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Research Article

Health Economic Burden of COVID-19 and its Comorbidities in India: An Exploratory Study

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I N F O

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A B S T R A C T

Introduction: COVID-19's economic impact is crucial for adding merits to the policymaking process. This study was designed to evaluate the economic burden (direct medical cost) on COVID-19 patients and compare the treatment cost of patients with and without comorbidities at a tertiary hospital, as well as assess the prevalence of comorbidities associated with COVID-19 patients.

Methods: The analysis was retrospectively conducted at National Heart Institute, New Delhi between June 1, 2020 and November 30, 2020. The study included diagnosed COVID-19 patients who were admitted to the hospital during these 6 months. The patient's demographics, hospitalisation characteristics, and coexisting medical conditions were all evaluated.

Results: The total direct medical costs were evaluated by cost factors. In this study, the demography of patients was recorded and found that out of 400 patients, 260 (65%) were male and 140 (35%) were female. 294 patients had at least one pre-existing disease. Finally, 360 (90%) subjects recovered whereas, 40 (10%) died. The overall mean cost per COVID-19 treatment episode was found to be INR 264,703.

Conclusion: The findings of this study demonstrated that the disease's severe condition resulted in an exceptionally high cost of illness.

Keywords: Economic Burden, COVID-19, Direct Medical Cost, Comorbidities

Introduction

The worldwide spread of the novel coronavirus disease (COVID-19) posed a threat to governments, people, and healthcare systems. From an economic perspective, the spread of COVID-19, large number of patients, and consequences of the disease have enforced higher direct and indirect medical expenditures on patients, healthcare systems, and the government.[1] COVID-19 treatment expenses vary greatly amongst people, based on their age, disease severity, and comorbidity status.[2] The costs varied depending on the severity of the disease, average

time of stay in the hospital, average time of stay in the ICU, etc.[1] All confirmed serious COVID-19 patients frequently needed expensive treatments like mechanical breathing and extracorporeal membrane oxygenation, thereby driving up the healthcare expenditures significantly.[3] In developing countries like India, there is a need to know the effect of COVID-19 on health economics. As there is very limited data available on how comorbidities and severity of COVID-19 affect the cost of treatment of COVID-19, this retrospective study is designed to answer some of the questions.

The goal of this study was to analyse the treatment expenditures of COVID-19 patients in a tertiary care hospital during the first wave of the pandemic. It also aimed to assess the prevalence of comorbidities in COVID-19 patients. The findings may help health policymakers get a better grasp of the primary cost associated with the management of patients admitted due to COVID-19. To address this public health issue, we conducted a retrospective cost and affordability analysis to evaluate the medical expenditures of COVID-19 patients in New Delhi, India as well as the factors that influence these costs.

Methods

Study Design

The current study was approved by the Biomedical Research Human Ethics Committee at the Delhi Pharmaceutical Sciences and Research University with protocol number DPSRU-BREC/2021/A/022. The National Heart Institute's Ethics Committee also approved the study.

This study was carried out retrospectively at the National Heart Institute, Delhi between June 1, 2020 and November 30, 2020. This hospital is designated as a tertiary care hospital for cardiovascular diseases, such as myocardial infarction, angina pectoris, chronic heart failure and other emerging cardiovascular ailments. Data were collected from Medical Record Department (MRD) and Accounts Department. The subject included all the in-patients having COVID-19 admitted to the hospital between June 1, 2020 and November 30, 2020. During these 6 months, 400 laboratory-confirmed patients with clinical symptoms and radiological abnormalities were admitted to the hospital, according to The National Institute of Health guidelines.[4] When the treatment criteria were met, the patients were released from the hospital. Two consecutive negative molecular diagnostic results, as well as considerable absorption of lesions and recovery from clinical symptoms, was considered a "cure". The patient medical records were used to collect demographic and clinical data, while the finance management system was used to collect economic data. The patient's demographics, hospitalisation characteristics, and co-existing medical conditions were all evaluated. The study included the costs and demographics of SARS-CoV-2 positive cases who underwent treatment at the hospital from diagnosis through discharge.

Calculation of Direct Medical Costs

In this study, the cost of radiographic analysis, clinical measurements, drug prescriptions, laboratory diagnostic tests and hospitalisation was taken into consideration. The following cost parameters were used to calculate the medical cost:

- Laboratory diagnostic testing like microbiology, biochemistry, haematology, etc.
- Radiographic measures such as chest X-ray and computed tomography
- Therapeutic measures like haemo-purification, supplemental oxygen, and other measures used for the treatment of COVID-19 and comorbidities
- Drug acquisition to treat COVID-19 and comorbidities
- Bed costs including costs of general wards and ICU

The sum of the average in-patient expenditures in each category was used to compute the average direct medical cost of each patient with COVID-19:

Mean direct medical cost/patient = (mean cost of medicine) + (mean cost of laboratory) + (mean cost of medical consumables) + (mean cost of radiographic measures) + (mean cost of bed charges) + (mean cost of physician services) + (mean cost of bio-medical waste) + (mean cost of other items)

Statistical Analysis

The data collected from Medical Record Department (MRD) and Accounts Department were entered in Microsoft Excel 2019. The statistical software GraphPad Prism (7.0) was used for statistical calculations. The categorical and continuous variables were taken as percentages, and as means with standard deviations, respectively. To compare the cost among different patient groups, a descriptive analysis was performed.

Results

Demographic and Clinical Characteristics

In the present study, a total of 400 COVID-19 patients were considered who were admitted to the hospital. Table 1 depicts the demographic and clinical characteristics of patients at the time of hospital admission.

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Table 1.Demographic and Clinical Characteristics of Patients

Characteristics	Patients (N = 400)
Male n (%)	260 (65)
Female n (%)	140 (35)
Age (in years) (median, IQR)	61 (49-70)
Pre-existing disorders	
Any pre-existing disorder n (%)	294 (73.5)
Cardiovascular disorder n (%)	100 (25)
Endocrine disorder n (%)	48 (12)
Neurological disorder n (%)	24 (6)
Renal disorder n (%)	17 (4.2)
Respiratory disorder n (%)	13 (3.2)
Liver disorder n (%)	7 (1.7)
Malignancy n (%)	4 (1)
Severity of disease	
Mild n (%)	231 (58)
Moderate n (%)	125 (31)
Severe n (%)	44 (11)
Drug acquisition	
Antiviral n (%)	194 (48.5)
Antibiotic n (%)	225 (56.2)
Antifungal n (%)	44 (11)
Immunomodulator n (%)	332 (83)
Pre-existing diseases n (%)	102 (25.5)
Clinical outcomes	
Cure n (%)	360 (90)
Death n (%)	40 (10)
Duration of hospitalisation, days (median, IQR)	9 (6-11)

Interquartile Range (IQR)

There were 260 men (65%) and 140 women (35%) in this study. The average age was found to be 61 years (interquartile range: 49-70). 294 individuals (73.5%) had pre-existing illness conditions. Cardiovascular illness was the most prevalent pre-existing disease (25%), followed by endocrine disease (12%), and neurological disease (6%). A total of 11% of patients suffered from severe symptoms (Table 1).

According to the national illness severity grading norms, 231 (58%) cases were mild, 125 (31%) were moderate, and 44 (11%) were severe. In 42% of patients, the oxygen saturation level was less than 93% and 5% of the patients were intubated.[5] Among all cases, 17% required admission to ICU as they had severe symptoms and continuous monitoring was required for them. Antiviral and antibiotic treatments were given to 48.5% (194/400) and 56.2% (225/400) of the patients, respectively. In addition, other often utilised medicines for COVID-19 treatment were immunomodulators which were prescribed to 83% (332/400) of patients. Finally, 360 (90%) cases were cured, and 40 (10%) succumbed to COVID-19.

Cost Analysis

As per the analysis, the mean cost for COVID-19 treatment was INR 264,703 which included the highest mean cost from beds (INR 94,330), accounting for 35.6% of the total cost. The mean prices for laboratory diagnosis and hospital consumables were INR 28,165 (10.6%) and INR 35,682 (13.4%), respectively. The results depicted that the bed charges were the most significant driver of total treatment expenses. Table 2 summarises the overall cost to manage COVID-19 based on several clinical and demographic factors. Patients with pre-existing disorders had a considerably higher total mean cost (INR 280,826) than those without pre-existing disorders (INR 221,606, $p < 0.05$). With advanced age, there was a greater mean total cost, ranging from INR 174,907 for 0-34 years to INR 291,830 for 70 years ($p < 0.001$), due to increased probabilities of pre-existing disorders in older patients.

Table 2.Comparison of Cost Based on Clinical and Demographic Factors to Manage COVID-19

Characteristics	Cost/Case (INR, Mean ± SD)	p Value
Sex		
Male	286,092 ± 22.543	0.001
Female	225,482 ± 15.283	
Age group (in years)		
0-34	174,907 ± 16.867	0.001
35-69	268,353 ± 20.524	
≥ 70	291,830 ± 20.897	
Pre-existing disease		
No	221,606 ± 18.120	0.01
Yes	280,826 ± 21.039	
Severity		
Mild	188,585 ± 11.944	< 0.001
Moderate	337,708 ± 20.386	
Severe	484,689 ± 34.711	

INR: Indian Rupee, SD: Standard deviation.

The data also demonstrated that the average cost was related to the severity of the condition, with seriously ill cases costing higher (INR INR 484,689) than mild cases (INR 188,585) and moderate cases (INR 337,708).

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Table 3. Comparative Cost Analysis to Manage COVID-19 With and Without Underlying Disorders

Classification	Cost Per Case (INR, Mean ± SD)		p Value
	Without pre-existing diseases	With pre-existing diseases	
Drug acquisition	53,730 ± 83.571	68,598 ± 87.778	NS
Laboratory diagnostics	23,444 ± 19.138	29,969 ± 24.137	0.01
Radiologic diagnostics	9,126 ± 7.521	9,135 ± 6.094	NS
Bed costs	76,382 ± 57.929	100,588 ± 67.387	0.001
Cardiology charges	2,650 ± 17.093	3,221 ± 5.579	NS
Hospital consumables	28,569 ± 20.828	38,247 ± 31.570	0.01
Healthcare professionals (physicians/ nurses)	29,213 ± 28.124	31,398 ± 27.261	NS
Biomedical waste management	6,570 ± 6.701	7,364 ± 11.613	NS

NS: Non-significant

The sex of a person had a considerable impact on the total cost. The mean cost of male treatment (INR 286,092) was higher than female treatment (INR 225,482).

Notably, all individual cost determinants studied in this study revealed statistically greater expenses in patients having pre-existing disorders ($p < 0.01$) (Table 3).

Discussion

The COVID-19 pandemic had a detrimental effect on the global healthcare system and affected every aspect of human and economic life.[6] In individuals with COVID-19, mortality was linked to age, sex, race, history of myocardial infarction, congestive heart failure, dementia, chronic pulmonary illness, liver disorders, renal disorders, etc.[7] The average age of the patients was found to be 48.9 years. Cardiovascular disorder (hypertension) was the most common comorbidity, followed by endocrine disorders, such as diabetes. 82% of patients said that they had two or more comorbidities.[8] The individuals with comorbidities had worse clinical outcomes than those without comorbidities in laboratory-confirmed cases of COVID-19. A higher comorbidity count was similarly linked to worse clinical outcomes.[9] Other frequently observed comorbidities with COVID-19 were obesity, hypothyroidism, chronic kidney disease, chronic obstructive respiratory disorders, benign prostatic hyperplasia, asthma, coronary artery disease, etc.[10]

Men were more likely than women to have worse COVID-19 outcomes. Sex (biological differences) and gender (socio-cultural and behavioural differences) have important roles in COVID-19.[11] Immune system responses differ significantly between males and females, with females triggering higher immune responses to infections. This disparity in immune system responses could play a significant role in viral load, illness severity, and mortality. Furthermore, because oestrogen has immunoenhancing properties while testosterone has immunosuppressive properties, variations in sex hormones may be a predictor of viral infections.[12] SARS-CoV-2 employs angiotensin-converting enzyme 2 (ACE2) as an entrance receptor, with cellular transmembrane serine protease 2 priming the virus's spike protein to facilitate virus entry. ACE2 is an X-chromosome-encoded gene that is downregulated by oestrogens and expresses differently in different tissues. Differences in ACE2 expression could be caused by ACE2 polymorphisms expressing differently in men and women. ACE2 is linked to interferon gene expression, which is regulated differently by men and women.[13] A similar study was carried out in Saudi Arabia by Khan et al.[14] The study demonstrated a cross-sectional cost descriptive study to measure the economic burden of COVID-19. The overall direct medical expenditures were projected to be USD 1,791,172, in which the majority of the costs (41%) included intensive and general care beds. In this study, bed charges included diet charges, laundry charges, nursing charges etc. The medicines and other medical consumables cost 28%, physician visits cost 12%, and electrography and laboratory expenditures cost 9% of the total cost.[14] The financial burden that was identified for a variety of criteria in Saudi Arabia, was identical to our findings.

Patients with pre-existing disorders had a considerably higher total mean cost (USD 9,525) than those without pre-existing disorders (USD 3,619). With advanced age, the mean cost increased, rising from USD 2,752 for the 0-34 years group to USD 11,668 for the 70-year group, which included the senior patients' higher likelihood of having pre-existing conditions. A similar study carried out in the United States also demonstrated the cost burden percentage which was reported to be less than our cost burden.[15]

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The majority of direct medical costs were provoked by critically sick persons who required ICU treatment. Despite the fact that ICU services were used by just around 7% of COVID-19 patients, they accounted for roughly a quarter of the total direct medical costs amounting to USD 477,600. Indeed, patient treatment in ICU is, on average, more expensive.[16-18]

Similarly, in our study, outcomes depicted that the majority of expenses were driven by critically ill patients who required intensive care unit treatment. This disparity can be attributed to the higher average cost of patient care in the ICU setting, underscoring the importance of effective management strategies for critically ill individuals to optimise healthcare resources and cost efficiency.

Future research should examine the survival probability for hospitalised COVID-19 patients with comorbidities. The cost of COVID-19 in other important sectors of the economy and the total direct medical costs of COVID-19 to the Indian healthcare system should also be examined.[19]

Conclusion

The current study clearly indicated that men appeared to be more vulnerable to COVID-19 than women. Patients in the age group of 60-69 years were at high risk followed by the patients in the age group of 50-59 years. Maximum COVID-19 patients suffered from mild illness followed by moderate and severe illness. Patients with comorbidities were at high risk and more vulnerable as compared to patients without comorbidities. Both cardiovascular and endocrine disorders were found to be the most prevalent comorbidities with COVID-19. A greater number of comorbidities correlated with the highest economic burden. The mean cost of the treatment was increasing with advanced age, i.e. the treatment cost of COVID-19 was higher in elder patients as compared to younger patients. The findings of this study showed that the disease's severe condition will result in an exceptionally high cost of illness. The cost of bed charges was the largest contributor to medical costs followed by drug acquisition and hospital consumable charges.

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Conflict of Interest: None

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