



Remdesevir Antiviral Therapy in Pregnant Women with COVID-19

Gulbanu Ganikyzy Shaimerdenova ^{1,*}, Gulzhan Narkenovna Abuova ¹, Serikbayeva Saltanat ², Saltanat Baimbetova ² and Atabay Aidana ¹

¹Department of Infectious Diseases and Dermatovenereology, South Kazakhstan Medical Academy, Shymkent, Kazakhstan

²Department of Infectious Diseases, International Kazakh Turkish University, Shymkent, Kazakhstan

*Corresponding author: Department of Infectious Diseases and Dermatovenereology, South Kazakhstan Medical Academy, Shymkent, Kazakhstan. Email: gulbanu1008@mail.ru

Received 2022 November 01; Revised 2023 April 26; Accepted 2023 April 26.

Abstract

Background: Coronavirus disease 2019 (COVID-19) is difficult to treat in pregnant women due to pregnancy itself and the lack of standard treatment for the disease. As of August 2021, the etiotropic drug remdesivir has been added to the prescription list for women during gestation. There are few publications in the global scientific community regarding the use of this antiviral drug in pregnant women. Moreover, there are only sporadic scientific studies in Kazakhstan, so the question remains open.

Objectives: This study aimed to evaluate the efficacy of remdesivir in pregnant women with probable or confirmed COVID-19.

Methods: The study comprehensively examined 120 pregnant women with severe to very severe COVID-19, who were divided into two groups of patients. The study group consisted of women who received remdesivir and standard therapy. The control group included patients who received standard therapy per the protocol.

Results: Statistically significant age differences were observed between the main and control groups ($P = 0.019$). The differences detected were due to a higher frequency in the age group of 33 and 42 years in patients taking remdesivir than in the control group ($P = 0.036$). Women in the main group (Median = 9.00; Q1 - Q3 = 8.00 - 11.0) had longer hospital stays than the control group (Me = 8.00; Q1 - Q3 = 7.00 - 10.0). This was due to the more severe condition of the patients in this group. There were statistically significant differences in amniotic fluid changes according to ultrasound between the control and main groups ($P = 0.013$). When comparing the groups in pairs, amniotic fluid was more common in women who received remdesivir ($P = 0.316$) than in the control group. Our study found that a decrease in temperature to normal levels occurred earlier in the control group (68%) than in the main group. Further SpO₂ increases of more than 95% were seen on days 3 - 4 in the main group (71%) and days 1 - 2 in the control group (43%). After three days, there was an improvement in respiratory rate (41.6%) and a reduction in subjective dyspnea (66.6%) in the main group.

Conclusions: The study found that repeat mothers have a more severe course of COVID-19. The older age group and the third trimester of pregnancy are risk factors for progression to severe disease.

Keywords: COVID-19, Pregnancy, Antiviral Drug, Retrospective Study

1. Background

Coronavirus disease 2019 (COVID-19) has been characterized by unabated progression and increasing numbers of infections and deaths since its detection in December 2019 in China. According to the World Health Organization (WHO), as of October 17, 2022, there were 629,959,595 cases of COVID-19 infection worldwide, with 6,571,489 deaths. In the Republic of Kazakhstan, 1,394,287 cases have been registered, with 13,692 deaths. In our country, 959 people are still being treated for the infection, including 107 inpatients and 852 outpatients. A total of 38149 cases of COVID-19 infection were registered in Shymkent city in 2020 - 2022, including 1,646 pregnant

women: 537 in 2020, 892 in 2021, and 217 in 2022 (1, 2). Concerning the pathogenicity, SARS-CoV-2 enters the target cell via surface receptors and the serine protease TMPRSS2, located on cells of various organs and tissues. The upper respiratory and digestive tracts are the entry gates for infection, where receptors for SARS-CoV-2 (ACE2 and CD147) and TMPRSS are located (3). According to a Moore et al. report, 15% had a severe course of infection, 5% had a critical course, and 80% had a mild to moderate course, which, according to the WHO, approximates the population figures (4).

Reduced immune reactivity and other physiological changes in the gestational period can increase

susceptibility to respiratory disease and severe pneumonia in pregnant women, leading to admission to intensive care units and ventilatory support (5). As known, SARS-CoV-2-induced disease depends directly on virus entry into host cells after binding to angiotensin-converting enzyme 2. Angiotensin-converting enzyme 2 (ACE2) proliferates on cell membranes and is tropic in the placenta throughout gestation. This phenomenon is a possible etiology of the susceptibility of pregnant women to COVID-19 (6). Also, COVID-19 in pregnant women is severe due to the gestation process and the lack of standard therapy for the disease. Since August 2021, the etiotropic drug remdesivir has been added to the prescription list for women during gestation, with an intravenous regimen of 200 mg on day 1, followed by 100 mg daily for a five-day course. Remdesivir is an antiviral agent that blocks the reproduction of SARS-CoV-2 (7). This drug is recommended for use based on international experience and the results obtained on a group of adult patients by scientists in the Republic of Kazakhstan (8). The antiviral drug is approved for the etiotropic treatment of coronavirus infection in pregnant women by the decision of a medical consilium, provided that the potential benefit of the drug exceeds the potential risk to the patient (7).

2. Objectives

Currently, the global scientific community has limited publications on the efficacy of remdesivir in pregnant women with COVID-19. In the Republic of Kazakhstan, there are only sporadic studies on drug use in adults. However, there are no studies conducted on women during gestation. To assess the efficacy of remdesivir in female patients, we investigated the following criteria: Timing of temperature normalization, improvement in respiratory rate, and subjective reduction in dyspnea.

3. Methods

To carry out the study, 120 pregnant women with severe and extremely severe coronavirus infections, who were admitted to the Shymkent City Infectious Disease Center in 2021 - 2022, were subjected to comprehensive evaluation. The diagnosis of COVID-19 in pregnant women was made based on the epidemiological history, the complex clinical symptoms of the disease, and the results of laboratory and instrumental investigations. Inclusion criteria included confirmed and probable cases of coronavirus infection among pregnant women, severe and extremely severe course of COVID-19, and remdesivir use as etiotropic treatment. Exclusion criteria were pregnancy without

COVID-19 and mild to moderate disease in pregnant women. We enrolled 120 out of 411 patients who fulfilled these criteria. Sample sizes were determined considering the confidence level of 95% and the test power of 80%. The sample size was calculated as 120 using G power software (version 3.1).

The patients were divided into two groups. The study group included women who received remdesivir at a dose of 200 mg intravenously on day one and standard therapy according to the clinical protocol for the diagnosis and treatment of coronavirus infection in pregnancy. The number of pregnant women was 60 women. The control group consisted of patients who received standard therapy per the above protocol. Sixty women were included in this group.

The following parameters were studied: Age, gestational age, delivery, and diagnosis by PCR. We took the following criteria for the efficacy of remdesivir therapy in pregnant women with COVID-19: Timing of temperature normalization, improvement in respiratory rate, and subjective reduction in dyspnea.

The Local Ethics Committee of the South Kazakhstan Academy approved the study protocol. Statistical analysis was performed using IBM SPSS Statistics 26.0 software. Nominal variables were analyzed using the Mann-Whitney, Pearson's chi-square, and Fisher's exact tests.

4. Results

Two groups of patients were studied. The study group included women who received remdesivir at 200 mg intravenously on the first day in addition to standard therapy according to the clinical protocol for the diagnosis and treatment of coronavirus infection in pregnant women. The control group (2) included patients who received standard therapy per the above protocol. There were 60 women in each group.

The following parameters were studied: Age, gestational age, delivery, and diagnosis by PCR. The results are presented in [Table 1](#).

Statistically significant differences were observed in age between the main and control groups ($P = 0.019$). The differences detected were due to a higher frequency in the age group of 33 to 42 years in patients taking remdesivir than in the control group ($P = 0.036$). The association between the compared features was medium ($V = 0.250$). Women aged 33 - 42 were 41.7% ($n = 25$) in the main group and 18.3% ($n = 11$) in the control group. Pregnancy term and parity were not statistically significant ($P > 0.05$). Most women were hospitalized with severe and extremely severe COVID-19 in the third trimester of pregnancy (63.3% and 65.0%, respectively). Pregnancy parity analysis showed that the most frequent indication for remdesivir was five

Table 1. Comparative Table of Age, Gestational Age, and Gestational Parity in Pregnant Women with COVID-19

Index	Absolute Number (%)		P-Value
	Therapy with Remdesivir (N = 60)	Therapy Without Remdesivir (N = 60)	
Age, y			0.019 ^a
18 - 25	17 (28.3)	22 (36.7)	
26 - 32	18 (30.0)	27 (45.0)	
33 - 42	25 (41.7)	11 (18.3)	
Gestational age, weeks			0.537
1 - 12	1 (1.7)	3 (5.0)	
13 - 27	21 (35.0)	18 (30.0)	
28 - 40	38 (63.3)	39 (65.0)	
Pregnancy parity			0.111
1	6 (10.0)	17 (28.3)	
2	14 (23.3)	8 (13.3)	
3	14 (23.3)	12 (20.0)	
4	11 (18.3)	8 (13.3)	
5 and more	15 (25.0)	15 (25.0)	

^a Differences are statistically significant ($P < 0.05$).

or more pregnancies (25.0%; $n = 15$), followed by four or more pregnancies, 18.3% ($n = 11$), confirming the more severe course of COVID-19 in multiparous women. In the control group, primiparous women accounted for 28.3% (17).

Pregnant women with confirmed (U 07.1) and probable (U 07.2) coronavirus infection were included in the study. In the main group, 80% ($n = 48$) of the sample had been confirmed in the case group versus 90% ($n = 54$) in the control group. Probable cases of coronavirus infection were twice as common in the study group compared with controls (20%, $n = 12$ vs. 10%, $n = 6$, respectively). Comparing the frequency of diagnosis by PCR depending on the prescription of remdesivir showed statistically significant differences ($P = 0.02$). The likelihood of prescribing remdesivir increased by 0.44 in pregnant women with confirmed coronavirus infection (95% CI: 0.15 - 1.28).

One of the indicators on which women during gestation were studied was the number of bed days in the hospital, as shown in [Figure 1](#).

When comparing the main and control groups, there were statistically significant differences in bed days ($P = 0.001$). Women in the core group (Median = 9.00; Q1 - Q3 = 8.00 - 11.0) stayed longer in the hospital than the control group (Mo = 8.00; Q1 - Q3 = 7.00 - 10.0). This is due to the more severe condition of patients in this group.

The results were not statistically significant ($P > 0.05$) ([Table 2](#)). However, there were 14 cases of preterm births (8 in the main group and 6 in the control group). More than half of the pregnancy complications were due to placenta detachment: 53.3% in the main group and 50% in the control group. There was one case of intrauterine fetal death in the control group. There were 6 cases of postpartum hemorrhage during the study period (60% in the first group and 75% in the second group) and one case of sepsis in the control group. The fatal case occurred in the control group ([Figure 2](#)).

There were statistically significant differences in amniotic fluid changes according to ultrasound between the control and main groups ($P = 0.013$). When comparing the groups in pairs, oligohydramnios was more common in women who received Remdesivir ($P = 0.316$) than in the control group. Oligohydramnios was detected in 52.8% ($n = 28$) of cases in the main group and 27.5% ($n = 14$) in the control group.

We took the following criteria for the efficacy of Remdesivir therapy in pregnant women with COVID-19: Timing of temperature normalization, improvement in respiratory rate, and subjective reduction in breathlessness. The normalization of body temperature on day 1 or 2 occurred in 68% ($n = 41$) of pregnant women in the control group, associated with a less severe course

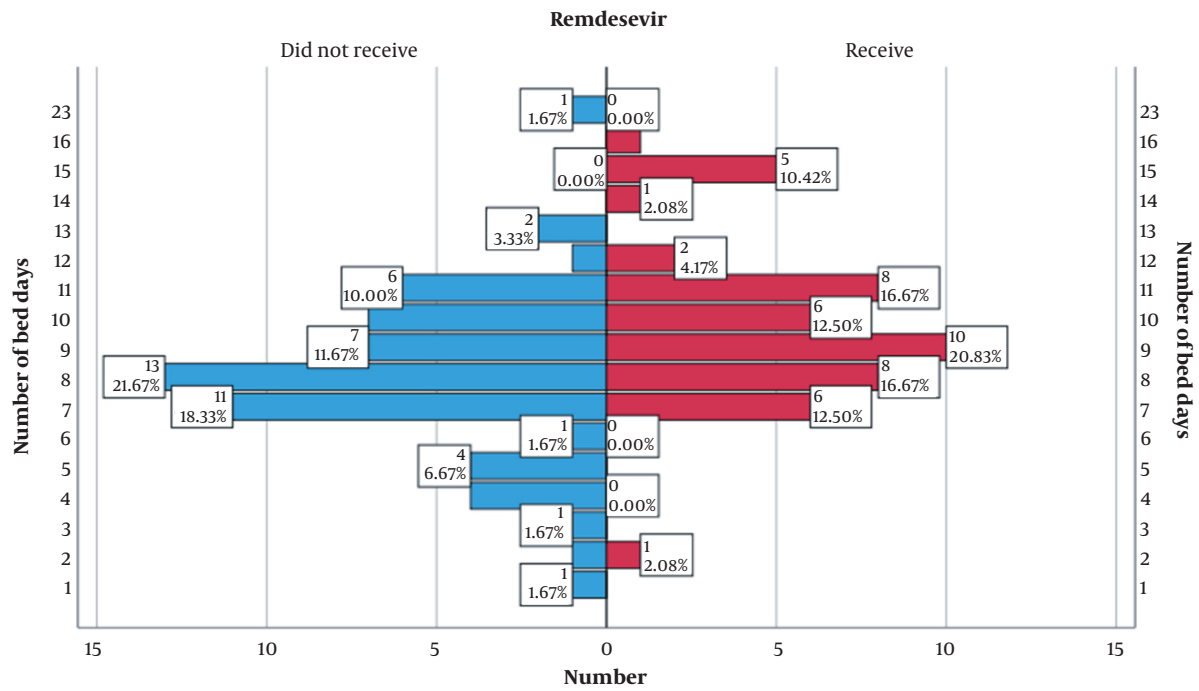


Figure 1. Number of hospital bed-days for pregnant women with coronavirus infection

Table 2. Comparative Table of Outcomes

Index	Absolute Number (%)		P-Value
	Therapy with Remdesivir (N = 60)	Therapy Without Remdesivir (N = 60)	
Outcome of pregnancy			0.795
Preterm birth	8 (13.3)	6 (10.0)	
Prolongation	36 (60.0)	40 (66.7)	
Birth at term	15 (25.0)	14 (23.3)	
Complication of pregnancy			1.000
Intrauterine fetal death	0 (0)	1 (6.3)	
Placental abruption	8 (53.3)	8 (50.0)	
Pre-eclampsia	7 (46.7)	6 (37.5)	
Chorioamnionitis	0 (0)	1 (6.3)	
Complications in the postpartum period			2.925
Bleeding	3 (60.0)	3 (75.0)	
Sepsis	0 (0)	1 (25.0)	
Endometritis	2 (40.0)	0 (0)	
Outcome of treatment			0.180
Recovery	1 (1.7)	3 (5.0)	
Improvement	59 (98.3)	56 (93.3)	
No change	0 (0)	1 (1.7)	
Mortality	0 (0)	0 (0)	

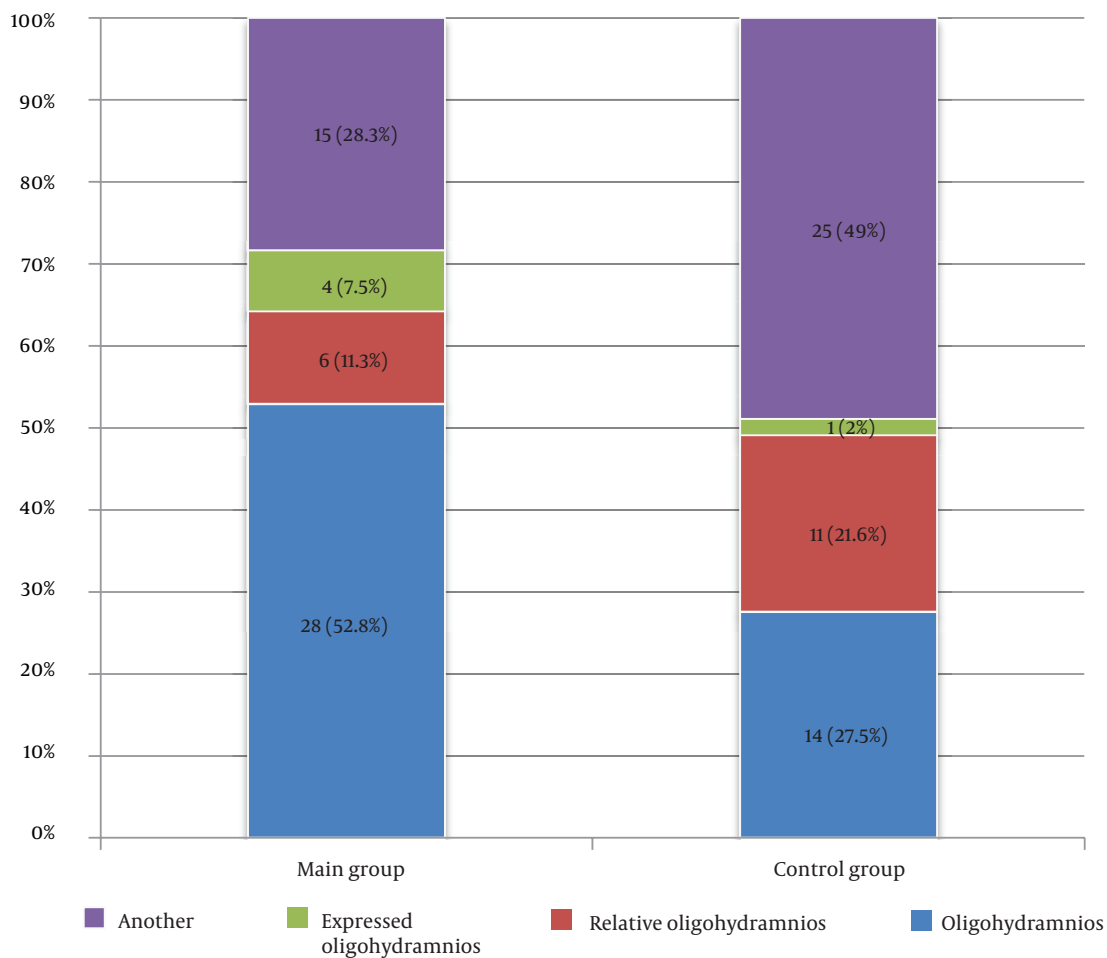


Figure 2. The state of the peritoneum according to ultrasound

of COVID-19 in this group of patients, whereas in the main group, it occurred in 28% ($n = 17$). Also, SpO_2 increased by more than 95%, leading to the cancellation of oxygen therapy on days 1 - 2 in the main group in 71% ($n = 43$), before four days of antiviral therapy in 10% ($n=6$), and days 7 - 8 after the start of etiotropic treatment only in 68% ($n = 41$). In the other group, cancellation of oxygen therapy due to improvement in SpO_2 by more than 95% was observed in 26 pregnant women (43%) on day 1, 38% ($n = 23$) on days 3 - 4, 15% ($n = 9$) on days 5 - 6, and 4% ($n = 2$) on days 7 - 8 after the start of therapy.

The respiratory rate dynamics were as follows: In the study group, 22 (36.6%) women had normalization of respiratory rate on the third day after the start of Remdesivir therapy, 25 (41.6%) had it later than three days after the start of therapy. In the remdesivir therapy group, the subjective sensation of dyspnea in pregnant women

stopped on day 2 in four (6.6%) patients, day 3 in 11 (18.3%), and later in 40 (66.6%) patients.

5. Discussion

Various researchers have reported that gestational women with coronavirus infection are more prone to progress to severe respiratory disease than non-pregnant women (9, 10). The etiologies are a weakened immune system, an increased risk of thromboembolism, and increased concentrations of circulating pro-inflammatory mediators (10, 11). Coronavirus infection during pregnancy can also lead to pre-eclampsia, preterm labor, and stillbirth, most commonly in patients with severe COVID-19 (10, 11). The difficulty in the clinical management and drug treatment of pregnant women with COVID-19 is related to the risk of possible teratogenic effects of

the drugs (10, 11). During the COVID-19 pandemic, many drugs were prescribed without evidence of efficacy and guaranteeing no long-term effects on the fetus (10). The development of etiotropic drugs was a process that took several years. Drug development was based on a study of the efficacy of existing antiviral drugs that could be effective against SARS-CoV-2 (12-15). Remdesivir was administered as a solution. To date, there are a limited number of studies evaluating the efficacy of remdesivir in pregnant women with COVID-19 worldwide. Meanwhile, there are no publications in this cohort in our country. There are only sporadic studies on the use of the drug in adults (12). Therefore, this issue is relevant and requires further study. Early positive results of this antiviral agent led to its emergency use in pregnant women with COVID-19 (16-20). Further studies are needed to evaluate its efficacy and safety in patients with COVID-19 so that it can be recommended in international COVID-19 treatment protocols (13-17, 21).

Women in the 33 - 42 age group (41.7%) received antiviral therapy more often than other pregnant women in the younger age group (30.0% and 28.3%). The third trimester was marked by hospital admission among patients. A more severe course of coronavirus infection was observed in multiparous mothers. The duration of hospital stay was longer in the main group of pregnant women (9.0 bed days) than in the control group (7.0 bed days). Amniotic fluid examination showed that scant amniotic fluid was more common in the study group than in the control group (52.8% and 27.5%, respectively). The criteria for the efficacy of remdesivir in women with COVID-19 during gestation were based on the dynamics of temperature normalization, improvement in respiratory rate, and subjective reduction in breathlessness. Our study found that a decrease in temperature to normal levels occurred earlier in the control group (68%) than in the main group. A further increase in SpO₂ by more than 95% was seen on days 3 - 4 in the main group (71%) and on days 1 - 2 in the control group (43%). After three days, there was an improvement in respiratory rate (41.6%) and a reduction in subjective dyspnea (66.6%) in the main group.

A Randomized Controlled Trial (RCT) showed that remdesivir therapy in pregnant women with Ebola was safe and without significant side effects (22). The use of this antiviral drug for moderate to severe COVID-19 requiring oxygenation has shown modest benefit (23). This was also confirmed in our study. According to various studies, among pregnant women with SARS-CoV-2 infection, the use of remdesivir for five days leads to a clinical improvement in the course of moderate COVID-19 (24), which is consistent with data in the general population (25). Burwick et al. reported that remdesivir given intravenously for 10 days clinically improves severe

COVID-19 in pregnant and postpartum patients (26). But in our study, the use of a 5-day course of remdesivir showed no clinical improvement in patients.

Recruitment of pregnant women with COVID-19 during the pandemic has been rapid, which is one of the study's strengths. However, the limitation was the creation of a comparison group. The prescription list for patients with severe and extremely severe COVID-19 included the antiviral drug remdesivir. Therefore, the comparison group included those pregnant women who did not give informed consent to additional treatment. Another limitation was that this study is a single center, which does not provide extended results. It should be noted that the sample size was relatively small.

5.1. Conclusions

A more severe course of coronavirus infection occurs in second-born women. Older age and third-trimester pregnancy are risk factors for progression to severe disease. The etiotropic agent remdesivir is not of reliable efficacy. There are a limited number of studies worldwide on using remdesivir in pregnant women with COVID-19. Further studies are needed to evaluate its efficacy and safety in gestational patients with COVID-19 for recommendations in international treatment protocols for coronavirus infection.

Footnotes

Authors' Contribution: Study concept and design: Shaimerdenova G. G. and Abuova G. N.; analysis and interpretation of data: Bayimbetova S. and Atabay A.; drafting of the manuscript: Bayimbetova S. and Serikbayeva S.; critical revision of the manuscript for important intellectual content: Abuova G. N. and Shaimerdenova G. G.; statistical analysis: Shaimerdenova G. G. and Serikbayeva S.

Conflict of Interests: The authors declare no conflict of interests.

Ethical Approval: The Local Ethics Committee of the South Kazakhstan Academy approved the study protocol.

Funding/Support: The authors of this article did not have financial support from any organizations, from both the place of work and other medical institutions. The study was funded by the authors voluntarily. No personal financial interests were pursued during the study. Professional and personal relationships with organizations and patients were not pursued. Consultations, shares, and shares in companies were not provided.

Informed Consent: Informed consent was obtained.

References

- Daily new confirmed COVID-19 cases per million people. Our World in Data; 2022. Available from: <https://ourworldindata.org/explorers/coronavirus-data-explorer0716/2022>.
- Data of the committee for sanitary and epidemiological control of the city of Shymkent. National center of public health care of the ministry of health of the Republic of Kazakhstan; 2022. Available from: <https://rkn-cph.kz/en/sanepidem-en/ezhemesyachnaya-situatsiya>.
- Warner FJ, Guy JL, Lambert DW, Hooper NM, Turner AJ. Angiotensin converting enzyme-2 (ACE2) and its possible roles in hypertension, diabetes and cardiac function. *Lett Pept Sci*. 2003;**10**(5):377-85. [PubMed ID: 32214681]. [PubMed Central ID: PMC7088140]. <https://doi.org/10.1007/s10989-004-2387-6>.
- Moore CA, Staples JE, Dobyns WB, Pessoa A, Ventura CV, Fonseca EB, et al. Characterizing the pattern of anomalies in congenital zika syndrome for pediatric clinicians. *JAMA Pediatr*. 2017;**171**(3):288-95. [PubMed ID: 27812690]. [PubMed Central ID: PMC5561417]. <https://doi.org/10.1001/jamapediatrics.2016.3982>.
- Zhu H, Wang L, Fang C, Peng S, Zhang L, Chang G, et al. Clinical analysis of 10 neonates born to mothers with 2019-nCoV pneumonia. *Transl Pediatr*. 2020;**9**(1):51-60. [PubMed ID: 32154135]. [PubMed Central ID: PMC7036645]. <https://doi.org/10.21037/tp.2020.02.06>.
- Liu D, Li L, Wu X, Zheng D, Wang J, Yang L, et al. Pregnancy and perinatal outcomes of women with coronavirus disease (COVID-19) Pneumonia: A preliminary analysis. *AJR Am J Roentgenol*. 2020;**215**(1):127-32. [PubMed ID: 32186894]. <https://doi.org/10.2214/AJR.20.23072>.
- Clinical protocol for the diagnosis and treatment of coronavirus infection COVID-19 in pregnant women, women in labour and puerperas of August 5, 2021. 2021. Available from: <http://www.rcrz.kz/index.php/ru/2017-03-12-10-50-44/press-reliz/2365-press-reliz-16.07.2022>.
- Giniyat A, Kulzhanova SA, Tuleshova GT, Konkayeva ME, Smagulova ZK, Beisenbieva NY, et al. Clinical efficacy of the antiviral drug remdesivir in the comprehensive treatment of patients with COVID-19. *Science Healthcare*. 2021;**3**(3):6-15.
- Poon LC, Yang H, Lee JCS, Copel JA, Leung TY, Zhang Y, et al. ISUOG Interim Guidance on 2019 novel coronavirus infection during pregnancy and puerperium: Information for healthcare professionals. *Ultrasound Obstet Gynecol*. 2020;**55**(5):700-8. [PubMed ID: 32160345]. [PubMed Central ID: PMC7228229]. <https://doi.org/10.1002/uoq.22013>.
- Vitiello A, Ferrara F, Zovi A, Trama U, Boccellino M. Pregnancy and COVID-19, focus on vaccine and pharmacological treatment. *J Reprod Immunol*. 2022;**151**:103630. [PubMed ID: 35483212]. [PubMed Central ID: PMC9023094]. <https://doi.org/10.1016/j.jri.2022.103630>.
- Chen H, Guo J, Wang C, Luo F, Yu X, Zhang W, et al. Clinical characteristics and intrauterine vertical transmission potential of COVID-19 infection in nine pregnant women: A retrospective review of medical records. *Lancet*. 2020;**395**(10226):809-15. [PubMed ID: 32151335]. [PubMed Central ID: PMC7159281]. [https://doi.org/10.1016/S0140-6736\(20\)30360-3](https://doi.org/10.1016/S0140-6736(20)30360-3).
- Chan JF, Kok KH, Zhu Z, Chu H, To KK, Yuan S, et al. Genomic characterization of the 2019 novel human-pathogenic coronavirus isolated from a patient with atypical pneumonia after visiting Wuhan. *Emerg Microbes Infect*. 2020;**9**(1):221-36. [PubMed ID: 31987001]. [PubMed Central ID: PMC7067204]. <https://doi.org/10.1080/22221751.2020.1719902>.
- Naqvi AAT, Fatima K, Mohammad T, Fatima U, Singh IK, Singh A, et al. Insights into SARS-CoV-2 genome, structure, evolution, pathogenesis and therapies: Structural genomics approach. *Biochim Biophys Acta Mol Basis Dis*. 2020;**1866**(10):165878. [PubMed ID: 32544429]. [PubMed Central ID: PMC7293463]. <https://doi.org/10.1016/j.bbadis.2020.165878>.
- Chen Y, Liu Q, Guo D. Emerging coronaviruses: Genome structure, replication, and pathogenesis. *J Med Virol*. 2020;**92**(4):418-23. [PubMed ID: 31967327]. [PubMed Central ID: PMC7167049]. <https://doi.org/10.1002/jmv.25681>.
- Fung TS, Liu DX. Human Coronavirus: Host-pathogen interaction. *Annu Rev Microbiol*. 2019;**73**:529-57. [PubMed ID: 31226023]. <https://doi.org/10.1146/annurev-micro-020518-115759>.
- Jorgensen SCJ, Kebriaei R, Dresser LD. Remdesivir: Review of pharmacology, pre-clinical data, and emerging clinical experience for COVID-19. *Pharmacotherapy*. 2020;**40**(7):659-71. [PubMed ID: 32446287]. [PubMed Central ID: PMC7283864]. <https://doi.org/10.1002/phar.2429>.
- Goldman JD, Lye DCB, Hui DS, Marks KM, Bruno R, Montejano R, et al. Remdesivir for 5 or 10 days in patients with severe Covid-19. *N Engl J Med*. 2020;**383**(19):1827-37. [PubMed ID: 32459919]. [PubMed Central ID: PMC7377062]. <https://doi.org/10.1056/NEJMoa2015301>.
- Cao YC, Deng QX, Dai SX. Remdesivir for severe acute respiratory syndrome coronavirus 2 causing COVID-19: An evaluation of the evidence. *Travel Med Infect Dis*. 2020;**35**:101647. [PubMed ID: 32247927]. [PubMed Central ID: PMC7151266]. <https://doi.org/10.1016/j.tmaid.2020.101647>.
- Shaimerdenova GG, Abuova GN, Zhumabekova S, Kaldybekova Z. [Clinic of COVID-19 in pregnant women. Principles of treatment in infectious disease hospitals of Shymkent. Actual problems of theoretical and clinical medicine]. Cyber Leninka; 2021. Russian. Available from: <https://cyberleninka.ru/article/n/klinika-covid-19-u-beremennyh-printsipy-lecheniya-v-infektsionnyh-statsionarah-goroda-shymkenta>.
- Yang K. What do we know about remdesivir drug interactions? *Clin Transl Sci*. 2020;**13**(5):842-4. [PubMed ID: 32402130]. [PubMed Central ID: PMC7272915]. <https://doi.org/10.1111/cts.12815>.
- Singh AK, Singh A, Singh R, Misra A. Remdesivir in COVID-19: A critical review of pharmacology, pre-clinical and clinical studies. *Diabetes Metab Syndr*. 2020;**14**(4):641-8. [PubMed ID: 32428865]. [PubMed Central ID: PMC7214279]. <https://doi.org/10.1016/j.dsx.2020.05.018>.
- Mulangu S, Dodd LE, Davey RJ, Tshiani Mbaya O, Proschan M, Mukadi D, et al. A Randomized, Controlled Trial of Ebola Virus Disease Therapeutics. *N Engl J Med*. 2019;**381**(24):2293-303. [PubMed ID: 31774950]. <https://doi.org/10.1056/NEJMoa1910993>.
- Hariyanto TI, Kwenandar F, Japar KV, Damay V, Kurniawan A. The effectiveness and safety of remdesivir for the treatment of patients with COVID-19: a systematic review and meta-analysis. *Anti-Infect Agents*. 2021;**19**(3):333-40. <https://doi.org/10.2174/2211352518999201009124433>.
- Maldarelli GA, Savage M, Mazur S, Oxford-Horrey C, Salvatore M, Marks KM. Remdesivir Treatment for Severe COVID-19 in Third-Trimester Pregnancy: Case Report and Management Discussion. *Open Forum Infect Dis*. 2020;**7**(9):ofaa345. [PubMed ID: 32934969]. [PubMed Central ID: PMC7478602]. <https://doi.org/10.1093/ofid/ofaa345>.
- Spinner CD, Gottlieb RL, Criner GJ, Arribas Lopez JR, Cattelan AM, Soriano Viladomiu A, et al. Effect of Remdesivir vs Standard Care on Clinical Status at 11 Days in Patients With Moderate COVID-19: A Randomized Clinical Trial. *JAMA*. 2020;**324**(11):1048-57. [PubMed ID: 32821939]. [PubMed Central ID: PMC7442954]. <https://doi.org/10.1001/jama.2020.16349>.
- Burwick RM, Yawetz S, Stephenson KE, Collier AY, Sen P, Blackburn BG, et al. Compassionate use of remdesivir in pregnant women with severe coronavirus disease 2019. *Clin Infect Dis*. 2021;**73**(11):e3996-e4004. [PubMed ID: 33031500]. [PubMed Central ID: PMC7797739]. <https://doi.org/10.1093/cid/ciaa1466>.