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Prescription patterns in an intensive care unit of COVID-19 patients in Bangladesh: A cross-sectional study

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Abstract

Background and Aims: To reduce death rates for critical patients hospitalized in intensive care units (ICUs), coronavirus (COVID-19) lacks proven and efficient treatment methods. This cross-sectional study aims to evaluate how physicians treat severe and suspected COVID-19 patients in the ICU department in the absence of an established approach, as well as assess the rational use of the medication in the ICU department.

Methods: Between June 16, 2021, and December 10, 2022, a total of 428 prescriptions were randomly gathered, including both suspected (yellow zone) and confirmed (red zone) COVID-19 patients. For data management, Microsoft Excel 2021 was utilized, while STATA 17 provided statistical analysis. To find associations between patients' admission status and demographic details, exploratory and bivariate analyses were conducted.

Results: Of the 428 patients admitted to the ICU, 228 (53.27%) were in the yellow zone and 200 (46.73%) were in the verified COVID-19 red zone. The majority of patients were male (54.44%), and the age range from 41 to 60 was the most common (41.82%). No significant deviation was detected to the yellow and red groups' prescription patterns. A total of 4001 medicines (mean 9.35/patient) were prescribed. Antiulcerants, antibiotics, respiratory, analgesics, anticoagulants, vitamins and minerals, steroids, cardiovascular, antidiabetic drugs, antivirals, antihistamines, muscle relaxants, and antifungal treatments were widely prescribed drugs. Enoxaparin (67.06%) appeared as the most prescribed medicine, followed by montelukast (60.51%), paracetamol (58.41%), and dexamethasone (51.64%).

Conclusion: The prescription patterns for the yellow and red groups were comparable and mostly included symptomatic treatment. Respiratory drugs constituted the most frequent therapeutic class. Polypharmacy should be taken under considerations. In ICU settings, the outcomes emphasize the need of correct diagnosis, cautious antibiotic usage, suitable therapy, and attentive monitoring.

KEYWORDS

Bangladesh, COVID-19, ICU, prescription pattern

1 | INTRODUCTION

The coronavirus (COVID-19) disease had a great impact on every aspect of healthcare systems causing an unprecedented crisis globally and the World Health Organization (WHO) declared this outbreak as a pandemic on March 11, 2020.[1] Statistics from the WHO dashboard indicated more than 767 million confirmed cases with almost 7 million deaths worldwide.[2] In Bangladesh, more than 2 million people have been infected and 29,463 (June 28, 2023) people died due to coronavirus.[3] Therefore, COVID-19 is a highly spreading infectious disease that is associated with inflammation, particularly in the respiratory tract, and also associated with microvascular thrombosis where the causative organism is the newly identified virus SARS-CoV-2.[4]

Ismail et al. reported that the sufferings level of the majority COVID-19 infected patients was mild to moderate, while the maximum may recover with or without specialized treatment.[5] However, in the European region, geriatric population or concomitant diseases like diabetes, cardiovascular disease, chronic respiratory diseases, and cancer increase the COVID-19 complications that ultimately leads to intensive care unit (ICU) admission as well as life-threatening consequences.[5–7] This catastrophic situation caused various clinical complications that required special care, including medical care, psychological care, respiratory support, life support, and renal replacement therapy, leading to admission to the ICU.[7–9] A range of different classes of medications such as antimalarial (hydroxychloroquine), antiparasitic (ivermectin), antibiotic (azithromycin), antiretroviral (darunavir), immunosuppressant (tocilizumab), and interferon-beta have been considered as therapeutic agents to minimize the mortality rate caused by acute respiratory syndrome, mechanical ventilation and complications of SARS-Cov-2 virus.[10,11] The National Health Service (NHS) of the United Kingdom presently recommends a neutralizing monoclonal antibody (sotrovimab) with some antiviral drugs namely nirmatrelvir, ritonavir, remdesivir, and molnupiravir for the treatment of COVID-19 affected people who are at the highest risk of getting critically ill.[12] Among them, remdesivir is US Food and Drug Administration-approved.[13] Unfortunately, most drugs did not show satisfactory efficacy in clinical studies, whereas other drugs still cannot be proven enough to be recommended.[10,11] Still, they are used to treat the disease holding the risk of adverse drug reactions and severe drug interactions.[14]

Among all prescribed drugs, antimicrobials are of great concern due to their intense use for respiratory illness. The results of several studies during the pandemic have demonstrated that 70% of patients admitted to hospitals receive one or more antibiotics that extend up to 100% in the ICU settings.[15] Bacterial coinfections are quite rare in COVID-19 patients of ICUs, but increasing empirical antibiotic use has been identified due to enhance risks of healthcare-associated infections.[16] Therefore, WHO recommends prescribing antimicrobial treatment in patients with severe disease to prevent further infection complications.[17] But overprescribing of antibiotics may complicate the condition more due to the drastic development of antimicrobial resistance (AMR) which is becoming a silent threat to human existence globally. Already WHO has shown concern about the possibility of a destructive AMR situation due to irrational antimicrobial uses during a pandemic.[5] Not only antibiotics but also many other drugs are also indiscriminately used for the treatment of COVID-19 patients which can be seen in several studies.[5]. From some studies on antimicrobial prescription patterns during COVID-19, the use of antimicrobials became highly prevalent among patients who are suspected of COVID-19 and admitted to hospitals in Bangladesh.[5] Although there were differences in prescription patterns between genders, geographical regions, and age groups, there is a true scarcity of data persistently on prescribing patterns of medications used for treating hospital-admitted COVID-19 patients, particularly in ICUs, especially in countries which have weak healthcare systems.[15,16]

Therefore, this study was conducted to find out about the overall ICU prescription pattern of COVID-19-affected patients who were staying in a tertiary care hospital in Bangladesh. As ICU patients are more prone to health risks, prescription evaluation will help to understand how physicians handle serious COVID-19 or suspected COVID-19 patients when no definitive protocol was established. Furthermore, the prescription patterns of these ICU patients may be supportive to promote the appropriate use of medication such as antibiotics, steroid, and anticoagulant within the ICU department.

2 | MATERIALS AND METHODS

2.1 | Study design, sample size determinations, and data collection

A cross-sectional study was examined in a tertiary-level government hospital in Bangladesh between June 16, 2021, to December 10, 2021. The study goal was to collect the prescriptions of ICU-admitted patients who were examined either COVID-19-confirmed patients or patients with symptoms of COVID-19 (not confirmed yet). Rasoft®, Inc. was employed to calculate the sample size at 95% confidence level. The margine error was considered 5%, while the reliability coefficient for 95% confidence level (Z = 1.96) and the population proportion was deemed at 50%.

$$n = \frac{z^2 pq}{d^2},$$

$$n = \frac{(1.96)^2 \times 0.5 \times 0.5}{(0.05)^2},$$

$$n = 384.$$

The 10% population of this study were considered as non-responsive. So, the overall 422 population data were calculated as a minimal requirement for conducting study sample size when the population size is more than hundreds of thousands. A total of 428 population data were gathered randomly from the hospital for conducting the study, which was higher than the minimal sample requirement. Of them, 200 were confirmed COVID-19 cases (red

zone), and the rest of the 228 patients were suspected COVID-19 patients (yellow zone). The confirmed cases were identified utilizing a reverse transcriptase polymerase chain reaction (RT-PCR) report, considered the gold standard for COVID-19 testing. Only the suggested prescription data and medication were evaluated for this study; patients' symptoms and infection were not considered.

2.2 | The clinical definition of COVID-19 patients

Based on standards adopted by the WHO, patients were divided into mild, moderate, severe, or critical groups upon admission.[18] Patients suspected of COVID-19 or patients expecting their RT-PCR report were taken into consideration for this study.

2.3 | Data management and statistical analysis

All the information was manually input into Microsoft Excel (2021) for analysis. Statistical analysis was carried out using STATA 17 (StataCorp LLC). Exploratory analysis was conducted to understand the descriptive statistics of the variables of this study. Bivariate analysis (χ^2 test) has also been carried out to determine the relationship between patients' admitted status (yellow and red zone) versus patients' demographic status/number of medications/injections, and so on. $p \leq 0.05$ were considered as significant in this study. Frequency and percentage of the samples were used to comparative analysis between the respective groups. Those prescriptions had more than or equal to five medicines were considered as having polypharmacy.[19] These cross-sectional studies were conducted as per strengthening the reporting of observational studies in epidemiology (STROBE) statement.[20]

2.4 | Ethical consideration

To conduct this study, permission was taken from both the Hospital authority and the Department of Pharmacy, University of Dhaka. The permission number was 1155 (Date: 15-6-2021). The confidentiality of information was protected according to the Helsinki Declaration and used only for research purposes. Furthermore, the agreement of the participants was taken before the data collection.

3 | RESULTS

Among 428 patients, 200 (46.73%) patients were admitted in the red zone with a confirmed COVID-19 positive result, and suspected 228 (53.27%) patients were admitted in the yellow zone. Their sociodemographic characteristics revealed a male predominance number of patients 233 (54.44%) than females 195 (45.56%; Table 1). Most patients 179 (41.82%) affected by the COVID-19 virus or suspected were placed in the age group ranging from 41 to 60 (Table 1). No significant statistical association was observed in the case of age ($p > 0.9$) or gender ($p > 0.1$) distribution between the yellow and red zones (Table 1).

A total of 4001 drug products were prescribed for 428 patients, that is, each patient carries 9.35 drugs with a range of 2–22 during their treatment period (Table 2). Of the total sampled patients, 221 (51.64%) patients received medications between 7 and 11; 118 (27.57%) patients were more than 11 medications whereas 89 (20.79%) patients received two to six medications. A significant difference ($p > 0.01$) in the number of medications prescribed per patient in the "yellow" and "red" zones was observed (Table 2).

The number of patients treated with different therapeutic classes of medications (Table 3) and the most prescribed drugs of different therapeutic classes (Figure 1) were determined within the hospital setting during COVID-19. Antiulcerant (361, 84.34%) was the most commonly prescribed medicine followed by antibiotics (356, 83.18%). Other therapeutic classes including respiratory (339, 79.20%); analgesics (311, 72.66%); anticoagulants (307, 71.73%); vitamin and mineral supplements (231, 53.97%); steroids (225, 52.57%); cardiovascular (191, 44.63%); antidiabetic (139, 32.48%); antiviral (135, 31.54%); antihistamines (91, 21.26%); central nervous system (56, 13.08%); muscle relaxant (44,10.28%); and antifungal (16, 3.74%) medications were prescribed. Some patients were prescribed to

TABLE 1 Sociodemographic characteristics of the patients admitted in yellow and red zones.

Age groups	Yellow ($n = 228$)	Red ($n = 200$)	Frequency ($n = 428$)	p Value
Age				
0–14	2 (0.88%)	1 (0.5%)	3 (0.7%)	>0.9
15–24	11 (4.82%)	10 (5.00%)	21 (4.91%)	
25–40	42 (18.42%)	41 (20.50%)	83 (19.39%)	
41–60	94 (41.23%)	85 (42.50%)	179 (41.82%)	
>60	79 (34.65)	63 (31.5%)	142 (33.18%)	
Gender				
Male	131 (57.46%)	102 (51.00%)	233 (54.44%)	>0.1
Female	97 (42.54%)	98 (49.00%)	195 (45.56%)	

TABLE 2 Number of medications prescribed per patient in different zones.

Number of medicines	Number of patients			*p* Value
	Yellow (*n* = 228)	Red (*n* = 200)	Total (*n* = 428)	
2–6	57 (25.00%)	32 (16.00%)	89 (20.79%)	<0.01
7–11	121 (53.07%)	100 (50.00%)	221 (51.64%)	
>11	50 (21.93%)	68 (34.00%)	118 (27.57%)	

TABLE 3 Number of patients prescribed from different therapeutic classes.

Therapeutic class	Age groups										Total
	0–14		15–24		25–40		41–60		>60		
	Y	R	Y	R	Y	R	Y	R	Y	R	
Antiulcerant	2	1	8	8	31	34	83	80	59	55	361 (84.34%)
Antibiotic	2	1	7	9	32	39	75	78	54	59	356 (83.18%)
Respiratory agents	2	-	9	4	34	35	71	73	55	56	339 (79.20%)
Analgesic	2	-	6	8	28	34	70	64	54	45	311 (72.66%)
Anticoagulant	2	-	8	3	21	32	64	71	51	55	307 (71.73%)
Vitamin and minerals	2	-	5	8	22	19	45	45	45	40	231 (53.97%)
Steroid	2	-	4	3	17	23	40	59	32	45	225 (52.57%)
Cardiovascular	-	-	7	3	22	8	44	39	33	35	191 (44.63%)
Antidiabetic	-	-	2	1	11	13	24	31	29	28	139 (32.48%)
Antiviral	-	-	2	1	9	16	23	40	16	28	135 (31.54%)
Antihistamine	-	-	5	2	8	14	23	12	16	11	91 (21.26%)
CNS	-	-	1	2	10	2	16	8	6	11	56 (13.08%)
Muscle relaxant	-	1	-	-	4	3	11	15	13	7	44 (10.28%)
Antifungal	-	-	-	-	1	1	7	2	3	2	16 (3.74%)

Abbreviation: CNS, central nervous system.

receive more than one drug from each therapeutic class. The prevalence of prescribing medicine from different therapeutic class showed that enoxaparin (67.06%) was found to be the most prescribed drug followed by montelukast (60.51%), paracetamol (58.41%), dexamethasone (51.64%), salbutamol (42.06%), salmeterol (40.19%), amoxicillin (39.02%), doxophylline (38.32%), remdesivir (31.54%), insulin (28.97), ceftriaxone (25.93%), and so on.

In terms of patient encounters with antibiotics assessed this study found that 83.18% (*n* = 356) patients received at least one antibiotic. Among these, amoxicillin with clavulanic acid 39.02% (*n* = 167) was the most prescribed antibiotic followed by ceftriaxone 25.93% (*n* = 111), meropenem 14.95% (*n* = 64), and clarithromycin 14.02% (*n* = 60) (Table 4).

The total number of injectables prescribed was 1316, that is, more than one injection was administered to each patient admitted to the yellow or red zones. The most frequently prescribed injectable was enoxaparin 287 (67.06%) including 127 (44.25%) patients in the yellow zone and 160 (55.75%) patients in the red zone, respectively. The other most commonly prescribed injectables were dexamethasone 221 (51.64%), amoxicillin + clavulanic acid 167 (39.02%), remdesivir 135 (31.54%), insulin 124 (28.97), ceftriaxone 111 (25.93%), meropenem 64 (14.95%), clopidogrel 55 (12.85%), and so on (Table 5).

The study also aimed to investigate the possible patterns of the prescribed antibiotic and drugs from the major therapeutic group. The results indicated that amoxicillin + clavulanic acid and enoxaparin was the most frequently combined prescribed drugs (Table 6). Remdesivir (an antiviral drug) was also repeatedly prescribed with amoxicillin and clavulanic acid (Table 6).

The association between anticoagulant and steroidal drugs to treat COVID-19 patients by showing the *p* value of different steroidal drugs where patients have at least one type of anticoagulant drug was determined (Table 7). Steroidal drugs are listed as dexamethasone, estradiol, hydrocortisone, and prednisolone. From the analysis, it was observed that dexamethasone was highly used along with anticoagulant drugs and the lowest *p* value ($p > 0.01$) determines the significant association between them. On the other hand, other steroidal drugs (estradiol, hydrocortisone, prednisolone) exhibited no significant association with anticoagulant drugs. Overall, the treatment of COVID-19 ICU patients with steroidal drugs, (dexamethasone), and anticoagulants would be a common practice.

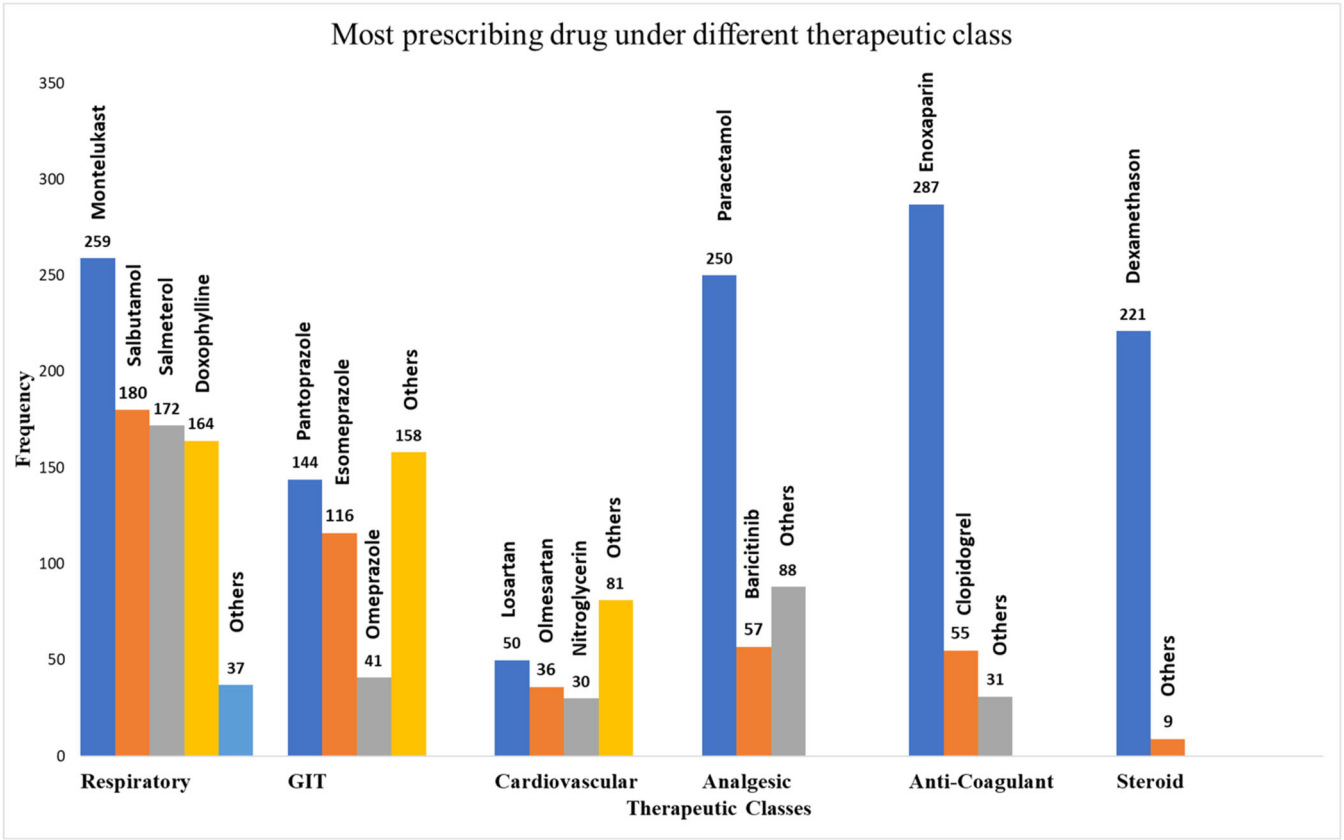

FIGURE 1 Most prescribing drugs under major therapeutic class.

TABLE 4 Distribution of antibiotics prescribed for patients admitted to the COVID-19 ward.

Antibiotics	Number of patients		
	Yellow	Red	Total
Amoxicillin + clavulanic acid	72 (43.11%)	95 (56.89%)	167 (39.02%)
Ceftriaxone	41 (36.94%)	70 (63.06%)	111 (25.93%)
Meropenem	28 (43.75%)	36 (56.25%)	64 (14.95%)
Clarithromycin	27 (45%)	33 (55%)	60 (14.02%)
Cefixime	18 (85.71%)	3 (14.29%)	21 (4.91%)
Erythromycin	14 (93.33%)	1 (6.67%)	15 (3.50%)
Imipenem	10 (90.91%)	1 (9.09%)	11 (2.57%)
Linezolid	8 (80.00%)	2 (20.00%)	10 (2.34%)
Flucloxacillin	8 (80.00%)	2 (20.00%)	10 (2.34%)
Ciprofloxacin	6 (75.00%)	2 (25.00%)	8 (1.87%)
Cefuroxime	6 (85.71%)	1 (14.29%)	7 (1.64%)
Cefotaxime	5 (83.33%)	1 (16.67%)	6 (1.40%)
Others	9 (69.23%)	4 (30.77%)	13 (3.04%)

Abbreviation: CNS, central nervous system.

TABLE 5 Distribution of injectables for patients admitted to yellow and red zones.

Injectables	Number of patients		
	Yellow	Red	Total
Enoxaparin	127 (44.25%)	160 (55.75%)	287 (67.06%)
Dexamethasone	92 (41.63%)	129 (58.37%)	221 (51.64%)
Amoxicillin + clavulanic acid	72 (43.11%)	95 (56.89%)	167 (39.02%)
Remdesivir	50 (37.04%)	85 (62.96%)	135 (31.54%)
Insulin	58 (46.77%)	66 (53.23%)	124 (28.97)
Ceftriaxone	41 (36.94%)	70 (63.06%)	111 (25.93%)
Meropenem	28 (43.75%)	36 (56.25%)	64 (14.95%)
Clopidogrel	33 (60.00%)	22 (40.00%)	55 (12.85%)
Frusemide	26 (63.41%)	15 (36.59%)	41 (9.58)
Tiemonium	11 (45.83%)	13 (54.17%)	24 (5.61)
Cefixime	18 (85.71%)	3 (14.29%)	21 (4.91%)
Ketorolac	6 (50.00%)	6 (50.00%)	12 (2.80%)
Imipenem	10 (90.91%)	1 (9.09%)	11 (2.57%)
Flucloxacillin	8 (80.00%)	2 (20.00%)	10 (2.34%)
Hydrocortisone	4 (80.00%)	1 (20.00%)	5 (1.17%)
Pethidine	3 (60.00%)	2 (40.00%)	5 (1.17%)
Haloperidol	2 (50.00%)	2 (50.00%)	4 (0.93)
Fluconazole	3 (75.00%)	1 (25.00%)	4 (0.93%)
Metronidazole	3 (75.00%)	1 (25.00%)	4 (0.93%)
Prochlorperazine	2 (66.67%)	1 (33.33%)	3 (0.70)
Amikacin	2 (66.67%)	1 (33.33%)	3 (0.70%)
Cefuroxime	2 (66.67%)	1 (33.33%)	3 (0.70%)
Atenolol	1 (50.00%)	1 (50.00%)	2 (0.47)
Estradiol	0 (0.00%)	1 (100%)	1 (0.23%)

4 | DISCUSSION

Physicians and healthcare professionals tried their best with conventional medicines and symptomatic treatment to fight against COVID-19. This study focuses to understand how physicians of Bangladesh maintain their serious COVID-19 patients when there are no established guidelines. At ICU, the patient's characteristics were not too much deviated from other studies' findings concerning sociodemographics, comorbidities, and pharmacological treatments.[21,22] The most affected patients' age group was found to be similar to some studies (55.0–60.0 years).[21–23] Male patients were dominant in this study, which may be due to biological factors such as sex hormones, genetic variation, or the types of microbiomes that can influence the host's immune response to infection.[24]

More than half of the total population (51.64%) received 7–11 medicines. Furthermore, 27.57% of the total population received more than 11 medicines. These indicated the presence of extreme polypharmacy practice at the ICU unit. Increasing polypharmacy indicated the climb of fatal consequences such as adverse reactions, drug interactions, vulnerability, and death.[25] Older patients are more prone to this risk,[25] while most of the participants' of this study are old adults (41–60) to geriatric (>60). If polypharmacy rises alongside ICU-admitted patients' symptoms, the result may have life-threatening consequences since both ICU patients' symptoms and polypharmacy may create a severe condition.[26] It is, therefore, advised to use polypharmacy with caution and to assess the risks involved if it is essential to prescribe polypharmacy for the treatment of multiple comorbidities or severe ICU conditions.[26]

Though previous complications of the patients were not the main subject of this study, some previous compilations like acute kidney illness, chronic obstructive pulmonary disease (COPD), hypertension, diabetes, heart disease, carcinoma, male gender, elderly age, persistent smoking, obesity, and so on might be present in the targeted population because of the presence of corresponding

therapeutic agents of those complications, indicated from the study's outcomes. Additionally, this study covers only COVID-19 ICU patients; one foreign and another Bangladeshi study mentioned that breathing problems and pneumonia are predictably too frequent symptoms of COVID-19 patients in Bangladesh.[7,27] For this reason, possibly respiratory tract-related drugs such as montelukast, salbutamol, salmeterol, and doxophylline were the most prescribed compared to other therapeutic agents. Among them, montelukast was more frequent than others; it mainly exhibited promising findings in faster recovery and reduced inflammatory cytokines, indicating it may be a practical COVID-19 therapeutic choice.[24] The pattern of respiratory drug prescribing was nearly similar to that of lower-middle-income countries such as Nepal, Peru, and Uganda, which suggested that prescribers used the usual pattern of respiratory drugs according to the country's economic conditions, even in COVID-19 cases.[28] Gastrointestinal diseases are one of the most frequent problems in Bangladesh[29]; therefore, antiulcerant medications might be given to maximum patients (84.34%). Fever and body aches are also common symptoms of COVID-19 patients; this may be the reason for the frequent prescribing of paracetamol in this study.[30]

Antibiotics are needed for COVID-19 patients because of the possible bacterial pneumonia or other secondary bacterial infections.[31] A previous study suggested that 28% of COVID-19 patients suffered from bacterial pneumonia associated with *Haemophilus influenza*, *Staphylococcus aureus*, *Enterobacteriaceae*, and *Streptococcus pneumonia*.[32] Though the participants' pneumonia or microbial infection evaluation was not subjected in this study, secondary bacterial infection and pneumonia may be the plausible reason for prescribing antibiotics for the COVID-19 patients in this study.[31] In this study, nearly 83.18% ($n = 356$) of patients received at least one antibiotic, which was higher than the meta-analysis and review of Langford et al., where the frequency of antibiotics prescribing was 74.6%; this review and meta-analysis was conducted by gathering 154 previous COVID-19 study reports.[33] Furthermore, this study indicated a higher antibiotic prescribing rate than another Russian COVID-19 critical care study (75.6%).[34] However, the trend of prescribing more antibiotics was also followed by another Bangladeshi study, such as the study of Molla et al., which demonstrated that 100% of COVID-19 patients received antibiotics.[15] One previous study indicated that roughly 28% of COVID-19 patients fall into pneumonia, while Santis et al. suggest that 36.3% of COVID-19 ICU patients suffered from at least one secondary infection[35] which implies the multiple prescribing of antibiotics in this study. Prescribers should be aware of such circumstances; otherwise, AMR can spread among the patients.

In the current study amoxicillin + clavulanic acid (39.02%) was the most frequent antibiotic, while ceftriaxone (25.93%), meropenem (14.95%), and clarithromycin (14.02%) were followed by (Table 4). Both red and yellow groups maintain the same antibiotic pattern in this study. These antibiotic prescribing patterns are also displayed differences from various studies. One ICU study at Kosovo, demonstrated that imipenem was among the most frequently administered antibiotic, making up 57.7% of cases, being followed by ceftriaxone (53.8% of all prescriptions), piperacillin/tazobactam (32.7% of all prescriptions), and fluoroquinolone (32.7% of all prescriptions).[36] Another study of eastern Romania revealed that linezolid were the most prescribed antibiotics (77.2%), while imipenem (75.5%) and ceftriaxone (33.7%) followed by.[37]

Several individuals are significantly inclined to develop tiny blood emboli in their lungs as a consequence of COVID-19, which can cause acute respiratory distress syndrome, a symptom of severe COVID-19 diseases, and lead to death.[38] Anticoagulants such as enoxaparin, unfractionated heparin, and rivaroxaban are often given to COVID-19 patients as part of their treatment.[39] In this study, the same pattern may apply to heal such embolism of severe COVID-19 patients, anticoagulants were used in more than two-thirds of the patients (71.73%) (Table 3). Furthermore, anticoagulant enoxaparin was suggested to treat these thromboses of lung failure, coagulation cascade, as well as a cytokine storm.[40] Consequently, these findings probably provide the explanation of the broad acceptance of enoxaparin (93.48% [$n = 287$] among the prescribed of anticoagulant agents) in COVID-19 patient care. Excessive use of anticoagulants may reduce the thrombolytic properties of the blood. So, it is recommended to maintain the precise dose of the anticoagulant agents.

Corticosteroids are thought to be a potential therapy choice for severe COVID-19 patients because of their immunosuppressive potency, which includes a decrease in interleukin-6, interleukin-10, granulocyte-macrophage colony-stimulating factor, tumor necrosis factor α, and immune cell activity.[41] These reasons may be responsible for the wide application of corticosteroids in ICU department as severe patients are treated here. More than half of the participants' of this investigation (52.57%) received corticosteroids such as dexamethasone, hydrocortisone, and prednisolone which was similar to some previous articles.[42–45] Among them, dexamethasone was dominated steroid in this study, may be it was highly recommended by various national and international clinical guidelines,[42] while other steroids were prescribed for one time only. The domination of dexamethasone may further be predicated that, a RECOVERY trial, 28-day mortality was 41% in the control care group, which indicated that dexamethasone improved the survival of patients receiving invasive mechanical ventilation or oxygen at randomization.[46] However, it is highly recommended to the rational use of steroids, because of the risk of adverse effects of steroidal therapy.

Several existing marketed drugs were considered for repurposed utilization to reduce viral spread such as ivermectin, hydroxychloroquine, chloroquine, remdesirvir, favipiravir, and lopinavir–ritonavir combination.[47] Among them, only remdesivir was provided for the COVID-19 ICU patients of this study. Remdesirvir is widely used in the ICU setting of COVID-19 patients which is considered to be a life-saving medication because remdesivir significantly lower mortality of the COVID-19 patients.[47] For this reason, prescribers of ICU of this study may confine to remdesirvir to restrict the viral dissemination within the infected patients.

Injectable products are crucial for the ICU department as these are needed for fast-acting drugs.[48] Enoxaparin ($n = 287$, 67.06%) is the most frequently prescribed medication among the injectable

TABLE 6 Patterns of top five antibiotics and major drugs from different therapeutic class.

Top five prescribed antibiotic	Top five prescribed drugs				
	Enoxaparin (*n* = 287)	Dexamethasone (*n* = 221)	Remdesivir (*n* = 135)	Insulin (*n* = 124)	Frusemide (*n* = 41)
Amoxicillin + clavulanic acid	141 (49.13%)	113 (51.13%)	71 (52.59%)	69 (55.65%)	6 (14.63%)
Ceftriaxone	80 (27.87%)	58 (26.24%)	32 (23.70%)	29 (23.39%)	-
Meropenem	50 (17.42%)	48 (21.72%)	38 (28.15%)	26 (20.97%)	10 (24.39%)
Clarithromycin	51 (17.77%)	42 (19.0%)	32 (23.70%)	32 (25.81%)	2 (4.88%)
Cefixime	12 (4.18%)	5 (2.26%)	7 (5.19%)	-	4 (9.76%)

TABLE 7 Association between steroidal drugs and COVID-19 patients taking anticoagulant drugs (*n* = 307).

Injectables	Number of patients			*p* Value
	Yellow	Red	Total	
Dexamethasone	88 (42.72%)	118 (57.28%)	206 (67.10%)	<0.05
Estradiol	0 (0.00%)	1 (100%)	1 (0.33%)	>0.3
Hydrocortisone	1 (100%)	0 (0.00%)	1 (0.33%)	>0.2
Prednisolone	1 (50.00%)	1 (50.00%)	2 (0.65%)	>0.9

products, followed by dexamethasone (*n* = 221, 51.64%), amoxicillin + clavulanic acid (*n* = 167, 39.02%), remdesivir (*n* = 135, 31.54%), and ceftriaxone (*n* = 111, 25.93%). Several symptoms, such as pneumonia, pulmonary embolism, and cytokine storm, are common for critical COVID-19 patients who need fast treatment, as these symptoms may lead to life-threatening situations.[49–51] For this reason, physicians may parenterally administrate enoxaparin for pulmonary embolism,[52] antibiotics for pneumonia,[53] and dexamethasone for cytokine storm.[46]

The results of the current investigation revealed that enoxaparin and dexamethasone, two of the most commonly used drugs, were prescribed along with antibiotics (Table 6). Because of the serious state of these patients, minor pulmonary embolism, cytokine storms, or both could develop simultaneously with pneumonia or secondary bacterial infections. So, physician may decide to combine anticoagulants with steroids, especially dexamethasone and anticoagulant drugs at the same time (Table 7).

5 | LIMITATIONS OF THE STUDY

The limitation of the study is that all symptoms and severity of diseases of the patients were not considered. Only prescribed medicine was considered, and signs and symptoms were discussed based on the previously published article of the COVID-19 patients. Moreover, the precise diagnosis and accuracy of the medicine provided by doctors were not considered. Additionally, the study happened only in a tertiary-level hospital in Bangladesh. Therefore, outcomes may be different in respect of other hospitals.

6 | CONCLUSION

The main benefit of this study is that it concentrates on the prescription patterns of key drugs often given to COVID-19 patients getting intensive care in hospital settings. In the ICU department, the yellow and red groups showed comparable prescription patterns. For both groups, medical professionals mostly used a symptomatic therapy strategy. Notably, the most often used treatment categories were antibiotics, anticoagulants, and steroids. Additionally, respiratory drugs were given out more frequently than those from other classifications. Although the prescription pattern for respiratory tract medicines matched with patterns observed in lower economic nations, antibiotic prescription patterns varied from previous research. The only treatment offered to lessen viral infections was remdesivir, one of the traditional antiviral medications. Clinical trial outcomes were more important to physicians than personal tactics. Due to numerous underlying medical disorders, the incidence of polypharmacy and therapeutic overlap was also seen in preventative therapy. Therefore, it is strongly advised as if patients receive an accurate diagnosis, proper antibiotic prescriptions during ICU stays, effective treatment strategies, and diligent patient monitoring.

AUTHOR CONTRIBUTIONS

Tanvir Rahman: Conceptualization; data collection; data curation, methodology; validation. **Md Saiful Islam**: Conceptualization; validation; data management; visualization. **Shyamjit Paul**: Formal analysis; software; validation; writing—original draft. **Md Momin. Islam**: Data curation; formal analysis; investigation; methodology; software and statistical analysis. **Md Abdus Samadd**: Conceptualization; formal analysis; methodology; software; writing—original draft;

writing—review and editing. **Rashmia Nargis Reyda**: Investigation; visualization; writing—original draft. **Md Raihan Sarkar**: Conceptualization; supervision; writing—review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The corresponding authors may provide data from this research upon sufficient request.

TRANSPARENCY STATEMENT

The corresponding author Md Raihan Sarkar and all co-authors affirm that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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