

BÖLÜM 8

COVID-19 TEDAVİSİ İLAÇLARI VE PSİKOFARMAKOLOJİ-3

Evren ŞAVLI¹

Giriş

COVID-19 Tedavisi ilaçları ve Psikofarmakoloji'nin III. Bölümünde Şiddetli Akut Solunum Sendromu ilişkili Koronavirüs -2'nin [Severe Acute Respiratory Syndrome related Coronavirus-2, (SARS-CoV-2)] yaşam siklusuna etkili ve Yeni Korona Virüs Hastalığı -19 'un (COVID-19) farklı klinik safhalarında kullanılan, yeniden konumlandırılmış (repurposed) **favipiravir, remdesivir, tosilizumab, interferon beta (İFN-beta), immün plazma tedavisi ve azitromisine** yer verilmiştir. Nöropsikiyatrik yan etkileri, psikotrop ilaçlar ile etkileşimleri değerlendirilmeye çalışılmış ve konuya ilişkin Liverpool Üniversitesi Liverpool Drug Interaction Group'a ait tablo (Tablo1) (1) II.Bölümün sonuna eklenmiştir.

COVID-19 Tedavisi İlaçları ve Psikofarmakoloji

Viral replikasyon- işlenme üzerine etkili ilaçlar

Favipiravir

T-705 olarak da bilinen, 6-fluoro-3-hidroksi-2-pirazin karboksamiddir, pirazinekarboksamid

türevidir. Bir pürin analogudur (2-4). İnfluenza A, B, C virüs enfeksiyonlarının tedavisinde kullanılmaktadır (3,4). Favipiravir ribonükleik asit (RNA) bağımlı RNA polimeraz (RdRp) inhibitörüdür (2-4). Favipiravir bir ön ilaçtır. Hücre içerisinde aktif formu olan ve bir pürin analogu gibi davranarak viral RNA sentezini inhibe eden favipiravir-ribofuranosil- 5'-trifosfat'a (favipiravir-RTP) dönüştürülür (2-4). Memeli hücresinde T-705'in aktif T-705-RTP'ye metabolik dönüşümünün ilk basamağında hipoksantin guanin fosforiboziltransferazın (HGPRT) rol aldığı belirtilmektedir (4). Viral replikasyon için gerekli influenza RNA polimerazını inhibe eder. SARS-CoV- 2 virüsü de genom replikasyonu için viral RNA polimerazı kullanmakta olduğundan (5,6) COVID- 19 tedavisinde yeniden konumlandırılarak tedavi etkinliği ve güvenliliği araştırılmaktadır (5,7). Başlıca hidroksile form olarak ve küçük bir miktarı ise değişmeden idrar ile atılmaktadır (2,3,6).

Favipiravir ile psikotrop ilaç etkileşimleri için II.Bölümün sonunda yer alan Tablo1 (1)'i inceleyiniz.

Gebelikte kullanılmamalıdır; teratojeniktir. Pharmaceuticals and Medical Devices Agency (PMDA) [İlaç ve Tıbbi Cihaz Kurumu (PMDA),

¹ Dr. Öğr. Üyesi Evren ŞAVLI, Ordu Üniversitesi Tıp Fakültesi Tıbbi Farmakoloji AD. evsavli@yahoo.com



Antiviral ve İmmünmodülasyona Etkili İlaçlar

Azitromisin

Antibakteriyel bir ilaç olan azitromisin Yeni Korona Virüs Hastalığı-19 (COVID- 19) tedavisi için yeniden konumlandırılmıştır. Hem virüs girişini azaltarak hem de virüse immün yanıtı artırarak etki gösterebileceği ileri sürülmektedir (61,62).

Azitromisin ile psikotrop ilaç etkileşimleri için II.Bölümün sonuna eklenen Tablo1(1)'i inceleyiniz.

Karaciğerde aktif olmayan metabolitlerine metabolize edilir. Başlıca safra ile atılır, %6'dan düşük bir oranda ise idrar ile atılır. P-gp'yi inhibisyonunun klinik önemi tam olarak bilinmemektedir (63). Karaciğer sitokrom P450 dizgesi ile belirgin etkileşim göstermez (63,64). Hepatotoksite riskini artırır (65,66). Doz ve konsantrasyon bağımlı bir şekilde QTc'de artışa neden olabilir. Uzun kardiyak repolarizasyonda ve QT aralığında uzamaya bağlı kardiyak aritmi ve Torsades de pointes (TdP) geliştirme riski bulunmaktadır (63). Azitromisin ve ritonavir özellikle QTc uzamasına katkı sağlayan ilaçlardır (67). QT uzamasına neden olmasına bağlı, benzer yan etkili psikotrop ilaçlar ile eş zamanlı kullanımından kaçınılmalıdır (66). QT uzaması riskinde artışa neden olan psikotrop ilaçlardan iyi bilinen örnekler olarak sitalopram, essitalopram, venlafaksin, tioridazin, loksapin, haloperidol (intravenöz uygulama özellikle), iloperidon, ziprasidon ve pimozid sayılabilir (67,68). Psikotik depresyon, agresyon (saldırganlık), kaygı, baş dönmesi, baş ağrısı, somnolans (uyku hali), katatonik (donakalım) ve deliryum gibi nöropsikiyatrik etkiler gözlenebilir (63,69).

SONUÇ

COVID-19'lu hastaların psikotrop ilaçlar ile tedavilerini tasarlarken SARS-CoV-2'nin sistemler üzerindeki tutulumları ve tedavisinde kullanılan deneysel ilaçların etkileşimleri göz önünde tutulmalıdır.

KAYNAKLAR

1. University of Liverpool, Liverpool Drug Interaction Group (2020) . Interactions with Experimental COVID-19 Therapies, Interactions with Experimental COVID-19 Immune Therapies. Updated 10 December 2020. (20.12.2020 tarihinde www.covid19-druginteractions.org, adresinden ulaşılmıştır)
2. Pharmaceuticals and Medical Devices Agency (PMDA). (2014). *Report on the Deliberation Results. (AVIGAN® Tablet 200mg, Favipiravir)*. (05.12.2020 tarihinde <http://www.pmda.go.jp/files/000210319.pdf> adresinden ulaşılmıştır.)
3. Furuta Y, Takahashi K, Kuno-Maekawa M, et al. Mechanism of action of T-705 against influenza virus. *Antimicrob Agents Chemother*. 2005;49(3):981-6. Doi: 10.1128/AAC.49.3.981-986.2005.
4. Naesens L, Guddat LW, Keough DT, et al. Role of human hypoxanthine guanine phosphoribosyltransferase in activation of the antiviral agent T-705 (favipiravir). *Mol Pharmacol*. 2013;84(4):615-29. Doi: 10.1124/mol.113.087247.
5. Du YX, Chen XP. Favipiravir: Pharmacokinetics and Concerns About Clinical Trials for 2019-nCoV Infection. *Clin Pharmacol Ther*. 2020;108(2):242-247. Doi: 10.1002/cpt.1844.
6. CDC, AVIGAN® (2020). *AVIGAN® tablets 200 mg, Favipiravir prescribing information*. (05.12.2020 tarihinde https://www.cdc.gov.tw/File/Get/ht8jUiB_MI-aKn-lwstwzvw adresinden ulaşılmıştır)
7. Takahashi T, Luzum JA, Nicol MR, et al. Pharmacogenomics of COVID-19 therapies. *NPI Genom Med*. 2020;5:35. Doi: 10.1038/s41525-020-00143-y.
8. Obach RS, Huynh P, Allen MC, et al. Human liver aldehyde oxidase: inhibition by 239 drugs. *J Clin Pharmacol*. 2004;44(1):7-19. Doi: 10.1177/0091270003260336.
9. FDA accessdata (2020). *Sonata (zaleplon) capsules Product Overview*. (05.12.2020 tarihinde http://www.accessdata.fda.gov/drugsatfda_docs/label/2013/020859s013lbl.pdf adresinden ulaşılmıştır)
10. Rochat B, Kose M, Boss G, et al. Stereoselective biotransformation of the selective serotonin reuptake inhibitor citalopram and its demethylated metabolites by monoamine oxidases in human liver. *Biochem Pharmacol*. 1998;56(1):15-23. Doi: 10.1016/S0006-2952(98)00008-2.
11. FDA accessdata (2020). Highlights of prescribing information ziprasidone HCl capsules Reference ID: 3669822. (05.12.2020 tarihinde http://www.accessdata.fda.gov/drugsatfda_docs/label/2014/020825s053,020919s040,s021483s013lbl.pdf adresinden ulaşılmıştır)
12. Sugihara K, Kitamura S, Tatsumi K. Involvement of mammalian liver cytosols and aldehyde oxidase in reductive metabolism of zonisamide. *Drug Metab Dispos*. 1996;24(2):199-202.
13. Bishara D, Kalafatis C, Taylor D. Emerging and experimental treatments for COVID-19 and drug interactions with psychotropic agents. *Ther Adv Psychopharmacol*. 2020;10:2045125320935306. Doi:



- 10.1177/2045125320935306.
14. Mishima E, Anzai N, Miyazaki M, et al. Uric Acid Elevation by Favipiravir, an Antiviral Drug. *Tohoku J Exp Med.* 2020;251(2):87-90. Doi: 10.1620/tjem.251.87
 15. Chinello P, Petrosillo N, Pittalis S, et al. QTc interval prolongation during favipiravir therapy in an Ebolavirus-infected patient. *PLoS Negl Trop Dis.* 2017;11(12):e0006034. Doi: 10.1371/journal.pntd.0006034
 16. Soh M, Hifumi T, Isokawa S, et al. Neuroleptic malignant syndrome in patients with COVID-19. *Am J Emerg Med.* 2020;38(10):2243.e1-2243.e3. Doi: 10.1016/j.ajem.2020.05.042
 17. Zhao Y, Harmatz JS, Epstein CR, et al. Favipiravir inhibits acetaminophen sulfate formation but minimally affects systemic pharmacokinetics of acetaminophen. *Br J Clin Pharmacol.* 2015;80(5):1076-85. Doi: 10.1111/bcp.12644.
 18. FDA, (2020). *Fact Sheet For Healthcare Providers Emergency Use Authorization (EUA) Of Veklury® (Remdesivir) For Hospitalized Pediatric Patients Weighing 3.5 Kg To Less Than 40 Kg Or Hospitalized Pediatric Patients Less Than 12 Years Of Age Weighing At Least 3.5 Kg.* (05.12.2020 tarihinde <https://www.fda.gov/media/137566/download> adresinden ulaşılmıştır)
 19. Al-Tawfiq JA, Al-Homoud AH, Memish ZA. Remdesivir as a possible therapeutic option for the COVID-19. *Trav Med Infect Dis.* 2020;34:101615. Doi: 10.1016/j.tmaid.2020.101615.
 20. FDA accessdata (2020). *VEKLURY® Highlights Of Prescribing Information, Remdesivir injection, for intravenous use, Reference ID: 4690158.* (05.12.2020 tarihinde https://www.accessdata.fda.gov/drugsatfda_docs/label/2020/214787Orig1s000lbl.pdf adresinden ulaşılmıştır)
 21. European Medicines Agency EMA(2020) . *Human Medicines Division. Summary on compassionate use. Remdesivir Gilead. Product No. EMEA/H/K/5622/CU.* (05.12.2020 tarihinde https://www.ema.europa.eu/en/documents/other/summary-compassionate-use-remdesivir-gilead_en.pdf adresinden ulaşılmıştır)
 22. EMA (2020). *Annex I Summary Of Product Characteristics VEKLURY® 100 mg concentrate for solution for infusion Remdesivir.* (05.12.2020 tarihinde https://www.ema.europa.eu/en/documents/product-information/veklury-epar-product-information_en.pdf adresinden ulaşılmıştır)
 23. EMA (2020). *Product Information as approved by the CHMP on 25 June 2020, pending endorsement by the European Commission Annex I Summary Of Product Characteristics* (05.12.2020 tarihinde https://www.ema.europa.eu/en/documents/other/veklury-product-information-approved-chmp-25-june-2020-pending-endorsement-european-commission_en.pdf adresinden ulaşılmıştır.)
 24. EMA (2020). *20 November 2014 EMA/CHMP/333892/2013 Committee for Human Medicinal Products (CHMP)Background review for cyclodextrins used as excipients In the context of the revision of the guideline on 'Excipients in the label and package leaflet of medicinal products for human use' (CPMP/463/00 Rev. 1).* (05.12.2020 tarihinde https://www.ema.europa.eu/en/documents/report/background-review-cyclodextrins-used-excipients-context-revision-guideline-excipients-label-package_en.pdf adresinden ulaşılmıştır)
 25. Rahimi MM, Jahantabi E, Lotfi B, et al. Renal and liver injury following the treatment of COVID-19 by remdesivir. *J Nephropathol.* 2021;10(2):e10. Doi: 10.34172/jnp.2021.10.
 26. Bilbul M, Paparone P, Kim AM, et al. Psychopharmacology of COVID-19. *Psychosomatics.* 2020;61(5):411-427. Doi: 10.1016/j.psych.2020.05.006)
 27. Chen L, Xiong J, Bao L, et al. Convalescent plasma as a potential therapy for COVID-19. *Lancet Infect Dis.* 2020;20(4):398-400. Doi: 10.1016/S1473-3099(20)30141-9
 28. Devasenapathy N, Ye Z, Loeb M, et al. Efficacy and safety of convalescent plasma for severe COVID-19 based on evidence in other severe respiratory viral infections: a systematic review and meta-analysis. *CMAJ.* 2020;192(27):E745-E755. Doi: 10.1503/cmaj.200642
 29. Pandey S, Vyas GN. Adverse effects of plasma transfusion. *Transfusion.* 2012;52 Suppl 1(Suppl 1):65S-79S. Doi: 10.1111/j.1537-2995.2012.03663.x.
 30. Nusrat S, Madhoun MF, Tierney WM. Use of diphenhydramine as an adjunctive sedative for colonoscopy in patients on chronic opioid therapy: a randomized controlled trial. *Gastrointest Endosc.* 2018;88(4):695-702. Doi: 10.1016/j.gie.2018.04.2342.
 31. Wenjing L, Yuanzheng F, Li JY, et al. Safety and efficacy of convalescent plasma therapy in severely and critically ill patients with COVID-19: A systematic review with meta-analysis. *Aging (Albany NY).* 2020;12. Doi: 10.18632/aging.202195.
 32. Sheppard M, Laskou F, Stapleton PP, et al. Tocilizumab (Actemra). *Hum Vaccin Immunother.* 2017;13(9):1972-1988. Doi: 10.1080/21645515.2017.1316909.
 33. FDA accessdata (2020). *ACTEMRA® Highlights of prescribing information, tocilizumab injection, for intravenous or subcutaneous use.* (05.12.2020 tarihinde https://www.accessdata.fda.gov/drugsatfda_docs/label/2017/125276s114lbl.pdf adresinden ulaşılmıştır)
 34. Di Lorenzo G, Di Trollo R, Kozlakidis Z, et al. COVID 19 therapies and anti-cancer drugs: A systematic review of recent literature. *Crit Rev Oncol Hematol.* 2020;152:102991. Doi: 10.1016/j.critrevonc.2020.102991.
 35. Jafari Coomes EA, Haghighyan H. Interleukin-6 in COVID-19: A systematic review and meta-analysis. *Rev Med Virol.* 2020;30(6):1-9. Doi: 10.1002/rmv.2141.
 36. EMA (2020). *Annex I Summary Of Product Characteristics. RoACTEMRA® 20 mg/mL concentrate for solution for infusion Tocilizumab.* (05.12.2020 tarihinde https://www.ema.europa.eu/en/documents/product-information/roactemra-epar-product-information_en.pdf adresinden ulaşılmıştır)
 37. Grange S, Schmitt C, Banken L, et al. Thorough QT/QTc study of tocilizumab after single-dose administration at therapeutic and supratherapeutic doses in healthy



- subjects. *Int J Clin Pharmacol Ther.* 2011;49(11):648-55. Doi: 10.5414/cp201549.
38. Singh JA, Beg S, Lopez-Olivo MA. Tocilizumab for rheumatoid arthritis: a Cochrane systematic review *J Rheumatol.* 2011;38(1):10-20. Doi: 10.3899/jrheum.100717.
 39. Harrold LR, John A, Reed GW, et al. Impact of tocilizumab monotherapy on clinical and patient-reported quality-of-life outcomes in patients with rheumatoid arthritis. *Rheumatol Ther.* 2017;4(2):405-417. Doi: 10.1007/s40744-017-0081-3.
 40. Knight JM, Costanzo ES, Singh S, et al.(2018). Inflammation and the brain: tocilizumab may redefine our understanding of depression and related symptoms in the medically ill. The Annual Meeting of the Academy of Consultation – Liaison Psychiatry 2018,16.11.2018, Orlando, Florida, NP06. (05.12.2020 tarihinde <https://www.clpsychiatry.org/wp-content/uploads/ACLP-Submission-Jennifer-Knight-MD-on-tocilizumab-and-depression-2018.pdf> adresinden ulaşılmıştır)
 41. Maini RN, Taylor PC, Szechinski J, et al. CHARISMA Study Group. Double-blind randomized controlled clinical trial of the interleukin-6 receptor antagonist, tocilizumab, in European patients with rheumatoid arthritis who had an incomplete response to methotrexate. *Arthritis Rheum.* 2006;54(9):2817-29. Doi: 10.1002/art.22033.
 42. Yokota S, Imagawa T, Mori M, et al. Efficacy and safety of tocilizumab in patients with systemic-onset juvenile idiopathic arthritis: a randomised, double-blind, placebo-controlled, withdrawal phase III trial. *Lancet.* 2008;371(9617):998-1006. Doi: 10.1016/S0140-6736(08)60454-7.
 43. Tatlı SZ, Çakar G, Çolak B, et al. Psychopharmacological treatment in COVID-19 pandemic (Tur). *J Clin Psy.* 2020;23(1):52-66. Doi: 10.5505/kpd.2020.56823
 44. Jacobs L, Johnson KP. A brief history of the use of interferons as treatment of multiple sclerosis. *Arch Neurol.* 1994;51(12):1245-52. Doi: 10.1001/archneur.1994.00540240089022
 45. Hensley LE, Fritz LE, Jahrling PB, et al. Interferon-beta 1a and SARS coronavirus replication. *Emerg Infect Dis.* 2004;10(2):317-9. Doi: 10.3201/eid1002.030482.
 46. Ströher U, DiCaro A, Li Y, et al. Severe acute respiratory syndrome-related coronavirus is inhibited by interferon- alpha. *J Infect Dis.* 2004;189(7):1164-7. Doi: 10.1086/382597.
 47. Lu CC, Chen MY, Lee WS, et al. Potential therapeutic agents against COVID-19: What we know so far. *J Chin Med Assoc.* 2020;83(6):534-536. Doi: 10.1097/JCMA.0000000000000318.
 48. Ziegler CGK, Allon SJ, Nyquist SK, et al. SARS-CoV-2 receptor ACE2 is an interferon-stimulated gene in human airway epithelial cells and is detected in specific cell subsets across tissues. *Cell* 2020;181:1016–1035.e19. Doi:10.1016/j.cell.2020.04.035.
 49. Busnadiego I, Fernbach S, Pohl MO, et al. Antiviral Activity of Type I, II, and III Interferons Counterbalances ACE2 Inducibility and Restricts SARS-CoV-2. *mBio.* 2020;11(5):e01928-20. Doi: 10.1128/mBio.01928-20.
 50. Okuno H, Kitao Y, Takasu M, et al. Depression of drug metabolizing activity in the human liver by interferon-alpha. *Eur J Clin Pharmacol.* 1990;39(4):365-7. Doi: 10.1007/BF00315411.
 51. Okuno H, Takasu M, Kano H, et al. Depression of drug-metabolizing activity in the human liver by interferon-beta. *Hepatology.* 1993;17(1):65-9.
 52. FDA accessdata (2020). *PEGASYS® Highlights of prescribing information Peginterferon alfa -2a Solution for Subcutaneous Injection.* (05.12.2020 tarihinde https://www.accessdata.fda.gov/drugsatfda_docs/label/2011/103964s51841bl.pdf adresinden ulaşılmıştır)
 53. McDonald EM, Mann AH, Thomas HC. Interferons as mediators of psychiatric morbidity. An investigation in a trial of recombinant alpha-interferon in hepatitis-B carriers. *Lancet.* 1987;2(8569):1175-8. Doi: 10.1016/S0140-6736(87)91319-5.
 54. Goldman LS. Successful treatment of interferon alfa-induced mood disorder with nortriptyline. *Psychosomatics.* 1994;35(4):412-3. Doi: 10.1016/S0033-3182(94)71769-2.
 55. Davoodi L, Masoum B, Moosazadeh M, et al. Psychiatric side effects of pegylated interferon-α and ribavirin therapy in Iranian patients with chronic hepatitis C: A meta-analysis. *Exp Ther Med.* 2018;16(2):971-978. Doi: 10.3892/etm.2018.6255
 56. Reder AT, Feng X. How type I interferons work in multiple sclerosis and other diseases: some unexpected mechanisms. *J Interferon Cytokine Res.* 2014;34(8):589-99. Doi: 10.1089/jir.2013.0158.
 57. FDA accessdata (2020). *TEGRETOL® carbamazepine USP Chewable Tablets of 100 mg, Tablets of 200 mg, Suspension of 100 mg/5 mL, Tegretol®-XR carbamazepine extended-release tablets 100 mg, 200 mg, 400 mg Prescribing Information.* (05.12.2020 tarihinde https://www.accessdata.fda.gov/drugsatfda_docs/label/2009/016608s101,018281s0481bl.pdf adresinden ulaşılmıştır.)
 58. McAllister-Williams RH, Young AH, Menkes DB. Anti-depressant response reversed by interferon. *Br J Psychiatry.* 2000;176:93. Doi: 10.1192/bjp.176.1.93.
 59. Werner-Felmayer G, Werner ER, Fuchs D, et al. Characteristics of interferon induced tryptophan metabolism in human cells in vitro. *Biochim Biophys Acta.* 1989;1012(2):140-7. Doi: 10.1016/0167-4889(89)90087-6.
 60. Ahmed F, Jacobson IM, Herrera JL, et al. Seizures during pegylated interferon and ribavirin therapy for chronic Hepatitis C: observations from the WIN-R trial. *J Clin Gastroenterol.* 2011;45(3):286-92. Doi: 10.1097/MCG.0b013e3181f656fb.
 61. Ulrich H, Pillat MM. CD147 as a Target for COVID-19 Treatment: Suggested Effects of Azithromycin and Stem Cell Engagement. *Stem Cell Rev Rep.* 2020;16(3):434-440. Doi: 10.1007/s12015-020-09976-7.
 62. Menzel M, Akbarshahi H, Bjermer L, et al. Azithromycin induces anti-viral effects in cultured bronchial epithelial cells from COPD patients. *Sci Rep.* 2016;6:28698. Doi: 10.1038/srep28698.
 63. FDA accessdata (2020). *Highlights of prescribing information*



mation ZITHROMAX®, (azithromycin) 250 mg and 500 mg tablets and oral suspension. (05.12.2020 tarihinde https://www.accessdata.fda.gov/drugsatfda_docs/label/2017/050710s44-050711s41-050784s28lbl.pdf adresinden ulaşılmıştır.)

64. Westphal JF. Macrolide - induced clinically relevant drug interactions with cytochrome P-450A (CYP) 3A4: an update focused on clarithromycin, azithromycin and dirithromycin. *Br J Clin Pharmacol*. 2000;50(4):285-95. Doi: 10.1046/j.1365-2125.2000.00261.x.
65. FDA accessdata (2020). ZITHROMAX® (azithromycin tablets and azithromycin for oral suspension). (05.12.2020 tarihinde https://www.accessdata.fda.gov/drugsatfda_docs/label/2013/050710s039,050711s036,050784s023lbl.pdf adresinden ulaşılmıştır.)
66. Leitner JM, Graninger W, Thalhammer F. Hepatotoxicity of antibacterials: Pathomechanisms and clinical. *Infection*. 2010;38(1):3-11. Doi: 10.1007/s15010-009-9179-z.
67. Beach SR, Celano CM, Noseworthy PA, et al. QTc prolongation, torsades de pointes, and psychotropic medications. *Psychosomatics*. 2013;54(1):1-13. Doi: 10.1016/j.psych.2012.11.001.
68. Beach SR, Celano CM, Sugrue AM, et al. QT Prolongation, Torsades de Pointes, and Psychotropic Medications: A 5-Year Update. *Psychosomatics*. 2018;59(2):105-122. Doi: 10.1016/j.psych.2017.10.009
69. Plana MT, Blanch J, Romero S, et al. Toxic catatonia secondary to azithromycin. *J Clin Psychiatry*. 2006;67(3):492-3. Doi: 10.4088/jcp.v67n0323a.