global collaboration, combined with sustained investment in research and innovation, creates a resilient foundation for identifying, managing, and containing emerging viral threats, protecting lives, and minimizing socio-economic disruptions[47].

B. Enhancing Surveillance

Enhancing surveillance systems is a cornerstone of preparing for future viral threats, enabling early detection, monitoring, and response to potential outbreaks. Advanced surveillance involves integrating modern technologies, such as artificial intelligence, genomic sequencing, and real-time data analytics, to track disease patterns and identify unusual activity in human, animal, and environmental health. Strengthening global networks like the One Health approach ensures a comprehensive understanding of zoonotic disease risks and facilitates the sharing of critical information across countries. Community-level surveillance and partnerships with local healthcare providers improve the detection of emerging threats in remote or underserved areas. Regular training for health workers and robust reporting mechanisms further enhance the effectiveness of these systems. Proactive surveillance not only helps contain outbreaks before they escalate but also informs vaccine development, public health policies, and global preparedness strategies, creating a stronger defense against future viral threats[48].

C. Promoting Education

Promoting education is a vital strategy for preparing for future viral threats, as informed communities are better equipped to prevent and respond to outbreaks. Public health education campaigns that focus on hygiene practices, vaccination, and the importance of early symptom recognition can significantly reduce transmission rates and improve compliance with preventive measures. By integrating virus-related topics into school curricula and public health training, we can foster a more informed population that understands the importance of staying vigilant during potential outbreaks. Media platforms, healthcare workers, and community leaders also play key roles in disseminating accurate information, combating misinformation, and ensuring that individuals understand how their actions contribute to public health. Empowering people with the knowledge to make informed decisions about health, hygiene, and safety helps create resilient communities capable of minimizing the impact of future viral threats[49].

(i) **Global Coordination**

Strengthening international partnerships to share data, expertise, and resources is crucial for managing cross-border outbreaks. Organizations like the WHO should be supported to facilitate coordinated global responses[50].

(ii) **Investing in Research and Innovation**

Accelerating research into emerging viruses and potential treatments can improve preparedness. Innovative technologies, including artificial intelligence, can enhance predictive modelling and outbreak simulations[51].

(iii) **Expanding Vaccine Equity**

Ensuring equitable access to vaccines and treatments for all populations will mitigate the disproportionate impact on vulnerable groups. Establishing regional manufacturing hubs can reduce reliance on global supply chains[52].

(iv) **Strengthening Health Education**

Raising public awareness about viral threats and preventive measures fosters community resilience.Combatting misinformation through transparent and credible communication is essential[53].

(v) **Enhancing Rapid Response Capabilities**

Developing rapid deployment teams and stockpiling essential medical supplies can minimize response times during outbreaks. Simulation exercises and training programs can ensure readiness for diverse scenarios[54].

(vi) **Integrating One Health into Policy**

Addressing the interconnectedness of human, animal, and environmental health is crucial for mitigating zoonotic risks.Policies should focus on sustainable land use, wildlife conservation, and vector control[55].

(vii) **Strengthening Localized Healthcare Infrastructure**

Building capacity at the community level ensures early detection and response capabilities.Equipping regional health centers with advanced diagnostic tools and personnel prepares them for outbreaks in remote or underserved areas[56].

(viii) **Expanding Global Funding Mechanisms**

Establishing emergency funds dedicated to outbreak preparedness and response enables rapid action. International financial institutions can support under-resourced nations in building their health capacities[57].

(ix) **Advancing Diagnostic and Monitoring Technologies**

Deploying portable diagnostic tools and real-time monitoring systems can accelerate outbreak identification. Integration of AI and machine learning can improve the accuracy and efficiency of predictive outbreak models [58, 59].

CONCLUSION

The threat of emerging viruses in the modern world is a complex and multifaceted challenge that requires coordinated global action. By addressing the underlying drivers of disease emergence and investing in robust surveillance, research, and health systems, the global community can better prepare for and mitigate the impact of future outbreaks. The lessons learned from recent pandemics should serve as a catalyst for sustained efforts to protect public health and ensure a safer, more resilient world.Viruses are an ever-present force in society, capable of causing significant harm but also driving scientific and technological advancements. By addressing the factors that exacerbate viral threats and leveraging the lessons learned from past outbreaks, society can better navigate the challenges posed by viruses while reaping the benefits of the innovations they inspire.

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Uncommon Presentation of SLE

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How to cite this article:

Kumkum Sarkar, Madhuchhanda Mandal, Sudeshna Mallik. Uncommon presentation of SLE. RFP Ind. Jr. Hosp. Inf., 2024,6(2):65–67.

Abstract

Systemic lupus erythematosus (SLE) is a connective tissue disease whose etiology is unknown and it predominantly affects women of childbearing age. We report a case of male SLE with puffiness of face and mild pedal edema and mild yellowish discoloration of eyes. After exclusion of all causes of hepatitis all evaluations were used to establish a diagnosis of SLE. It is a great challenge to diagnose SLE among males as it has lower prevalence. Therefore, as primary care doctors, we need to have a high suspicion of SLEeven in male. Thus, early treatment may help patients to prevent complications and improve their quality of life.

Keywords: Male, Lupus Erythematous, Cutaneous, Antibodies, Antinuclear.

INTRODUCTION

SLE is an idiopathic autoimmune disease which involves multiple organs and has varied clinical presentations. Among all the organs involvement, the skin and kidney are more frequently affected. This disease is most common in women of reproductive age.[1] The female-to-male ratio as reported is 8–15:1, whereas the ratios prior to puberty and post menopause are significantly lower at 2–6:1 and 3–8:1, respectively.[2] Among different ethnic groups, the prevalence for Indians was 12 per 100,000 individuals, with an overall male-to-female ratio of 1:12.[3] Though hormone plays an important role in the pathogenesis of the disease, there is not yet an accurate explanation for the decreased occurrence in men.[4] The common symptoms such as joint pain, extreme fatigue, and skin rashes are seen in both males and females, but males tend to experience a more severe clinical course.[5] The approach to managing SLE frequently depends on the specific disease severity and the manifestations of individual patients. Hydroxychloroquine remains the primary long-term treatment component for all SLE patients.[8] Corticosteroids (e.g. prednisone, methylprednisolone) are commonly prescribed for a short duration.[9] Other medications options are non-biological disease-modifying antirheumatic drugs (DMARDS) such as mycophenolate, azathioprine cyclosporine, cyclophosphamide and methotrexate, and non-steroidal antiinflammatory agents.[10]

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Received on: 19.02.2025

Accepted on: 11.03.2025

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CASE

A 23 year male presented with puffiness of face and mild pedal edema and mild yellowish discoloration of eyes for 15 days. He gave history of low grade fever for 2 days before onset of these symptoms. He had associated anorexia and 2 kg weight loss during this 15 days. On examination he had mild pallor, icterus and edema. His blood pressure was high on repeated records though his previous blood pressure was normal. His systemic examination was normal. By keeping mind differentials as acute hepatitis and glomerulonephritis we sent all relevant investigations, which showed normocytic normochromic anemia, slightly high liver enzymes with normal bilirubin and proteinuria 1.6 gram per day. His blood for HBsAg came positive but Anti HBc total antibody was nonreactive and HBV-DNA was not detected. USG whole abdomen and fibroscan of liver were normal. By the time ANA came positive and positive DsDNA but antismooth muscle antibody (ASMA), anti-liver-kidney microsome antibodies were negative. So we sent blood for HBsAg again for reconfirmation, which came negative this time. Now on thorough examination we found faint malar rash which we ignored earlier. We did kidney biopsy which revealed stage IV lupus nephritis. So, we diagnosed him as lupus nephritis with lupushepatitis. We treated him with monthly cyclophosphamide with oral prednisolone. After 1 month his symptoms were improved, blood pressure was controlled, liver enzymes became normal and proteinuria decreased.

Fig. 1 & 2: Malar rash

DISCUSSION

SLE is a clinically heterogeneous autoimmune disease whose etiology is unknown. This disease is characterized serologically by autoantibodies that target self-proteins. Different organs and cells of affected individuals undergo damage mediated by tissue-binding autoantibodies and immune complexes.[11] Presentation of SLE are similar in men and women, particularly skin rash, extreme fatigue, and joint pain. But, the findings suggest that the disease course is more complex in men, and some studies have shown that renal impairment, central nervous system, and vascular disease are more common in men than in women.[12]

Hepatomegaly is quite common among patients with SLE. The most common cause of elevated liver enzymes in SLE patients is drug-induced (Non-steroidal anti-inflammatory drugs). Coincidental liver disease, thrombotic events with or without lupus anticoagulant including Budd-Chiari syndrome and veno-occlusive diseaseare other common causes.[13] Though it is still a controversy, there is compiling evidence in the literature that SLE itself is not associated with a specific, severe and progressive liver injury. But, several authors have pointed a role for SLE in triggering an often subclinical hepatopathy, referred to as “lupus hepatitis”. They also had described that this disease as an asymptomatic hypertransaminasemiaand commonly associated with exacerbations of the lupus disease, which returns to normal range after corticosteroid therapy.[14]

CONCLUSION

This case emphasizes the importance of considering SLE in a male patient specially those presented with uncommon symptoms of SLE. Primary recognition and quick diagnosis are vital for the timely initiation of treatment to prevent the severity of future complications. The findings highlight different systemiccomplications of SLE, necessitating the individualization of treatment based on specific manifestations. We concluded that liver is often a target of SLE, and biochemical liver tests should be systematically carried out in these patients in regular interval.

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Subject Index

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[1] Flink H, Tegelberg Å, Thörn M, Lagerlöf F. Effect of oral iron supplementation on unstimulated salivary flow rate: A randomized, double-blind, placebo-controlled trial. J Oral Pathol Med 2006; 35: 540-7.

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Article in supplement or special issue

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Corporate (collective) author

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Unpublished article

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Reference from electronic media

[9] National Statistics Online—Trends in suicide by method in England and Wales, 1979-2001. www.statistics.gov.uk/downloads/theme_health/HSQ 20.pdf (accessed Jan 24, 2005): 7-18. Only verified references against the original documents should be cited. Authors are responsible for the accuracy and completeness of their references and for correct text citation. The number of reference should be kept limited to 20 in case of major communications and 10 for short communications.

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