List of Publications

1. **Padhan S**, T, Chandrakar R, et al. (November 18, 2021) Assessment of the Impact of COVID-19 on Drug Store Management in a Tertiary Care Teaching Hospital of Central India. Cureus 13(11): e19723. DOI 10.7759/cureus.19723
2. Giri, A.K., **Padhan, S.**, Galhotra, A. (2022). Epidemiology of Rhinosporidiosis. In: Nagarkar, N.M., Mehta, R. (eds) Rhinosporidiosis. Springer, Singapore. https://doi.org/10.1007/978-981-16-8508-8_2
3. **Padhan S**, Mohapatra A, Ramasamy S, et al. (August 03, 2023) Artificial Intelligence (AI) and Robotics in Elderly Healthcare: Enabling Independence and Quality of Life. Cureus 15(8): e42905. DOI 10.7759/cureus.42905
4. **Padhan S**. Lack of structured career pathways, plans, and policies for public health graduates in India. J Public Health Prim Care 2023; 4:121-2.
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Assessment of the Impact of COVID-19 on Drug Store Management in a Tertiary Care Teaching Hospital of Central India

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Abstract

Introduction: One-third of the annual hospital budget is spent on the purchase of medicines, materials, and supplies. Drug store management is a complex but critical process within the healthcare delivery system. Health supply chains, the import of active pharmaceutical ingredients, transportation, procurement, finished products have been disrupted by COVID-19.

Materials & methods: A retrospective, observational study was carried out at the Department of Hospital Administration, All India Institute of Medical Sciences (AIIMS), Raipur. Quantitative data about the pattern of consumption of 20 most commonly used drugs (10 antibiotics, three analgesics, three antipyretics, two anticoagulants, and two steroids), and 20 most frequently used consumables were sourced from existing records of the Central Pharmacy for 24 months between 1st January 2019 to 31st December 2020.

Results: A significant rise in the consumption pattern was seen in 25 drugs and consumables out of 40 total selected drugs and consumables. The maximum increase was observed in antibiotics followed by antipyretics, and the least increase was observed in analgesics followed by anticoagulants. Tablet Azithromycin 500 mg was the most frequently used antibiotic during the COVID-19 Period as compared to the Pre-COVID-19 period followed by injection Piperacillin + Tazobactam. The only antibiotic having a decline in consumption and also with the lowest consumption was tablet Metronidazole 400 mg. The highest increase in consumables occurs by 10088% in N95 Masks, followed by 573% in shoe covers, and 153% in face masks (three-layers), respectively.

Conclusion: This study will enhance education to the pharmaceutical industries, policymakers to the Government, and other hospitals on how to better manage drug stores in future pandemic-like situations. Proper drug store management played a crucial role in medication usage that improved patient outcomes and prevented the misuse of medications. The pattern of changes in the consumption of drugs and consumables in the present study can be utilized by other hospitals in the third wave of the pandemic.

Categories: Health Policy
Keywords: utilization, shortage, impact, drug store, pandemic, antibiotics

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 ranging from the common cold to more severe disorders such as pneumonia [2]. The COVID-19 pandemic has quickly altered our daily lives, enterprises, and disrupted world trade and movements. As COVID-19 continues to spread, supply chains and logistics vulnerabilities have been exposed [3]. During the initial phase, it rendered many drugs and consumables unavailable. Health supply chains, active pharmaceutical ingredients, transportation, procurement, finished products, and many more have been disrupted [4].

Management of stock (drugs and consumables) ensures availability and minimizes investment [5]. Drug store management is a complex but critical process within the healthcare delivery system [6]. Hospitals risk being unable to give patients the most suitable medication at the right time without efficient 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 outpatient departments (OPDs) were closed, some diagnostic procedures and routine surgeries were postponed, and most of the work in the hospital was mainly related to the management of COVID-19 patients. In such a

situation, 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 and to stockpile the drugs and 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 a similar pandemic situation in future. Also, there was a need to measure the underutilized stock quantity left due to COVID-19.

Materials And Methods

A retrospective, observational study was carried out at the Department of Hospital Administration, AIIMS Raipur. Ethical clearance for this study was obtained from the Institute Ethics Committee of All India Institute of Medical Sciences, Raipur (Ref No: 1488/IEC-AIIMSRPR/2021). A total of 20 most commonly used drugs (10 antibiotics, three analgesics, three antipyretics, two anticoagulants, and two steroids) and 20 most frequently used consumables were selected based on the last two-year consumption rate from central pharmacy data. Quantitative data on the pattern of demand, supply and consumption of drugs, and hospital consumables were 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 two periods: a pre-pandemic or pre-COVID-19 period (1st January 2019 to 31st December 2019), and 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 March 2020 in our hospital and the first COVID-19 case in India was reported on 27th January 2020; the data for the whole month of January was included. After calculating the monthly consumption for each month, the mean average monthly consumption in the pre-COVID-19 period (2019) and the mean average monthly consumption during the COVID-19 period (2020) were calculated separately.

The data of stock and monthly consumption of selected drugs and consumables were collected from the central pharmacy in a predesigned proforma. The data regarding total functional beds, average occupied beds, and the average bed occupancy rate was collected from the Medical Record Department (see Appendix A). The drug consumption and utilization pattern of the 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.

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 analyzed 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.

Results

We observed that out of 20 selected drugs, there was a surge in drug consumption of 15 drugs and a decline in drug consumption in only five drugs in 2020 when compared to 2019.

Also, out of the 20 selected consumables, there was a surge in consumption of 10 consumables and a decline in the consumption of nine other consumables, and no change in the consumption of only one consumable in 2020 as compared to 2019.

Figure *1* shows that there was an overall increase in drug consumption during COVID-19 in five categories of drugs. The maximum increase occurs in antibiotics followed by antipyretics. The least increase occurs in analgesics followed by anticoagulants.

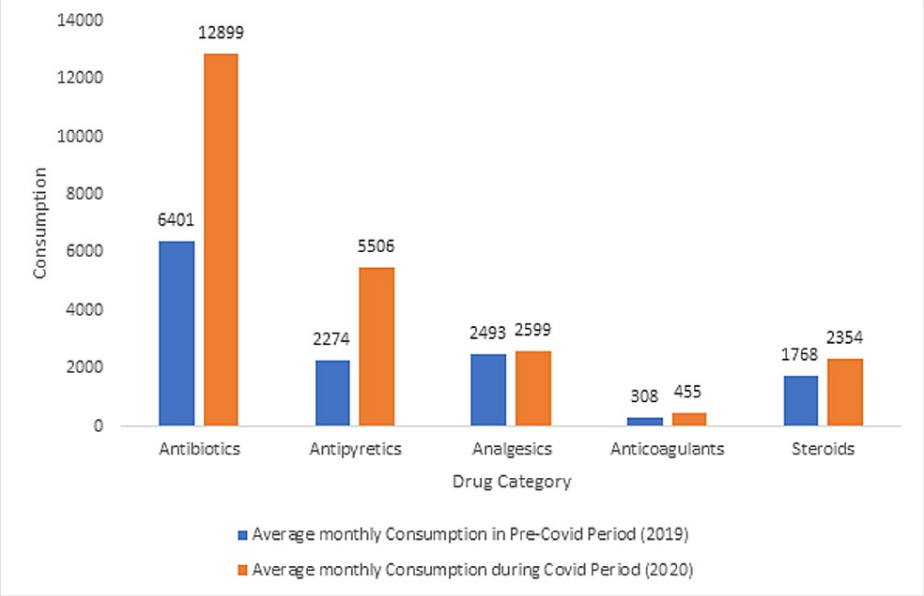

FIGURE 1: Category-wise drug consumption pattern

Table *1* shows that before COVID-19, the five most commonly consumed antibiotics were the injection Piptaz, tablet metronidazole 400 mg, injection metronidazole 100 ml, tablet azithromycin 500 mg, and tablet ceftriaxone 500 mg, respectively. During the pandemic, the five most commonly consumed antibiotics were tablet azithromycin 500 mg, injection piperacillin + tazobactam, injection ceftriaxone 1 gm, injection metronidazole 100 ml, and tablet ceftriaxone 500 mg. The highest surge in consumption was for the antibiotic injection ceftriaxone 1 gm (273%) followed by azithromycin 250 mg (204%) with $p < 0.05$. The only antibiotic having a significant decline in consumption was tablet metronidazole 400 mg (-36 %).

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 4 gm + tazobactam 500 mg	16393	30292	85	3815.61	P <0.00001
Tablet metronidazole 400 mg	12635	8035	-36	1387.12	P <0.00001
Injection metronidazole 100 ml	11279	19305	71	15390.79	P <0.00001
Tablet 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 amoxicillin + 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
Tablet azithromycin 250 mg	3260	9900	204	238.62	P <0.00001
Tablet ciprofloxacin 500 mg	3180	6310	98	624.5	P <0.00001
Tablet 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
Tablet 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

TABLE 1: Change in overall drug consumption pattern

Table *2* shows that the highest 10821% increase in consumption occurs in N95 face masks followed by shoe covers (624), and triple-layered face masks (172 %) during COVID-19 when compared to the pre-pandemic period with a p-value less than 0.05. The maximum 48% decline in consumption occur in Foley's catheter 16

followed by syringe 10 ml (34%) and blood glucose strips (25%) during COVID-19 in comparison to the pre-pandemic period ($p < 0.05$).

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 (three 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

TABLE 2: Change in overall consumables consumption pattern

PPE: Personal protective equipment

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 defined daily dose (DDD)/100 bed days followed by azithromycin 500 mg

with 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 paracetamol 500 mg utilization followed by a 153 % increase in the consumption of azithromycin 500 mg with p-value less than 0.05. The drugs that had a significant decline in utilization in the COVID-19 period as compared to pre-pandemic period were metronidazole 400 mg with a 40% decline in utilization ($p < 0.05$).

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 gm + 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*

TABLE 3: Analysis of defined daily dose (DDD) per 100 bed days of the drug. Comparison is based on DDD WHO/anatomical therapeutic chemical (ATC) code.

Table 4 shows that the average consumption of surgical masks and N95 masks per health care worker per day were 3.70 and 0.37, respectively. This data is based on the peak of the COVID-19 wave in our area during September 2020.

Consumables	Total Consumption in September 2020	Average Consumption per Day	Total Health Care Workers	Average Consumption per Day per HCW
Surgical Masks	246750	8225	2220	3.70
N95 Masks	24721	824	2220	0.37

TABLE 4: Consumption comparison of surgical masks and N95 masks at the peak of the COVID-19 wave (September 2020)

HCW: Health care worker

Discussion

The overall monthly antibiotic usage in 2020 increased significantly (102%) when compared to 2019 ($p < 0.0001$) especially as the COVID-19 pandemic progressed drastically through March and April 2020. A before and after cross-sectional study conducted by Abelenda-Alonso et al. comparing the data in 2019 and 2020 for the periods from January 1 to April 30 also showed similar results [14]. Another study by Gonzalez-Zorn showed that antibiotic consumption increased significantly by 115% when compared to the 2019 peak. The current study found that the use of azithromycin in 2020 increased by 204%. 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 of 400% in the consumption of azithromycin during the pandemic when 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 shows that some common antibiotics, such as azithromycin and ciprofloxacin, were consumed at their peak during the pandemic's early stages (April to July 2020). The rest of the antibiotics, particularly those with a broader spectrum, such as piperacillin+tazobactam and ceftriaxone, peaked in subsequent months (August to 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 the consumption of ceftriaxone and azithromycin increased during March 2020, consumption of daptomycin, carbapenems, linezolid, and ceftaroline increased from April to 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 antibiotic metronidazole decreased by 36% from April 2020 to August 2020 as COVID-19 restrictions were imposed. The antibiotic metronidazole is mainly used in postoperative patients [18]. The adaptation of Covid appropriate behavior like hand hygiene amongst the population decreased commonly occurring household infections like diarrhea. Also, the closure of operation theatres (OTs) during the lockdown led to a decrease in 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. Patients with COVID-19 need special drugs to control lower pain, fever, and inflammation in the early stage. The increase in paracetamol use was driven by guidelines recommended for mild 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 staff preferred intravenous over intramuscular to avoid touching the patients as much as possible thus, decreasing its consumption.

As the routine OPDs and inpatient departments (IPDs) were closed from March 2020 to August 2020, there was an overall reduction of 36% in the use of the local anesthetic 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 pre-pandemic time, masks were only used in OTs, ICUs, and a few OPDs like in pulmonary medicine, and 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; also, the surgical mask was compulsory for asymptomatic COVID-19 patients without oxygen support admitted in the hospital to prevent the infection from spreading to the healthcare workers.

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

The use of personal protective equipment (PPE) kit is another critical component of the infection control strategy. When there is a risk of infection or exposure to infectious materials, PPE is used [20]. A PPE includes 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 is now widely used in the treatment of COVID-19. 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 coveralls 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 and examination) increased during the pandemic as every healthcare provider was using gloves during patient handling, including touching the patient. Also, during Covid care, double gloves are necessary and that too 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 and surgical procedures during the pandemic period, especially during the lockdown period.

During the peak of the Covid wave, the adherence to Covid guidelines was almost perfect. The lesser

consumption of N95 masks compared to surgical masks was due to restricting its usage to only healthcare providers in highly infectious vulnerable areas as per Indian Council of Medical Research (ICMR) guidelines. The information regarding the consumption of masks per healthcare worker will help in proper demand forecasting for future waves.

Strengths and limitations

The extensive data covering the consumption of a few selected drugs and consumables used in the hospital over a two-year period is the study's strength. This lengthy follow-up period provides valuable insight into the rate of utilization and drug consumption in a tertiary care hospital in a developing country dealing with the challenges of an economic transition in the healthcare system. Another strength of the study is the completeness of the data and the ability to compare data from the same practices across two time periods.

The study has several limitations; It was a single-centered study, i.e., the consumption of drugs and consumables may not be representative of other hospitals in the country. The monthly consumption data was collected from the central pharmacy stock register and there may be a chance of human errors. It is very important to bear in mind during this period that pharmacies work under extremely controlled conditions (e.g., reduced teams) and as the shortages of medicines depend on the direct reports of the pharmacists, the central pharmacy registry may suffer from underreporting. The emergency procurement of drugs and consumables from AMRIT (Affordable Medicines and Reliable Implants for Treatment) is not a continuous process, and there is a lack of information technology during the procurement.

Recommendations

In the fight against the COVID-19 pandemic, the Government should strengthen the drug support services. In hospitals, the unique needs of pharmacy services should be identified and addressed. The hospital administration should ensure that various drugs are available 24 hours a day, seven days a week as they are necessary for patients' care. The cost of drug management and delivery is frequently borne by pharmacy departments. The pharmacy management team should focus on creating effective drug and human resource leverage strategies. The adaptation of a web-based system to monitor the entire logistic and supply chain that includes procurement processes starting from tender processing, then placing purchase orders and stock monitoring, and drug distribution, is essential.

Resource Allocation During a Pandemic

The allocation of resources can be challenging, especially if there is a supply shortage. To address the drug shortage, patient priority criteria should be developed with a multidisciplinary team of medical, nursing, and pharmaceutical staff. Contact with other sites or health systems must be maintained because large health systems are often able to survive drug shortages through a shift in drug stocks between sites.

Medication Storage and Preparation Areas

To guarantee pharmaceutical integrity and personnel safety throughout the hospital, there should be enough facilities for receiving, storing, and preparing pharmaceuticals under sufficient sanitation, temperature, light, moisture, ventilation, segregation, and security conditions. Additional non-functional units of the hospitals should be preserved for the anticipated extra quantity of drugs and consumables during the pandemic.

Maintain an Adequate Supply of COVID-19 Prevention Medications and Products

During the pandemic, most hospitals rely on central pharmacies to adequately supply their medicinal products and COVID-19 preventive products (e.g., masks, alcohol-based hand rubs). Central pharmacies must retain appropriate stocks for supplying demand by pharmaceutical products.

Ensure Safe and Efficient Operation

Central pharmacies shall adopt safe and efficient operations during the pandemic, including appropriate environmental control, personnel protection, and the establishment of an emergency plan. In the face of the COVID-19 pandemic, the pharmacy should also establish new workflows and develop emergency plans or protocols for the management of COVID-19 and possible drug deficiencies.

Use of Automated Systems

All automated pharmacy systems must be evaluated, selected, used, calibrated, monitored, and maintained in accordance with policies and procedures. Drugs and consumables ordering and preparation, drug distribution, and clinical monitoring can all be made safer, more efficient, and more accurate with the help of automated mechanical systems and software.

Use of More Advanced Information Technology

A full-feature pharmacy computer system is required. Other hospital information systems and software, such as computerized provider order entry, medication delivery, electronic health records, and patient billing systems, should be fully networked as well.

Staff Training

Hospitals shall carry out training for all their staff in order to provide pharmacy personnel with sufficient information on the prevention, monitoring, and control of the environment of COVID-19. Guidance must also be included regarding new workflows and emergency plans to deal with pandemics. Adequate pharmacist training is crucial to the successful performance of drug stores.

Conclusions

The current study is the first that attempts to assess the impact of COVID-19 on drug store management in a tertiary care teaching hospital. A significant rise in the consumption pattern was seen in 25 drugs and consumables out of 40 total selected drugs and consumables. Tablet azithromycin 500 mg was the antibiotic having a maximum rise in consumption during the COVID-19 period followed by injection of piperacillin 4 gm + tazobactam 500 mg. The only antibiotic having a decline in consumption and also with the lowest consumption was tablet metronidazole 400 mg. The highest increase in consumption occurs by 10821 % in N95 Masks, followed by 573 % in shoe covers, and 153 % in surgical masks (three-layered), respectively.

The pattern of changes in drugs and consumables consumption in the present study can be utilized by other hospitals in the third wave of the pandemic. The underutilized drugs and consumables can be returned to the companies or exchanged to prevent their wastage. This study will enhance education to the pharmaceutical industries, policymakers in the Government, and other hospitals, to better manage drug stores in future pandemic-like situations. The pharmaceutical companies should increase their production of overutilized drugs and 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 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.

Appendices

Appendix A

The data regarding bed occupancy was collected from the Medical Record Department of AIIMS Raipur.

Month & Year	Total no. of Functional Beds	Average no. of Occupied beds	Average Bed Occupancy Rate
January 2019	600	306	51.0 %
February 2019	600	321	53.5 %
March 2019	600	337	56.1 %
April 2019	600	335	55.8 %
May 2019	600	348	58.0 %
June 2019	668	410	61.4 %
July 2019	668	450	67.4 %
August 2019	668	453	67.8 %
September 2019	700	482	68.9 %
October 2019	700	465	66.4 %
November 2019	700	522	74.6 %
December 2019	700	531	75.8 %
January 2020	700	534	76.3 %
February 2020	800	536	67.0 %
March 2020	800	403	50.4 %
April 2020	800	211	26.4 %
May 2020	800	317	39.6 %
June 2020	800	365	45.6 %
July 2020	800	409	51.1 %
August 2020	800	510	63.8 %
September 2020	800	562	70.3 %
October 2020	800	450	56.2 %
November 2020	900	498	55.4 %
December 2020	900	531	59.0 %

TABLE 5: Bed occupancy rate from 1st January 2019 to 31st December 2020

Additional Information

Disclosures

Human subjects: All authors have confirmed that this study did not involve human participants or tissue. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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References

1. Devnani M, Gupta A, Nigah R: ABC and VED Analysis of the pharmacy store of a tertiary care teaching, research and referral healthcare institute of India. J Young Pharm. 2010, 2:201-205. 10.4103/0975-1483.63170
2. Abdelrahman Z, Li M, Wang X: Comparative review of SARS-CoV-2, SARS-CoV, MERS-CoV, and Influenza A respiratory viruses. Front Immunol. 2020, 11:552909. 10.3389/fimmu.2020.552909
3. Impact of the pandemic on trade and development: transitioning to a new normal . (2020). Accessed: January 2, 2021: https://unctad.org/webflyer/impact-covid-19-pandemic-trade-and-development-transitioning-new-normal.
4. Sharma A, Gupta P, Jha R: COVID-19: impact on health supply chain and lessons to be learnt . SAGE Journals. 2020, 22:248-261. 10.1177/0972063420935653
5. Inventory management in 2021: techniques, formulas, software . (2021). Accessed: January 2, 2021: https://www.shopify.in/retail/inventory-management.
6. BP703T_PP_V.pdf. Accessed: January 2, 2021: https://www.iptsalipur.org/wp-content/uploads/2020/08/BP703T_PP_V.pdf.
7. Debbarma M, Rani U: A review study on pharmaceutical inventory management & store keeping practices of pharmacy in rural hospitals. Indian J Public Health Res Dev. 2020, 11:550-554. 10.37506/v11/i2/2020/ijphrd/194862
8. Velo GP, Minuz P: Medication errors: prescribing faults and prescription errors . Br J Clin Pharmacol. 2009, 67:624-628. 10.1111/j.1365-2125.2009.03425.x
9. Liu S, Luo P, Tang M, Hu Q, Polidoro JP, Sun S, Gong Z: Providing pharmacy services during the coronavirus pandemic. Int J Clin Pharm. 2020, 42:299-304. 10.1007/s11096-020-01017-0
10. Iyengar K, Vaishya R, Bahl S, Vaish A: Impact of the coronavirus pandemic on the supply chain in healthcare. Br. J. Health Care Manag.. 2020, 26:1-4. 10.12968/bjhc.2020.0047
11. Kokilam MB, Kamath V: Assessment of pharmaceutical store and inventory management in rural public health facilities - a study with reference to Udupi District, Karnataka. Pharm Methods. 2015, 6:53-59. 10.5530/PHM.2015.6.7
12. Shinde R, Kale A, Chube S, Sawant M: Drug utilization study in medical intensive care unit in a rural tertiary care teaching hospital in Maharashtra. Int J Med Sci Public Health. 2017, 6:1. 10.5455/ijmsph.2017.1165030112016
13. Hussain M, Siddharth V, Arya S: ABC, VED and lead time analysis in the surgical store of a public sector tertiary care hospital in Delhi. Indian J Public Health. 2019, 63:194-198. 10.4103/ijph.IJPH_282_18
14. Abelenda-Alonso G, Padullés A, Rombauts A, et al.: Antibiotic prescription during the COVID-19 pandemic: a biphasic pattern. Infect Control Hosp Epidemiol. 2020, 41:1371-1372. 10.1017/ice.2020.381
15. Ammassari A, Di Filippo A, Trotta MP, Traversa G, Pierantozzi A, Trotta F, Magrini N: Comparison of demand for drugs used for COVID-19 treatment and other drugs during the early phase of the COVID-19 pandemic in Italy. JAMA Netw Open. 2021, 4:e2037060. 10.1001/jamanetworkopen.2020.37060
16. Gonzalez-Zorn B: Antibiotic use in the COVID-19 crisis in Spain . Clin Microbiol Infect. 2021, 27:646-647. 10.1016/j.cmi.2020.09.055
17. Grau S, Echeverria-Esnal D, Gómez-Zorrilla S, et al.: Evolution of antimicrobial consumption during the first wave of COVID-19 pandemic. Antibiotics (Basel). 2021, 10:132. 10.3390/antibiotics10020132
18. Gharebaghi R, Heidary F, Moradi M, Parvizi M: Metronidazole; a potential novel addition to the COVID-19 treatment regimen. Arch Acad Emerg Med. 2020, 8:e40.
19. Yasri S, Wiwanitkit V: Pain management during the COVID-19 pandemic . Pain Med. 2020, 21:2008. 10.1093/pm/pnaa200
20. Rational use of personal protective equipment for coronavirus disease (COVID-19): interim guidance . (2020). Accessed: 2 January 2021: https://apps.who.int/iris/handle/10665/331215.
21. Personal protective equipment for COVID-19 . (2021). Accessed: January 2, 2021: https://www.who.int/teams/health-product-policy-and-standards/assistive-and-medical-technology/medical-devices/ppe/pp....
22. World Health Organization. Transmission of SARS-CoV- 2: implications for infection prevention precautions. (2020). Accessed: January 2, 2021: https://www.who.int/news-room/commentaries/detail/transmission-of-sars-cov-2-implications-for-infection-prevention-pr....

Epidemiology of Rhinosporidiosis

Anjan K. Giri, Srikanta Padhan, and Abhiruchi Galhotra

Introduction

Rhinosporidiosis is a chronic granulomatous infective, non-contagious, sporadic, benign, usually non-fatal disorder producing polypoidal, pedunculated, and soft tissue mass [1]. It is a chronic condition that frequently recurs after surgery and occasionally spreads from the initial focus, which is usually observed in the upper respiratory tract. More than 70% of cases affect the nose and the nasopharynx. Ocular lesions, particularly of the conjunctiva and lachrymal sac, account for 15% of cases. Rhinosporidial polyps are also reported from different rare sites like lips, palate, uvula, maxillary antrum, epiglottis, larynx, trachea, bronchus, ear, scalp, vulva, penis, rectum, or skin. Infections that spread to the limbs, trunk, bone, brain, and internal organs have been documented [2, 3].

The aetiological agent of Rhinosporidiosis is *Rhinosporidium Seeberi* has been an enigma for a century. The causal pathogen is commonly assumed to be a fungus; however, its specific taxonomy is still being debated [4]. Guillermo Seeber reported Rhinosporidiosis for the first time in 1900 from the new world city of Buenos Aires, Argentina. It appeared as a nasal polyp, and Seeber rightly thought that the condition was caused by an infection. He proposed the infective aetiology for this disease to be a fungus, which was later isolated by Ashworth in 1923, who in turn described the life cycle of the organism and established the nomenclature *Rhinosporidium seeberi* [5]. Rhinosporidiosis was later discovered in both the new and the old worlds.

In India, the first case was reported by O'Kinealy in 1903, which was observed by him in 1894. Rhinosporidiosis is a sporing organism, and Kannankutty first identified its life cycle in 1974. He showed that Rhinosporidiosis produces a chemical comparable to hyaluronidase that causes submucosal dissemination [6].

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Human beings are not the only definitive host for the organism. A wide range of domestic and wild animals, including cows, buffaloes, dogs, cats, horses, mules, ducks, and swans, are also found to be affected [7].

Problem/Prevalence

World

Rhinosporidiosis has been recorded in around 70 countries, with a wide range of geographical distribution and clinical manifestations. Although the disease is sporadic in parts of Europe, Africa, the southern United States, North, and South American temperate regions, as well as western and Middle Eastern countries, it is endemic in tropical areas, such as Brazil, Argentina, Uganda, Texas, India, and Sri Lanka [8, 9]. The disease can be distributed in a large scale due to trading, international import, intercontinental movement of affected animals or human beings.

Southeast Asia

Rhinosporidiosis is most prevalent in South Asia, particularly in southern India and Sri Lanka. Increased migration to the West of people who contracted Rhinosporidiosis in their original Asian countries has led to an increase in the disease's incidence in the West. However, 90% of the total cases were found to be present in the Indian Subcontinent [10].

India

Bihar was the first state in India to register a Rhinosporidiosis. It has been reported in Madhya Pradesh, Maharashtra, Odisha, Pondicherry, Rajasthan, Uttar Pradesh, Haryana, Kerala, Tamil Nadu, West Bengal, and Chhattisgarh [11]. The disease is quite common in Raipur, Durg, Bilaspur, and Dhamtari districts of Chhattisgarh State [12].

Epidemiology

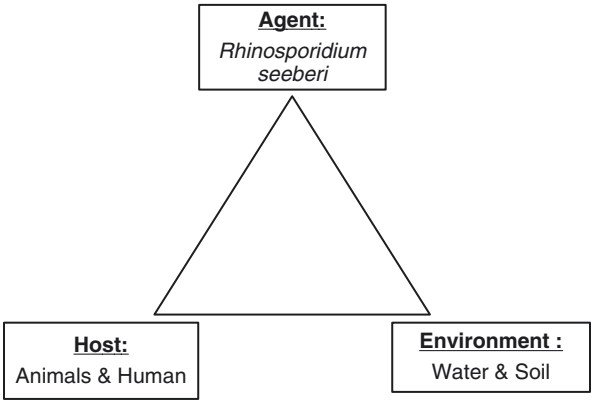

Fig. 1 An epidemiological triad of Rhinosporidiosis

Agent

Rhinosporidium seeberi was once thought to be a sporozoan, but it is now thought to be a fungus, and Ashworth has tentatively placed it in the Olipidiaceae family, order chritridiales of phycomyetes. It is now classified as part of the DRIP clade (Dermocystidium, Rosette agent, Icthyophonus, and Psoropermium), a group of fish parasites that flourish in the hot and humid climate [13]. Despite substantial research, no consensus exists on where Rhinosporidium should be classified in the Taxonomic classification. Even after using sensitive methods such as polymerase chain reactions, it has been impossible to detect fungal proteins in Rhinosporidium.

The infectious agent forms round and thick-walled sporangia in the submucosa of the affected site, varying from 10 to 200 mm in size, which are visible as white dots in the mucosa containing smaller 'daughter cells' (called 'sporangiospores'). It can be visualized with fungal stains such as Gomori Methenamine Silver (GMS) and Periodic Acid-Schiff (PAS), as well as with standard Haematoxylin and Eosin (H&E) staining [14].

Host

Rhinosporidiosis mainly affects mammals, primarily humans, although it has also been observed in domestic and wild animals and birds, including cattle, equines, caprines, dogs, felines, and avian species such as waterfowl, swans, geese, and wild ducks. The disease has also been observed in fish [15–17]. The disease rarely

affects children; it is most commonly found in individuals aged 20–40 years for unknown reasons. The disease has also been observed to affect animals such as cows, bulls, horses, mules, and dogs in areas where men and animals share infected ponds [18].

Risk Factors

- **Gender: Male.**
  The study reveals that Rhinosporidiosis is more common in males with a male-to-female ratio of 4:1. This may partly be explained by the lesser chances of animal contact of females and less frequent pond baths [19]. The effect of oestrogens in females might provide some protection from the disease [20].
- **Age: 21–40.**
  According to the available literature, nasal Rhinosporidiosis is most commonly reported in people in their second and third decades, when they are most likely to engage in outdoor activities. Rhinosporidiosis appears to primarily affect young adults in their most productive years. The majority of lesions documented in the third decade of life are at extra nasal locations [21].
- **Bathing History: Ponds.**
  People who bathe in ponds, lakes, or reservoirs are more likely to get rhinosporidiosis of the upper respiratory tract and eye than those who bathe in well water or home tap water. Bathing in rivers with suspended sharp spicules formed from sand may explain the prevalence of ocular lesions in people who are occupationally or recreationally exposed to river water [22].
- **Occupation: Agriculture.**
  Rhinosporidiosis is widespread among farmers who are exposed to dust and muddy water containing soil particles during cultivation. Rhinosporidiosis in the respiratory tract is due to a contaminated wet environment, and that in the ocular form is mainly due to a contaminated dry, dusty environment. The significance of paddy fields as *R. Seeber* sources has probably been overstated [23].
- **Low Socioeconomic status, Rural Residential Status and Backward Caste.**
  The probable reason for this may be the practice of pond bathing and the poorer standards of hygiene among people of low socioeconomic status, rural residential status, and backward class [24].
- **Religion:**

Customs, ways, manners, and sanitary conditions have been found to be associated with the disease incidence [25–27]. However no particular pattern with any community is seen.

- **Blood groups: O.**

ABO blood grouping of the patients reveals that the highest incidence of Rhinosporidiosis is in group O [28].

Environment

The exact mode(s) of transmission and the host or natural reservoirs are unknown; however, the disease is most likely transmitted by infected soil and stagnant water. The disease is spread via water and dust in the environment. Patients with Rhinosporidiosis report bathing in dirty water, contaminated ponds, tanks, and rivers. Sugarcane and paddy producers have reported a high prevalence. The sickness primarily affects those who live near farms and ponds [6, 21].

Modes of Transmission

R. seeberi is a naturally occurring dweller of contaminated water and dust particles that contain spores. The spores of these diseases are found in soil and water, and hence water and soil serve as reservoirs for this pathogen [29]. Contaminated drinking water may expose the nasal mucosa to infection (70% cases). Dust fomites may give rise to ocular form (15%) of disease. It is neither contagious nor transmitted through sexual contact.

The incubation period is very long. Cases are more frequently observed in communities residing near swamp areas as contaminated water serves as a source of infection; hence earlier, it was considered an aquatic fungus. It suggests a possible synergism between aquatic microorganisms and *Rhinosporidium seeberi* for the propagation of infection through stagnant water. Although no direct transmission between humans and animals has been observed, the transmission may occur by direct contact with fungal spores via aerosols, inhalation of dust particles, infected clothing, or swimming in torpid polluted water [30].

Autoinoculation through transepithelial infection, lymphatic and hematogenous pathways into broken skin, or traumatized epithelium may also play a role in the entry and dispersion of spores in the body. Adjacent epithelium may be autoinoculated if endospores can break out of polyps after any trauma or operation. Haematogenous dissemination from a subclinical form of upper respiratory infection (nasal or nasopharynx) can be a possible route of transmission for anatomically distant places in the body of the host. Though few researchers have suggested the probability of lymphatic spread into regional parts of the body but this route is yet not confirmed [31].

Signs and Symptoms

Rhinosporidiosis is painless and not life threatening. Infections of up to 30 years in duration have been reported. The main effects are discomfort when the lesion becomes large enough to obstruct a passage or put pressure on the nerve or vascular tracts. Symptoms vary according to the stage of development and site of infection. The infection produces a slow-growing mass that degenerates into polyps. The polyps are pink to purple, friable, with grey, white, or yellow sporangia on their surface. In the early stages, the patient may complain of nasal discharge, which is often blood-tinged and nasal stuffiness. Sometimes, frank epistaxis is the only presenting complaint [32, 33].

Management

The mainstay of treatment is surgical excision of the lesion. Recurrences are common, and the only drug useful in reducing recurrence is Dapsone which arrests the maturation of sporangia and promotes fibrosis in the stroma when used as an adjunct to surgery, but it has a limited role in reducing the chances of recurrence [34]. Wide surgical excision that is advised cannot be done in most cases because it can result in complications such as septal perforation, excessive crusting, atrophic rhinitis, and haemorrhage. Total excision of the lesion, followed by electrocautery of the base, is the recommended mode of treatment [35]. Recurrence may occur due to spillage of endospores in the surrounding mucosa during removal. Good results without recurrence have been reported following the use of endoscopes during surgery [36].

Prevention and Control

Rhinosporidiosis is an infective condition that is commonly seen in the second and third decades of life. It is seen in people belonging to the low socioeconomic group and those living in rural areas, being more common in males, in individuals who take baths in surface water bodies. In most cases, lesions of Rhinosporidiosis are restricted to the nasal cavity and present with nasal complaints such as nasal mass, nasal bleeding, and nasal obstruction. Nasal endoscopy has to be done in all the suspected cases to detect the site of attachment and the number of lesions. Laryngoscopy is advised in order to rule out the lesions in larynx and laryngopharynx. Surgical excision with electrocautery of the base is preferred to reduce recurrence.

Repeated follow-up of the patients for early detection of lesions is essential. Certain precautions, like avoidance of the use of surface water for bathing and other domestic purposes, also helps in reducing the chances of recurrence. Common

water sources used for the bathing of cattle and for human needs should be discouraged. In general, improvement in sanitation and general hygiene, provision of clean water supply, along with imparting proper health education to the high-risk groups residing in rural areas of coastal India can reduce the incidence of Rhinosporidiosis.

The disease incidence may be reduced through raising knowledge on its various mechanisms of transmission, prominent symptoms, early care, and prevention. The role of health care workers has to be emphasized to educate the vulnerable population to modify their risky habits related to their livelihood and lifestyle. A robust system of public health education may help to reduce the incidence of disease.

Contents of Public Health Education

It covers every aspect of personal, family, community, and environmental health.

1. **Personal Health:**
   (i) Maintenance of personal hygiene will be the best option to be safe from an infective disease like Rhinosporidiosis as the disease takes a chronic course which makes diagnosis difficult.
   (ii) Hence swimmers and persons who are frequent visitors to water bodies should have safety precautions as this disease-causing organism gets transferred through cut wounds.
2. **Family Health:**
   (i) Rhinosporidiosis is not contagious. So, there is no transmission of disease among family members. Most probably, the contact of the traumatized epithelium of nostrils with natural aquatic habitat act as the primary mode of entry of pathogen.
   (ii) The role of the family in health promotion and in the prevention of this disease, early diagnosis, and care of the sick is of crucial importance. One of the main tasks of health education is to promote a family's self-reliance, especially regarding the family's responsibilities in maintaining a clean and hygienic environment and in influencing their children to adopt a healthy and hygienic lifestyle.
   (iii) All the family members of endemic villages have a common habit of frequent pond baths. As contaminated water bodies could be the source of infection, hence avoiding water bodies with spores will help to reduce the high incidence of this disease in the villages.
3. **Community Health:**
   (i) The sources of Rhinosporidiosis cases area-wise should be mapped out, which may be helpful to identify the villages with a higher incidence of the disease.

(ii) Health talks regarding symptomatology, disease course, and preventive measures should be given in these villages.

4. **Environmental Health:**

(i) A health education component should be included in an environmental sanitation program with a focus on clean and safe use of water bodies. It is insufficient to provide sanitary wells, latrines, and waste disposal facilities. If people do not use the facilities, they will continue to suffer from diseases caused by inadequate sanitation.
(ii) People will participate in identifying their sanitation problems and choosing the remedies and facilities they want if a health education approach is used.

5. **Disease prevention and control.**

(i) Drugs or surgery alone will not solve health problems without public health education, a person may fall sick again and again from the same disease.
(ii) Education of the people about the prevention and control of locally endemic diseases is one of the eight essential elements in primary health care.

6. **Use of health services.**

(i) Many people, particularly in rural areas, do not know what health services are available in their community for Rhinosporidiosis, and many more do not know what signs to look for that indicate a visit to the doctor is necessary.
(ii) One of the declared aims of public health education is to inform the people about the health services that are available in the community and how they can utilize them.

Approach in Public Health Education

Since individuals vary so much in their socioeconomic conditions, traditions, attitudes, beliefs, and level of knowledge, a single approach may not be suitable. A combination of approaches must be evolved depending upon the local circumstances.

1. **Service approach:**

(i) It should aim at providing all the health services needed by the people at their doorsteps on the assumption that people would use them to improve their own health.
(ii) Availability of alternate sources of water for bathing can make people stay away from the contaminated ponds and diseases acquired by it.

2. **Health Education approach**:

(iii) Because attitudes and behavioural habits are formed in childhood, we need to go back in time and begin health education with young people. The belief

is that young people's behaviour is easier to regulate or develop than that of adults.

3. **Primary health care approach:**

(iv) Recurrences are prevalent, most likely due to incomplete excision or intra-operative contamination of neighbouring tissues or cells with resident endospores, making the disease much worse. As a future preventive step, electrocauterization at the excision site is indicated.

(v) Newer assays should thus be developed to detect this disease early in human and animal conditions in order to successfully control the disease.

References

1. Sengupta S, Pal S, Biswas BK, Jana S, Biswas S, Minz RS. Clinico-pathological study of 273 cases of Rhinosporidiosis over a period of ten years in a tertiary care institute catering predominantly rural population of tribal origin. Bangladesh Journal of Medical Science. 2015 Apr 18;14(2):159–64.
2. Franca GV Jr, Gomes CC, Sakano E, Altermani AM, Shimizu LT. Nasal rhinosporidiosis in children. J Pedatr (Rio J). 1994;70:299–301.
3. Makannavar JH, Chavan SS. Rhinosporidiosis, a clinicopathological study of 34 cases. Indian J Pathol Microbiol. 2001 Jan 1;44(1):17–21.
4. Arseculeratne SN. Recent advances in rhinosporidiosis and Rhinosporidium seeberi. Indian J Med Microbiol. 2002 Jul 1;20(3):119–31.
5. Ahluwalia KB. New interpretations in rhinosporidiosis, enigmatic disease of the last nine decades. J Submicrosc Cytol Pathol. 1992 Jan 1;24(1):109–14.
6. Banjare B, Sherwani N, Neralwar A. A study on Rhinosporidiosis cases attending a tertiary care hospital of Raipur City (C.G.) India. Indian J Research. 2015;4(8):260–4.
7. Vukovic Z, Bobic-Radovanovic A, Latkovic Z, Radovanovic Z. An epidemiological investigation of the first outbreak of rhinosporidiosis in Europe. J Trop Med Hyg. 1995 Oct 1;98(5):333–7.
8. Rao PR, Jain SN, Rao TH. Animal rhinosporidiosis in India with case reports. Annals of the Belgian society of. Trop Med. 1975;55:119–24.
9. Londero AT, Santos MN, Freitas CJ. Animal rhinosporidiosis in Brazil. Report of three additional cases. Mycopathologia. 1977 Jan 1;60(3):171–3.
10. Morelli L, Polce M, Piscioli F, Del Nonno F, Covello R, Brenna A, et al. Journal search results. Diagn Pathol. 2006;1(1):25.
11. Andleigh HS. Two rare cases of fungus infection of skin in Rajasthan: actinomycosis and rhinosporidiosis. Indian Med Gaz. 1951 Mar;86(3):100.
12. Gupta RK, Singh BP, Singh BR. Rhinosporidiosis in Central India: a cross-sectional study from a tertiary care hospital in Chhattisgarh. Trop Parasitol. 2020 Jul;10(2):120.
13. Das C, Das SK, Chatterjee P, Bandyopadhyay SN. Series of atypical Rhinosporidiosis: our experience in Western part of West Bengal. Indian J Otolaryngol Head Neck Surg. 2019 Nov;71(3):1863–70.
14. Pandey RK, Kumar A, Kumar D. Incidence of Rhinosporidiosis in Jharkhand. & Chao SS, Loh KS. Rhinosporidiosis: an unusual cause of nasal masses gains prominence. Singap Med J. 2004 May 1;45:224–6.
15. Myers DD, Simon J, Case MT. Rhinosporidiosis in a horse. J Am Vet Med Assoc. 1964;145(4):345–7.

16. Pal M. Nasal rhinosporidiosis in a bullock in Gujarat (India). Rev Iberoam Micol. 1995;12(3):61–2.
17. Das S, Kashyap B, Barua M, Gupta N, Saha R, Vaid L, Banka A. Nasal rhinosporidiosis in humans: new interpretations and a review of the literature of this enigmatic disease. Med Mycol. 2011 Apr 1;49(3):311–5.
18. Dhingra P, Dhingra S. Diseases of ear, nose and throat & head and neck surgery. 6th ed. New Delhi: Elsevier; 2014.
19. Chao SS, Loh KS. Rhinosporidiosis: an unusual cause of nasal masses gains prominence. Singap Med J. 2004 May 1;45:224–6.
20. Venkateswaran S, Date A, Job A, Mathan M. Light and electron microscopic findings in rhinosporidiosis after dapsone therapy. Tropical Med Int Health. 1997 Dec;2(12):1128–32.
21. Dutta S, Haldar D, Dutta M, Barik S, Biswas KD, Sinha R. Socio-demographic correlates of rhinosporidiosis: a hospital-based epidemiologic study in Purulia, India. Indian J Otolaryngol Head Neck Surg. 2017 Mar 1;69(1):108–12.
22. Senaratne T, Senanayake S, Edussuriya K, Wijenayake P, Arseculeratne S. Ocular Rhinosporidiosis with staphyloma formation: the first report in Sri Lanka. J Infect Dis Antimicrob Agents. 2007;24:133–41.
23. Karunaratne WA, Rhinosporidiosis in Man. Rhinosporidiosis in Man. Athlone: University of London; 1964.
24. Pandey RK, Kumar A, Kumar D. Incidence of Rhinosporidiosis in Jharkhand. Indian J Pathol Microbiol. 2001;44(1):17–21.
25. Kurup PK. Rhinosporidium kinealyi infection. Indian Med Gaz. 1931 May;66(5):239.
26. Arseculeratne SN, Sumathipala S, Eriyagama NB. Patterns of Rhinosporidiosis in Sri Lanka: comparison with international data. Southeast Asian J Trop Med Public Health. 2010 Jan 1;41(1):175.
27. Kutty MK, Unni PN. Rhinosporidiosis of the urethra. A case report. Trop Geogr Med. 1969;21(3):338–40.
28. Jain SN. Aetiology and incidence of rhinosporidiosis. Indian J Otolaryngol. 1967 Mar 1;19(1):1–21.
29. Rath R, Baig SA, Debata T. Rhinosporidiosis presenting as an oropharyngeal mass: a clinical predicament? J Nat Sci Biol Med. 2015 Jan;6(1):241.
30. Govinda R, Lakshminarayana CS. Investigation into transmission, growth and serology in rhinosporidiosis. Indian J Med Res. 1962;50(3):363–70.
31. Vanbreuseghem R. Rhinosporidiosis: clinical aspects, epidemiology and ultrastructural studies on Rhinosporidium seeberi. Dermatol Monatsschr. 1976 Jun 1;162(6):512–26.
32. Vadakkan JR, Ganeshbala A, Jalagandesh B. A clinical study of rhinosporidiosis in rural coastal population: our experience. J Evol Med Dent Sci. 2014 Oct 9;3(51):11938–43.
33. Rippon JW. Medical mycology; the pathogenic fungi and the pathogenic actinomycetes. Eastbourne: UK; WB Saunders Company; 1982.
34. Branscomb R. Rhinosporidiosis update. Lab Med. 2002 Aug 1;33(8):631–3.
35. Sarker MM, Kibria AG, Haque MM. Disseminated subcutaneous rhinosporidiosis: a case report. TAJ: J Teach Assoc. 2006;19(1):31–3.
36. Sonkhya N, Singhal P, Mishra P. Naso-oropharyngeal rhinosporidiosis: endoscopic removal. Indian J Otolaryngol Head Neck Surg. 2005 Oct;57(4):354–6.