Peer Reviewed and Refereed Journal

Pharmacological exploration of COVID-19

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Abstract

The virus threatening the world by its emergence and spread originated from Wuhan, China in 2019 and called a novel coronavirus (COVID-19) or SARS-COV-2 took a face of pandemic and spreads throughout the world, affecting lives and results in world financial crisis as well. The disease is transmitted by inhalation and hence everyone was advised to wear masks and maintain social distance to stop the spread of the deadly virus. The symptoms are mild in most people which resembles the symptoms of pneumonia, whereas in some elderly and comorbidities it's severe and can even lead to death. Many people are asymptomatic as well. The rapid mutation of a virus is also a matter of concern which affects diagnosis also. Some vaccines are been approved worldwide by date (1st June 2021) for emergency uses and some are under trials expected to be approved soon. Being a matter of world health concern live updates are available on social platforms. This virus is not only affecting physically but also mentally traumatic because of the unceasingly escalating number of affected patients and deaths globally. The purpose of this review article is to evidence the types of treatment available and are been used to treat this deadly virus globally. Some of these treatment options have had a huge impact in terms of morbidity and mortality. In this review, we collected information about the most widely used drugs to treat COVID-19 belonging to different groups of antivirals, antibiotics, steroids, and also the methods of treatment majorly plasma therapy, monoclonal antibodies, and vaccination. The recent drugs approved. The detailed study of pros and cons of these treatments and drugs is been discussed along with their combination, composition, number and time of doses, price details, side effects, recommended for, manufacturer, brand names of producer and institutes that approves. Detailed information about vaccination is also discussed.

Keywords- COVID-19, SARS-COV-2, Drugs, plasma therapy, monoclonal antibodies, vaccination.

Introduction

Coronavirus belongs to the Coronaviridae family and Nidovirales order. The genus ‘corona’ means ‘crown’ as the virus appears to be in crown-like projections on its surface [1]. It is a diverse group of viruses that infects many different animals and can cause mild to severe respiratory infections in humans as well [2]. Symptoms can show up in 2 to 14 days, it varies from person to person. As the genomic sequence of a new virus is closely related to that of SARS-COV, the International Committee on Taxonomy of Viruses (ICTV) officially designated the virus as SARS-CoV-2. This virus is a single-stranded RNA virus with the largest known genome (from 25 to32 kb) among RNA viruses [3]. SARS-COV-2 (Novel Severe Acute Respiratory Syndrome Coronavirus-2) is declared a pandemic by WHO in

March 2020 [4, 5]. This virus also shows mutations very frequently and some of its known mutants till now are- D614G, B.1.1.7, N501Y, E484K, K147N, D936Y, etc.

The most common symptoms of COVID-19 are fever, dry cough & fatigue, loss of smell or taste, nasal congestion, sore throat, headache, muscles or joint pain, chills or dizziness, joint pain, nausea or vomiting, etc. [6]. Symptoms of severe COVID-19 disease: shortness of breath, loss of appetite, confusion, persistent pain or pressure in the chest [7].7 other symptoms have been associated with the new strain of coronavirus are fatigue, loss of appetite, headache, diarrhea, mental confusion, muscle pain, skin rashes [8]. The virus can lead to pneumonia, respiratory failure, heart problems, septic shock, and death [9]. Coronavirus primarily infects the respiratory system infecting the nose, throat & lungs but it harms the brain, heart, circulatory system, liver pancreas, kidney too.

There are some diagnosis methods including- CT Scan, RT-q PCR, CRISPR- based detection, antibody detection, antigen detection, biosensors, etc. [10, 11].

Currently, some of the drugs belonging to groups of antivirals, antibiotics, steroids [13] along with some methods majorly plasma therapy, monoclonal antibodies, and vaccination are being approved by WHO (World Health Organization), NIH (National Institutes of Health), FDA (Food and Drug Administration) and other health organization for treatment. Approved drug details are well explained in Table 1. Also, there are some clinical guidelines for the management of COVID-19 that have been made by the government of different countries {diagram 1}. Other methods of treatment like plasma therapy, monoclonal antibodies, kinase inhibitors, and interferons are also discussed in table 2. Vaccination is a major precaution and preventive method for COVID-19, along with wearing masks, cleaning our hands, ensuring good ventilation indoors, physically distancing, and avoiding crowds. Being a method of world health concern vaccination statistics is available on social websites of different health organizations. Details of vaccination are discussed in Table3. A new drug 2-DG is also developed by India for the treatment of COVID-19 which is discussed below.

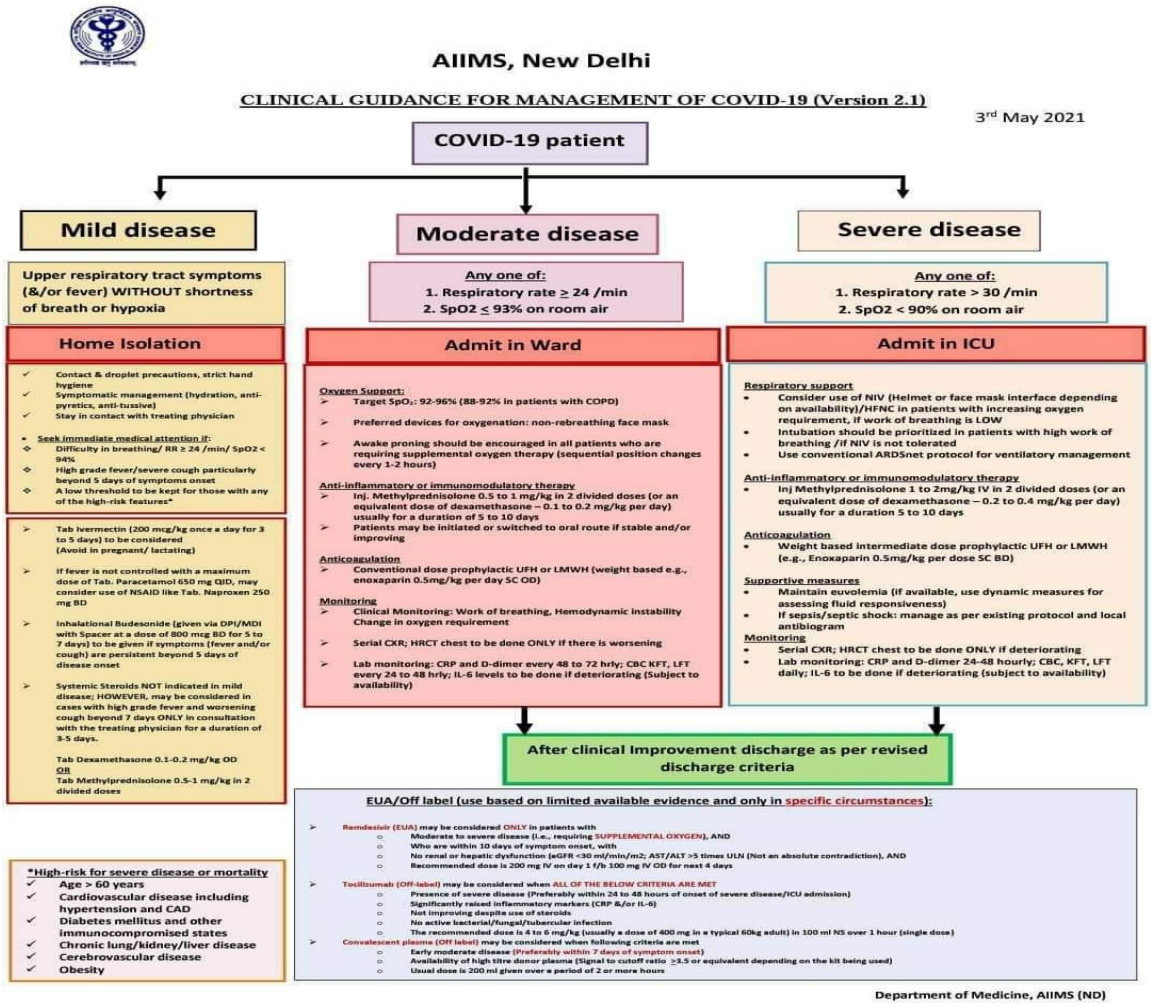

Diagram1

Table1

Drug Details	Composition of drug	Side effects of drugs	Manufacturing	Recommended for	Combinations With other drugs	Used for	Days of effect
Remdesivir ***-Brand-*** veklury ***-Price-*** Rs899-3490 (differ with brands) [14] ***-Approved by-*** FDA [15]	-Prodrug of an ATP -Active form-GS-441524 -Formula-C27H35N6O8P [16]	-Respiratory failure -Blood biomarkers of organ impairment, including low albumin, low potassium, low count	-Human drugs (veklury) -Requires 70 raw materials; reagents, and catalysts -Also contains some dangerous	-hospitalized COVID-19 patients - patients above age 12 who requires hospitalization. [18]	Baricitinib with Remdesivir [15]	Providing supplemental oxygen and mechanical ventilation, also reducing mortality rate.	29 days [15]

		of RBC, low count of thrombocytes, elevated bilirubin (jaundice) -Adverse effects- gastrointestinal distress, elevated transaminase levels in blood (liver enzymes), infusion site reactions (low BP, nausea, vomiting, sweating or shivering), electrocardiogram abnormalities.[17]	ingredient for humans, trimethylsilyl cyanide [17]			[15]	
Dexamethasone ***Brands***-- Decadron® -Dexamethasone -Intensol® -Dexpak® Taperpak® ***Price***-$1.39 [19] ***Approved by***- NIH [20]	-Synthetic adrenal corticosteroid -Fluorinated steroid 3-oxo-Delta (1), Delta (4)-steroid, A glucocorticoid, 20-oxo-steroid, 11beta-hydroxy steroid, 17 alpha-hydroxy Steroid, 21-hydroxy steroid [21]	-upset stomach, stomach irritation, vomiting, headache, dizziness, insomnia, restlessness, depression, anxiety, acne, increased hair growth, easy bruising,	-Implant manufacture- Prepared by hot-melt extrusion using a HAAKE MiniCTW (Thermo Fisher, Waltham, MA). The temperature was set to be	-Serious patients who requires ventilators - patients above 12 years of age	If dexamethasone is not available, alternative glucocorticoids such as prednisone, methylprednisolone, or hydrocortisone can be used.	Potent anti-inflammatory effects of corticosteroids might prevent or mitigate the deleterious effects. [20]	28 days [20]

		irregular or absent menstrual periods. -Severe symptoms-skin rash, swollen (face, lower legs, ankles), vision problems, cold or infection that lasts a long time, muscle weakness, black or tarry stool. [22]	1000C. [23]				
Hydroxychloroquine ***Brand-*** Plaquenil® -Advanz Pharma -Teva Pharmaceutical Industries Ltd -Sanofi -Novartis AG -Mylan N.V. -Zydus Cadila -Amneal Pharmaceuticals Inc -Lupin, Laurus Labs Ltd -Appco Pharma LLC -Hikma Pharmaceuticals PLC -Sun Pharmaceutical Industries Ltd -Intas Pharmaceuticals Ltd -Dr. Reddy's Laboratories Ltd [19] ***Price-*** $0.08/day [24] ***Approved by***	-Formula-$C_{18}H_{26}ClN_3O$ -4-aminoquinoline with immunosuppressive, anti-autophagy, and antimalarial activities. [26]	-Headache, dizziness, loss of appetite, nausea, Diarrhea, stomach pain, vomiting, rash -Adverse symptoms-difficulty reading or seeing (words, letters, or parts of objects missing), sensitivity to light, blurred vision, changes in vision, seeing light	-European Medicines Agency (EMA) -FDA Drugs	-used in treatment of malaria, and auto immune conditions like rheumatoid arthritis, lupus. -Hospitalized patients with mild symptoms of COVID-19. {disapproved by WHO now} -for 30+age people only.[25]	-Hydroxychloroquine with chloroquine -hydroxychloroquine and zinc with azithromycin -hydroxychloroquine with doxycycline [28]	Increases treatment efficacy and reduces risk in mild cases.[28]	5-7 days

FDA but disapproved by WHO. [25]		flashes or streaks, difficulty hearing, ringing in ears, muscle weakness, unusual bleeding or bruising, bleaching or loss of hair, mood or mental changes, irregular heartbeat, drowsiness, convulsions, decreased consciousness or loss of consciousness, thinking about harming or killing yourself [27]					
Chloroquine ***Brand***-Aralen {This branded product is no longer on the market. Generic alternatives may be available. ***Price***-$0.02/day [24] ***Approved by***-Not approved by WHO	-Formula-$C_{18}H_{26}ClN_3$ -4-aminoquinoline with antimalarial, anti-inflammatory and potential chemo-sensitization and radio-sensitization activities. [29]	-Headache, nausea, loss of appetite, diarrhea, upset stomach, stomach pain, rash, itching, hair loss -Adverse condition-seeing light	European Medicines Agency (EMA) -FDA Drugs [29]	- The COVID-19 Treatment Guidelines Panel (the Panel) recommends against the use of chloroquine or hydroxychloroquine with or without	-Chloroquine with hydroxychloroquine -chloroquine with azithromycin	Used in clinical trials [31]	28days

		flashes and streaks, blurred vision, reading or seeing difficulties (words disappear, seeing half an object, misty or foggy vision), difficulty hearing, ringing in ears, muscle weakness, drowsiness, vomiting, irregular heartbeats, convulsions, difficulty breathing, mood or mental changes, decreased consciousness or loss of consciousness, thinking about harming or killing yourself [30]		azithromycin for the treatment of COVID-19 in hospitalized patients (AI). -In non-hospitalized patients, the Panel recommends against the use of chloroquine or hydroxychloroquine with or without azithromycin for the treatment of COVID-19, except in a clinical trial (AIIa). -The Panel recommends against the use of high-dose chloroquine (600 mg twice daily for 10 days) for the treatment of COVID-19 (AI). [31]			
Azithromycin ***Brand***-Many companies [32] ***Price***-$0.10/day [24] ***Approved by***-	-Formula-C38H72N2012 -derived from erythromycin [33]	diarrhea or loose stools, nausea, abdominal pain, stomach upset, vomiting, constipation, dizziness,	-EMA -FDA Drugs [33]	-Antibiotic used to treat bacterial infections such as bronchitis and pneumonia. -also works against influenza A, zika but not	Ivermectin-azithromycin-cholecalciferol [35]	Increase oxygen saturation and oxygenation index. [35]	14days [35]

Not approved by WHO, approved by FDA		tiredness, headache, vaginal itching or discharge, nervousness, sleep problems (insomnia), skin rash or itching, ringing in the ears, hearing problems, or decreased sense of taste or smell. [34]		against MERS. -people above age 18 having mild symptoms of COVID-19 [35]			
Tocilizumab ***Brand***-Actemra [36] **Approved by** WHO for EUA	- recombinant humanized anti-interleukin-6 receptor (IL-6R) monoclonal antibody [37]	a cough or sore throat, blocked or runny nose, headaches or dizziness, mouth ulcers, high blood pressure, hypercholesterolaemia (increased cholesterol in the blood), allergic reactions - this can include aching muscles, feeling out of breath, having a tight chest, wheezing, and a high temperature, weight gain or swollen ankles, skin rashes, infections or itching stomach irritation or abdominal pain. [38]	TCZ is a humanized recombinant monoclonal antibody of the IgG1 k subclass produced using recombinant DNA technology [37]	-For COVID-19 patients who are not in ICU. -approved for rheumatoid arthritis and juvenile idiopathic arthritis.	Favipiravir combined with tocilizumab [39]		14 days [39]
Lopinavir/ritonavir ***Brand***-Kaletra [41] **Price-** $0.28/day [24]	**Composition** -Formula-C37H48N4O5 (lopinavir) -substitute of amphetamine. -C37H48N6O5S2 (ritonavir) -an anticoronavi	Diarrhea, vomiting, nausea, increased fats in blood (triglycerides or cholesterol) [41]	-EMA Drug category-human drugs -human pharmacotherapeutic group -EU pediatric investigation plans -FDA drugs [30]	Patients above 12 years {disapproved by WHO as it does not reduce the rate of mortality} [42]	Lopinavir with ritonavir	It is protease inhibitor, widely used in treatment of HIV and also shows some preliminary evidence of effectiveness in	28 days

	ral agent. -member of amphetamines and a dicarboxylic acid diamide.[40]					treatment of covid-19. -LPVr may have reduced mortality and shortened ICU admissions and time to discharge [43]	
Ivermectin ***Brand-*** Stromectol® [46] **Approved by** FDA	Bioavailable macrocyclic lactone derived from Streptomyces avermitilis, with antiparasitic and potential anti-viral activities. [45]	-Dizziness, loss of appetite, nausea, vomiting, stomach pain or bloating, diarrhea, constipation, weakness, sleepiness, uncontrollable shaking of a part of the body, chest discomfort. -adverse conditions- Fever, blistering or peeling skin, rash, itching [46]	- EMA-human drugs -EU pediatric investigation plans -FDA Drugs -FDA approved animal drug products - anthelminthic agent -joint FAO/WHO Expert committee on Food Additives (JECFA) [45]	Only to be used within clinical trials -WHO [47]	Ivermectin-azithromycin - cholecalciferol [48]	Increase oxygen saturation and oxygenation index. [48]	14days [48]
Tamiflu (oseltamivir) ***Brand-***Tamiflu **Approved by-** NIH	monosodium citrate, saccharin sodium, sodium benzoate, sorbitol, titanium dioxide, tutti-frutti flavouring, and xanthan gum. (oseltamivir phosphate) for oral suspension [49]	-nausea, vomiting, headache, and pain -severe symptoms- sudden confusion, tremors or shaking, unusual behaviour, and hallucinations	Hoffmann-La Roche Inc. and Gilead Sciences, Inc. (NASDAQ: GILD), announced today that Roche's TAMIFLU ™ (oseltamivir phosphate) has been approved by the U.S. Food and Drug Administration (FDA) [50]	-adults and adolescents (13years and older) -pediatric patients (2weeks of age through 12 years of age)	Hydroxychloroquine, Oseltamivir and Azithromycin [51]	Reduce hospitalization, able to resume normal activities. -requires less supplemental oxygen [51]	7 days
Avigan (Favipiravir)	-Povidone, colloidal silicon dioxide, low-	- Shock, anaphylaxis - Pneumonia - Hepatitis fulminant,	Dr Reddy's	18 years to 65 years (adult, older adult) [53]	Favipiravir with tocilizumab [53]	Reduce viral load of respiratory specimen	7 days [53]

Brand- AVIGAN Tablets **Price-** $1.45/day [24] **Approved by-** NIH	substituted hydroxypropyl cellulose, crospovidone, sodium stearyl fumarate, Hypromellose, titanium dioxide, talc, yellow ferric oxide [52]	hepatic dysfunction, jaundice - Toxic epidermal necrolysis (TEN), oculomucocutaneous syndrome (Stevens-Johnson syndrome) -Acute kidney injury -White blood cell count decreased, neutrophil count decreased, platelet count decreased - Neurological and psychiatric symptoms (consciousness disturbed, abnormal behaviour, deliria, hallucination, delusion, convulsion, etc.) - Colitis haemorrhagic [52]				[53]	
Colcrys (Colchicine) **Brand-**Colcrys **Approved by-** NIH, WHO	Formula- $C_{22}H_{25}NO_6$ - alkaloid isolated from Colchicum autumnale with anti-gout and anti-inflammatory activities. [54]	-Nausea, vomiting, diarrhea, stomach cramps or pain severe symptoms- muscle pain or weakness, numbness or tingling in the fingers or toes, unusual bruising or bleeding, sore throat, fever, chills, and other signs of infection, weakness or tiredness, paleness or grayeness of the lips, tongue, or palms [55]	-Human Drugs - FDA Drugs - NJDOH RTK Hazardous Substance List - NORMAN Suspect List Exchange - The National Institute for Occupational Safety and Health (NIOSH) [54]	18 years and older	Colchicine with placebo [56]	Increased amt. of supplemental oxygen - mechanical ventilation is reduced [56]	14 days

Methods of treatments- The COVID-19 Treatment Guidelines Panel (the panel) recommends some supportive therapies in order to reduce the risk of deaths and severe symptoms in patients infected with COVID-19. These therapies have the greatest potential for clinical benefits during the earliest stages of infections. These therapies are approved by different public health organizations. Some of the effective therapies used till now are – convalescent plasma, MABs, kinase inhibitors, interferons, etc. These are discussed in detail in Table 2.

Table2

1) Convalescent plasma	2) Monoclonal antibodies (MABs)	3) Kinase inhibitors	4) Interferons
Approved by-On August, 2020, FDA issued an EUA for hospitalized patients with COVID-19 [57]. **Procedure**- plasma obtained from an individual who has recovered from infection (e.g., prospective donors). It is then transfused into someone with an active coronavirus infection [58]. **Criteria for donor**-donor must be recovered from COVID-19 recently and have no symptoms for last 14 days, and currently tested negative for COVID-19. It is important that they have high enough antibody levels in their plasma for donation. A donor and patient must have compatible blood types. The donated plasma should also be screened for other infectious diseases, such as HIV. Donating plasma should not weaken the donor's immune system, nor make the donor more susceptible to getting reinfected with the virus [59]. **Benefits**- death rate of those who got plasma earlier is lower as compared to others who didn't get any. Death rates were also lower in patients who got convalescent plasma with higher antibody levels compared to plasma with lower antibody levels [57].	**Approved by**- FDA [59]. **Companies approved**- *Eli Lilly* and *Regeneron* which develop MABs currently named Bamlanivimab (LY-CoV555) and REGN-COV2 respectively. **Procedure**-Monoclonal antibodies (MABs) are antibodies artificially made in laboratories to help fight infections by binding to foreign pathogens, like viruses, and help destroy them. As the body naturally takes about weeks to develop antibodies, injecting MABs externally helps in easily fighting against infections and show better results soon. **Some MABs**-Bamlanivimab, etesevimab, casirivimab, and imdevimab are IV infusion therapies. -AstraZeneca is also starting studies on long-acting antibody combinations called AZD7442. -VIR-7831 and the combination BRII-196 and BRII-198 [57]. **Benefits**- they're administered as outpatient therapy and intended for people who have less severe disease. Their purpose is to help reduce the risk of hospitalization [60].	**Approved by**- NIH **Benefits**-Many kinase inhibitors are also used in the treatment of cancer and inflammatory conditions like rheumatoid arthritis. They broadly suppress the immune system and can make it difficult to fight infection. Additional trials are needed to better understand their role in COVID-19 [57]. **Some kinase inhibitors-** Acalabrutinib (Calquence), Baricitinib (Olumiant), Ruxolitinb (Jakafi), Tofacitinib (Xeljanz).	**Approved by**- NIH currently recommends against using interferons for severe COVID-19 because they have not shown benefit when used for other coronavirus infections (like MERS or SARS) and have safety concerns [57]. **Benefits**-They are signaling proteins (cytokines) that tell the body a virus is present and to ramp up defenses. In vitro studies have shown that interferon-alfa (IFN-α) and interferon-beta (IFN-β) have antiviral activity against the SAR-CoV-2 virus.

Vaccination- A vaccine basically trains the human immune system to recognize and attack a virus, even one it hasn't seen before. This is the major preventive method known yet for the treatment of COVID-19 and perhaps the best hope for ending the pandemic. Currently, some vaccines are being approved and their details are discussed in Table3.

Table 3- Vaccine Details

Vaccine details	Composition	Manufacturer	Side effects	No. of shots	Recommended	Who should not get it

					for	
Pfizer-BioNTech vaccine **Approved by**-WHO andmulti agencies[61] **Type of vaccine**-mRNA[62] **Origin**-UK and many countries	-ALC-0315 = ((4-hydroxybutyl azanediyl) bis(hexane-6,1-diyl) bis(2-hexyldecanoate) -ALC-0159 = 2-[(polyethylene glycol)-2000]-N,N-ditetradecylacetamide -1,2-distearoyl-sn-glycero-3-phosphocholine (DSPC) -cholesterol -dibasic sodium phosphate dihydrate -monobasic potassium phosphate -potassium chloride -sodium chloride -sucrose -water for injection [61]	Pfizer, Inc., BioNTech	Chills, Tiredness, Headache [61]	2 shots,21 days apart	Recommended for people aged 16 years and older [62].	-People who had severe allergic reaction or an immediate allergic reaction. (before vaccination or after first dose) -People who gets symptoms like hives, swelling or wheezing (respiratory distress) within 4 hours. -This includes allergic reactions to polyethylene glycol (PEG) and polysorbate. Polysorbate is not an ingredient in either mRNA COVID-19 vaccine but is closely related to PEG, which is in the vaccines. People who are allergic to PEG or polysorbate should not get an mRNA COVID-19 vaccine [61].
Covishield **Approved by**- DCGI **Origin**-Serum institute of India (SII) and ICMR [63]	L-Histidine, L-hitidine hydrochloride monohydrate, Magnesium chloride hexahydrate, Polysorbate 80, ethanol, sucrose, sodium chloride, disodium edetate dehydrate (EDTA), water for injection. [63]	Serum Institute of India	Fatigue, chills, headache, nausea, joint pain or muscle ache, vomiting, flu-like symptoms Uncommon symptoms-Feeling dizzy, decreased appetite, Abdominal pain, Enlarged lymph nodes, Excessive sweating, Itchy skin or	One dose Second dose-after 4-6 weeks after first dose. [63] {don't miss second dose}	Individuals 18years of age and older	-People with several allergic reaction(anaphylaxis) -People who have fever -Bleeding disorder or are on a blood thinner -Immunocompromised or are on a medicine that affects your immune systems. -Pregnant or plan to become pregnant -Breastfeeding -If received another covid-19 vaccine [63]

			rash [63].			
Covaxin **Approved by**- DCGI **Origin-** Bharat biotech in collaboration with ICMR [64]	6µg of whole-virion inactivated SARS-CoV-2 antigen (Strain: NIV-2020-770), and the other inactive ingredients such as Aluminium hydroxide gel (250 µg), TLR 7/8 agonist (imidazoquinolinone) 15 µg, TM 2-phenoxyethanol 2.5 mg, and phosphate buffer saline up to 0.5 ml. [64]	Bharat Biotech in collaboration with ICMR	Body ache, headache, fever, malaise, weakness, rashes, nausea, vomiting [64]	2- dose series, 4 weeks apart	CDSCO has authorized the Restricted Use of COVAXIN under Clinical Trial Mode. Individuals who are prioritized under the public health program of the Ministry of Health & Family Welfare, Government of India will TM be covered under this endeavour [64]	-Have any history of allergies. -Have fever. -Have a bleeding disorder or are on a blood thinner. -Are immune-compromised or are on a medicine that affects your immune system -Are pregnant. -Are breastfeeding. -Have received another COVID-19 vaccine. - Any other serious health related issues, as determined by the Vaccinator/Officer supervising vaccination [64].
Sputnik V **Approved by**- DCGI **Origin-** Gamaleya National Research Centre for Epidemiology and Microbiology (Moscow, Russia) [65]	-The Gam-COVID-Vac is a two-vector vaccine. -The active component for both vectors is a modified (recombinant) replication-defective adenovirus of a different serotype (Serotype 26 containing (1.0 ± 0.5) × 1011 particles of gene for the first vaccination and serotype 5 containing (1.0 ± 0.5) × 1011 particles of gene for the second vaccination), which has been modified to include the spike protein-expressing gene of SARS-CoV-2. -other ingredients - Tris(hydroxymethyl)aminomethane -Sodium chloride (salt) -Sucrose (sugar) -Magnesium chloride hexahydrate -Disodium EDTA dihydrate (buffer) -Polysorbate 80 -Ethanol 95% -Water [66]	-Gamaleya National Research Centre for Epidemiology and Microbiology -Russian Direct Investment fund (RDIF)-tied up with Dr Reddy's lab (for trials in India) [67]	Mild flu like symptoms Weakness or low energy [66]	2 doses at 21 days difference [66]	Individuals of more than equal to 18 years of age. [66]	Individuals of 17 years and younger age groups until more studies are conducted. Anybody with a body temperature above 38.50C must defer vaccination till the fever subsides. [67]

Drug approved by DRDO (2-DG)

- Recently in May 1, 2021, DGCI approved EUA to DRDO's 2-DG drug. It helps in the faster recovery of hospitalized patients and reduces supplemental oxygen dependence. Phase-3 trials for the 2-DG drug were conducted at 27 covid hospitals across the country.
- It is produced by pharma giant- Zydus Cadila.
- It is developed by DRDO's Institute of Nuclear Medicine and Allied Sciences (INMAS) in collaboration with Hyderabad based Dr. Reddy's Laboratories

- This drug accumulates in virus-infected cells, and prevent the growth of the virus by stopping viral synthesis and energy production. Its selective accumulation in virally-infected cells make this drug unique.
- The drug- Virafin, was shown to reduce the need for oxygen support among mild and moderate cases of COVID-19, along with improving recovery time.
- 2-DG drugs showed RT-PCR negative conversions in COVID patients. And has shown immense benefits to people suffering from COVID-19 [71].

References-

1) Mahalmani VM, Mahendru D, Semwal A, Kaur S, Kaur H, Sarma P, Prakash A, Medhi B. COVID-19 pandemic: A review based on current evidence. Indian J Pharmacol [serial online] 2020 [cited 2021 May 14];52:117-29. Available from: https://www.ijp-online.com/text.asp?2020/52/2/117/285727
2) https://www.nature.com/articles/s41579-020-00459-7
Hu, B., Guo, H., Zhou, P. *et al.* Characteristics of SARS-CoV-2 and COVID-19. *Nat Rev Microbiol* **19,** 141–154 (2021). https://doi.org/10.1038/s41579-020-00459-7
3) Liu X, Liu C, Liu G, Luo W, Xia N. COVID-19: Progress in diagnostics, therapy and vaccination. *Theranostics* 2020; 10(17):7821-7835. doi:10.7150/thno.47987. Available from https://www.thno.org/v10p7821.htm
4) **On Classification and Taxonomy of Coronaviruses (Riboviria, Nidovirales, Coronaviridae) with the special focus on severe acute respiratory syndrome-related coronavirus 2 (SARS-Cov-2)**
Evgeny V. Mavrodiev, Melinda L. Tursky, Nicholas E. Mavrodiev, Malte C. Ebach, David M. Williams
doi: https://doi.org/10.1101/2020.10.17.343749
https://www.biorxiv.org/content/10.1101/2020.10.17.343749v1.full
5) National Center for Immunization and Respiratory Diseases (NCIRD), Division of Viral Diseases Coronavirus Home Coronavirus Disease 2019 (COVID-19) **Human Coronavirus Types**
https://www.cdc.gov/coronavirus/types.html
6) COVID-19 infection: Origin, transmission, and characteristics of human coronaviruses
Shereen, Muhammad Adnan; Khan, Suliman; Kazmi, Abeer; Bashir, Nadia; Siddique, Rabeea.
https://pesquisa.bvsalud.org/global-literature-on-novel-coronavirus-2019-ncov/resource/en/covidwho-8831
7) https://en.wikipedia.org/wiki/Coronavirus
8) https://www.who.int/health-topics/coronavirus#tab=tab_1
9) https://www.webmd.com/lung/coronavirus
10) **COVID-19: Progress in diagnostics, therapy and vaccination**

Xue Liu[1#], Chao Liu[2#], Gang Liu[2], Wenxin Luo[1] ✉, Ningshao Xia[1]

Theranostics 2020; 10(17):7821-7835. doi:10.7150/thno.47987

https://www.thno.org/v10p7821.htm

11) **Diagnostic techniques for COVID-19 and new developments**

Author links open overlay panelElhamSheikhzadeh[a]ShimaaEissa[b]AziahIsmail[a]MohammedZourob

https://doi.org/10.1016/j.talanta.2020.121392

https://www.sciencedirect.com/science/article/abs/pii/S0039914020306834

12) **https://www.fda.gov/drugs/coronavirus-covid-19-drugs/coronavirus-treatment-acceleration-program-ctap**
13) **The latest treatments for COVID-19**

Authored by Andrea Downey

Reviewed by Dr Sarah Jarvis MBE

17-Nov-20
https://patient.info/news-and-features/the-latest-on-treatments-for-covid-19

14) **Inside the treacherous black market for Remdesivir in India— from private hospitals to distributors**

APR 23, 2021, 11:42 IST

https://www.businessinsider.in/science/health/news/how-remdesivir-drug-black-market-working-in-india/articleshow/82210121.cms

15) **Coronavirus (COVID-19) Update: FDA Authorizes Drug Combination for Treatment of COVID-19**
November 19, 2020
https://www.fda.gov/news-events/press-announcements/coronavirus-covid-19-update-fda-authorizes-drug-combination-treatment-covid-19#:~:text=Today%2C%20the%20U.S.%20Food%20and,or%20older%20requiring%20supplemental%20oxygen%2C

16) National Center for Biotechnology Information (2021). PubChem Compound Summary for CID 121304016, Remdesivir. Retrieved May 3, 2021 from https://pubchem.ncbi.nlm.nih.gov/compound/Remdesivir.

17) https://en.wikipedia.org/wiki/Remdesivir#Side_effects

18) https://www.who.int/news-room/feature-stories/detail/who-recommends-against-the-use-of-remdesivir-in-covid-19-patients#:~:text=WHO%20recommends%20against%20the%20use%20of%20remdesivir%20in%20COVID%2D19%20patients,-20%20November%202020&text=WHO%20has%20issued%20a%20conditional,other%20outcomes%20in%20these%20patients.

19) https://www.beckershospitalreview.com/pharmacy/dexamethasone-price-has-increased-137-in-recent-months.html

20) **Corticosteroids**
Last Updated: November 3,2020
https://www.covid19treatmentguidelines.nih.gov/immunomodulators/corticosteroids/

21) National Center for Biotechnology Information (2021). PubChem Compound Summary for CID 5743, Dexamethasone. Retrieved May 3, 2021 from https://pubchem.ncbi.nlm.nih.gov/compound/Dexamethasone

22) https://medlineplus.gov/druginfo/meds/a682792.html

23) Ryan A. Kelley, Alireza Ghaffari, Yan Wang, Stephanie Choi, Jonathan R. Taylor, Rachel R. Hartman, and Uday B. Kompella.Journal of Ocular Pharmacology and Therapeutics.Jun 2020.290-297.http://doi.org/10.1089/jop.2019.0074

24) Andrew Hill, Junzheng Wang, Jacob Levi, Katie Heath, Joseph Fortunak,
Minimum costs to manufacture new treatments for COVID-19,
Journal of Virus Eradication, Volume 6, Issue 2,2020,Pages 61-69,ISSN 2055-6640,
https://doi.org/10.1016/S2055-6640(20)30018-2.
(https://www.sciencedirect.com/science/article/pii/S2055664020300182)

25) https://www.who.int/news-room/q-a-detail/coronavirus-disease-covid-19-hydroxychloroquine

26) National Center for Biotechnology Information (2021). PubChem Compound Summary for CID 3652, Hydroxychloroquine. Retrieved May 3, 2021
from https://pubchem.ncbi.nlm.nih.gov/compound/Hydroxychloroquine

27) https://medlineplus.gov/druginfo/meds/a601240.html

28) https://clinicaltrials.gov/ct2/show/NCT04370782

29) https://pubchem.ncbi.nlm.nih.gov/compound/Chloroquine

30) https://medlineplus.gov/druginfo/meds/a682318.html

31) Chloroquine or Hydroxychloroquine With or Without Azithromycin
Last Updated: October 9, 2020://www.covid19treatmentguidelines.nih.gov/antiviral-therapy/chloroquine-or-hydroxychloroquine-with-or-without-azithromycin/

32) https://www.medlineindia.com/antibiotic-and-antiviral/azithromycin.htm

33) National Center for Biotechnology Information (2021). PubChem Compound Summary for CID 447043, Azithromycin. Retrieved May 3, 2021 from https://pubchem.ncbi.nlm.nih.gov/compound/Azithromycin.

34) https://www.rxlist.com/zithromax-side-effects-drug-center.htm

35) https://clinicaltrials.gov/ct2/show/NCT04399746

36) https://www.drugs.com/ingredient/tocilizumab.html

37) Sheppard, M., Laskou, F., Stapleton, P. P., Hadavi, S., & Dasgupta, B. (2017). Tocilizumab (Actemra). *Human vaccines &immunotherapeutics*, *13*(9), 1972–1988.
https://doi.org/10.1080/21645515.2017.1316909https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5612212/

38) https://www.versusarthritis.org/about-arthritis/treatments/drugs/tocilizumab/
39) https://clinicaltrials.gov/ct2/show/NCT04310228
40) National Center for Biotechnology Information (2021). PubChem Compound Summary for CID 92727, Lopinavir. Retrieved May 3, 2021 from https://pubchem.ncbi.nlm.nih.gov/compound/Lopinavir.
41) https://www.rxlist.com/kaletra-tablets-drug.htm#description
42) https://www.who.int/news/item/04-07-2020-who-discontinues-hydroxychloroquine-and-lopinavir-ritonavir-treatment-arms-for-covid-19
43) Lopinavir/ritonavir: A rapid review of effectiveness in COVID-19 ,April 14, 2020

https://www.cebm.net/covid-19/lopinavir-ritonavir-a-rapid-review-of-the-evidence-for-effectiveness-in-treating-covid/
44) https://medlineplus.gov/druginfo/meds/a607069.html
45) National Center for Biotechnology Information (2021). PubChem Compound Summary for CID 6321424, Ivermectin. Retrieved May 3, 2021 from https://pubchem.ncbi.nlm.nih.gov/compound/Ivermectin.
46) https://medlineplus.gov/druginfo/meds/a607069.html
47) https://www.who.int/news-room/feature-stories/detail/who-advises-that-ivermectin-only-be-used-to-treat-covid-19-within-clinical-trials
48) https://clinicaltrials.gov/ct2/show/NCT04399746
49) https://www.gene.com/download/pdf/tamiflu_patientinfo.pdf
50) **Roche Receives FDA Approval Of TAMIFLU™, First Pill To Treat The Most Common Strains Of Influenza (A&B)**

TAMIFLU™ (oseltamivir phosphate) Decreases Duration of Flu Symptoms

NUTLEY, N.J. -- October 27, 1999

https://www.gilead.com/news-and-press/press-room/press-releases/1999/10/roche-receives-fda-approval-of-tamiflu-first-pill-to-treat-the-most-common-strains-of-influenza-ab
51) https://clinicaltrials.gov/ct2/show/NCT04338698
52) https://www.cdc.gov.tw/File/Get/ht8jUiB_MI-aKnlwstwzvw
53) https://clinicaltrials.gov/ct2/show/NCT04310228
54) National Center for Biotechnology Information (2021). PubChem Compound Summary for CID 6167, Colchicine.

Retrieved May 3, 2021 from https://pubchem.ncbi.nlm.nih.gov/compound/Colchicine.
55) https://medlineplus.gov/druginfo/meds/a682711.html
56) https://clinicaltrials.gov/ct2/show/NCT04527562
https://en.wikipedia.org/wiki/Blood_plasma
57) https://www.health.harvard.edu/diseases-and-conditions/treatments-for-covid-19
58) **The Latest Research on COVID-19 Treatments and Medications in the Pipeline, Jennifer Tran, PharmD, RPh,** March 17, 2021, 1:40PM (PT)

https://www.goodrx.com/blog/coronavirus-treatments-on-the-way/
59) **Current Treatments for COVID-19**

Medically reviewed by Joseph Vinetz, MD — Written by Daniel Yetman — Updated on February 18, 2021
https://www.healthline.com/health/coronavirus-treatment
60) **https://www.cdc.gov/coronavirus/2019-ncov/vaccines/different-vaccines.html**
61) https://en.wikipedia.org/wiki/Pfizer%E2%80%93BioNTech_COVID-19_vaccine#Composition
62) Covid-19: An FAQ factsheet for Covishield vaccine by Serum Institute
https://www.aninews.in/news/national/general-news/covid-19-an-faq-factsheet-for-covishield-vaccine-by-serum-institute20210113014822/
63) https://www.bharatbiotech.com/covaxin.html#:~:text=COVAXINTM%20-%20India's%20First,Institute%20of%20Virology%20(NIV)

64) Sputnik V COVID-19 vaccine candidate appears safe and effective
Ian Jones, Polly RoyPublished:February 02, 2021DOI:https://doi.org/10.1016/S0140-6736(21)00191-4https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(21)00191-4/fulltext