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Original Research Article

Efficacy and adverse effects of remdesivir in patients with COVID-19 pneumonia: a retrospective study

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ABSTRACT

Background: Remdesivir is an antiviral medication approved by the US FDA to treat COVID-19 in hospitalized patients. However, it has unknown adverse effects and has shown deleterious impacts on several organ systems in randomized controlled trials. This study aims to describe the safety and efficacy of Remdesivir administration in a cohort of 586 patients admitted to a tertiary hospital in Qatar for COVID-19-related reasons.
Methods: A retrospective study of 586 patients admitted with a diagnosis of COVID-19 and treated with Remdesivir were compared to 200 patients with COVID-19 who did not receive Remdesivir.
Results: The rate of mechanical ventilation admission to the intensive care unit was comparable across the two groups (2.35% vs. 2%, p=0.75). Death rates were similar between the two groups (0.02% vs. 0.03%, p=0.43). There was a mean reduction in heart rate within the first three days of antiviral therapy. Negligible variations in serum AST, ALT, ALP, and eGFR levels were detected. Remdesivir-treated patients had a significantly shorter hospital stay.
Conclusions: When using Remdesivir in COVID-19 patients, it's important to be cautious by evaluating baseline parameters and avoiding concurrent use of drugs that could affect the heart, kidneys, or liver.

Keywords: COVID-19, Drug-induced liver injury, Elevated liver function tests, Hepatic dysfunction, Remdesivir

INTRODUCTION

This review presents data on the efficacy and potential hepatic, renal, and cardiac adverse effects of Remdesivir in COVID-19-infected patients. We conducted a retrospective search on COVID-19 patients admitted to our hospital between March 2020 and December 2021 who received remdesivir therapy.[1-5] Although the COVID-19 pandemic started worldwide in March 2020, Remdesivir was licensed at the end of August 2020 and was introduced in our healthcare system for COVID-19 patients. Patients from March 2020 through August 2020 were not prescribed Remdesivir.

Coronavirus disease 2019 (COVID-19) is an ailment brought on by the coronavirus that results in severe acute respiratory syndrome (SARS-CoV-2). Remdesivir, an adenosine nucleotide analog prodrug, is a COVID-19 antiviral agent approved by the FDA for hospitalized COVID-19 patients later in the pandemic. It exhibits

broad-spectrum in vitro antiviral efficacy against several virus families.[1-9] There are currently limited trials on the use of Remdesivir in individuals with hepatic, renal, or cardiac impairment, and there is scant data available on the potential adverse effects of this medication. Remdesivir has been demonstrated to be cytotoxic to humans on a cellular level. The FDA has stated the incidence of increased liver enzymes in Remdesivir-treated patients, which may indicate drug-induced liver injury.[3-8] The FDA fact sheet warns prescribers about potential side effects such as increased liver enzymes, allergic reactions, hypotension, tachycardia, bradycardia, shortness of breath, wheezing, angioedema, and respiratory distress, among others.[9] Few clinical trials have demonstrated that it is effective in shortening the recovery period after COVID-19.[3-6] However, the properties of Remdesivir in slowing the progression of COVID-19 are still being debated.[11] The objective of this study was to evaluate the outcomes of COVID-19 patients treated with Remdesivir during the pandemic wave in Qatar, focusing on ICU admission and mortality rates, clinical recovery time, and potential organ toxicity, to assess its effectiveness and safety compared to other treatments and informing future management strategies for COVID-19, especially in the context of emerging variants.

METHODS

Data collection/sample size

A retrospective analysis was conducted on all patients admitted to the Hazm Mebaireek General Hospital (HMGH), a COVID-19-designated hospital, between March 2020 and December 2021, provided they met the following criteria: 1) Age ≥ 18 years, 2) Diagnosis of SARS-CoV-2 infection confirmed with positive Polymerase Chain Reaction (PCR) on nasal-pharyngeal swab, 3) Prescribed five-day course treatment with Remdesivir per hospital protocol and recommendations from the infectious disease department. Besides antiviral treatment, all patients received standard care therapy for SARS-CoV2 pneumonia: Dexamethasone 6 mg once daily, Low Molecular Weight Heparin (LMWH), and antimicrobial prophylaxis, 4) Eligibility for Remdesivir was established at admission.

Contraindications included (i) AST or ALT or ALP ≥2 times the normal range values, (ii) eGFR <30 mL/min, hemodialysis, or peritoneal dialysis, (iii) evidence of severe bradycardia (heart rate <40 bpm), current cardiac arrhythmia, or under treatment for any arrhythmia.

Medical records provided information on demographics, clinical data, hospital admission, discharge dates, Remdesivir administration dates, co-medications, and oxygen support requirements upon admission. The length of the hospital stays, the time until the first negative SARS-CoV-2 PCR on a nasal-pharyngeal swab, and the timing of Remdesivir administration from symptom onset were all calculated. The severity of the illness at the time of admission and the prognosis upon discharge or transfer to the intensive care unit were determined. "Clinical recovery" was defined as the stable remission of symptoms and signs of infection noted at the time of patient presentation with COVID-19 PCR nasopharyngeal swab results. If clinical recovery was achieved, it was recommended but not necessary for patients to be discharged from the hospital with a negative SARS-CoV2 PCR on nasal-pharyngeal swabs. "Virological recovery" was defined as the concordance between clinical recovery and a negative SARS-CoV-2 PCR on nasal pharyngeal swabs taken before discharge. The severity of the disease was determined using current WHO guidelines 12.

Study design and statistical analysis

The primary endpoint was to report on the efficacy of the Remdesivir five-day course treatment. To that end, a descriptive statistical analysis of clinical traits and outcomes, oxygen support, and baseline laboratory markers was performed on all Remdesivir patients treated in our unit during the study period. We were looking for changes in the effectiveness and safety of antiviral medication during remdesivir treatment Figure 1. Group A was patients received Remdesivir and Group B was patients did not receive Remdesivir.

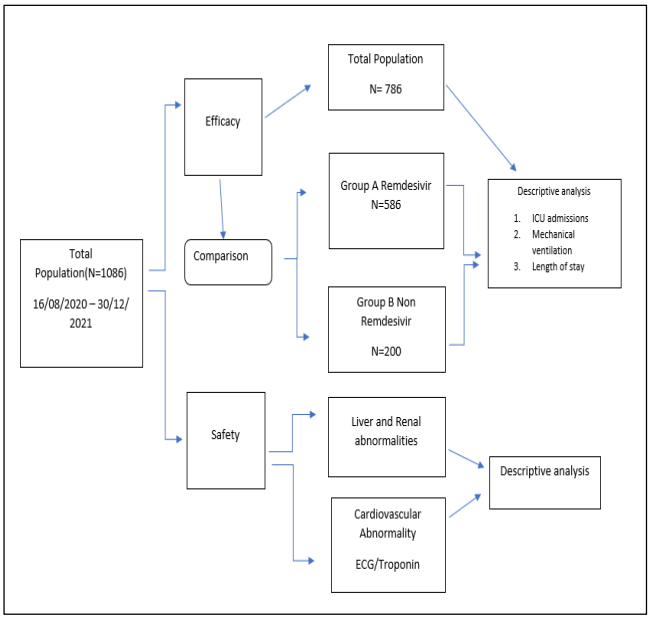

Figure 1: The flowchart illustrating the study design.

Each group received a descriptive statistical analysis. The proportions between Groups A and B were compared using the Chi-square test or Fisher exact test, as appropriate. A $p<0.05$ was considered statistically significant.

Univariate analysis was performed for the total population to highlight the possible correlation between the following: i) Progression to non-invasive ventilation.

ii) Clinical recovery. iii) Hospital length-of-stay. iv) Time between the first positive and the first negative nasal-pharyngeal swab, as well as the patient's baseline laboratory and clinical characteristics, with a particular emphasis on the date of hospitalization, the interval between hospitalization and the onset of symptoms, and the interval between the administration of Remdesivir and the onset of symptoms. A $p<0.05$ was considered statistically significant.

The description of Remdesivir's safety in terms of drug-induced liver and renal toxicity, as well as cardiac rhythm abnormalities, was among the secondary goals of our study. To that end, all patients with available serum ALT, AST, ALP, and eGFR levels at baseline and within seven days of Remdesivir intake were included in the study. The cardiac rhythm study was conducted on a subset of subjects who had at least two ECG recordings during Remdesivir treatment and ECGs performed on admission and discharge. The corrected duration of the QT interval (QTc) concerning heart rate was calculated using Bazett's formula. The term "QTc prolongation" refers to the observation of values beyond the normal range (440 ms for men and 460 ms for women). The potential clinical repercussions of cardiac arrhythmias, such as sinus pause, sinus node arrest, tachycardia-bradycardia, atrioventricular block, atrial flutter, and atrial fibrillation, were also observed. Descriptive statistics were applied. A p 0.05 level of significance was considered statistically significant.

RESULTS

Characteristics of the study population

The retrospective analysis included 586 patients, 464 males (79.18%) and 122 females (20.82%), with mean (SD) age 53 (32-85) years. Table 1 summarizes the general characteristics of all included patients.

Table 1: General characteristics of patients treated with and without Remdesivir.

Variable	Group A Remdesivir (n=586)	Group B Non Remdesivir (n= 200)	P value <0.05
Mean age	53 (32-85)	54 (33-82)	
Gender, %			
Males	79.18 (464)	75 (150)	
Females	20.82 (122)	25 (50)	
Comorbidities (%)			
Hypertension	58.19 (340)	52 (104)	p = 0.13
Diabetes	72.87 (428)	74 (148)	p = 0.79
Cardiovascular disease	62.46 (363)	61 (122)	p = 0.04
Chronic lung disease including bronchial asthma	16.55 (100)	21 (42)	p = 0.21
Chronic liver disease	4.44 (23)	3 (6)	p = 0.54
Chronic kidney disease	12.63 (76)	16 (32)	p = 0.28
Malignancy	2.73 (17)	2 (4)	p = 0.49
Two or more coexisting conditions,	56 (328)	55 (110)	p = 0.81
Oxygen required at admission (%)	99.34 (580)	99 (188)	p = 0.95
Low flow	27.52 (164)	30 (60)	p = 0.46
High flow	63.66 (375)	60 (120)	p = 0.45
NIV	6.47 (38)	7 (14)	p = 0.80
Mechanical Ventilation	2.35 (13)	2 (4)	p = 0.89
Covid19 severity as per WHO (%)			
Mild	4.06 (23)	12 (24)	p .00006
Moderate	19.70 (115)	25 (50)	
Severe	67.42 (395)	55 (110)	
Critical	8.82 (52)	8 (16)	
Progress to mechanical ventilation (%)	2.35 (14)	2 (4)	p = 0.75
Virologic clearance (recovery)	65.35 (283)	55 (110)	p = 0.10
Median time from first positive to first negative on NP swab	7 (6-9)	9 (7-14)	
Median length of hospital stays	7 (5-10)	10(9-15)	
Laboratory tests at admission, median (IQR)			
RBS, mg/dl	112 (88-228)	122 (98-258)	
IL-6, pg/ml	17 (7-37)	27 (17-47)	

Continued.

Variable	Group A Remdesivir (n=586)	Group B Non Remdesivir (n= 200)	P value <0.05
D-dimer, mg/ml	1.4 (0.1 – 6.0)	1.8 (0.6 – 8.0)	
AST, U/L	28 (21-40)	34 (21-60)	
ALT, U/L	28 (19-50)	48 (29-71)	
ALP, U/L	37 (23-61)	47 (43-81)	
eGFR, ml/min	91 (32-107)	70 (32-90)	
Troponin I	12 (6-34)	11 (7-32)	
Laboratory tests after 3 days of initiating treatment median (IQR)			
RBS, mg/dl	104 (88-156)	106 (98-122)	
IL-6, pg/ml	12 (7-27)	17 (12-27)	
D-dimer, mg/ml	0.8 (0.1 – 3.0)	1 (0.6 – 2.4)	
AST, U/L	38 (31-50)	32 (28-45)	
ALT, U/L	34 (29-60)	38 (24-61)	
ALP, U/L	67 (43-81)	37 (33-71)	
eGFR, ml/min	92 (42-102)	72 (32-95)	
Troponin I	14 (7-22)	12 (10-24)	
Laboratory tests before discharge median (IQR)			
RBS, mg/dl	106 (80-144)	92 (80-140)	
IL-6, pg/ml	8 (7-17)	10 (6-27)	
D-dimer, mg/ml	0.6 (0.1 – 2.0)	0.6 (0.2 – 2.0)	
AST, U/L	30 (21-40)	34 (21-40)	
ALT, U/L	32 (19-50)	28 (19-31)	
ALP, U/L	52 (23-62)	32 (20-41)	
eGFR, ml/min	90 (32-104)	70 (32-90)	
Troponin I	6 (4-12)	5 (4-16)	
Mean Heart rate at admission	112/min (88-132)	108/min (76-130)	
Mean Heart rate after 72 hours of treatment	70/min (56-84)	84/min (70- 102)	
Mean Heart rate at time of discharge	72/min (58-90)	76/min (60- 94)	
QTc interval prolongation > 440 ms in women and > 460 ms in men	21% (123)	12% (24)	
Death	0.02% (12)	0.03% (6)	p = 0.43

Remdesivir was prescribed after a median (IQR) of 5 (3-7) days from the onset of symptoms. Clinical recovery was observed in 527 patients (90%), of whom 383 (65.35%) also reported virological recovery after a median of 7 (IQR 6-9) days in the Remdesivir group. In contrast, in the non-remdesivir group, clinical recovery was observed. In 170 (85%) patients and 110 patients (55%) had virological recovery documented at 9 (7-14) days.

The total study population was then divided into two groups based on the hospital admission date (see Methods). There was no significant difference in hospitalization time from symptom onset between Groups A and B (median (IQR) 5 (3-8) vs. 6 (3-8) days. The two groups were comparable in age, gender, the frequency of comorbid cardio-metabolic diseases, and admission-level baseline inflammatory markers. Remarkably, the Remdesivir group had a higher proportion of patients with severe COVID-19 (445 pts., 76% vs. 126, 63%; p= 0.001). Patients progressing from low-flow oxygen support to NIV (38 pts, 6.47% vs. 14 pts, 7%, p =.8) were insignificant in both groups.

Nonetheless, the death rates were comparable between Groups (12 patients, 0.02% vs. 6 patients, 0.03%, p=0.43). Differences in median (IQR) hospital stay duration was significantly shorter in Remdesivir group 7 (5-10) vs. non Remdesivir 10 (9-15) days.

Remdesivir safety

Toxicity of the liver and kidney

The study included patients with at least one ALT, AST, ALP, and estimated Glomerular Filtration Rate (eGFR) test available at baseline and within seven days of Remdesivir discontinuation.

Liver

In group A patients (remdesivir), The median (IQR) baseline ALT value detected was 28 (19-50) U/L; by the end of the treatment, the value had increased to 32 (19-50) U/L (p=0.54). A slight, non-significant increase in ALP from a median (IQR) value of 37 (23-61) to 52 (23-62) U/L was observed, as well as an increase in AST

serum levels from a median (IQR) baseline value of 28 (21-40) before Remdesivir to a final median value of 30 (21-40) UI/mL after remdesivir.

Renal

In group A patients (remdesivir), The median (IQR) baseline eGFR value detected was 91 (32-107) ml/min by the end of the treatment. The value remained almost the same at 90 (32-104) ml/min. Similarly, no significant reduction in e GFR was observed before discharge in group B patients.

Cardiac

The decrease in heart rate was more significant between days 1 and 3 of antiviral treatment (p=0.001) than between days 3 and 5 (p 0.05). The median (IQR) heart rate reduction was 42 (34-48) bpm. The reduction in heart rate was proportional to baseline heart rate values. It is important to emphasize that in most cases; baseline tachycardia was associated with high body temperatures (fever) and tachypnea at admission. QTc interval prolongation of more than 440 ms in women and more than 460 ms in men was reported in 123 patients (21%) in group B vs. 12% (24) in group B. Except for isolated ventricular ectopic beats, no new-onset heart rhythm abnormalities were observed in any patient group. There was no significant bradycardia or ectopic-related clinical symptoms in any of the patients, and remdesivir could continue the full course.

DISCUSSION

Many antiviral medications have been proposed for the treatment of COVID-19, but only remdesivir has been approved following a clinical trial that demonstrated its efficacy.[5] According to data from international clinical studies, remdesivir as a five-day course medication successfully shortens patients' hospital stays and time to recovery when they have moderate to severe SARS-CoV-2 pneumonia and need low-flow oxygen support.[11-14]

Remdesivir actively acts as a competitive inhibitor of viral RNA-dependent RNA polymerase, causing a delay in its activity.[17,18] It follows that a significant part of remdesivir's antiviral action is likely dominant due to delayed chain termination.[5,16]

In a study published in the New England Journal of Medicine, researchers employed remdesivir on a compassionate basis on 53 patients hospitalized with Covid-19. Participants were people diagnosed with SARS-CoV-2 and had an oxygen saturation level of 94% or less in room air. RDV was administered to patients throughout 10 days period. The administration of remdesivir, according to the authors, improved the clinical condition of 36 out of 53 patients (68%) who had COVID-19 infections.[10]

While remdesivir treatment in the ACTT-1 study did not significantly reduce the risk of mortality at day 29 for the entire patient population, it did significantly reduce the risk of mortality at day15.[5]

According to Beige et al., remdesivir therapy may have stopped the development of a more serious respiratory condition. For patients who were on oxygen at the time of enrollment, taking remdesivir was linked to fewer days of subsequent oxygen use, as well as shorter subsequent durations of mechanical ventilation or ECMO. Overall, these results imply that remdesivir treatment may not only lessen the severity of the disease but may also lower the demand for the limited healthcare resources available during this pandemic.[5]

Remdesivir may be beneficial as an adjunctive therapy for individuals with severe COVID-19, particularly those with significant lung damage at HRCT, according to the Simoli et al trial.[6] The subject of the drug's early beginning has been highlighted by the author, nevertheless.

In a large retrospective comparative effectiveness analysis of over 100,000 patients in the United States, remdesivir beginning within the first two days of COVID-19 hospitalization was related to increased survival compared to the non-remdesivir group. At 14 and 28 days, it had a significant impact on survival. Patients who initially had NSO, LFO, or IMV/ECMO showed the greatest results.[20]

Remdesivir antiviral activity was assessed in hospitalized COVID-19 patients ≥18 years of age in the WHO Solidarity Trial, which contrasted remdesivir with the regional standard of treatment, and assessed mortality. However, the main objective of the study was to ascertain whether any of the four repurposed antivirals (remdesivir, hydroxychloroquine, lopinavir, and interferon) could at least slightly impact in-hospital mortality. The trials show that the drug had no impact on mortality, the initiation of ventilation, the length of hospital stay, or patients with low oxygen requirements. Although its findings should be seen in the context of the mortality data from all studies, it includes more than three-fourths of that data for remdesivir and interferon.[15]

The inclusion of patients with COVID-19 at various stages and severity levels 10, the lack of a standardized method to evaluate remdesivir efficacy, and, in certain trials, the absence of a remdesivir-free control arm, could all contribute to the controversy surrounding clinical trial findings.[11-13] It should be reexamined in light of what is known about the complex and quick evolution of COVID-19's natural course in clinical practice. Remdesivir has an excellent safety profile and is supported by recent real-world trials as having a lower mortality rate than a placebo.[17-20] Remdesivir's effectiveness has also been examined for mild COVID-19. Patients who received a 5-day course of remdesivir

had significantly higher odds of having a better clinical status distribution on day 11 compared to those who received standard care, whereas there was no difference in the clinical status distribution between the 10-day remdesivir and standard care groups. However, after taking into consideration all the model's variables, the model demonstrated that remdesivir lowers mortality (including duration of symptoms, ethnicity, and other medications).[19]

The difficulty in determining the precise time of symptom onset from patients' histories, as well as the general tendency of primary care physicians to wait and see, are the two factors that can; (i) bias the calculation of the precise time of symptom onset, and (ii) delay the timing of hospitalization from the onset of the infection. The latter condition may explain the association between baseline oxygen flow needs and the progression to non-invasive ventilation. The timing and dosages of home-prescribed steroid drugs, which were excluded from our data collection, might have an effect. Our research demonstrates the importance of devising a prompt strategy to prevent COVID-19 progression, such as the early initiation of antiviral therapy.

In line with previous research, our findings show that preexisting comorbidity and an increase in baseline inflammatory markers substantially impact the progression of COVID-19.[24] This data suggests that careful observation of patients at admission and periodic re-evaluation throughout hospitalization are essential for selecting the appropriate treatment based on individual characteristics and COVID-19 severity and progression. Nonetheless, despite the increased clinical complexity of patients admitted to hospitals in recent years, we have observed a reasonable recovery rate and a minimal Intensive Care Unit admission or death rate compared to the total population. This may indicate that antiviral treatment has been effective regardless of the admission date.

Remdesivir's cardiac, renal, and hepatic safety was evaluated. Using a real-life design, we investigated the effects of a five-day remdesivir treatment in patients with mild renal and hepatic insufficiency at admission. Glomerular filtration rate and liver enzymes were observed, showing negligible variation that could be related to the progression of the viral infection rather than drug-related toxicity. Furthermore, despite a significant decrease in heart rate following remdesivir administration, no severe cardiovascular toxicity was observed in COVID-19 patients, even those with severe disease and cardiovascular comorbidity.[13,23-24] We consider the clinician's job to evaluate the cause of the impairment.

This study has few limitations. Results can be generalized because the sample of patients represents all hospitalizations with moderate to severe COVID-19 infections in Qatar. The study has a monocentric architecture, which could lead to findings that are influenced by regional COVID-19 management practices. Also, a lack of appropriate blood sampling and ECGs excluded some individuals from analyzing renal and hepatic safety and examining heart rate irregularities. Finally, we are conscious that the results' precision and reliability may be affected by the absence of a Remdesivir-free control group. The results should be cautiously evaluated due to these circumstances and the fact that the study was not conducted with randomized groups to reduce the presence of confounding factors. However, this research offers important clinical practice insights and attempts to define the usefulness of antiviral medication within the context of the same population set but with a different treatment management strategy in terms of antiviral therapy 22.

CONCLUSION

Our cohort of COVID-19 patients treated with Remdesivir during the COVID-19 pandemic wave in Qatar found a similar rate of ICU admission and death, a shortened rate of clinical recovery evidenced by the reduction in acute hospital length of stay, and insignificant cardiac, renal, or hepatic toxicity. Regardless of the date of hospitalization, a high proportion of subjects had favorable outcomes. Further research is required to ascertain the true benefits of using Remdesivir during this pandemic to optimize the management of COVID-19 patients in any future variant wave.

Recommendations

Further research is needed to determine the true benefits of Remdesivir for optimizing COVID-19 patient management in future variant waves.

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