Title of the Research Project: Assessment of the Impact of COVID-19 on Drug Store Management in a Tertiary Care Teaching Hospital of Raipur City

Introduction:

The drug store is one of the hospital's most widely used treatment plants and one of the few areas that regularly spend a considerable amount of money on purchases. About one-third of the annual hospital budget is spent on the purchase of medicines, materials, and supplies.[1]The new coronavirus strain is a member of a large family of viruses that cause a wide range of respiratory illnesses, from the common cold to more severe disorders like pneumonia.[2]COVID-19 has quickly altered our daily lives, enterprises, and disturbing world trade and movements. As COVID-19 continues to spread, supply chains and logistics vulnerabilities have been exposed.[3] During the initial phase, it made many drugs & consumables unavailable.[3] Health supply chains, active pharmaceutical ingredients, transportation, procurement, finished products, and many more have been disrupted.[4]

Management of stocks (Drugs & Consumables) ensures availability and minimizes investment as required of materials.[5] Drug store management is a complex but critical process within the healthcare delivery system.[6] Hospital's risk being unable to give patients the most suitable medication at the right time without adequate drugstore management practices. Additionally, pharmacy dispensing patterns and drug selection choices may have a direct effect on the quality of patient care.[7-8] In addition to the safety of patients and financial considerations, the management of the drug store also raises the importance of keeping effective monitoring of drug stocks in today's growing healthcare environment.[9] During Lockdown, all hospital OPDs were closed, some diagnostic procedures & routine surgeries were postponed & most of the work in the hospital was mainly related to the management of COVID-19 patients. Stock-outs of essential items could severely impede patient care and hospital operations, resulting in an unacceptable negative impact on patient outcomes.[10]

Drug utilization is referred to as "the marketing, distribution, prescription, and use of drugs in a society with special emphasis on the resulting medical and social consequences."[11] It is an important tool for the study and impact on the health system of clinical consumption of drugs in populations.[12-13] The rationale for conducting this study was to avoid stock-outs & to stockpile the drugs & consumables in the hospital by estimating the Surge/Decline in drugs and consumables utilization after COVID-19 and to develop a proper management plan for the drug store to deal with such a pandemic situation in future. Also, there was a need to measure the underutilized stock quantity left due to COVID-19.

Objectives:

Primary:

To estimate the Surge/Decline in drugs and consumables utilization during the first wave of COVID-19.

Secondary:

1. To measure the quantity of underutilized stock due to COVID-19.

2. To suggest a management plan for the drug store to tackle any future pandemic situation.

Materials & Methods:

A retrospective, observational study was carried out at the Department of Hospital Administration, AIIMS Raipur. A total of 20 most commonly used drugs (10 antibiotics, 3 analgesics, 3 antipyretics, 2 anticoagulants, & 2 steroids) and 20 most frequently used consumables were selected based on the last 3-year consumption rate from central pharmacy data. Quantitative data about the pattern of demand, supply & consumption of drugs, and hospital consumables was sourced from the existing records of the Central Pharmacy for 24 months from 1st January 2019 to 31st December 2020.

To assess the potential impact of the COVID-19 pandemic on drug store management, the study period was separated into 2 Periods: a Pre-Pandemic or Pre-COVID-19 period (1st January 2019 to 31st December 2019 & the COVID-19 Pandemic Period (1st January 2020 to 31st December 2020). However, we acknowledge that the first confirmed case of COVID-19 was admitted on the 18th of March in our hospital & on the first COVID-19 case in India reported on 27th of January; the data for the whole month of January was included. After calculating the monthly consumption for each month, the mean average monthly consumption in Pre COVID-19 Period (2019) & the mean average monthly consumption during the COVID-19 Period (2020) were calculated separately.

The data of Stock & monthly consumption of selected drugs & consumables were collected from the Central Pharmacy in a predesigned Proforma. The data regarding total functional beds, average occupied beds & average bed occupancy rate was collected from Medical Record Department. Drug Consumption, Utilization Pattern of most commonly used drugs in the hospital were studied. Most commonly used drugs were classified according to the anatomical therapeutic chemical (ATC) classification system, and drug utilization was measured in DDD/100 bed-days.

Ethical clearance was obtained from the Institute Ethics Committee of All India Institute of Medical Sciences, Raipur, with Ref No: 1488/IEC-AIIMSRPR/2021 dated 16/02/2021.

Results:

We observed that out of 20 selected drugs, there was a surge in drug consumption in 15 drugs & a decline in drug consumption in only five drugs in 2020 as compared to 2019 (Figure-1). Also, out of 20 selected consumables, there was a surge in consumption in 10 consumables & a decline in consumption in 9 consumables & no change in consumption in only one consumable in 2020 as compared to 2019 (Figure-2).

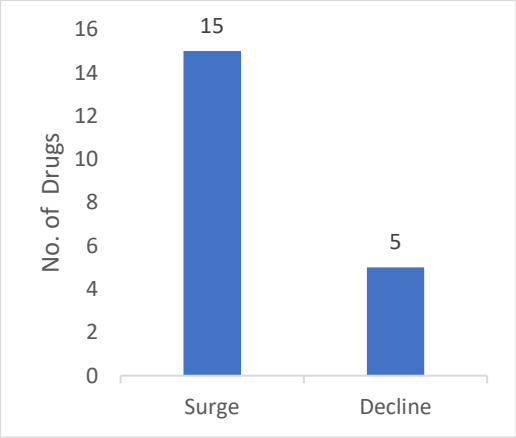

Figure-1: Change in Drug Consumption Pattern

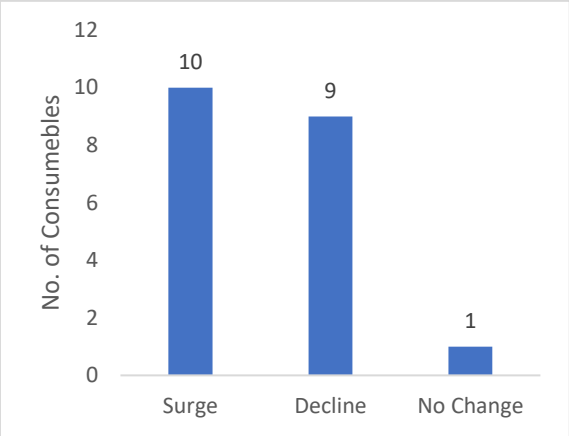

Figure-2: Change in Consumables Consumption Pattern

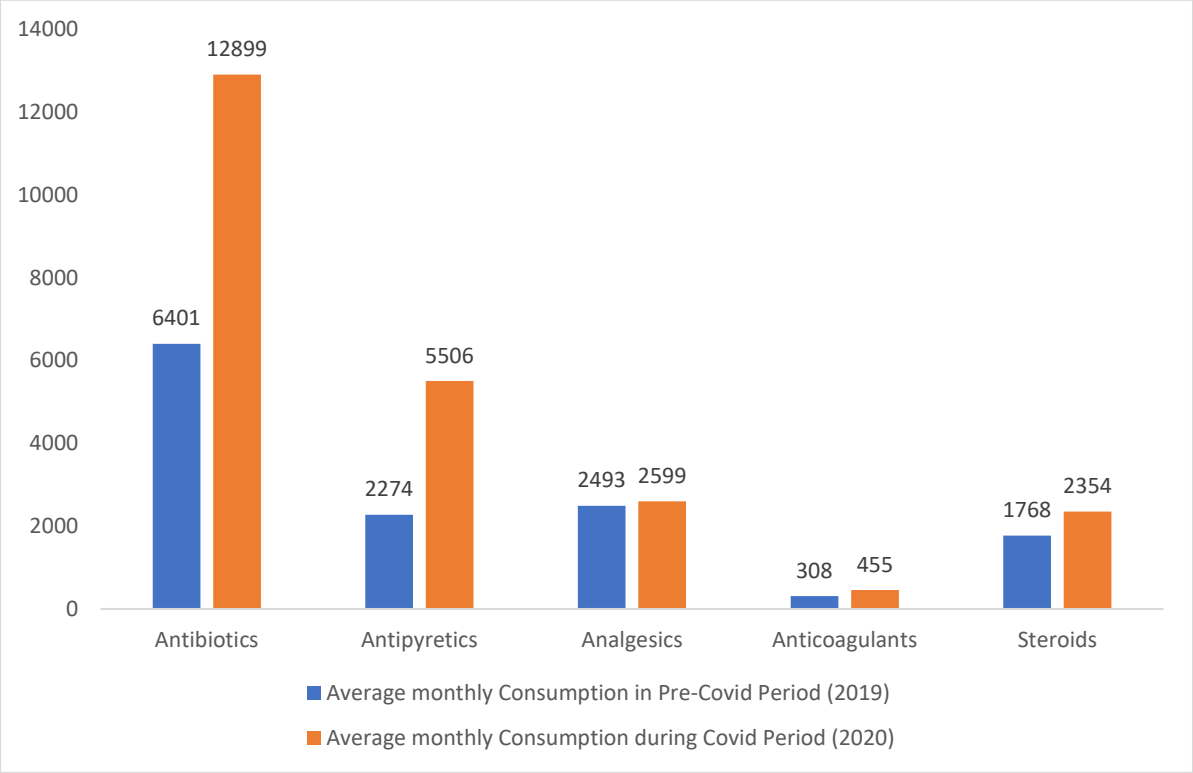

Figure-3: Category wise Drug Consumption Pattern

Figure-3 shows that there was an overall increase in drug consumption during Covid 19 in each category of drugs. The maximum increase occurs in antibiotics followed by antipyretics. The least increase occurs in analgesics followed by anticoagulants.

Table-1: Change in Overall Drugs Consumption Pattern

Drug/Consumable Name	Total Consumption in Pre-Covid 19 Period (2019)	Total Consumption During Covid 19 Period (2020)	Increase/ Decrease (%)	Chi-Square Value	P value
Injection Piperacillin 4gm + Tazobactam 500 mg	16393	30292	85	3815.61	P < 0.00001
Tab Metronidazole 400 mg	12635	8035	-36	1387.12	P < 0.00001
Injection Metronidazole 100 ml	11279	19305	71	15390.79	P < 0.00001
Tab Azithromycin 500 mg	11100	30300	173	203.05	P < 0.00001
Injection Ceftriaxone 500 mg	6400	16300	155	1067.90	P < 0.00001
Injection Meropenem 1 gm	5588	7626	36	2422.33	P < 0.00001
Injection Amoxycillin + Clavulanic Acid 1.2 gm	5420	9862	82	998.75	P < 0.00001
Injection Ceftriaxone 1 gm	5310	19810	273	4965.88	P < 0.00001
Tab Azithromycin 250 mg	3260	9900	204	238.62	P < 0.00001
Tab Ciprofloxacin 500 mg	3180	6310	98	624.5	P < 0.00001
Tab Paracetamol 500 mg	17090	53210	211	1730.61	P < 0.00001
Injection Paracetamol 2 ml	7135	6865	-4	1482.62	P < 0.00001
IV Paracetamol 100 ml	3055	6000	96	768.14	P < 0.00001
Tab Diclofenac 50 mg	16280	17700	9	2312.68	P < 0.00001
Injection Diclofenac Sodium 1 ml	10000	11160	11.6	0.05	**P = 0.4945***
Lignocaine 2% 30 ml	3633	2326	-36	466.98	P < 0.00001
Dexamethasone 2 ml	15009	23452	56	283.65	P < 0.00001
Hydrocortisone 100 mg	6200	4800	-23	663.89	P < 0.00001
Heparin 5000 IU	2082	4500	116	1108.77	P < 0.00001
Heparin 25000 IU	1363	965	-29	228.13	P < 0.00001

*** Not Significant at p < 0.05**

Table - 1 shows that before Covid 19, the five most commonly consumed antibiotics were Injection Piperacillin 4gm + Tazobactam 500 mg, Tab Metronidazole 400 mg, Injection Metronidazole 100 ml, Tab Azithromycin 500 mg & Injection Ceftriaxone 500 mg respectively and but during Covid 19, the 5 most commonly consumed antibiotics were Tab Azithromycin 500 mg, Injection Piperacillin 4gm + Tazobactam 500 mg, Injection Ceftriaxone 1 gm, Injection Metronidazole 100 ml, Injection Ceftriaxone 500 mg. The highest surge in consumption in antibiotic Injection Ceftriaxone 1 gm (273%) followed by Azithromycin 250 mg (204%). The only antibiotic having a significant decline in consumption was Tab Metronidazole 400 mg (-36 %).

Table-2: Change in Overall Consumables Consumption Pattern

Drug/Consumables Name	Total Consumption in Pre-Covid 19 Period	Total Consumption During Covid 19 Period	Increase/ Decrease (%)	Chi-Square Value	P-Value
Face masks (3 layers)	544500	1482450	172	3171.18	P <0.00001
Syringes 5 ml	348100	276100	-21	52122.90	P <0.00001
Syringes 10 ml	319150	210850	-34	95323.85	P <0.00001
Syringes 2 ml	316695	288700	-9	28646.55	P <0.00001
Surgical Gloves 7	162350	162545	0	287.42	P <0.00001
Surgical Gloves 7.5	116625	118700	2	199.11	P <0.00001
Cap Male (Surgeon)	136900	203600	49	70627.29	P <0.00001
Cap Female (Buffet)	116500	201750	73	4766.24	P <0.00001
IV Set Micro	16205	22988	42	1282.32	P <0.00001
IV Cannula 22	37790	30280	-20	4497.05	P <0.00001
IV Cannula 20	37522	52448	40	15380.83	P <0.00001
IV Cannula 18	21722	21566	-1	10015.86	P <0.00001
Shoe Cover	22850	165400	624	751.59	P <0.00001
Examination Gloves	14601	21813	49	6693.72	P <0.00001
Urobags	10187	9500	-7	2565.95	P <0.00001
Foley's Catheter 16	5750	2993	-48	806.462	P <0.00001
Foley's Catheter 14	1968	1616	-18	2.90	**P =0.88502***
Blood Glucose Strips	4316	3224	-25	330.50	P <0.00001
Face Masks N95	1396	152462	10821	1134150.04	P <0.00001
PPE Kit (Disposable)	0	92057	NA	NA	NA

*** Not Significant at p < 0.05 NA-Not Applicable**

Table -2 shows that the highest 10821 % increase in consumption occurs in Face masks N95 followed by Shoe Cover (624%) & Face masks triple-layered (172 %) during Covid 19 compared to the pre-covid period. The maximum 48% decline in consumption occur in Foley's Catheter 16 followed by syringe 10 ml (34%) & Blood Glucose Strips (25%) during Covid 19 as compared to the pre-covid period.

Table-3: Analysis of Daily Defined Dose (DDD) per 100 bed days of the drug (Comparison based on DDD WHO/ATC code)

Drug Name	**ATC Code**	**DDD by WHO**	**DDD/100 Bed Days (2019)**	**DDD/100 Bed Days (2020)**	**Increase/Decrease (%)**	**t Value**	**p-Value**
Piperacillin 4 mg + Tazobactam 500 mg (Oral)	JO1CR05	14 gm	3.4	6.1	79	2.494	0.0298
Metronidazole 400mg (Oral)	JO1XD01	1.5 gm	33.5	19.8	-40	-2.497	0.0296
Meropenem 1 gm (Oral)	JO1DH02	3 gm	1.2	1.5	25	0.185	**0.8583***
Ceftriaxone 500 mg (Parentral)	JO1DD04	2 gm	3.1	7.5	141	2.412	0.0343
Azithromycin 500 mg (Oral)	JO1FA10	0.5 gm	22.1	56	153	4.408	0.0010
Ciprofloxacin 500 mg (Oral)	JO1MA02	1 gm	10.5	19.4	85	2.139	**0.0581***
Paracetamol 500 mg (Oral)	NO2BE01	3 gm	18.9	54.6	189	2.855	0.0156
Diclofenac 50 mg (Oral)	MO1AB05	0.1 gm	54	54.5	1	1.388	**0.1925***
Dexamethasone 2 ml (Parentral)	H02AB02	1.5 mg	53.1	77.1	45	2.620	0.0238
Hydrocortisone 100 mg (Parentral)	HO2AB09	30 mg	13.7	9.8	-28	-0.618	**0.5535***

***Not significant at $p < 0.05$**

Table-3 shows that Dexamethasone 2 ml was the most commonly used drug during the Covid 19 Period having a drug consumption of 77.1 DDD/100 Bed days followed by Azithromycin 500 mg having a drug consumption of 56 DDD/100 Bed days. There was a significant increase in the amount of utilization of drugs in the Covid 19 Period as compared to the pre-Covid 19 Period with the highest 189 % increase in the antibiotic Paracetamol 500 mg utilization followed by a 153 % increase in Consumption in Azithromycin 500 mg in Covid-19 Period as compared to pre-Covid 19 Period. The drugs had a significant decline in utilization in the Covid-19 Period as compared to Pre Covid-19 Period was Metronidazole 400 mg with 40 % decline in utilization.

Table 4: Consumption comparison of Surgical masks & N95 masks

Consumables	Total Consumption in Sept 2020	Total Health Care Workers	Average Consumption per HCW	Average Number of occupied Beds in Sept 2020	Average consumption per bed
Surgical Masks	246750	2220	111	562	439
N 95 Masks	24721	2220	11	562	44

Table- 4 shows that the average consumption per health care worker per month of surgical masks & N95 masks were 111 & 11 respectively in the peak month (September 2020) whereas average consumption per bed per month of surgical masks & N95 masks were 439 & 44 respectively.

Statistical Analysis:

The data was transcribed in an MS Excel spreadsheet (Microsoft Corporation, Redmond, WA) in the form of frequency, percentages, and graphs. Data analysis was carried out using SPSS V26 statistical software (IBM Corp., Armonk, NY). A Chi-square test was used for comparison. A p-value of <0.05 was taken as statistically significant. Drug utilization pattern was analysed by comparing mean utilization rate of pre-COVID-19 period and during COVID-19 period by paired t-test, and p-value of <0.05 was considered to be a significant mean difference.

Discussion:

The overall monthly antibiotic usage increased significantly (102%) compared to 2019 ($p < 0.0001$) as the COVID 19 Pandemic proceeded drastically through March and April 2020. A before and after a cross-sectional study conducted by Abelenda- Alonoso G et. al. (2020) at Bellvitge University Hospital, Spain, comparing the data in 2019 and 2020 for the periods from January 1 to April 30 was also showing the similar results.[14] Another study by Gonzalez-Zorn B[44] showed antibiotic consumption increased significantly 115% compared to the 2019 peak. The current study found that the use of azithromycin in 2020 was increased by 204% using the same molecule in 2019. However, the study conducted by Adriana Ammassari et al. [15] showed a 230% increase in azithromycin use in 2020 compared to 2019. Also, according to another study conducted in Spain [16], there was an increase in 400% consumption of azithromycin during the pandemic compared to the pre-pandemic period. This may be because azithromycin was included in the treatment protocols for the treatment of COVID-19.

The current study showed that some common antibiotics, such as azithromycin and ciprofloxacin, were consumed at their peak during the pandemic's early stages (April-July 2020). The rest of the antibiotics, particularly those with a broader spectrum, such as piperacillin + tazobactam and ceftriaxone, peaked in subsequent months (August-November 2020). This increase could be attributed to an increase in device-related infections (primarily catheter-related bloodstream infections) and superinfections. According to a study conducted by Santiago Grau et al. [17], while consumption of ceftriaxone and azithromycin increased during

March 2020, consumption of daptomycin, carbapenems, linezolid, and ceftaroline increased during April–May 2020.

Except for metronidazole, none of the antibiotics studied in the current study showed a decrease in use when pre-pandemic and pandemic periods were compared. The monthly consumption of antibiotics, metronidazole, decreased by 36% from April 2020-August 2020 as COVID-19 restrictions were imposed. The antibiotic metronidazole is mainly used in postoperative patients.[18] The adaptation of Covid Appropriate Behaviour like hand hygiene amongst the population decreased the commonly occurring household infections like diarrhoea and closer of OTs during lockdown, decreasing the consumption of metronidazole. As previously suspended health care services were restored following COVID-19 restrictions, their use gradually returned to baseline.

The monthly consumption of the antipyretic drug paracetamol has increased significantly (211%) during the pandemic period compared to the pre-pandemic period at the hospital. COVID-19 patients need special drugs to control lower pain, fever and inflammation in the early stage. The increase in paracetamol use was driven by guidelines recommended in relation to light to moderate pain and fever reduction under COVID 19, by public health authorities including the World Health Organization (WHO).[19] Injection paracetamol is given for fever, but during COVID 19 the clinical staffs preferred intravenous over intramuscular to avoid touching the patients as much as possible thus, decreasing its consumption.

As the routine OPDs & IPDs were closed from March 2020 to August 2020, there was an overall reduction of 36% in the use of the local anaesthetic agent lignocaine at the hospital. The use of anti-inflammatory corticosteroids such as dexamethasone increased by 56% during the study period due to its use in hospitalized patients who require supplemental oxygen. In patients who required mechanical ventilation, the most significant benefit of steroid use was observed. The use of dexamethasone in this context has thus been enormously increased. Also, a decrease of 23% in the consumption of steroid-like hydrocortisone was noticed.

There has been an exponential increase of 172 % in triple-layered surgical masks during the pandemic. Earlier in the prepandemic time, masks were only used in OTs, ICUs, and a few OPDs like pulmonary medicine, ENT & medicine, where patients usually present with respiratory complaints. But with the emergence of the COVID-19 pandemic, it was mandatory to use surgical masks for every healthcare worker working in every corner of the hospital [48]; also, surgical mask was asked to wear by asymptomatic Covid 19 patients without oxygen support admitted in the hospital to prevent the infection to the healthcare workers.

Therefore, a remarkable rise of 10821% in demand & consumption for N95 masks was seen during the pandemic period compared to the pre-pandemic period. To meet the significant volume demand of N 95 by the health care sector, GOI (Government of India) started mass production and certification by BIS (Bureau of Indian Standard) under the category of Make in India.

The use of a PPE Kit is another critical component of the infection control strategy. When there is a risk of infection or exposure to infectious materials, personal protective equipment (PPE) is used.[20] PPE will include face protection, gloves, gown, headcover, goggles and mask or

face shield, and rubber boots if the infection is severe, such as in blood or airborne diseases.[21] It is used to treat diseases such as Ebola and HIV, and it is now widely used in the treatment of COVID-19 patients. Its primary function is to protect the skin and mucous membranes.[22] While donning and doffing the PPE, the standard operating procedure (SOP) is followed. The current study's findings showed a total of 92057 consumption of coverall till 31 December 2020 during the COVID-19 pandemic period as it was not used earlier in our institute.

The consumption of gloves (both surgical & examination) increased during the pandemic as every health care provider was using gloves during patient handling, including touching the patient. Also, during donning for covid care, double gloves are necessary that also increased the use of surgical and examination gloves. The decline in consumption of consumables was due to the reduction in the number of routine diagnostic & surgical procedures during the pandemic period, especially during the lockdown period.

Recommendations

- The pattern of changes in drugs & consumables consumption of the present study can be utilized by other hospitals in the future waves of the pandemic.
- The pharmaceutical companies should increase their production of the overutilized drugs & consumables depending upon the consumption, while the Government should supply the raw materials for the production.
- The underutilized drugs & consumables can be returned to the companies or exchanged to prevent their wastage.

Conclusion:

The current study is the first study that attempts to assess the impact of COVID-19 on drug store management in a tertiary care teaching hospital. The drug utilization study can provide a framework for continuous prescription audits in the hospital. The long-term consequences of this pandemic are unknown, but they should be closely monitored. More research is needed to determine the COVID-19 pandemic's long-term impact. This study will enhance education to the pharmaceutical industries, policymakers to the Government, and other hospitals to better manage drug stores in any future pandemic-like situations. The pharmaceutical companies should increase their production of the overutilized drugs & consumables depending upon the consumption, while the Government should supply the raw materials for the production. Proper drug store management was critical in improving patient outcomes and preventing medication misuse. The pattern of changes in drugs & consumables consumption of the present study can be utilized by other hospitals in the third wave of the pandemic. The underutilized drugs & consumables can be returned to the companies or exchanged to prevent their wastage.

Impact of Research in the advancement of knowledge or benefit to mankind:

The Study provides valuable insights into the challenges and adaptations faced by healthcare institutions in managing drug stores during the COVID-19 pandemic. This research sheds light on the disruptions caused by the pandemic in the procurement, supply chain, and consumption patterns of essential drugs and medical consumables. By analyzing the consumption patterns

of commonly used drugs and consumables over a span of two years, the study highlights significant changes and trends that occurred during the pandemic period. This knowledge is crucial not only for the hospital administration but also for pharmaceutical industries, policymakers, and other healthcare facilities worldwide.

The findings offer a comprehensive understanding of how drug store management strategies need to evolve during times of crisis, enabling hospitals and healthcare systems to be better prepared for similar future situations. The research underscores the importance of proper drug store management in maintaining effective healthcare delivery, optimizing resource utilization, and ultimately improving patient outcomes. As we continue to navigate the challenges posed by the pandemic and potential future waves, the insights from this study contribute to the advancement of knowledge in healthcare management and have a direct, positive impact on the well-being of individuals worldwide.

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