Efficacy and Safety of Remdesivir in COVID-19 Patients: A Retrospective Analysis of Active Surveillance Database

Vaishali Gupte (dr.gupte@Cipla.com)
Cipla Ltd. https://orcid.org/0000-0003-4439-2416
Rashmi Hegde
Cipla Ltd.
Sandesh Sawant
Cipla Ltd.
Kabil Kalathingal
Cipla Ltd.
Sonali Jadhav
Cipla Ltd.
Rohit Malabade
Cipla Ltd.
Jaideep Gogtay
Cipla Ltd.

Research article

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Abstract

Background: Real-world data on safety and efficacy of remdesivir in COVID-19 management is scant. We present findings of data analysis conducted for assessing the clinical outcomes of remdesivir treatment for COVID-19 in India.

Methods: This retrospective analysis used data from an active surveillance programme database of hospitalised patients with COVID-19 who were receiving remdesivir.

Results: Of the 2329 patients included, 67.4% were men. Diabetes (29.69%) and hypertension (20.33%) were the most common comorbidities. At remdesivir initiation, 2272 (97.55%) patients were receiving oxygen therapy. Remdesivir was administered for 5 days in 65.38% of patients. Antibiotics (64.9%) and steroids (47.9%) were the most common concomitant medications. Remdesivir was overall well tolerated: 13% of patients reported 119 adverse events; most common were nausea and vomiting in 45.4% and increased liver enzymes in 14.28% patients. 84% of patients were cured/improved, 6.02% died, and 9.16% showed no improvement in their clinical status at data collection. Subgroup analysis showed that the mortality rate was significantly lower in patients < 60 years old than in those > 60 years old. Amongst patients on oxygen therapy, the cure/improvement rate was significantly higher in those receiving standard low-flow oxygen than in those receiving mechanical ventilation, non-invasive ventilation, or high-flow oxygen. Risk factors for higher mortality were age > 60 years, hypertension, cardiac disease, diabetes, and mechanical ventilation.

Conclusion: Our analysis showed that remdesivir is well tolerated and has an acceptable safety profile. The cure/improvement rate was 84%, with a higher improvement in patients < 60 years old and on standard low-flow oxygen.

Introduction

Coronavirus disease 2019 (COVID-19) is a novel respiratory disease caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). In March 2020, the COVID-19 outbreak was declared as a global pandemic by the World Health Organization (WHO) [1]. As of 28 December 2020, the global incidence of COVID-19 had reached 79,232,555 confirmed cases; India was the second most-affected country in the world, with a case burden of 10,187,850 confirmed cases. As the pathogenesis underlying COVID-19 became more apparent, global strategies evaluating therapeutic options, including new antivirals, evolved rapidly. However, repositioning the already existing therapeutics remained a commonly adapted strategy recommended by the WHO [2].

Remdesivir is an adenosine analogue with broad-spectrum antiviral activity against several single-stranded RNA viruses. It was originally developed for treating patients with Ebola virus infection [3]. After recording the potential benefits of remdesivir against SARSCoV-2 in *in vitro*, pre-clinical, and human cell line studies, its efficacy was evaluated in patients with COVID-19 [4–6]. On 1 May 2020, remdesivir received the Emergency Use Authorisation (EUA) status based on a preliminary report from an interim

analysis of an ongoing double-blind randomised controlled trial by the United States Food Drug Administration (US FDA) [7]. On 21 June 2020, the Central Drugs Standard Control Organisation (CDSCO) approved its restricted emergency use for treating patients with severe COVID-19 infection in India; the indication was later expanded to moderate and severe disease. However, the CDSCO approved remdesivir with a condition to provide data from an active surveillance programme on a monthly basis by the pharmaceutical manufacturers [7]. Given the global emergency and the unmet medical need with respect to COVID-19 treatment, the Drugs Controller General of India (DCGI) also provided a clinical trial waiver for remdesivir use in India [7]. At the time of writing this paper, clinical evidence for its safety and efficacy in COVID-19 pertains mainly to randomised trials, and only few observational data are available that show its safety in real practice. In this paper, we present a retrospective analysis of data from an active surveillance programme conducted for remdesivir use in patients with COVID-19 in India.

Methods

Surveillance design and participants

This retrospective analysis evaluated active surveillance data of hospitalised patients with COVID-19 who received remdesivir treatment (Cipremi®; Cipla Ltd). Remdesivir was administered to patients with COVID-19 at participating hospitals in accordance with the restricted emergency use approval for remdesivir by CDSCO, India.

We retrospectively analysed the data of patients who had received remdesivir therapy from July 2020 until October 2020, with an aim to evaluate its safety and efficacy. All hospitals that administered remdesivir in COVID-19 patients were obliged to provide data through an active surveillance form.

Procedure and outcomes

The physician/clinical staff filled an online surveillance form (Fig. S1) for each patient with suspected or confirmed COVID-19 who was administered remdesivir. Data regarding patient age, gender, comorbid conditions, concomitant medicines, status of oxygen supplementation, remdesivir treatment duration, and any adverse event were collected. Clinical outcomes were defined as cure (complete resolution of symptoms), improvement, no improvement, or death.

Statistical analysis

Continuous and quantitative variables are summarised using descriptive statistics. Categorical data are presented as frequency count (*N*) and percentages (%). All statistical analyses were performed using the Statistical Package for the Social Sciences version 23.0. A subgroup analysis was performed to assess the association of clinical and demographic characteristics with the clinical outcomes. Patients with missing information for a given variable were excluded from the calculations/analysis. A p value of < 0.05 was considered statistically significant.

Results

Patient demographics

Data of 2329 patients were available through the online or paper-based active surveillance log from July 2020 up to 15 October 2020. The geographical distribution showed that Tamil Nadu (29.4%), Telangana (11.1%), Uttar Pradesh (10%), West Bengal (9.3%), and Maharashtra (8.8%) contributed maximally to the current data. Most patients were in the age group of 40–60 years (49.9%) followed by the age group of > 60 years (33.7%). Men comprised 67.4% of the analysed patient population (Table 1).

Table 1
Patient demographics

Characteristics	*N* (%)
Age group (years)	
< 12	2 (0.1)
≥ 12 to < 20	5 (0.2)
≥ 20 to < 40	376 (16.1)
≥ 40 to < 60	1162 (49.9)
≥ 60	784 (33.7)
Gender	
Male	1570 (67.4)
Female	583 (25)
Gender not disclosed	176 (7.6)

Clinical characteristics

Up to 98.2% of patients had comorbid conditions. Diabetes (29.69%) was the most common comorbid condition followed by hypertension (20.33%), cardiac diseases (6.34%), and lung disease (4.37%) (Fig. 1a). In addition to these comorbidities, 44.82% had other diseases such as blood cancer, cholangitis, and chronic kidney disease. A total of 2,272 (97.55%) patients were receiving oxygen therapy at the time of starting remdesivir: the most common oxygen supplementation method was standard lowflow oxygen (65.27%), followed by high-flow oxygen (19.06), non-invasive ventilation (12.02), and mechanical ventilation (3.52%) (Fig. 1b). Duration of remdesivir administered in 65.38% of patients was 5 days, while 12% of patients received remdesivir for ≥ 6 days. Among 1081 patients on concomitant medications, antibiotics were the most common concomitant medications (64.9% of the patients) followed by steroids (47.9% of the patients) (Fig. 1c).

Adverse events and safety

A total of 119 adverse events were reported in 13% of patients; most common were nausea and vomiting (45.4%) followed by increased liver enzyme levels (increased serum glutamic pyruvic transaminase [SGPT], serum glutamic oxaloacetic transaminase [SGOT] levels) (14.28%), rash (5.8%), bradycardia (2.5%), nephrotoxicity (1.68%), and oral ulcer (0.8%).

Clinical outcomes

The clinical outcome of cure or improvement was recorded in 84%, death in 6.02%, and no improvement in 9.16% of the patients at the time of data collection (Fig. 2).

Subgroup analysis

Results of various subgroup analyses are presented in Table 2. When clinical outcomes were analysed by patient age, cure/improvement rate was significantly higher in the age groups of 20–40 years (91.45%, $p < 0.0001$) and 40–60 years (85.33%, $p = 0.0011$) compared with that in the age group of ≥ 60 years (78.99%). Similarly, the cure/improvement rate was significantly higher in the age group of 20–40 years compared with that in the age group of 40–60 years (91.45% vs 85.33%, $p = 0.0083$). Mortality rate was higher in patients ≥ 60 years old compared with those 20–40 years old (10.07% vs 3.62%, $p < 0.0001$) and 40–60 years old (10.07% vs 5.37%, $p = 0.0004$).

Table 2
Subgroup analysis of clinical outcomes by clinical and demographic characteristics

Characteristics	*N* (%)		
	Cure/improvement	Death/ death related to COVID-19	No improvement
Age group (years)			
12–20	4 (80.00)	0 (0.00)	1 (20.00)
20–40	278 (91.45) #*	11 (3.62) ##**	15 (4.93) ###***
40–60	826 (85.33) $	52 (5.37) $$	90 (9.30) $$$
≥ 60	549 (78.99)	70 (10.07)	75 (10.79)
Gender			
Male	1,206 (83.29) @	108 (7.46) @	134 (9.25) @
Female	451 (86.07)	26 (4.96)	47 (8.97)
Diabetes			
Yes	489 (78.36)	62 (9.93)	72 (11.54)
No	1,136 (85.52)	71 (5.41)	106 (8.07)
Hypertension			
Yes	377 (87.06)	23 (5.32)	33 (7.62)
No	1,248 (82.98)	110 (7.31)	145 (9.64)
Other cardiac conditions			
Yes	105 (81.40)	19 (14.73)	5 (3.88)
No	1,520 (84.07)	114 (6.31)	173 (9.57)
Lung disease			

Note: The patient status “No improvement” in the last column was reported at the time of data entry which can eventually change.

SLFO, standard low-flow oxygen; HFO, high-flow oxygen; NIV, non-invasive ventilation; MV, mechanical ventilation

$p = 0.0083$ vs 40–60 years; * $p < 0.0001$ vs > 60 years; $ $p = 0.0011$ vs > 60 years; ## $p = 0.2812$ vs 40–60 years; ** $p < 0.0001$ vs > 60 years; $$ $p = 0.0004$ vs > 60 years; ### $p = 0.0219$ vs 40–60 years; *** $p = 0.004$ vs > 60 years; $$$ $p = 0.3515$ vs > 60 years; @ $p = 0.156$ for cure, 0.065 for death, and 0.916 for no improvement; @@ $p = 0.112$ compared with patients not receiving steroids

Characteristics	*N* (%)		
	Cure/improvement	Death/ death related to COVID-19	No improvement
Yes	72 (77.42)	10 (10.75)	11 (11.83)
No	1,553 (84.22)	123 (6.67)	167 (9.06)
Received oxygen support			
Yes	1,608 (83.62)	134 (6.97)	181 (9.41)
No	37 (100.00)	0 (0.00)	0 (0.00)
SLFO	1,107 (93.97)	26 (2.21)	45 (3.82)
HFO	332 (80.58)	24 (5.82)	56 (13.59)
NIV	146 (57.71)	48 (18.97)	59 (23.32)
MV	23 (28.75)	36 (45.00)	21 (26.25)
Received steroids	383 (79.95) @@	40 (8.35) @@	56 (11.69) @@
Received antibiotics	456 (79.31)	52 (9.05)	67 (11.65)
Received anticoagulants	253 (81.35)	19 (6.11)	39 (12.54)

Note: The patient status “No improvement” in the last column was reported at the time of data entry which can eventually change.

SLFO, standard low-flow oxygen; HFO, high-flow oxygen; NIV, non-invasive ventilation; MV, mechanical ventilation

$p = 0.0083$ vs 40–60 years; * $p < 0.0001$ vs > 60 years; $ $p = 0.0011$ vs > 60 years; ## $p = 0.2812$ vs 40–60 years; ** $p < 0.0001$ vs > 60 years; $$ $p = 0.0004$ vs > 60 years; ### $p = 0.0219$ vs 40–60 years; *** $p = 0.004$ vs > 60 years; $$$ $p = 0.3515$ vs > 60 years; @ $p = 0.156$ for cure, 0.065 for death, and 0.916 for no improvement; @@ $p = 0.112$ compared with patients not receiving steroids

Although the mortality rate was slightly higher among the older adults (> 60 years), difference in the mortality rate remained statistically non-significant for the age groups of 40–60 years and 20–40 years (5.37% vs 3.62%; $p < 0.2812$). The clinical outcomes were not different between men and women ($p > 0.05$). Furthermore, similar cure/improvement rates were observed irrespective of comorbid conditions (diabetes: 50%, hypertension: 59%, cardiac diseases: 58%, lung disease: 57%). Mortality rate was significantly lower among those who received standard low-flow oxygen (2%) compared with those who received mechanical ventilation (45%, $p < 0.0001$), noninvasive ventilation (19%, $p < 0.0001$), or high-flow oxygen (6%, $p < 0.001$). Interestingly, mortality rate was not different between patients who received and those who did not receive concomitant steroids ($p = 0.112$).

Another subgroup analysis assessed the factors associated with the incidence of death (Table 3). The odds of death were 2.98 times higher in patients ≥ 60 years old compared with patients 20–40 years old. Comorbidities such as cardiac disease and diabetes increase the odds of death by 1.93 and 2.5 times compared with absence of these comorbidities, respectively. Similarly, the odds of death were higher amongst patients receiving high-flow oxygen, non-invasive ventilation, or mechanical ventilation compared with standard low-flow oxygen.

Table 3
Factors associated with mortality rate

Variables	Odds ratio	95% Confidence interval	*p* - value
Age group (years)			
20–40	1		
40–60	1.512	(0.779, 2.936)	0.222
≥ 60	2.988	(1.559, 5.728)	0.001
Gender			
Male	1.544	(0.99, 2.398)	0.062
Female	1		
Co-morbidities			
Hypertension (Yes/No)	0.71	(0.447, 1.128)	0.146
Diabetes (Yes/No)	1.93	(1.36, 2.75)	0.000
Lung disease (Yes/No)	1.845	(0.959, 3.559)	0.063
Cardiac (Yes/No)	2.565	(1.52, 4.33)	0.000
Type of Oxygen Support			
SLFO	1		
HFO	2.74	(1.55, 4.83)	0.000
NIV	10.37	(6.29, 17.10)	0.000
MV	36.25	(20.14, 65.23)	0.000

SLFO, standard low-flow oxygen; HFO, high-flow oxygen; NIV, non-invasive ventilation; MV, mechanical ventilation

Discussion

In this retrospective analysis of data from an active surveillance programme, we assessed efficacy and safety of remdesivir by measuring the clinical outcomes (cure, improvement, no improvement, or death)

in hospitalised patients with COVID-19 who were treated with remdesivir, and their subgroups. The cure/improvement rate was 84%, which is in accordance with the cure/improvement reported in historical cohorts [8–15]. Most patients were male, were in the age group of 40–60 years, required oxygen therapy, and received remdesivir for 5 days. Diabetes and hypertension were the most common comorbidities. Low cure rate and high mortality was seen in patients > 60 years old.

Remdesivir is a nucleotide prodrug effective against various RNA viruses such as Nipah virus, respiratory syncytial virus, Ebola virus, SARS-CoV-1, and the Middle East respiratory syndrome coronavirus (MERS-CoV) [16]. Remdesivir is metabolised intracellularly to its ATP analogue, which inhibits viral RNA polymerase and thus halts viral replication [3]. Remdesivir emerged as a candidate drug in the current COVID-19 pandemic and received full approval for use in COVID-19 by the USFDA [3, 17]. Remdesivir was well tolerated in clinical trials and in the compassionate-use programme. Common adverse events reported were nausea, elevated ALT levels, headache, hypokalaemia, worsening respiratory failure, and constipation [8–10, 12, 13]. In our analysis, 13% patients reported adverse events, with nausea and increased liver enzyme levels being the most common.

In the randomised, controlled ACTT-1 trials, patients in the remdesivir group were significantly more likely to have clinical improvements than those in the placebo group [8, 10]. In a robust pooled analysis that included patients enrolled in the SIMPLE-severe trial and a retrospective cohort of severe COVID-19 patients receiving standard-of-care, recovery rate was 74.4% on day 14 [11]. An improvement in the clinical status by at least 2 points on the ordinal scale (or being discharged alive) was seen in 71.9% of the patients and that by ≥ 1 points was seen in 76.2% of the patients on day 14 [11]. The cure/improvement rate in our analysis was 84%.

In the SIMPLE-severe trial, patients randomised to a 5- or 10-day course of remdesivir did not show a significant difference. Our analysis showed that most patients received a 5-day course of remdesivir therapy, which is in line with the DCGI-approved prescribing information.

The mortality rate following 5 days of treatment with remdesivir was 8% on day 14 in the SIMPLE-severe trial and 1% on day 28 in the SIMPLE-moderate study [8, 9]. Following 10 days of treatment with remdesivir, the mortality rate by day 15 was 6.7% in the ACTT-1 trial and 2% by day 14 in the SIMPLE-severe trial [9, 10]. The WHO Solidarity trial, which included 11,330 patients from 30 countries, showed no improvement in the mortality rate in patients randomised to remdesivir treatment compared with the local standard-of-control. In another pooled analysis, the mortality rate was 7.6% on day 14 [18]. In our analysis, the mortality rate was 6.02%.

During the COVID-19 pandemic, several studies reported that older adults and those with comorbid hypertension, diabetes, obesity, and heart disease are at higher risk for developing life-threatening COVID-19 illness [13, 19]. In the current analysis, remdesivir therapy showed similar cure/improvement rate irrespective of comorbid conditions. However, numerically higher mortality was observed in patients with cardiac disease (12%), followed by that in lung disease (11%), diabetes (8%), and hypertension (4%). Lower grade of respiratory support and age < 65 years were associated with a > 2 point improvement on

the ordinal scale in patients treated with remdesivir [20]. Our results showed higher patient cure/improvement rate when patients did not require oxygen support and were < 60 years of age. An Indian retrospective study, the SORT trial enrolled 350 patients treated with remdesivir and showed that patients who received remdesivir early (within 9 days of symptom onset) were more likely to have a lower incidence of mortality compared with those treated after ≥ 9 days of symptom onset, suggesting that initiating remdesivir earlier during the disease course in moderate-to-severe COVID-19 infection may show better clinical improvements/outcomes [15].

Our analysis had some limitations as well. This was a retrospective analysis of the data obtained from an active surveillance programme database; therefore, comparison of the results with the control group could not be performed. Moreover, this analysis could not detect the association using multivariate analysis. Cure/improvement rates were not defined in terms of the ordinal scale. Data was collected at a single time point. However, our analysis presents findings of a large cohort of COVID-19 patients treated with remdesivir in real-life clinical settings in India and adds to the clinical evidence on remdesivir use in COVID-19.

Conclusion

The retrospective analysis of data from an active surveillance programme of remdesivir therapy in patients with COVID-19 showed that remdesivir was well tolerated and had an acceptable safety profile. The cure/improvement rate was 84%, with greater cure rate in patients with age < 60 years and receiving standard low-flow oxygen.

Abbreviations

COVID-19: Coronavirus disease 2019; SARS-CoV-2: severe acute respiratory syndrome coronavirus-2; WHO: World Health Organization; US FDA: United States Food Drug Administration; CDSCO: Central Drugs Standard Control Organisation; DCGI: Drugs Controller General of India; SGPT: serum glutamic pyruvic transaminase; SGOT: serum glutamic oxaloacetic transaminase; MERS-CoV: Middle East respiratory syndrome coronavirus.

Declarations

Ethics approval and Consent to participate

All hospitals and clinics that administered remdesivir in COVID-19 patients were obliged to provide data through an active surveillance form thus, obtaining ethical approval and informed consent is not required.

Consent for publication

Not applicable.

Competing interests

All the authors are permanent employees of Cipla, Ltd.

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Authors' contributions

All authors contributed equally to the study conception, design, data collection and analysis. All the authors had equal contribution in drafting the manuscript or revising it critically for important intellectual content. All authors read and approved the final manuscript.

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Availability of data and material

There are no associated data other than that included in the manuscript.

Author details

[1]Director, Medical Services, Cipla Ltd., Mumbai, India. [2]Vice President, Medical Services, Cipla Ltd., Mumbai, India. [3]Senior Director, Head Clinical Research, Cipla Ltd., Mumbai, India. [4]Associate Director, Drug Safety, Cipla Ltd., Mumbai, India. [5]Manager, Medical Services - Clinical Trial Group, Cipla Ltd., Mumbai, India. [6]Deputy Manager, Medical Services, Cipla Ltd., Mumbai, India. [7]Executive Vice President, Global Chief Medical Officer, Cipla Ltd., Mumbai, India.

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Figures

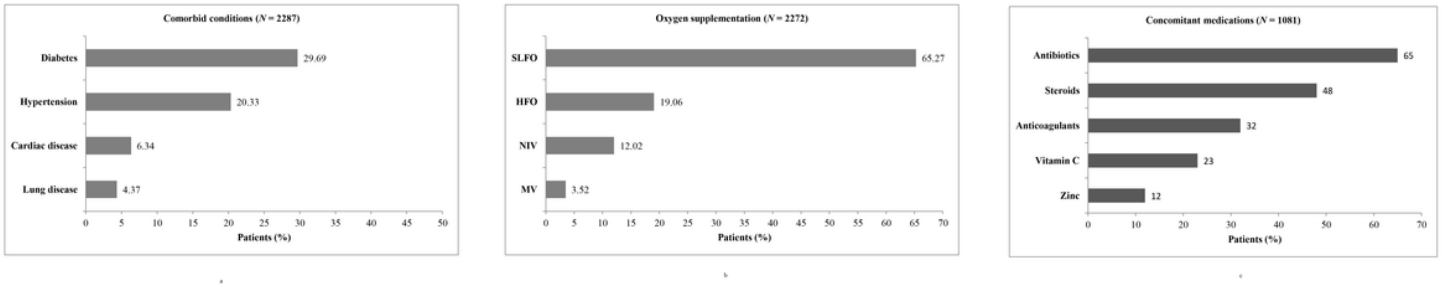

Figure 1

(a through c, respectively) represents the comorbid conditions of, status of oxygen support to, and concomitant medications administered to hospitalised patients with COVID-19 who were treated with remdesivir 1a Comorbid conditions 1b Oxygen support SLFO, standard low-flow oxygen; HFO, high-flow oxygen; NIV, non-invasive ventilation; MV, mechanical ventilation 1c Concomitant medications

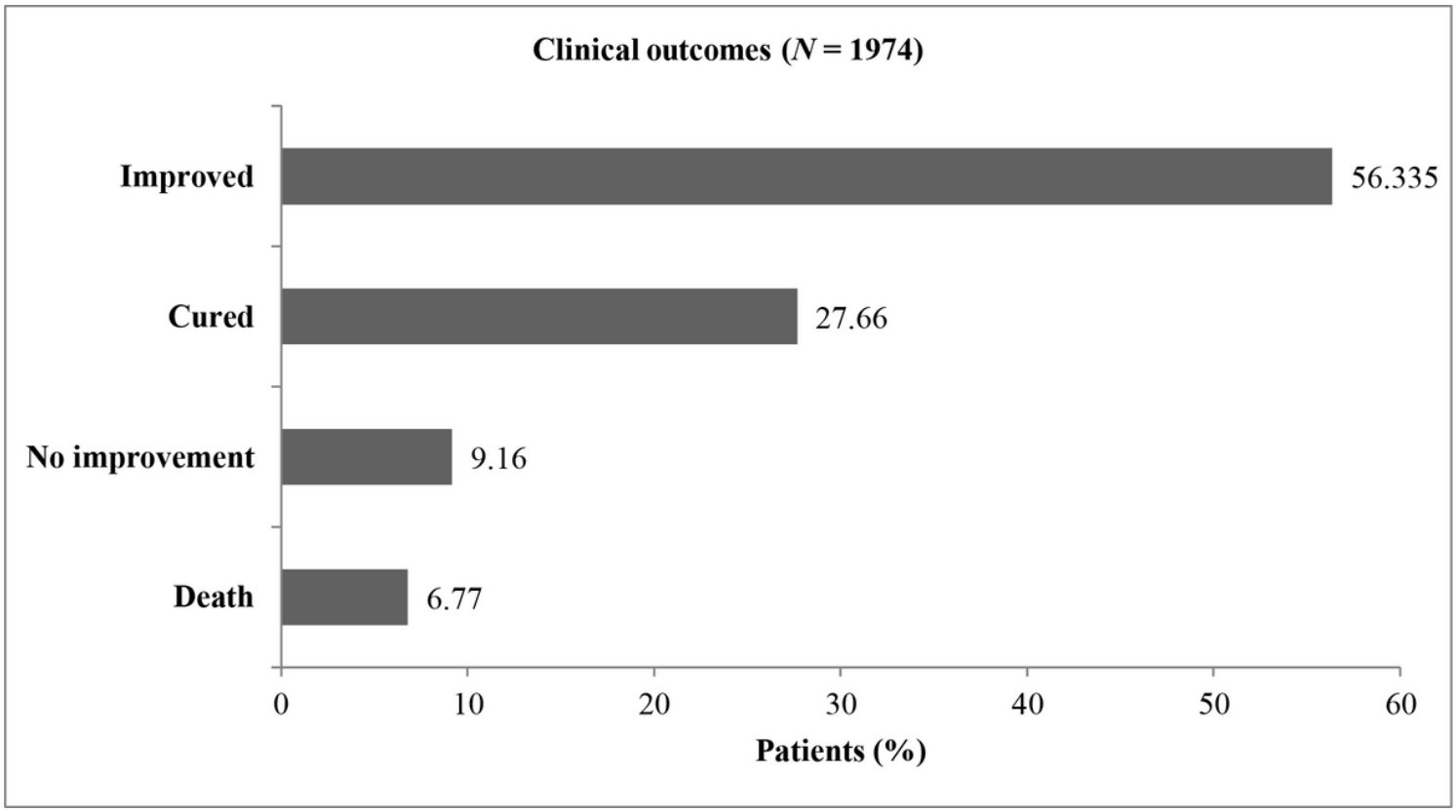

Figure 2

Clinical outcomes

Supplementary Files

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- Fig.S1.tif