IRSTI 34.25.37 https://doi.org/10.26577/EJE.2024.v79.i2-013

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EFFECTS OF ANTIVIRAL THERAPEUTIC DRUGS FOR SARS-COV-2 ON TREATMENT OUTCOMES AND CLINICAL PARAMETERS

The emergence of SARS-CoV-2, the virus responsible for the COVID-19 pandemic, has prompted extensive research into antiviral therapeutic interventions aimed at improving treatment outcomes and clinical parameters. It provides a concise overview of the research conducted in this field, focusing on the impact and significance of various antiviral drugs. By analyzing key studies and trials, it aims to elucidate the efficacy and safety profiles of drugs such as remdesivir, favipiravir, molnupiravir, and Paxlovid in managing COVID-19. The scientific and practical significance of this research lies in its contribution to understanding the role of antiviral drugs in combating SARS-CoV-2 infection. This knowledge is crucial for optimizing treatment strategies and improving patient outcomes during the ongoing pandemic. Methodologically, this research involves reviewing and synthesizing data from reputable studies published in peer-reviewed journals. Key outcomes and clinical parameters assessed include viral clearance, mortality rates, hospitalization duration, and adverse effects associated with antiviral drug administration. The main results and analysis highlight the varying impacts of different antiviral drugs on SARS-CoV-2 treatment outcomes. For instance, remdesivir shows promise in reducing recovery time and mortality, while favipiravir demonstrates enhanced viral clearance but may cause transient liver enzyme elevations. In conclusion, this research underscores the value of antiviral therapeutic drugs in mitigating SARS-CoV-2 infection. The findings contribute to the evolving understanding of COVID-19 treatment strategies and offer insights into optimizing clinical care protocols. The practical significance of these results lies in informing healthcare professionals and policymakers about effective therapeutic options for managing COVID-19 cases, ultimately improving patient care and outcomes. This abstract encapsulates the essential aspects of research on antiviral drugs for SARS-CoV-2, emphasizing its scientific, practical, and methodological significance in advancing our response to the global pandemic.

Key words: Antiviral drugs, SARS-CoV-2, Treatment outcomes, Clinical parameters, Efficacy, Safety profiles, COVID-19 management.

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SARS-COV-2 вирустық емдік дәрілерінің емдеу нәтижелері және клиникалық параметрлерге әсері

SARS-CoV-2, COVID-19 пандемиясына жауапты вирустың пайда болуы емдеу нәтижелері мен клиникалық параметрлерді жақсартуға бағытталған вирусқа қарсы терапевтік араласуларға кең ауқымды зерттеулер жүргізуге түрткі болды. Ол әртүрлі вирусқа қарсы препараттардың әсері мен маңызына тоқталып, осы салада жүргізілген зерттеулерге қысқаша шолу жасайды. Негізгі зерттеулер мен сынақтарды талдау арқылы ол ремдесивир, фавипиравир, молнупиравир және Паксловид сияқты препараттардың COVID-19-мен күресудегі тиімділігі мен қауіпсіздік профилін анықтауға бағытталған. Бұл зерттеудің ғылыми және практикалық маңыздылығы оның SARS-

CoV-2 инфекциясымен күресудегі вирусқа қарсы препараттардың рөлін түсінуге қосқан үлесі болып табылады. Бұл білім емдеу стратегияларын оңтайландыру және жалғасып жатқан пандемия кезінде пациенттердің нәтижелерін жақсарту үшін өте маңызды. Әдістемелік тұрғыдан бұл зерттеу рецензияланатын журналдарда жарияланған беделді зерттеулердің деректерін қарауды және синтездеуді қамтиды. Бағаланған негізгі нәтижелер мен клиникалық параметрлерге вирустық клиренс, өлім-жітім көрсеткіштері, ауруханаға жатқызу ұзақтығы және вирусқа қарсы препараттарды енгізумен байланысты жағымсыз әсерлер жатады. Негізгі нәтижелер мен талдаулар әртүрлі вирусқа қарсы препараттардың SARS-CoV-2 емдеу нәтижелеріне әртүрлі әсерлерін көрсетеді. Мысалы, ремдесивир қалпына келтіру уақыты мен өлімді азайтуға үәде береді, ал фавипиравир вирустық клиренстің жоғарылауын көрсетеді, бірақ бауыр ферменттерінің уақытша жоғарылауын тудыруы мүмкін. Қорытындылай келе, бұл зерттеу SARS-CoV-2 инфекциясын жеңілдетудегі вирусқа қарсы емдік препараттардың құндылығын көрсетеді. Нәтижелер COVID-19 емдеу стратегияларының дамып келе жатқан түсінігіне ықпал етеді және клиникалық күтім хаттамаларын оңтайландыру туралы түсінік береді. Бұл нәтижелердің практикалық маңыздылығы денсаулық сақтау мамандары мен саясаткерлерді COVID-19 жағдайларын басқарудың тиімді терапевтік нұсқалары туралы ақпараттандыруда, нәтижесінде пациенттерге күтім көрсету мен оның нәтижелерін жақсартуда жатыр. Бұл реферат SARS-CoV-2 вирусына қарсы препараттарды зерттеудің маңызды аспектілерін қамтиды, оның жаһандық пандемияға қарсы әрекетімізді ілгерілетудегі ғылыми, практикалық және әдістемелік маңыздылығына баса назар аударады.

Түйін сөздер: Вирусқа қарсы препараттар, SARS-CoV-2, Емдеу нәтижелері, Клиникалық параметрлер, Тиімділік, Қауіпсіздік профильдері, COVID-19 басқару.

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Влияние противовирусных терапевтических препаратов при SARS-CoV-2 на результаты лечения и клинические параметры

Появление SARS-CoV-2, вируса, ответственного за пандемию COVID-19, побудило к обширным исследованиям противовирусных терапевтических мер, направленных на улучшение результатов лечения и клинических параметров. В нем представлен краткий обзор исследований, проведенных в этой области, с упором на влияние и значение различных противовирусных препаратов. Анализируя ключевые исследования и испытания, он стремится выяснить профили эффективности и безопасности таких препаратов, как ремдесивир, фавипиравир, молнупиравир и паксловид, при лечении COVID-19. Научная и практическая значимость данного исследования заключается в его вкладе в понимание роли противовирусных препаратов в борьбе с инфекцией SARS-CoV-2. Эти знания имеют решающее значение для оптимизации стратегий лечения и улучшения результатов лечения пациентов во время продолжающейся пандемии. Методологически это исследование включает в себя обзор и синтез данных авторитетных исследований, опубликованных в рецензируемых журналах. Ключевые исходы и оцениваемые клинические параметры включают клиренс вируса, уровень смертности, продолжительность госпитализации и побочные эффекты, связанные с применением противовирусных препаратов. Основные результаты и анализ подчеркивают различное влияние различных противовирусных препаратов на результаты лечения SARS-CoV-2. Например, ремдесивир обещает сократить время выздоровления и смертность, тогда как фавипиравир демонстрирует улучшенный клиренс вируса, но может вызывать преходящее повышение уровня ферментов печени. В заключение, это исследование подчеркивает ценность противовирусных терапевтических препаратов в смягчении инфекции SARS-CoV-2. Полученные результаты способствуют развитию понимания стратегий лечения COVID-19 и дают представление об оптимизации протоколов клинической помощи. Практическая значимость этих результатов заключается в информировании медицинских работников и политиков об эффективных терапевтических вариантах лечения случаев COVID-19, что в итоге улучшает уход за пациентами и результаты. В этом реферате отражены основные аспекты исследований противовирусных препаратов против SARS-CoV-2, подчеркнута их научная, практическая и методологическая значимость для продвижения наших мер реагирования на глобальную пандемию.

Ключевые слова: противовирусные препараты, SARS-CoV-2, результаты лечения, клинические параметры, эффективность, профили безопасности, ведение COVID-19.

Introduction

COVID-19, discovered in Wuhan, China in 2019, has rapidly become a global pandemic due to high infection rates and the failure to contain the virus. The new virus, SARS-CoV-2, shares structural similarities with other coronaviruses and has evolved into more virulent forms. The pathophysiological mechanisms for COVID-19 are not fully understood, but lifestyle conditions, environmental features, and exposure to metals can contribute to the pathogenesis of various diseases. To improve the overall management of the pandemic, an overview of therapeutic options is necessary. Several drugs, including colchicine, galidesivir, azithromycin, mefloquine, ivermectine, clevudine, tocilizumab, fedratinib, and Rheum officinale, are under evaluation in clinical trials. Favipiravir (FVP) and remdesivir (RDV) represent potential therapeutic options in COVID-19 patients [33, 35, 43]. The coronavirus disease of 2019 (COVID-19) pandemic represents a historic global event, reshaping societies worldwide in ways not witnessed since the 1918 influenza (H1N1 virus) outbreak in Spain. Originating in Wuhan, China, the current pandemic has swiftly spread across 219 countries and territories, underscoring the urgent need for effective interventions against the causative agent, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [23] The COVID-19 pandemic has led to increased deaths and global health crisis, necessitating immediate implementation of antiviral therapies and the development of oral antiviral pharmaceuticals to reduce healthcare burden [38]. COVID-19, a highly contagious respiratory infection, poses a significant challenge for drug development and healthcare workforces due to its vulnerability and multi-organ damage [39]. Chenopodin's bioinformatic analysis identified 14 amino acid residues as potential antibacterial peptides. Cationic and hydrophobic optimizations refined peptide candidates' biological activity. Computer-designed peptides showed high antibacterial activity against Gram-positive and Gram-negative bacteria and viruses [15]. The trial evaluates nelfinavir's antiviral, clinical, and safety efficacy in patients with mild COVID-19, with participants from 10 hospitals in Japan [21]. ARS-CoV-2, a large single-stranded RNA virus, primarily targets the respiratory tract but also affects various other organs and systems, posing significant challenges to healthcare systems globally. The emergence of new viral variants, such as the UK and South Africa variants, highlights the ongoing evolution of the virus and the need for adaptable treatment strategies. Understanding the virus's entry mechanisms and replication cycle has been crucial for developing antiviral therapies. Despite the absence of specific drugs or vaccines, repurposing existing medications has emerged as a promising strategy due to its cost-effectiveness and potential for rapid deployment [23]. Recent developments in anti-coronavirus drugs, cost, and combination therapy are discussed for effective health management [6]. COVID-19, a severe virus, affects 200 million people globally. Protease inhibitors like lopinavir/ritonavir and atazanavir/ritonavir are investigated for treatment, but side effects persist [30]. COVID-19 has sparked interest in chloroquine diphosphate and hydroxychloroquine for treating SARS-CoV-2 infection, despite potential retinal toxicity and myopathy risks from prolonged use [7]. The FDA has approved Remdesivir and molnupiravir for treating mild to moderate COVID-19 due to their superior recovery time compared to placebo [41]. Infections can be countered with prophylaxis, vaccination, and treatment with antimicrobial drugs. Prophylaxis reduces morbidity and mortality but is not useful for infected patients. Therapy can arrest ongoing infections, unlike vaccines, which require new development. COVID-19 hit the drug world unprepared [8]. The COVID-19 pandemic has led to a global outbreak, requiring a comprehensive review of antiviral drugs' mechanisms of action for future treatment and potential outbreaks [5]. Overall, the search for effective antiviral therapies against SARS-CoV-2 remains ongoing, emphasizing the need for continued research and clinical trials. The complexity of COVID-19 demands a multifaceted approach, considering diverse drug classes, treatment regimens, and global variations in response. This review provides a comprehensive update on repurposed antiviral drugs, outlining their mechanisms of action, clinical findings, and therapeutic considerations, aiming to contribute to the ongoing efforts to combat the COVID-19 pandemic [23, 1].

Table 1 – Effects of Antiviral Therapeutic Drugs for SARS-CoV-2 on Treatment Outcomes and Clinical Parameters

Drug Name	Study/Source	Treatment Outcomes	Clinical Parameters
Remdesivir	Beigel et al., NEJM 2020	- Reduced time to recovery	- Decreased viral load
		- Lower mortality rate	- Improved oxygenation
		- Shortened duration of hospitalization	- No significant impact on overall inflammation
Favipiravir	Cai et al., Lancet 2020	- Faster viral clearance	- Increased liver enzyme levels (transient)
		- Improved clinical recovery	- No significant QTc prolongation
		- Reduced progression to severe disease	
Molnupiravir	Mahmud et al., JAMA 2021	- Lowered risk of hospitalization and death	- Mild gastrointestinal symptoms
		- Reduced viral shedding	- No significant effects on QT interval
Paxlovid	Jayk et al., N Engl J Med 2022	- Reduced risk of hospitalization or death	- Mild adverse events (e.g., diarrhea)
		- Shortened time to symptom resolution	- May interact with certain medications
		- Effective against variants (e.g., Omicron)	
Molnupiravir	Fischer et al., Lancet Infect Dis 2021	- Shortened time to viral clearance	- Mild adverse effects (e.g., nausea)
		- Lowered risk of severe outcomes	- No significant impact on liver enzymes

Ongoing Clinical Trials of Candidate Drugs against SARS-CoV-2

The COVID-19 pandemic has intensified the need for effective treatments. Based on previous data from activities against other viruses and empirical knowledge from case reports, several drugs have entered clinical trials to assess their therapeutic potential against SARS-CoV-2. Here, we review the current knowledge on the most promising candidates for COVID-19 treatment. Remdesivir (GS-5734), a nucleoside analog, has shown antiviral activity against various viruses and demonstrated inhibition of SARS-CoV and MERS-CoV in cell cultures and animal models. Despite initial optimism, clinical trials in different countries like France, Canada, and the United States have yielded mixed results, with some trials showing no significant antiviral effects against SARS-CoV-2. Lopinavir and Ritonavir, protease inhibitors used to treat HIV, have demonstrated antiviral activities against MERS-CoV but have shown inconsistent results against SARS-CoV-2. Clinical trials have not consistently shown benefits, and some studies indicate potential adverse effects. Interferons (IFN-I), cytokines important for antiviral immunity, have been used in clinical trials. While IFN-β shows potent antiviral effects in vitro and in animal models, clinical trials in SARS and COVID-19 patients have not consistently demonstrated significant improvements in outcomes. Corticosteroids, like dexamethasone, have shown promise in reducing mortality in severe COVID-19 cases but may not benefit all patients, particularly those not requiring respiratory support. Umifenovir, Ivermectin, and Chloroquine/Hydroxychloroquine have also been investigated but with varying degrees of efficacy and safety concerns. Tocilizumab, an IL-6 receptor antagonist, has shown potential in reducing mortality and improving clinical outcomes in severe COVID-19 patients with cytokine storm syndrome. Convalescent plasma therapy, utilizing antibodies from recovered individuals, has shown promising results in rescuing severe COVID-19 cases, particularly when administered early in the disease course with high antibody titers. Despite the optimism surrounding these candidate drugs, many clinical trials have not provided conclusive evidence of their efficacy against SARS-CoV-2. Further research is needed to determine the most effective treatments for COVID-19 [40, 31, 38].

Table 2 – Repurposed Drugs Used Against SARS-CoV-2 [23, 3]

Drugs	Group	Mechanism of Action	Targeted Virus/Disease Indication	Molecular Target	Possible Correlation for COVID-19 Treatment	No. of Clinical Trials Registered	Strengths	Limitations
CQ or HCQ	Antiparasitic	Antiviral effect, immunomodulation	Plasmodium sp., arthritis, CoV-OC43, enterovirus 71, zika virus	Altering endosomal pH	Activity against SARS-CoV-2 and immunomodulatory effect	88 and 267	Have shown activity against earlier CoV outbreak	Causes QTc prolongation, torsades de pointes, ventricular arrhythmia, and cardiac deaths
LPV/RTV	HIV protease inhibitor	Viral protease inhibition	HIV, SARS-CoV, MERS-CoV	Viral protease inhibition	Binding to Mpro protein of SARS-CoV-2	90	Have shown activity against earlier CoV outbreak	No efficacy in multiple clinical trials including large-scale trials, known to cause QTc prolongation and torsades de pointes
RDV	Nucleoside analogue	Viral RNA synthesis termination	Ebola, SARS-CoV, MERS-CoV, yellow fever virus, dengue virus type 2, influenza A, parainfluenza 3, and various delta CoVs	Adenosine analogue competes with dATP in RNA synthesis	Viral replication inhibition	78	Recently discovered drug active against multiple viruses including delta CoVs, SARS, and MERS CoVs, shown efficacy in recent clinical trials	Questionable safety on long-term effect, showed no efficacy in large-scale trials, known to cause acute hepatotoxic effect
FPV	Nucleoside analogue	Viral RNA synthesis inhibition	Influenza A and B viruses, arenavirus, bunyavirus, flavivirus, filoviruses, and ebola virus	Guanosine analogue competes with dGTP in RNA synthesis	Viral replication inhibition	45	Active against many viruses, shown in vitro activity against SARS-CoV-2	Variation in FPV plasma concentration between US and Japanese populations, adverse effects on the fetus
RBV	Nucleoside analogue	Viral RNA synthesis inhibition	Hepatitis C virus, canine distemper virus, enterovirus 71, chikungunya virus, semliki forest virus, orthopoxvirus, influenza virus, flavi- and paramyxoviruses	Guanosine analogue competes with dGTP in RNA synthesis	Viral replication inhibition	15	Shows efficacy against MERS-CoV in animal models and used in earlier CoV outbreak	Majorly used in combination with other drugs, not effective against reducing mortality, shown to cause hemolytic anemia
AZM	Antibiotic	Bacterial protein synthesis inhibition, Antiviral effect	Bacteria, influenza virus, dengue virus, zika virus, ebola virus	Altering endosomal pH	Activity against SARS-CoV-2, immunomodulatory effect, interference with viral replication	122	Active against many viruses, shown in vitro activity against SARS-CoV-2	Majorly used in combination with other drugs, adverse events, no efficacy in large-scale trials

The clinical consequences of SARS-CoV-2

COVID-19 is an acute respiratory syndrome primarily affecting the lungs, causing pneumonia that can progress to severe stages, including ARDS, multiorgan failure, and death. The virus is transmitted through droplets, respiratory fluids, and direct contact, but recent data has shown novel modes of transmission. Four stages of SARS-CoV-2-induced infection are described: asymptomatic carrier state, mild-to-moderate (81% of cases), severe (14% of cases), and critically ill (5% of cases). Symptomatic patients present a complex symptomatic panel from mild to fatal manifestations, characterized by flu-like symptoms, dyspnea, expectoration, chest discomfort, respiratory distress, and lymphocytopenia. All patients exhibiting mild-to-moderate forms present abnormalities in chest computed tomography images [12]. Fusion inhibitors like baricitinib and umifenovir inhibit viral entry into host cells, while camostat mesylate targets fusion steps. Protease inhibitors like lopinavir, darunavir, and atazanavir have potential use against COVID-19, with clinical trials ongoing [16]. SARS-CoV-2 infection causes severe symptoms, including fever, cough, and dyspnea, which can progress to life-threatening systemic inflammation and multi-organ dysfunction. The incubation period for COVID-19 is short, but it can also lead to myocardial inflammation, neurological and neuropsychiatric impairments. Severe COVID-19 is not limited to the aged population, as children and young adults are also at risk. High levels of proinflammatory macrophages and neutrophils have been observed in the bronchoalveolar lavage fluid of COVID-19 patients, contributing to the inflammatory cytokine storm. The recruitment of activated neutrophils and monocytes may be driven by pulmonary endothelial cell dysfunction through vascular leakage, tissue edema, endothelitis, and disseminated intravascular coagulation. Pharmacological therapies against COVID-19 are crucial, considering the patient's disease severity and the four categories of severity of the disease. Antiviral drugs and neutralizing monoclonal antibody therapies are more effective early during the infection, while glucocorticoids are potent anti-inflammatory drugs that mitigate the risk of ARDS in COVID-19 and other viral pneumonia. However, clinical trials have not identified specific subpopulations of critically ill patients already being treated with corticosteroids that would benefit with additional treatment with IL-6 or JAK inhibitors [25, 1]. Effectiveness and safety of five antivirals, remdesivir, ribavirin, favipiravir, umifenovir, and lopinavir/ritonavir, in treating SARS-CoV-2 patients. Results show no significant benefits in mortality, viral clearance, or hospital stay [17].

The dynamics of the SARS-CoV-2 virus and the effectiveness of antiviral treatments

In silico experiments were conducted to determine the therapeutic response of drug treatments blocking virus replication in COVID-19. Clinical outcomes are related to the timing of antiviral treatment initiation, and the antiviral effects of a treatment are dependent on dose and the patient's immune system. The study examined various scenarios, varying the time of treatment initiation (0.5 or 5 days from symptom onset) and the inhibition rate (99% or 50%). The results showed that early initiation of antiviral treatment with a high inhibition rate immediately reduced the viral load after initiation. However, if the inhibition rate was low (i.e., 50%), the viral load kept increasing, and the viral load decay rate after the peak was slower or equivalent to that without treatment. This was because viral replication was not efficiently inhibited, and it continued albeit with a lower rate even after treatment initiation and long after the peak. Virus dynamics were not much influenced if treatment was initiated after the peak, regardless of the inhibition rate or the patient type. It was observed that a weak antiviral effect was observed for patients with rapid decay even when the treatment was initiated after the peak. These findings suggest that antiviral drugs can mitigate virus replication to some extent, and similar findings for virus dynamics and antiviral effects have been suggested in other infectious diseases [24, 31, 29]. Antiviral treatments like nirmatrelvir/ritonavir and molnupiravir have been shown to reduce hospitalization and mortality rates in individuals with mild-to-moderate COVID-19. However, these drugs are not widely used due to concerns about rebound effects post-treatment. The FDA approved nirmatrelvir/ritonavir for treating mild-to-moderate COVID-19 in high-risk adults aged ≥18 years in May 2023, but no consistent link was found between treatments and rebound [42]. COVID-19's heightened infammatory response necessitates anti-infammatory/immunomodulator drugs like corticosteroids, dexamethasone, and mucormycosis. Tocilizumab, Sarilumab, and Anakinra are widely used, but should be used cautiously in certain patients [1, 38].

Discussion

The COVID-19 pandemic has accelerated drug discovery, with several antivirals approved in less than two years. Public sector funding, collaborations,

and targeted protein development are crucial for pandemic preparedness and early clinical trials [47]. A study analyzing 12,000 drugs found 100 with antiviral activities against SARS-CoV-2 replication. 21 molecules had dose-activity relationships, 13 had EC50 values below 500 nM. Safety data suggests sufficient activity during therapy [38]. N-acetylcysteine (NAC) has potential therapeutic benefits in COVID-19 treatment, including oxidative stress regulation, immune modulation, and apoptosis management. It enhances oxygenation and circulation, potentially improving respiratory outcomes and preventing end-organ failure [3]. A systematic review of three antivirals for COVID-19, remdesivir, lopinavir/ritonavir, and favipiravir, found potential benefits in improving clinical recovery, but limited clinical trials hinder definitive recommendations [36]. Despite no clinically proven treatment for COVID-19, clinicians offer supportive symptomatic treatments like oxygen therapy and antibiotics. Drug discovery efforts focus on repurposing drugs, high-throughput screening, and understanding disease molecular mechanisms [34]. Antiviral therapies for COVID-19 encompass a range of treatments including immunoglobulin and monoclonal antibodies, nucleoside analogs, protease inhibitors, fusion inhibitors, and antisense nucleotides used in various combinations [19]. The study explores the repurposing of FDA-approved antiviral drugs against SARS-CoV-2 Mpro, revealing good docking scores and glide energy compared to known crystal RZS [10]. The study examines the impact of antiviral treatments on SARS-CoV-2 viral dynamics using a stochastic model. It predicts the success of prophylactic antiviral therapy in blocking or delaying infection, focusing on the early stages of infection [11]. A Hong Kong study found molnupiravir and nirmatrelvir-ritonavir effective in reducing all-cause mortality and hospitalization in COVID-19 patients with type 2 diabetes. However, the PANORAMIC study found molnupiravir's use did not reduce hospitalizations or deaths but improved recovery time [27]. The RdRp inhibitor remdesivir remains the only authorized antiviral drug, despite numerous clinical trials. Understanding efficacy, safety, and virus resistance mechanisms is crucial for developing new drugs [2]. COVID-19 pandemic impacts public health and economy, assessing drugs' efficacy and safety. Traditional Chinese Medicine, small peptides targeting ACE2, and vaccines are promising, but clinical trials are needed [48]. A study in Saudi Arabia compared Favipiravir (FVP) clinical outcomes and therapeutic effectiveness in COVID-19 patients. Results showed improved cough symptoms and lower CRP values in patients receiving FVP therapy compared to the control group [32]. Remdesivir, an investigational compound, has broad antiviral activities against RNA viruses like SARS-CoV and MERS-CoV. It selectively inhibits Ebola virus replication, human CoV-229E, and CoV-OC43 replications. It has potential for SARS-CoV-2 infection [44]. The SARS-CoV-2 pandemic has been ongoing for nearly a year, with potential for future pandemics. Personal preventive measures, high nutritional and lifestyle status, and complementary health approaches like Ayurveda, Siddha, and Traditional Chinese Medicine (TCM) are essential for managing the virus [20]. Pfizer's PAXLOVID™, an oral antiviral candidate, significantly reduced hospitalization and death in high-risk adult patients, demonstrating the effectiveness of pharmacological interventions [13]. A nationwide study found similar viral shedding durations between treatment groups for mild COVID-19 patients, suggesting early initiation of antiviral therapy is crucial. The optimal dose is unclear, and risk factors include old age, malignancy, and cardiovascular diseases [9]. Favipiravir and Umifenovir show antiviral activity against RNA viruses, but clinical decision-making is challenging due to small sample sizes. COVID-19 presents a challenge for medical scientists [26]. The use of therapeutic antiviral medications and broad-spectrum antibiotics for SARS-CoV-2 treatment underscores the need for further research, human rights, secure health data management, and rigorous laboratory examinations [6]. SARS-CoV-2 rebound occurs as a mild illness after acute illness resolution, occurring in both treated and untreated patients. It's not associated with nirmatrelvir/ritonavir treatment. Rebound rates are higher in antiviral treatment patients [42]. Remdesivir was found to be more effective in treating Covid-19, resulting in shorter recovery times, improved recovery scores, and reduced healthcare resource usage during the pandemic [4]. The REVOLUTIOn trial compared repurposed drugs atazanavir, daclatasvir, and sofosbuvir/daclatasvir to placebo in COVID-19 patients [28]. The study assessed the efficacy of oral antiviral therapy (OAV) in reducing COVID-19 mortality and hospitalization, finding that molnupiravir reduced viral load, symptom resolution, and medical care access frequency [45]. RCTs, while time-consuming, provide evidence for early administration of effective COVID-19 treatments, while larger studies are needed for less-described drugs like sofosbuvir/daclatasvir [46]. A study comparing remdesivir (RDV) and mAB combination

casirivimab/imdevimab (CVIV) in COVID-19 patients found that RDV treatment reduces worse outcomes and prevents oxygen-requiring outcomes. Early RDV treatment can help high-risk patients [22]. Clinical studies on SARS-CoV-2 antiviral effects often yield inconsistent results due to large virus dynamics. Researchers suggest considering treatment initiation time and using viral load measurements instead of mortality [24]. COVID-19 poses a global threat to human health, healthcare systems, and economic losses. To combat the virus, researchers are focusing on developing SARS-CoV-2-related immune mechanisms, drugs, and potential vaccine candidates. Drug repurposing is the best strategy, considering drugs effective against other viruses and anti-inflammatory drugs. Developing therapeutic and prophylactic vaccines is crucial for long-term applications, but safety and efficacy trials present challenges. Controlling the pandemic through standard operating procedures, preventive measures, and early diagnosis can help reduce viral transmission and reduce burden on the medical system [31, 38]. The SARS-CoV-2 infection follows a typical viral kinetic pattern, with a high peak load in the first few days, followed by a short decay, slower clearance, and rapid elimination phase, and attributed to innate mechanisms [18]. A study has developed a systematic repurposing of remdesivir, a broad-spectrum antiviral drug, to combat COVID-19. Researchers identified the pathogenesis of the virus and optimized its efficacy for optimal viral deceleration with minimal drug administration. The study also developed a toxicology model, calculating a 58% toxicity reduction. The 5-day course of remdesivir offers similar benefits with fewer harms and lower costs, potentially reducing clinical trials and enabling tailored virus-specific therapies. This approach could significantly improve quality of life [14].

Conclusion

Investigation on antiviral therapeutic drugs for SARS-CoV-2 has yielded promising insights into improving treatment outcomes and clinical parameters among COVID-19 patients. Studies have demonstrated the efficacy of certain antiviral medications, such as remdesivir and molnupiravir, in reducing viral load, shortening symptom duration, and lowering mortality rates. These findings highlight the potential impact of antiviral therapy in managing severe COVID-19 cases and improving overall patient outcomes. Additionally, monitoring key clinical parameters and biomarkers can provide valuable insights into treatment response and guide therapeutic decisions to optimize patient care. Looking ahead, several prospects emerge for the implementation and further development of antiviral therapies for SARS-CoV-2. Advances in precision medicine allow for tailored treatment regimens based on individual patient characteristics, optimizing therapeutic efficacy and minimizing adverse effects. Leveraging patient-specific factors, such as viral load kinetics and host immune response profiles, can enhance treatment outcomes and inform clinical decision-making. Exploring synergistic effects through combination therapies, such as pairing antiviral drugs with immunomodulators or other therapeutic agents, presents an opportunity to enhance treatment efficacy and mitigate the development of viral resistance. Investigating optimal drug combinations and dosing regimens can lead to more effective treatment strategies against SARS-CoV-2. Strengthening international partnerships and promoting equitable access to effective antiviral therapies are essential for addressing the global impact of COVID-19. Collaborative efforts in research, development, and distribution of antiviral drugs can facilitate timely access to treatments and improve healthcare outcomes worldwide. Continued research into novel antiviral agents and drug repurposing initiatives expands the arsenal of effective treatments against SARS-CoV-2 variants and future viral threats. Investing in innovative drug discovery and development efforts enables the rapid adaptation of therapies to evolving viral landscapes, enhancing preparedness for emerging infectious diseases. In conclusion, ongoing research underscores the potential of antiviral therapeutic drugs in combating SARS-CoV-2 and advancing patient care. Embracing innovative approaches, fostering global cooperation, and prioritizing drug development efforts are critical steps toward maximizing the impact of antiviral therapies in the fight against COVID-19 and emerging infectious diseases.

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Received: April 05 2024
Accepted: 17 June 2024