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Review Article

DRUG THAT FAILED TO CURE COVID 19¹Vikas Bhagwat, ¹Nikita Jadhav, ¹Sakshi Rajwade, ²Monali Shelar, ²Akshay Harpade,
²Mr. Manish Dattatraya Ahire¹Research Scholars, JES SND Institute of Pharmacy Babhulgaon Yeola Nashik -423401²Assistant Professor, JES SND Institute of Pharmacy Babhulgaon Yeola Nashik -423401**Abstract:**

The outbreak of the new coronavirus, SARS-CoV-2, led to an unusual global health crisis, demanding immediate and thorough examination of medications and treatment approaches to counteract COVID-19. An examination of the published material looks closely at the treatments and approaches that, despite early promise, fell short of expectations in the search for a cure.

Our review covers a variety of medicinal substances and strategies, many of which are intended to either directly target the virus or affect the host's immunological response. By means of an in-depth analysis of the scientific justification, clinical trial procedures, and ensuing results, we clarify the differences and difficulties experienced in these activities. The information gained from this study not only advances our comprehension of the complex nature of COVID-19 treatments,

The understanding acquired from these errors serves as an essential guide as the world's scientific community tries to contain the pandemic and directs research efforts in healthier directions. The need of collaborative, multidisciplinary attempts to understand the complexity of COVID-19 and develop therapies that can overcome the virus's cryptic nature is highlighted by the growing need for adaptable and creative strategies.

In conclusion, by providing some light on the difficulties and drawbacks encountered in the search for COVID-19 treatments, this study review provides to the body of knowledge. Recognizing these failures helps to build a stronger and more knowledgeable scientific community that can move forward towards practical solutions for the present and next global health emergencies while negotiating the changing terrain of infectious diseases.

Keywords: COVID-19, medicinal, infectious, complex, collaborative.

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INTRODUCTION:

During an enormous national health emergency that are brought on by a newly discovered coronavirus, severe acute respiratory syndrome coronavirus 2, the scientific and medical communities began a quick search for efficient medications and treatment approaches to tackle COVID-19. In an effort to find a treatment for the elusive virus, scientists increased their investigation of already available drugs and developed innovative interventions therefore it is imperative that you act fast. But there have been some obstacles and frustrations with this project.¹

This review of the literature aims to provide an understanding of the medications and approaches that, although indicating promise at first, did not prove to be as effective as expected in treating COVID-19. Numerous medicinal substances and treatment methods were put out and researched as the epidemic spread; each had its own processes and justifications. While some tried to modify the host immune response to lessen the severity of the sickness, others directly targeted the virus in an effort to prevent its addition or entry into host cells. The complicated mechanisms behind these unsuccessful initiatives will be thoroughly investigated in this review, including the scientific justification for every medication or approach, the techniques used in clinical trials, and the resulting results that eventually failed to live up to expectations.² We hope to gain important insights from an awareness of the flaws and difficulties encountered in these initiatives, insights that will help shape future research areas and influence the development of antiviral therapies with greater efficacy.

It is obvious from navigating the maze of COVID-19 therapeutic research that there are many challenges in the way of an effective treatment.³ However, the knowledge base is expanded by the lessons learned from the mistakes detailed in this analysis, which moves us one step closer to the unachievable target of ending the ongoing global health crisis.⁴

Drug Profile of Therapeutic Agents Investigated for COVID-19

1. Lopinavir

Mechanism of Action: Lopinavir is an HIV-1 protease inhibitor that prevents the cleavage of viral Gag-Pol polyproteins, thereby interfering with the production of mature, infectious HIV particles. It was investigated for COVID-19 because of its potential antiviral activity; however, its mechanism against HIV does not necessarily translate into effective inhibition of SARS-CoV-2.⁹

Reason for Failure: Clinical studies did not demonstrate a significant clinical benefit of lopinavir/ritonavir in hospitalized patients with COVID-19. Its limited activity against SARS-CoV-

2 and the lack of improvement in major clinical outcomes led to the conclusion that it was not an effective treatment option for this indication.¹⁰

2. Remdesivir

Mechanism of Action: Remdesivir is a nucleotide analogue prodrug that inhibits the RNA-dependent RNA polymerase (RdRp) of SARS-CoV-2. Following intracellular activation, its active metabolite competes with natural nucleotides during viral RNA synthesis, resulting in delayed chain termination and inhibition of viral replication.¹¹⁻¹⁸

Reason for Limited Effectiveness: Although remdesivir has demonstrated antiviral activity and can provide clinical benefits in selected patients, its effectiveness depends on the timing of administration, disease severity, and the patient's clinical condition. It has not consistently demonstrated a mortality benefit across all hospitalized patient populations, particularly when administered after advanced inflammatory disease has developed.¹⁹

3. Darunavir

Mechanism of Action: Darunavir is an HIV-1 protease inhibitor that blocks the cleavage of viral Gag and Gag-Pol polyproteins, preventing the formation of mature, infectious HIV particles. It was investigated as a potential repurposed antiviral agent for COVID-19 because of its established activity against HIV protease.²⁰⁻²⁶

Reason for Failure: Darunavir did not demonstrate meaningful antiviral activity against SARS-CoV-2 in relevant laboratory studies. The protease targeted by darunavir in HIV differs from the principal proteases involved in SARS-CoV-2 replication; therefore, its established efficacy against HIV could not be extrapolated to COVID-19 treatment.^{27, 28}

4. Hydroxychloroquine

Mechanism of Action: Hydroxychloroquine is an antimalarial and immunomodulatory drug that can alter intracellular organelle pH and interfere with certain cellular processes involved in viral entry. It was initially investigated for COVID-19 because these effects were hypothesized to interfere with SARS-CoV-2 infection and replication.²⁹⁻³⁶

Reason for Failure: Subsequent clinical evidence did not establish a meaningful benefit of hydroxychloroquine in preventing or treating COVID-19. Furthermore, the drug can prolong the QT interval and increase the risk of potentially serious cardiac arrhythmias, particularly in susceptible patients or when combined with other QT-prolonging medicines.³⁷

5. Favipiravir

Mechanism of Action: Favipiravir is an antiviral prodrug that is converted intracellularly into favipiravir-ribofuranosyl-5'-triphosphate (favipiravir-RTP). This active metabolite interferes

with viral RNA-dependent RNA polymerase activity and may induce lethal mutagenesis or inhibit viral RNA synthesis, depending on the virus and experimental conditions.³⁸⁻⁴⁴

Reason for Limited Effectiveness: Clinical evidence has not established a consistent, clinically meaningful benefit of favipiravir against COVID-19. Reported adverse effects include gastrointestinal disturbances and elevations in liver enzymes. Hyperuricaemia is also a recognized adverse effect. These safety considerations, together with uncertainty regarding clinical efficacy, limit its role in routine COVID-19 treatment.^{45, 46}

6. Umifenovir

Mechanism of Action: Umifenovir, also known as arbidol, is an antiviral agent that interferes with membrane fusion and viral entry by stabilizing viral envelope proteins and preventing the fusion process required for infection. It has also been investigated for potential immunomodulatory effects and activity against respiratory viruses, including SARS-CoV-2.⁴⁷⁻⁴⁹

Reason for Limited Effectiveness: Clinical studies have not established sufficient evidence to support umifenovir as an effective treatment for COVID-19. Although some studies reported gastrointestinal adverse effects, including nausea and diarrhoea, the major limitation was the lack of consistent evidence of clinically significant benefit rather than a clearly established safety concern.⁵⁰

7. Corticosteroids

Mechanism of Action: Corticosteroids bind to intracellular glucocorticoid receptors and regulate the transcription of genes involved in inflammation and immune responses. They reduce the production of pro-inflammatory mediators and suppress excessive immune activation, potentially limiting tissue damage associated with severe respiratory infections.⁵¹⁻⁵³

Reason for Limited Effectiveness: Corticosteroids did not consistently improve outcomes in earlier coronavirus infections, including SARS and MERS, and their effects depend on disease severity and treatment timing. In COVID-19, systemic corticosteroids such as dexamethasone are beneficial in patients requiring supplemental oxygen or ventilatory support, but they are not recommended routinely for patients who do not require oxygen because unnecessary immunosuppression may cause harm.⁵⁴

8. Ivermectin

Mechanism of Action: Ivermectin is an antiparasitic agent that acts primarily through glutamate-gated chloride channels in invertebrates, causing neuromuscular paralysis and parasite death. It was investigated for COVID-19 after preliminary laboratory studies suggested possible antiviral

effects; however, the concentrations required for these effects in vitro raised concerns regarding their clinical feasibility.⁵⁵⁻⁵⁸

Reason for Failure: Available clinical evidence has not established a reliable benefit of ivermectin for preventing or treating COVID-19. Inadequate evidence of clinically meaningful efficacy, together with concerns regarding the translation of laboratory findings into achievable human drug concentrations, limits its use for this indication.⁵⁹

9. Dexamethasone

Mechanism of Action: Dexamethasone is a potent glucocorticoid that binds to intracellular glucocorticoid receptors and modifies the expression of genes involved in inflammatory responses. It reduces excessive inflammation and immune-mediated lung injury, making it useful in selected patients with severe or critical COVID-19.^{60, 61}

Therapeutic Outcome and Limitations: Unlike several repurposed drugs that failed to demonstrate clinical benefit, dexamethasone has been shown to reduce mortality in hospitalized patients requiring supplemental oxygen or mechanical ventilation. However, it does not provide the same benefit to patients who do not require respiratory support and may increase the risk of adverse effects when used inappropriately.^{62, 63}

10. Tocilizumab

Mechanism of Action: Tocilizumab is a monoclonal antibody that binds to soluble and membrane-bound interleukin-6 (IL-6) receptors, inhibiting IL-6-mediated signalling. By reducing excessive inflammatory responses, it may help control systemic inflammation and respiratory deterioration in selected patients with severe or critical COVID-19.⁶⁷⁻⁷²

Reason for Variable Effectiveness: The clinical benefit of tocilizumab depends on patient selection, disease severity, timing of administration, and concomitant treatment, particularly systemic corticosteroids. Evidence supports its use in selected hospitalized patients with severe or critical COVID-19 and systemic inflammation; however, it is not universally beneficial and can increase susceptibility to secondary infections.^{73, 74}

11. Baricitinib

Mechanism of Action: Baricitinib is an inhibitor of Janus kinase 1 and 2 (JAK1/JAK2). It reduces intracellular signalling mediated by several inflammatory cytokines, including IL-2, IL-6, IL-10, interferon- γ , and granulocyte-macrophage colony-stimulating factor. It may also interfere with host-cell pathways involved in viral entry, although its principal clinical role in COVID-19 is immunomodulation.⁷⁵⁻⁸³

Therapeutic Outcome and Limitations: Clinical trials have demonstrated that baricitinib can improve

outcomes in selected hospitalized patients with COVID-19, particularly when used with appropriate standard care. Nevertheless, treatment requires monitoring for infections, thrombosis, changes in liver function, cytopenias, and other potential adverse effects. Its use should be guided by disease severity and current treatment recommendations.⁸⁴

12. Tofacitinib

Mechanism of Action: Tofacitinib is a Janus kinase inhibitor that primarily inhibits JAK1 and JAK3, with activity against JAK2 at higher concentrations. By interfering with cytokine-mediated intracellular signalling, it reduces the production and activity of inflammatory mediators that contribute to excessive immune activation.⁸⁵⁻⁹¹

Therapeutic Outcome and Limitations: A randomized clinical trial reported a lower risk of respiratory failure or death by day 28 among hospitalized patients with COVID-19 pneumonia treated with tofacitinib compared with placebo. However, evidence remains more limited than for some other immunomodulatory agents, and potential risks include serious infections, thrombosis, and laboratory abnormalities. Its use therefore requires careful patient selection and clinical monitoring.^{92,93}

13. Sarilumab

Mechanism of Action: Sarilumab is a monoclonal antibody that inhibits both soluble and membrane-bound IL-6 receptors. By blocking IL-6-mediated signalling, it may reduce excessive inflammatory activity associated with severe COVID-19 and help control inflammation-related respiratory deterioration.⁹³⁻⁹⁷

Reason for Variable Effectiveness: Clinical trials have produced variable results regarding the efficacy of sarilumab in COVID-19. Some studies have reported limited or no significant improvement in major clinical outcomes, and secondary infections remain a concern in critically ill patients. Its effectiveness may depend on the severity of inflammation, treatment timing, and concomitant therapies.⁹⁸

14. Anakinra

Mechanism of Action: Anakinra is a recombinant interleukin-1 receptor antagonist that competitively inhibits the binding of IL-1 α and IL-1 β to the IL-1 type 1 receptor. By suppressing IL-1-mediated inflammatory signalling, it may help control excessive inflammation in selected patients with severe COVID-19 and features of systemic hyperinflammation.⁹⁹

Reason for Variable Effectiveness and Adverse Effects: The clinical benefit of anakinra in COVID-19 has varied across studies and depends on patient selection, disease severity, and the timing of treatment. Potential adverse effects include

injection-site reactions, nausea, diarrhoea, headache, and an increased risk of infection. Its use is therefore restricted to selected clinical circumstances in which an appropriate benefit-risk assessment supports treatment.^{100,101}

Pharmacological Profiles and Clinical Evaluation of Repurposed Drugs for COVID-19

1. Lopinavir/Ritonavir: Viral Protease Inhibition and Clinical Outcomes

Pharmacological basis. Lopinavir inhibits HIV protease, preventing the cleavage of viral Gag-Pol polyproteins and thereby interfering with the maturation of infectious HIV particles. Ritonavir is administered primarily to inhibit CYP3A-mediated metabolism of lopinavir and increase its systemic exposure. This combination was investigated for COVID-19 because of the possibility of repurposing protease inhibitors as antiviral agents.^{5,6}

Clinical evidence and limitations. Clinical investigations did not demonstrate a significant improvement in major outcomes among hospitalized patients with COVID-19. The lack of meaningful clinical benefit, together with the differences between HIV protease and SARS-CoV-2 proteases, limited the therapeutic applicability of this combination.^{7,8}

2. Remdesivir: Inhibition of Viral RNA Replication

Molecular target. Remdesivir is a nucleotide analogue prodrug that undergoes intracellular conversion to an active metabolite capable of inhibiting the RNA-dependent RNA polymerase of SARS-CoV-2. Its antiviral activity results from interference with viral RNA synthesis, making it mechanistically different from drugs that primarily target host inflammatory pathways.¹²⁻¹⁴

Therapeutic limitations. Clinical outcomes depend on the timing of administration, disease severity, and the stage of viral replication. Although remdesivir has demonstrated benefits in selected clinical settings, its effects are not uniform across all patient groups, and a consistent mortality benefit has not been established in every hospitalized population.¹⁵

3. Darunavir: Limitations of Protease-Inhibitor Repurposing

Pharmacological basis. Darunavir inhibits HIV protease and prevents the processing of viral Gag and Gag-Pol polyproteins into functional structural and enzymatic components. Its established activity against HIV prompted investigation of its possible application against SARS-CoV-2.²¹⁻²³

Evidence of limited activity. Darunavir did not demonstrate convincing antiviral activity against SARS-CoV-2 in relevant experimental studies. The differences in protease structure and drug-target interactions help explain why its established antiretroviral activity did not translate into a demonstrated therapeutic benefit for COVID-19.²⁴

4. Hydroxychloroquine: Early Antiviral Hypothesis and Subsequent Evidence

Proposed mechanism. Hydroxychloroquine is an antimalarial and immunomodulatory agent that can alter endosomal and lysosomal pH and interfere with certain cellular processes associated with viral entry. These properties initially generated interest in its potential application against SARS-CoV-2.^{30,32}

Clinical limitations. Subsequent clinical research did not establish a meaningful benefit for COVID-19 treatment or prevention. Furthermore, its potential to prolong the QT interval and cause serious cardiac arrhythmias represents an important safety concern, particularly in patients with additional cardiac risk factors.³³

5. Favipiravir: Interference with Viral RNA Synthesis

Molecular mechanism. Favipiravir is converted intracellularly into favipiravir-ribofuranosyl-5'-triphosphate, which interferes with viral RNA-dependent RNA polymerase activity. Depending on the viral system and experimental conditions, this interference may suppress RNA synthesis or promote the accumulation of mutations in the viral genome.^{39,40}

Clinical limitations and safety. The clinical evidence has not established a consistent, clinically meaningful benefit for favipiravir in COVID-19. Hyperuricaemia, gastrointestinal disturbances, and elevations in liver enzymes have been reported, requiring consideration of its safety profile alongside the uncertainty regarding therapeutic effectiveness.^{41,42}

Dark and light side of Drug used in Covid-19.

6. Lopinavir: Antiretroviral medication lopinavir is used to treat HIV; it was not created especially for COVID-19. Although it was first thought to be a possible COVID-19 therapy, investigations have produced contradictory findings. The drawbacks include possible adverse effects such as gastrointestinal problems and restricted effectiveness. On the plus side, it is widely accessible and has a well-established safety profile, although it is yet unclear how effective it is against COVID-19. To ensure you have the most recent information on COVID-19 therapies, always speak with medical professionals.²

Remdesivir: The antiviral drug remdesivir has been approved for use in treating COVID-19 in an emergency. Positively, it has demonstrated potential in clinical trials and may help certain patients recover faster. On the other hand, its drawbacks include the lack of evidence regarding mortality advantages, possible adverse effects such as elevation of liver enzymes, and the requirement for intravenous administration, which makes it less practical for usage as an outpatient. Seeking

individualised advice from healthcare professionals on COVID-19 therapies is imperative.¹²

7. Darunavir: An HIV protease inhibitor called Darunavir has been investigated as a possible treatment for COVID-19. On the plus side, because it is used to treat HIV, its safety profile is comparatively well-established and it has demonstrated antiviral effectiveness in laboratory tests. On the other hand, its effectiveness against COVID-19 appears to be limited based on little clinical evidence, and its potential for treating this virus is still being studied. Speaking with medical experts is crucial if you want the most recent details on COVID-19 therapies.²¹

Hydroxychloroquine: Early in the COVID-19 pandemic, hydroxychloroquine attracted attention, although its application has been debatable. On the down side, extensive research revealed that it poses possible hazards like irregular heartbeat and is unsuccessful in treating COVID-19. Its proven use for autoimmune disorders and malaria indicates a known safety profile, which is the positive side. Its current COVID-19 treatment advice is, however, limited, so careful assessment is essential. For the most recent advice on COVID-19 therapies, always seek the advice of medical professionals.³⁰

8. Favipiravir: One antiviral drug being investigated for COVID-19 treatment is favipiravir. Positively, several studies have indicated that it is useful in lowering symptoms and recovery time. On the other hand, there is conflicting clinical evidence, little information on the advantages of mortality, and worries over safety when pregnant. Its significance in treating COVID-19 is still being studied, and for individualized advice, speaking with medical professionals is crucial.⁴⁰

Umifenovir: Arbidol, also called umifenovir, is an antiviral drug that is mostly used to treat influenza, while it has also been researched for possible use in COVID-19. On the plus side, some research points to antiviral action against coronaviruses, and COVID-19 treatment has been used in some nations. On the other hand, there isn't much solid clinical data to support its effectiveness, and its use in treating COVID-19 isn't widely acknowledged. It's critical to speak with medical professionals to get the most recent recommendations on COVID-19 therapy as research advances.⁵⁰

Corticosteroids: By lowering inflammation, corticosteroids such as dexamethasone have demonstrated efficacy in the treatment of severe COVID-19 patients. Prolonged use, however, may have negative effects as well, such as weakened immunity and a higher chance of recurring infections. It's critical to weigh the advantages and possible disadvantages of them while under medical care.⁵²

9. Ivermectin: The application of ivermectin for COVID-19 is still debatable. Studies vary in their prospective advantages and lack of statistical significance. Adverse effects may result from misuse and self-medication. Making educated judgments about Ivermectin and COVID-19 requires depending on trustworthy medical advice and further research.⁵⁶

Tocilizumab: By focusing on cytokine storms, the anti-inflammatory medication tocilizumab exhibits potential in the treatment of severe COVID-19. It is not, however, generally advised, and possible adverse effects include elevated liver enzymes and heightened susceptibility to infections. Its use ought to be carefully evaluated in light of the unique circumstances of each patient and under medical supervision.⁶⁷

10. Baricitinib: The immunosuppressive medication baricitinib has been approved for use in conjunction with remdesivir to treat severe COVID-19 cases. It reduces inflammation. Its use could, however, increase the risk of infections and other negative effects. To weigh the advantages against any potential disadvantages for each patient, medical monitoring is essential.⁷⁷

Sarilumab In situations of severe COVID-19, sarilumab, an interleukin-6 receptor antagonist, is used to treat excessive inflammation. Although there may be advantages, there may also be disadvantages, such as an elevated risk of infections and abnormal liver enzyme levels. Healthcare practitioners must carefully assess each patient to weigh the benefits against any possible negative effects.⁹⁴

Anakinra: The interleukin-1 receptor antagonist anakinra is being investigated for the treatment of severe COVID-19-related inflammation. There could be advantages, but there could also be disadvantages, such a higher chance of infections. In COVID-19 patients, its use necessitates cautious thought and medical monitoring in order to balance its anti-inflammatory benefits and any side effects.⁹⁹

11. Dexamethasone: Advantages and disadvantages of COVID-19 treatment. Positively, it has shown effectiveness in lowering mortality rates in severe cases by inhibiting the cytokine storm, an overreaction of the immune system. However, there are some negative consequences linked to its use, including immunosuppression, a higher chance of developing secondary infections, and metabolic problems. When administering dexamethasone to COVID-19 patients, caution and close observation are essential.⁶¹

Tofacitinib: When it came to lowering the for individuals with COVID-19 pneumonia who were at risk of death or respiratory failure through day 28, tofacitinib performed better than a placebo in a

clinical trial. Are hospitalized. These results were true for all individuals,⁹² irrespective of their age, gender, glucocorticoid usage, or length of symptoms at baseline. They also held true for varying degrees of extra oxygen consumption at the beginning.⁹³

REFERENCES:

1. Nutho B, Mahalapbutr P, Hengphasatporn K, Pattarangoon NC, Simanon N, Shigeta Y, et al. Why are lopinavir and ritonavir effective against the newly emerged coronavirus 2019? Atomistic insights into the inhibitory mechanisms. *Biochemistry*. 2020 May 12;59(18):1769–79.
2. SYSTEMATIC REVIEW
Lopinavir/ritonavir for COVID-19: A living systematic review-
Medwave[Internet]. Available from <http://viej.medwave.cl/link.cgi/English/Original/SystReviews/7966.act...>
3. Lopinavir/ritonavir: Repurposing an old drug for HIV infection in CO.
4. Kaizer AM, Shapiro NI, Wild J, Brown SM, Cwik BJ, Hart KW, et al. Lopinavir/ritonavir for treatment of non-hospitalized patients with COVID-19: a randomized clinical trial. *International Journal of Infectious Diseases*. 2023 Mar 1;128:223–9.
5. A Trial of Lopinavir–Ritonavir in Covid-19. *New England Journal of Medicine*. 2020 May 21;382(21):e68.
6. Hui DS, I Azhar E, Madani TA, Ntoumi F, Kock R, Dar O, et al. The continuing 2019-nCoV epidemic threat of novel coronaviruses to global health — The latest 2019 novel coronavirus outbreak in Wuhan, China. Vol. 91, *International Journal of Infectious Diseases*. Elsevier B.V.; 2020. p. 264–6.
7. Negru PA, Radu AF, Vesa CM, Behl T, Abdel-Daim MM, Nechifor AC, et al. Therapeutic dilemmas in addressing SARS-CoV-2 infection: Favipiravir versus Remdesivir. Vol. 147, *Biomedicine and Pharmacotherapy*. Elsevier Masson s.r.l.; 2022.
8. Pruijssers AJ, George AS, Schäfer A, Leist SR, Gralinski LE, Dinno KH, et al. Remdesivir Inhibits SARS-CoV-2 in Human Lung Cells and Chimeric SARS-CoV Expressing the SARS-CoV-2 RNA Polymerase in Mice. *Cell Rep*. 2020 Jul 21;32(3).
9. Beigel JH, Tomashek KM, Dodd LE, Mehta AK, Zingman BS, Kalil AC, et al. Remdesivir for the Treatment of Covid-19 — Final Report. *New England Journal of Medicine*. 2020 Nov 5;383(19):1813–26.
10. Lee TC, McDonald EG, Butler-Laporte G, Harrison LB, Cheng MP, Brophy JM. Remdesivir and systemic corticosteroids for the treatment of COVID-19: A Bayesian re-

- analysis. *International Journal of Infectious Diseases*. 2021 Mar 1;104:671–6.
11. Whittington MD, Pearson SD, Rind DM, Campbell JD. The Cost-Effectiveness of Remdesivir for Hospitalized Patients With COVID-19. Available from: www.elsevier.com/locate/jval
 12. Maciorowski D, Idrissi SZE, Gupta Y, Medernach BJ, Burns MB, Becker DP, et al. A Review of the Preclinical and Clinical Efficacy of Remdesivir, Hydroxychloroquine, and Lopinavir-
 13. Ritonavir Treatments against COVID-19. Vol. 25, SLAS Discovery. SAGE Publications Inc.; 2020. p. 1108–22.
 14. Lee TC, Murthy S, Del Corpo O, Senécal J, Butler-Laporte G, Sohani ZN, et al. Remdesivir for the treatment of COVID-19: a systematic review and meta-analysis. Vol. 28, *Clinical Microbiology and Infection*. Elsevier B.V.; 2022. p. 1203–10.
 15. Chhatwal J, Basu A. Cost-Effectiveness of Remdesivir for COVID-19 Treatment: What Are We Missing? Vol. 25, *Value in Health*. Elsevier Ltd; 2022. p. 697–8.
 16. Budi DS, Pratama NR, Wafa IA, Putra M, Wardhana MP, Wungu CDK. Remdesivir for pregnancy: A systematic review of antiviral therapy for COVID-19. *Heliyon*. 2022 Jan 1;8(1).
 17. Sharma T, Qamar I, Zwarenstein M. How pragmatic are randomized trials of remdesivir and favipiravir for in-hospital treatment of COVID-19: a descriptive methodological review of trial design using the PRECIS-2 framework. Vol. 152, *Journal of Clinical Epidemiology*. Elsevier Inc.; 2022. p. 193–200.
 18. Tumminia A, Romano R, Brugaletta G, Scicali R, Biondi G, Oliveri R, et al. The impact of obesity and dyslipidemia on Remdesivir effectiveness in hospitalized patients with SARS-CoV-2-related pneumonia: An observational study. *Nutrition, Metabolism and Cardiovascular Diseases*. 2022 Jul 1;32(7):1635–41.
 19. Brouqui P, Giraud-Gatineau A, Raoult D. Critical reappraisal of remdesivir investigational trials in COVID-19. Vol. 38, *New Microbes and New Infections*. Elsevier Ltd; 2020.
 20. Halimi V, Daci A, Ridova N, Panovska-Stavridis I, Stevanovic M, Filipce V, et al. The use of remdesivir outside of clinical trials during the COVID-19 pandemic. Vol. 13, *Journal of Pharmaceutical Policy and Practice*. BioMed Central Ltd; 2020.
 21. Chu CM, Cheng VCC, Hung IFN, Wong MML, Chan KH, Chan KS, et al. Role of lopinavir/ritonavir in the treatment of SARS: Initial virological and clinical findings. *Thorax*. 2004 Mar;59(3):252–6.
 22. Wang M, Cao R, Zhang L, Yang X, Liu J, Xu M, et al. Remdesivir and chloroquine effectively inhibit the recently emerged novel coronavirus (2019-nCoV) in vitro. Vol. 30, *Cell Research*. Springer Nature; 2020. p. 269–71.
 23. Tashima K, Crofoot G, Tomaka FL, Kakuda TN, Brochot A, Van de Casteele T, et al. Cobicistat-boosted darunavir in HIV-1-infected adults: Week 48 results of a Phase IIb, open-label single-arm trial. *AIDS Res Ther*. 2014 Dec 1;11(1).
 24. Hoehl S, Rabenau H, Berger A, Kortenbusch M, Cinatl J, Bojkova D, et al. Evidence of SARS-CoV-2 Infection in Returning Travelers from Wuhan, China. *New England Journal of Medicine*. 2020 Mar 26;382(13):1278–80.
 25. Navarro J, Curran A. Profile of once-daily darunavir/cobicistat fixed-dose combination for the treatment of HIV/AIDS. Vol. 8, *HIV/AIDS - Research and Palliative Care*. Dove Medical Press Ltd.; 2016. p. 175–82.
 26. Cahn P, Fourie J, Grinsztejn B, Hodder S, Molina JM, Ruxrungtham K, et al. Week 48 analysis of once-daily vs. twice-daily darunavir/ritonavir in treatment-experienced HIV-1-infected patients. *AIDS*. 2011 Apr 24;25(7):929–39.
 27. Hui DS, I Azhar E, Madani TA, Ntoumi F, Kock R, Dar O, et al. The continuing 2019-nCoV epidemic threat of novel coronaviruses to global health — The latest 2019 novel coronavirus outbreak in Wuhan, China. Vol. 91, *International Journal of Infectious Diseases*. Elsevier B.V.; 2020. p. 264–6.
 28. Baden LR, Rubin EJ. Covid-19 — The Search for Effective Therapy. *New England Journal of Medicine* [Internet]. 2020;382(19):1851–2. Available from: <https://doi.org/10.1056/NEJMe2005477>
 29. De Meyer S, Bojkova D, Cinatl J, Van Damme E, Buyck C, Van Loock M, et al. Lack of antiviral activity of darunavir against SARS-CoV-2. *International Journal of Infectious Diseases*. 2020 Aug 1;97:7–10.
 30. Frommeyer G, Fischer C, Ellermann C, Dechering DG, Kochhäuser S, Lange PS, et al. Additive Proarrhythmic Effect of Combined Treatment with QT-Prolonging Agents. *Cardiovasc Toxicol*. 2018 Feb 1;18(1):84–90.
 31. Darpo B, Karnad DR, Badilini F, Florian J, Garnett CE, Kothari S, et al. Are women more susceptible than men to drug-induced QT prolongation? Concentration-QTc modelling in a phase 1 study with oral rac-sotalol. *Br J Clin Pharmacol*. 2014 Mar;77(3):522–31.

32. Mason JW. Antimicrobials and QT prolongation. *Journal of Antimicrobial Chemotherapy*. 2017 May 1;72(5):1272–4.
33. Funck-Brentano C, Salem JE. Chloroquine or hydroxychloroquine for COVID-19: why might they be hazardous? *The Lancet*. Lancet Publishing Group; 2020.
34. Mehra MR, Desai SS, Ruschitzka F, Patel AN. RETRACTED:Hydroxychloroquine or chloroquine with or without a macrolide for treatment of COVID-19: a multinational registry analysis. *The Lancet*. Lancet Publishing Group; 2020.
35. 37-Drugs for Treating Protozoan Infections.
36. Vlachos K, Georgopoulos S, Efremidis M, Sideris A, Letsas KP. An update on risk factors for drug-induced arrhythmias. Vol. 9, Expert Review of Clinical Pharmacology. Taylor and Francis Ltd; 2016. p. 117–27.
37. White NJ. Cardiotoxicity of antimalarial drugs [Internet]. 2007. Available from: <http://infection.thelancet.comVol>
38. Sarganas G, Garbe E, Klimpel A, Hering RC, Bronder E, Haverkamp W. Epidemiology of symptomatic drug-induced long QT syndrome and torsade de pointes in Germany. *Europace*. 2014 Jan;16(1):101–8.
39. Vlachos K, Georgopoulos S, Efremidis M, Sideris A, Letsas KP. An update on risk factors for drug-induced arrhythmias. Vol. 9, Expert Review of Clinical Pharmacology. Taylor and Francis Ltd; 2016. p. 117–27.
40. 37-Drugs for Treating Protozoan Infections.
41. White NJ. Cardiotoxicity of antimalarial drugs [Internet]. 2007. Available from: <http://infection.thelancet.comVol>
42. Darpo B, Karnad DR, Badilini F, Florian J, Garnett CE, Kothari S, et al. Are women more susceptible than men to drug-induced QT prolongation? Concentration-QTc modelling in a phase 1 study with oral rac-sotalol. *Br J Clin Pharmacol*. 2014 Mar;77(3):522–31.
43. Mason JW. Antimicrobials and QT prolongation. *Journal of Antimicrobial Chemotherapy*. 2017 May 1;72(5):1272–4.
44. Frommeyer G, Fischer C, Ellermann C, Dechering DG, Kochhäuser S, Lange PS, et al. Additive Proarrhythmic Effect of Combined Treatment with QT-Prolonging Agents. *Cardiovasc Toxicol*. 2018 Feb 1;18(1):84–90.
45. Sarganas G, Garbe E, Klimpel A, Hering RC, Bronder E, Haverkamp W. Epidemiology of symptomatic drug-induced long QT syndrome and torsade de pointes in Germany. *Europace*. 2014 Jan;16(1):101–8.
46. Mehra MR, Desai SS, Ruschitzka F, Patel AN. RETRACTED:Hydroxychloroquine or chloroquine with or without a macrolide for treatment of COVID-19: a multinational registry analysis. *The Lancet*. Lancet Publishing Group; 2020.
47. Funck-Brentano C, Salem JE. Chloroquine or hydroxychloroquine for COVID-19: why might they be hazardous? *The Lancet*. Lancet Publishing Group; 2020.
48. Berendsen BJA, Wegh RS, Essers ML, Stolker AAM, Weigel S. Quantitative trace analysis of a broad range of antiviral drugs in poultry muscle using column-switch liquid chromatography coupled to tandem mass spectrometry. *Anal Bioanal Chem*. 2012 Feb;402(4):1611–23.
49. Deng L, Li C, Zeng Q, Liu X, Li X, Zhang H, et al. Arbidol combined with LPV/r versus LPV/r alone against Corona Virus Disease 2019: A retrospective cohort study. *Journal of Infection*. 2020 Jul 1;81(1):e1–5.
50. Kons A, Bērziņš A, Krūkle-Bērziņa K, Actiņš A. Characterization and Physicochemical Evaluation of Molecular Complexes Formed Between Umifenovir and Dicarboxylic Acids. *Latvian Journal of Chemistry*. 2014 Sep 19;52(1–2):28–40.
51. Lian N, Xie H, Lin S, Huang J, Zhao J, Lin Q. Umifenovir treatment is not associated with improved outcomes in patients with coronavirus disease 2019: a retrospective study. *Clinical Microbiology and Infection*. 2020 Jul 1;26(7):917–21.
52. Zha L, Li S, Pan L, Tefsen B, Li Y, French N, Chen L, Yang G, Villanueva EV. Corticosteroid treatment of patients with coronavirus disease 2019 (COVID-19). *Medical Journal of Australia*. 2020 May;212(9):416–20.
53. Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet* 2020; 395: 497–506.
54. Xu Z, Shi L, Wang Y, et al. Pathological findings of COVID-19 associated with acute respiratory distress syndrome. *Lancet Respir Med* 2020; [https://doi.org/10.1016/s2213-2600\(20\)30076-x](https://doi.org/10.1016/s2213-2600(20)30076-x) [Epub ahead of print].
55. Lu H. Drug treatment options for the 2019-new coronavirus (2019-nCoV). *Biosci Trends* 2020; 14: 69–71.
56. Popp M, Stegemann M, Metzendorf MI, Gould S, Kranke P, Meybohm P, Skoetz N, Weibel S. Ivermectin for preventing and treating COVID-19. *Cochrane Database of Systematic Reviews*. 2021(7).
57. Higgins JP, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, et al, editor(s). *Cochrane Handbook for Systematic Reviews of Interventions* version 6.1 (updated September 2020). Cochrane, 2020. Available from training.cochrane.org/handbook/archive/v6.1

58. Marshall JC, Murthy S, Diaz J, Adhikari NK, Angus DC, Arabi YM, et al. A minimal common outcome measure set for COVID-19 clinical research. *Lancet Infectious Diseases* 2020;20(8):e192-7. [DOI: 10.1016/S1473-3099(20)30483-7] [PMID: 32539990]
59. Singh B, Ryan H, Kredon T, Chaplin M, Fletcher T. Chloroquine or hydroxychloroquine for prevention and treatment of COVID-19. *Cochrane Database of Systematic Reviews* 2021, Issue 2. Art. No: CD013587. [DOI: 10.1002/14651858.CD013587.pub2]
60. Higgins JP, Eldridge S, Li T. Chapter 23: Including variants on randomized trials. In: Higgins JP, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, et al, editor(s). *Cochrane Handbook for Systematic Reviews of Interventions* version 6.1 (updated September 2020). Cochrane, 2020. Available from training.cochrane.org/handbook/archive/v6.1.
61. Matthay MA, Thompson BT. Dexamethasone in hospitalised patients with COVID-19: addressing uncertainties. *The Lancet Respiratory Medicine*. 2020 Dec 1;8(12):1170-2.
62. Centers for Disease Control and Prevention. Outbreak of lung injury associated with the use of e-cigarette, or vaping products. Feb 25, 2020. https://www.cdc.gov/tobacco/basic_information/e-cigarettes/severe-lung-disease.html (accessed Sept 29, 2020).
63. Layden JE, Ghinai I, Pray I, et al. Pulmonary illness related to e-cigarette use in Illinois and Wisconsin—final report. *N Engl J Med* 2020; 382: 903–16.
64. Foust AM, Winant AJ, Chu WC, Das KM, Phillips GS, Lee EY. Pediatric SARS, H1N1, MERS, EVALI, and now coronavirus disease (COVID-19) pneumonia: what radiologists need to know. *AJR Am J Roentgenol* 2020; 215: 736–44.
65. Blagev DP, Harris D, Dunn AC, Guidry DW, Grissom CK, Lanspa MJ. Clinical presentation, treatment, and short-term outcomes of lung injury associated with e-cigarettes or vaping: a prospective observational cohort study. *Lancet* 2019; 394: 2073–83.
66. Shields PG, Song MA, Freudenheim JL, et al. Lipid laden macrophages and electronic cigarettes in healthy adults. *EBioMedicine* 2020; 60: 102982.
67. Blount BC, Karwowski MP, Shields PG, et al. Vitamin E acetate in bronchoalveolar-lavage fluid associated with EVALI. *N Engl J Med* 2020; 382: 697–705.
68. Toniati P, Piva S, Cattalini M, Garrafa E, Regola F, Castelli F, Franceschini F, Airò P, Bazzani C, Beindorf EA, Berlendis M. Tocilizumab for the treatment of severe COVID-19 pneumonia with hyperinflammatory syndrome and acute respiratory failure: a single center study of 100 patients in Brescia, Italy. *Autoimmunity reviews*. 2020 Jul 1;19(7):102568.
69. Grasselli G, Pesenti A, Cecconi M. Critical care utilization for the COVID-19 outbreak in Lombardy, Italy: early experience and forecast during an emergency response. *JAMA - J Am Med Assoc* 2020. <https://doi.org/10.1001/jama.2020.4031> AIFA. <https://www.aifa.gov.it/sperimentazioni-cliniche-covid-19>.
70. Zamperetti N, Latronico N. Clinical research in critically ill patients: the situation in Italy. *Intensive Care Med* 2008;34:1330–2. <https://doi.org/10.1007/s00134-008-1096-6>
71. Piva S, Filippini M, Turla F, Cattaneo S, Margola A, De Fulviis S, et al. Clinical presentation and initial management of critically ill patients with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection in Brescia, Italy. *J Crit Care* 2020;58:29–33. <https://doi.org/10.1016/j.jcrc.2020.04.004>.
72. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *Lancet* 2020;395. [https://doi.org/10.1016/S0140-6736\(20\)30566-3](https://doi.org/10.1016/S0140-6736(20)30566-3).
73. Lippi G, Plebani M. Laboratory abnormalities in patients with COVID-2019 infection. *Clin Chem Lab Med* 2020. <https://doi.org/10.1515/cclm-2020-0198>.
74. Shoenfeld Y. Corona (COVID-19) time musings: our involvement in COVID-19 pathogenesis, diagnosis, treatment and vaccine planning. *Autoimmun Rev* 2020;102538. <https://doi.org/10.1016/j.autrev.2020.102538>.
75. Lin Z, Niu J, Xu Y, Qin L, Ding J, Zhou L. Clinical efficacy and adverse events of baricitinib treatment for coronavirus disease-2019 (COVID-19): A systematic review and meta-analysis. *Journal of Medical Virology*. 2022 Apr;94(4):1523-34.
76. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Ann Intern Med*. 2009;151(4):264-269. doi:10.7326/0003-4819-151-4-200908180-00135
77. Olivo SA, Macedo LG, Gadotti IC, Fuentes J, Stanton T, Magee DJ. Scales to assess the quality of randomized controlled trials: a systematic review. *Phys Ther*. 2008;88(2):156-175. doi:10.2522/ptj.20070147
78. Oremus M, Wolfson C, Perrault A, Demers L, Momoli F, Moride Y. Interrater reliability of

- the modified Jadad quality scale for systematic reviews of Alzheimer's disease drug trials. *Dement Geriatr Cogn Disord*. 2001;12(3):232-236. doi:10.1159/000051263
79. Hasan MJ, Rabbani R, Anam AM, et al. Impact of high dose of baricitinib in severe COVID-19 pneumonia: a prospective cohort study in Bangladesh. *BMC Infect Dis*. 2021;21(1):427. doi:10.1186/s12879-021-06119-2
 80. Bronte V, Ugel S, Tinazzi E, et al. Baricitinib restrains the immune dysregulation in patients with severe COVID-19. *J Clin Invest*. 2020; 130(12):6409-6416. doi:10.1172/JCI141772
 81. Rodriguez-Garcia JL, Sanchez-Nievas G, Arevalo-Serrano J, Garcia- Gomez C, Jimenez-Vizuet JM, Martinez-Alfaro E. Baricitinib improves respiratory function in patients treated with corticosteroids for SARS-CoV-2 pneumonia: an observational cohort study. *Rheumatology*. 2021;60(1):399-407. doi:10.1093/rheumatology/keaa587
 82. Ioannidis JP, Trikalinos TA. The appropriateness of asymmetry tests for publication bias in meta-analyses: a large survey. *CMAJ*. 2007; 176(8):1091-1096. doi:10.1503/cmaj.060410
 83. Lo CK, Mertz D, Loeb M. Newcastle-Ottawa Scale: comparing reviewers' to authors' assessments. *BMC Med Res Methodol*. 2014;14: 45. doi:10.1186/1471-2288-14-45
 84. Margulis AV, Pladevall M, Riera-Guardia N, et al. Quality assessment of observational studies in a drug-safety systematic review, comparison of two tools: the Newcastle-Ottawa Scale and the RTI item bank. *Clin Epidemiol*. 2014;6:359-368. doi:10.2147/CLEP.S66677
 85. Guimarães PO, Quirk D, Furtado RH, Maia LN, Saraiva JF, Antunes MO, Kalil Filho R, Junior VM, Soeiro AM, Tognon AP, Veiga VC. Tofacitinib in patients hospitalized with Covid-19 pneumonia. *New England Journal of Medicine*. 2021 Jul 29;385(5):406-15.
 86. Fajgenbaum DC, June CH. Cytokine storm. *N Engl J Med* 2020;383:2255-73.
 87. Dowty ME, Lin TH, Jesson MI, et al. Janus kinase inhibitors for the treatment of rheumatoid arthritis demonstrate similar profiles of in vitro cytokine receptor inhibition. *Pharmacol Res Perspect* 2019; 7(6):e00537.
 88. Boor PPC, de Ruiter PE, Asmawidjaja PS, Lubberts E, van der Laan LJW, Kwekkeboom J. JAK-inhibitor tofacitinib suppresses interferon alfa production by plasmacytoid dendritic cells and inhibits arthrogenic and antiviral effects of interferon alfa. *Transl Res* 2017;188:67-79
 89. Mehta P, McAuley DF, Brown M, Sanchez E, Tattersall RS, Manson JJ. COVID-19: consider cytokine storm syndromes and immunosuppression. *Lancet* 2020;395: 1033-4.
 90. Maeshima K, Yamaoka K, Kubo S, et al. The JAK inhibitor tofacitinib regulates synovitis through inhibition of interferon- γ and interleukin-17 production by human CD4⁺ T cells. *Arthritis Rheum* 2012;64: 1790-8.
 91. Gadina M, Johnson C, Schwartz D, et al. Translational and clinical advances in JAK-STAT biology: the present and future of jakinibs. *J Leukoc Biol* 2018;104: 499-514.
 92. Fleischmann R, Mysler E, Hall S, et al. Efficacy and safety of tofacitinib monotherapy, tofacitinib with methotrexate, and adalimumab with methotrexate in patients with rheumatoid arthritis (ORAL Strategy): a phase 3b/4, double-blind, head-to-head, randomised controlled trial. *Lancet* 2017;390:457-68.
 93. Sandborn WJ, Su C, Sands BE, et al. Tofacitinib as induction and maintenance therapy for ulcerative colitis. *N Engl J Med* 2017;376:1723-36.
 94. Kyriazopoulou E, Panagopoulos P, Metallidis S, Dalekos GN, Poulakou G, Gatselis N, Karakike E, Saridaki M, Loli G, Stefos A, Prasianaki D. An open label trial of anakinra to prevent respiratory failure in COVID-19. *Elife*. 2021 Mar 8;10:e66125.
 95. Barrera CM, Mykietiak A, Metev H, Nitu MF, Karimjee N, Doreski PA, Mitha I, Tanaseanu CM, Molina JM, Antonovsky Y, Van Rensburg DJ, Rowe BH, Flores-Figueroa J, Rewerska B, Clark K, Keedy K, Sheets A, Scott D,
 96. Azam TU, Shadid H, Blakely P, O'Hayer P, Berlin H, Pan M. 2020. Soluble urokinase receptor in COVID-19 related acute kidney injury. *Journal of the American Society of Nephrology* : JASN 31:2725–2735. DOI: <https://doi.org/10.1681/ASN.2020060829>
 97. Horwith G, Das AF, et al. 2016. Efficacy and safety of oral solithromycin versus oral moxifloxacin for treatment of community-acquired bacterial pneumonia: a global, double-blind, multicentre, randomised, active-controlled, non-inferiority trial (SOLITAIRE-ORAL). *The Lancet Infectious Diseases* 16:421–430. DOI: [https://doi.org/10.1016/S1473-3099\(16\)00017-7](https://doi.org/10.1016/S1473-3099(16)00017-7), PMID: 26852726
 98. Bleesing J, Prada A, Siegel DM, Villanueva J, Olson J, Ilowite NT, Brunner HI, Griffin T, Graham TB, Sherry DD, Passo MH, Ramanan AV, Filipovich A, Grom AA. 2007. The diagnostic significance of soluble CD163 and soluble interleukin-2 receptor alpha-chain in macrophage activation syndrome and untreated new-onset systemic juvenile idiopathic arthritis. *Arthritis & Rheumatism* 56:965–971.

- DOI: <https://doi.org/10.1002/art.22416>, PMID: 17328073
99. Cauchois R, Koubi M, Delarbre D, Manet C, Carvelli J, Blasco VB, Jean R, Fouche L, Bornet C, Pauly V, Mazodier K, Pestre V, Jarrot PA, Dinarello CA, Kaplanski G. 2020. Early IL-1 receptor blockade in severe inflammatory respiratory failure complicating COVID-19. PNAS 117:18951–18953. DOI: <https://doi.org/10.1073/pnas.2009017117>, PMID: 32699149
100. Cavalli G, De Luca G, Campochiaro C, Della-Torre E, Ripa M, Canetti D, Oltolini C, Castiglioni B, Tassan Din C, Boffini N, Tomelleri A, Farina N, Ruggeri A, Rovere-Querini P, Di Lucca G, Martinenghi S, Scotti R, Tresoldi M, Ciceri F, Landoni G, et al. 2020. Interleukin-1 blockade with high-dose Anakinra in patients with COVID-19, acute respiratory distress syndrome, and hyperinflammation: a retrospective cohort study. The Lancet Rheumatology 2:e325–e331. DOI: [https://doi.org/10.1016/S2665-9913\(20\)30127-2](https://doi.org/10.1016/S2665-9913(20)30127-2), PMID: 32501454
101. Cavalli G, Colafrancesco S, Emmi G, Imazio M, Lopalco G, Maggio MC, Sota J, Dinarello CA. 2021. Interleukin 1a: a comprehensive review on the role of IL-1a in the pathogenesis and treatment of autoimmune and inflammatory diseases. Autoimmunity Reviews 20:102763. DOI: <https://doi.org/10.1016/j.autrev.2021.102763>, PMID: 33482337