

Covid-19 in Rio de Janeiro/Brazil: efforts of hospital pharmacy services

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Abstract

Objective: To investigate the efforts of hospital pharmacy services in Brazilian public hospitals during the coronavirus pandemic. **Methods:** A cross-sectional study about practical and routine hospital pharmacy services in hospitals in the city of Rio de Janeiro (Brazil) was developed. The online survey consisted of 22 questions (3 multiple choice questions, 14 yes/no questions and 5 open-response questions) and the instrument was applied to 20 frontline pharmacists of 6 different hospitals from September 15th to 30th of 2020. Descriptive analysis was made by means of estimation of proportions. **Results:** We observed that 12 of the 20 participating pharmacists were trained about the new protocols and practice. Two hospitals have altered their Pharmacy Department, creating two groups: (1) services supply of COVID-19 and (2) services supply for others disease or complications. It was found that 3 of the 6 hospitals implemented an exclusively electronic medical prescription system and all of them used individualized dispensing system. At least one pharmacist of each hospital reported a lack or shortage of one or more drugs used in the COVID-19 treatment. Six main causes of drug scarcity were cited and 5 hospitals pointed two of them: increased cost of drug manufacturing and insufficient quantities of raw materials. In addition, we found out that essential ICU drugs, such as ceftriaxone, azithromycin, fentanyl and midazolam were the most prescribed ones, being cited by 5 hospitals (each one). **Conclusion:** This study showed that pharmaceutical services from six public hospitals of the city of Rio de Janeiro have been adjusted and redesigned to fight the COVID-19. Furthermore, this work can contribute to a more comprehensive vision of the pharmaceutical community about their challenges in the fight against COVID-19 and to provide positive suggestions for improving pharmacy practices.

Keywords: coronavirus infections; pharmacy service, hospital; pharmaceutical services; surveys and questionnaires; electronic prescribing; drug storage.

Covid-19 no Rio de Janeiro/Brasil: esforços dos serviços de farmácia hospitalar

Resumo

Objetivo: Investigar os esforços dos serviços de farmácia hospitalar em hospitais públicos do Brasil durante a pandemia do coronavírus. **Métodos:** Um estudo transversal sobre a prática e os serviços de farmácia hospitalar em hospitais da cidade do Rio de Janeiro (Brasil) foi desenvolvido. A pesquisa online consistia de 22 perguntas (3 questões de múltipla escolha, 14 questões de sim/não e 5 questões de resposta livre), a qual foi aplicada para 20 farmacêuticos de 6 hospitais diferentes no período de 15 a 30 de setembro de 2020. Uma análise descritiva dos dados foi realizada por meio de estimativas de proporções. **Resultados:** Nós observamos que 12 dos 20 farmacêuticos participantes foram treinados sobre novos protocolos e práticas. Dois hospitais reorganizaram sua equipe da farmácia hospitalar em dois grupos: (1) gestão de insumos para COVID-19 e (2) gestão de insumos para outras doenças ou complicações. Foi encontrado que 3 dos 6 hospitais adotaram exclusivamente um sistema de prescrição médica eletrônica e todos os seis utilizaram sistema de dispensação individualizada. Pelo menos, um farmacêutico de cada hospital relatou falta ou escassez de um ou mais medicamentos utilizados no tratamento da COVID-19. Seis principais causas para essa escassez de medicamentos foram citadas e 5 hospitais apontaram duas delas: aumento do custo de produção e quantidade insuficiente de matéria-prima. Além disso, observou-se que medicamentos essenciais para UTI, como ceftriaxona, azitromicina, fentanil e midazolam foram os mais prescritos, sendo esses citados por 5 hospitais. **Conclusão:** Neste estudo, mostrou-se que os serviços de farmácia, dos seis hospitais públicos da cidade do Rio de Janeiro, precisaram ser ajustados e redesenhados para combater a COVID-19. Além disso, nosso trabalho pode contribuir para uma maior compreensão da comunidade farmacêutica sobre seus desafios na luta contra a COVID-19 e prover sugestões positivas para melhorar as práticas farmacêuticas.

Palavras chaves: infecções por coronavírus; serviço de farmácia hospitalar; assistência farmacêutica; inquéritos e questionários; prescrição eletrônica; armazenamento de medicamentos.



Introduction

At the end of 2019, a new coronavirus infected millions of people across the world, which triggered a public health crisis and caused negative impacts both on the economy and on society. Coronavirus disease-2019 (COVID-19) is a serious health problem caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), that can lead to a variety of clinical syndromes, including respiratory failure, septic shock and death.^{1,2}

SARS-CoV-2 is a new strain of a large family of coronavirus which often cause the common cold in humans.^{2,3} However, by analyzing the numbers of SARS-CoV-2 transmission and COVID-19 deaths, this virus can be considered more dangerous and lethal than other viruses of the family. As the Center for Systems Science and Engineering at The Johns Hopkins University reported on June 1st, 2021, the SARS-CoV-2 pandemic caused 3,565,352 deaths, with a total of 171,475,750 confirmed cases in 191 countries/regions.⁴ Brazil became one of the COVID-19 affected countries on February 26th. According to the Brazilian Ministry of Health, on May 28th, 2021, there were around 16,274,695 cases and over 452,031 deaths in Brazil. It is noteworthy that, from 2002 to 2003, the severe acute respiratory syndrome coronavirus 1 (SARS-CoV-1) infected about 8,500 people in 27 countries and caused 866 deaths³, indicating the higher severity of SARS-CoV-2.

One of the main concerns of health authorities about COVID-19 is the increase in the rates of hospitalizations, especially in intensive care units (ICU). In many countries, including Brazil, hospitals rapidly reached 100% occupancy, leading to significant implications on hospital services and compromising the workforce of health professionals.^{5,6} This fact forced hospitals to focus on increasing bed capacity, adjusting the infrastructure and re-allocating human and equipment resources.⁷ Hospital pharmacies had to reorganize and concentrate their activities on the health crisis. In this regard, emergency plans and support for management of the potential impacts of COVID-19 on hospital pharmacy services were formulated by the pharmaceutical community around the world.^{8,9} The Brazilian Society of Hospital Pharmacy and Health Services (Sociedade Brasileira de Farmácia Hospitalar e Serviços de Saúde, SBRAFH) has suggested technical-scientific measures related to pharmaceutical care in the face of pandemic.⁸ These recommendations highlight safe working strategies for hospital pharmacists during the treatment of COVID-19 hospitalized patients, addressing issues such as the logistical cycle of medicines and health products.

It has been shown that, although medication shortages precede the COVID-19 outbreak, this problem increased in relation to certain medications during the pandemic.^{10,11} After studies *in vitro* showed a possible benefit of chloroquine and hydroxychloroquine in combating COVID-19, associated with widespread media coverage, a spike in demand for these drugs was observed, impacting its stock and distribution.^{12,13} New treatment strategies were proposed for the management of COVID-19 patients and a number of fast-changing guidelines emerged, with drugs that would allegedly inhibit SARS-CoV-2 or enhance immune response to the virus.¹⁰ This context has generated extra concern for pharmacists and medical community, since the safety and efficacy of some drugs prescribed for COVID-19-treatment were unclear at the time.

Once met with public health challenges, the pharmacy support system can play a significant role. Several studies have shown that clinical pharmacists are a vital member to multidisciplinary health teams, assisting mainly in the review of the prescribed pharmacotherapy and in the drug therapy management.^{14,15}

Aiming at providing care for patients with mild COVID-19 symptoms, the Wuhan Union Medical College Hospital created a module pharmaceutical care and achieved excellent outcomes.¹⁰ Therefore, it is important to explore how pharmacists and hospital pharmacies around the world manage their practice and routine during the COVID-19 outbreak.¹⁵

This study aims to investigate the efforts of hospital pharmacy services in Brazilian public hospitals located in the city of Rio de Janeiro during the coronavirus pandemic, considering that innovative pharmaceutical practices have been developed and adopted throughout the world in the fight against COVID-19. To clarify this objective, an online questionnaire was elaborated by authors and applied to hospital pharmacists, with the purpose of exploring the impact of COVID-19 on hospital pharmacy staff and practice, in addition to management of medicines.

Methods

This is a cross-sectional study based on a survey of pharmacists working at hospitals of Rio de Janeiro with care for COVID-19. The study was prepared based on the regulatory guidelines for research involving humans and was approved by the ethics committee of Federal Institute of Education, Science and Technology of Rio de Janeiro (CAAE 36505020.3.0000.5268) in September of 2020.

The authors developed a survey about practice and routine pharmacy service of public hospitals in Rio de Janeiro/Brazil during the coronavirus pandemic. The definitions of the issues addressed was preceded by a literature search for identification of the problems considered most important and common in Brazil and other countries when facing the COVID-19. The project description as well as the research instrument were sent to different public hospitals in Rio de Janeiro by email. About fifteen hospitals were invited to participate in the survey. The six hospitals selected for the study, were only those whose directors agreed with the project and signed the institutional consent form. No specific hospital profile was selected, only the presence of beds for COVID-19 treatment was considered essential. Google Forms was used to create an online survey and the participants were contacted by email. All of them provided electronic informed consent that contained information about the study, voluntary participation and contact information of the researchers. The poll consisted of 22 questions (3 multiple choice questions, 14 yes/no questions and 5 open-response questions) and the instrument was applied to twenty (20) frontline pharmacists of six (6) different (A, B, C, D, E, F) hospitals, from September 15th to 30th of 2020. The six public hospitals that participate of survey were not referral hospital for COVID-19 treatment. A, B, C, D and E are large federal hospitals. F is a state medium hospital. The survey was opened to all pharmacists who were willing to participate. This would allow obtaining information about different sectors of the hospital pharmacy, since the pharmacist could be in a single sector without communication with the others.

The survey included information about different stages of the pharmaceutical assistance cycle to find out how the services were restructured to serve the specific demand. In addition, the pharmacists indicated the main drugs prescribed for the treatment of COVID-19 as well as the supply profile, the causes for possible shortages and the alternatives applied by the hospital pharmacy in order to solve the problem of medicine shortages. All research variables were defined based on the survey responses.



To guarantee the reliability of the questionnaire, in a non-biased way, the statements of the questions were constructed impartially, allowing the participant to express their own opinion. In multiple choice questions, it was established that the first option would always be positive. Thus, the order of the response alternatives would not influence the pharmacist. The size of the study was determined through the deadline for receiving responses, with the same deadline for each participating hospital.

The final data were downloaded from Google Forms into a Microsoft Excel file for a qualitative analysis. Descriptive analysis was made by means of estimation of proportions.

Results

Several organizations, including Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO), have recommended the creation of specific modules/areas and beds in hospitals for COVID-19 patients.¹⁶ This was expected due to the virus being highly contagious and rapidly transmitted².

Based on the responses of pharmacists to the poll, it was observed that the six hospitals participants reorganized their beds and infrastructure to attend COVID-19 patients. Table 1 analyzed the number of beds in infirmary and intensive unit care (ICU) to SARS-CoV-2 infected patients for each of the six hospitals. Hospitals B and F showed higher bed capacity (97 and 63, respectively) than the others. Considering the supply of UTI beds, we found higher capacity in hospitals B and F (41 and 13, respectively). It is worth mentioning that hospital D had only infirmary beds. Furthermore, these results indicate a more worrisome situation in relation to ICU beds in the majority of hospitals studied (A, C, D, E, F).

To address the new needs brought by COVID-19, hospitals and other important operational services revised their own related regulations and guidelines, and developed detailed implementation plans for health care facilities.⁷ In that regard, we investigated whether there was a relocation of hospital pharmacy staff to respond to the pandemic demands in these six hospitals. Only two hospitals (A e B) have altered their Pharmacy Department workforce during the coronavirus pandemic, creating two groups: (1) services supply of COVID-19 and (2) services supply for others disease or complications. This split was not observed in the other

Table 1. Characterization of hospitals participating in the study and problems and solutions presented in the shortage.

Information	All n (%)	Hospital A n (%)	Hospital B n (%)	Hospital C n (%)	Hospital D n (%)	Hospital E n (%)	Hospital F n (%)
Number of beds (infirmary plus ICU) for COVID-19							
Total beds	257 (100,0)	-	-	-	-	-	-
51 to 150 beds	-	-	97 (37,7)	-	-	-	63 (24,5)
50 beds or less.	-	24 (9,3)	-	41 (16,0)	16 (6,2)	16 (6,2)	-
Public administration	6 (100,0)	-	-	-	-	-	-
Intensive care unit (ICU) beds for COVID-19							
Total ICU beds	79 (100,0)	-	-	-	-	-	-
4 or less	-	-	-	-	-	-	-
5 to 10	-	10 (12,7)	-	7 (8,9)	-	8 (10,1)	-
≥ 10	-	-	41 (51,9)	-	-	-	13 (16,5)
Number of pharmacists in training on new protocols and practices to combat COVID-19 by hospital							
Pharmacists in training	12 (60,0)	3 (15,0)	1 (5,0)	5 (25,0)	1 (5,0)	1 (5,0)	1 (5,0)
Prescription systems by hospitals during the COVID-19 pandemic.							
Paper prescription	3 (50,0)	1 (16,7)	-	1 (16,7)	-	1 (16,7)	-
Electronic prescription	5 (83,3)	1 (16,7)	1 (16,7)	-	1 (16,7)	1 (16,7)	1 (16,7)
Drug dispensing implemented by hospitals during the COVID-19 pandemic.							
Unit dose	1 (16,7)	1 (16,7)	-	-	-	-	-
Individualized	6 (100,0)	1 (16,7)	1 (16,7)	1 (16,7)	1 (16,7)	1 (16,7)	1 (16,7)
Collective	2 (33,3)	1 (16,7)	-	-	-	1 (16,7)	-
Possible causes of drug shortage during the COVID-19 pandemic (analyses by hospitals)							
Increased cost of drug manufacturing	5 (83,3)	1 (16,7)	1 (16,7)	1 (16,7)	-	1 (16,7)	1 (16,7)
Insufficient quantities of raw materials	5 (83,3)	1 (16,7)	1 (16,7)	1 (16,7)	-	1 (16,7)	1 (16,7)
Temporary lockdown of manufacturing sites	4 (66,7)	1 (16,7)	-	1 (16,7)	1 (16,7)	1 (16,7)	-
Increased demand and not enough time for replenishment	2 (33,3)	1 (16,7)	-	1 (16,7)	-	-	-
Insufficient human resources	1 (16,7)	-	-	1 (16,7)	-	-	-
No bidding contract available	1 (16,7)	-	-	-	-	1 (16,7)	-
Potential solutions to drug shortage during the COVID-19 pandemic (analyses by hospitals)							
Exchanging drugs among hospitals to treat infected patients	4 (66,7)	1 (16,7)	-	1 (16,7)	1 (16,7)	-	1 (16,7)
Verifying alternative medicines on the basis of hospital protocols and national guidelines	4 (66,7)	1 (16,7)	1 (16,7)	1 (16,7)	-	-	1 (16,7)
Adjusting drug dose	1 (16,7)	-	-	-	-	1 (16,7)	-
Promoting return of medicines from infirmaries and relocating of such drugs	1 (16,7)	-	-	-	-	1 (16,7)	-
Analyzing the stock of medicines for COVID- 19 treatment daily	1 (16,7)	-	-	-	-	-	1 (16,7)
Holding of waiver of bid to medicine purchase	1 (16,7)	1 (16,7)	-	-	-	-	-

hospitals (C, D, E, F) (data not shown). Table 1 shows that all hospitals trained their pharmacist teams about the new protocols and practice to fight COVID-19. However, some pharmacists from hospitals A and B did not participate in this training, which can indicate a lack of standard procedures in these hospitals.

Innovative protocols and optimized workflow have been established by hospitals and other diverse healthcare settings during the COVID-19 pandemic in order to reduce the infection risk to both themselves and their patients.⁷ For instance, routine hospital pharmacy tasks, such as medication preparation, dispensing and medication return processing needed to be redesigned to minimize the potential spread of disease. Bearing

in mind, participating hospital pharmacists were asked about particularly 2 tasks developed by the pharmacy department: (1) access to medication orders and prescriptions and (2) drug dispensing system. It was observed that 3 hospitals (B, D, F) used an exclusively electronic medical prescription system, whereas hospital C maintained only paper drug prescription (Table 1). It is noteworthy that both prescription dynamics (paper and electronic) were mentioned to the hospitals A and E (Table 1). In relation to the different types of drug-dispensing systems for medical prescriptions in the hospitals, all six hospitals worked with individualized drug dispensing system (Table 1). In addition, the collective dispensing system was also declared in hospitals A and E. Unit dose system was reported only in hospital A.

Table 2. Most dispensed drugs for the treatment of COVID-19

ATC classification code	All (n=6) n (%)	Hospital A	Hospital B	Hospital C	Hospital D	Hospital E	Hospital F
J Antiinfectives for systemic use							
Ceftriaxone	5 (83,3)	X	X	X		X	X
Azithromycin	5 (83,3)	X	X	X		X	
Clarithromycin	3 (50,0)			X	X	X	
Oseltamivir	3 (50,0)	X		X	X		
Amoxicillin/clavulanic acid	2 (33,3)			X	X		
Meropenem	1 (16,7)						X
Piperacillin/tazobactam	1 (16,7)						X
P Antiparasitic products, insecticides and repellents							
Ivermectin	3 (50,0)	X		X	X		
Chloroquine	1 (16,7)	X					
B Blood and blood forming organs							
Acetylsalicylic acid	1 (16,7)				X		
Abumin	1 (16,7)						X
Enoxaparin	1 (16,7)	X					
Heparin	1 (16,7)	X					
C Cardiovascular system							
Norepinephrine	4 (66,7)	X	X	X			X
M Musculo-skeletal system							
Atracurium	2 (33,3)		X	X			
Cisatracurium	2 (33,3)	X		X			
Rocuronium bromide	1 (16,7)			X			
Suxamethonium	1 (16,7)						X
N Nervous system							
Fentanyl	5 (83,3)	X	X	X		X	X
Midazolam	5 (83,3)	X	X	X		X	X
Dexmedetomidine	3 (50,0)		X	X			X
Metamizole sodium	3 (50,0)	X			X		X
Propofol	3 (50,0)	X	X				X
Esketamine	1 (16,7)			X			
Etomidate	1 (16,7)						X
Haloperidol	1 (16,7)						X
Lidocaine	1 (16,7)						X
Quetiapine	1 (16,7)						X
R Respiratory system							
Salbutamol	1 (16,7)	X					
H Systemic hormonal preparations, excl. Sex hormones and insulins							
Dexamethasone	3 (50,0)	X		X		X	
Hydrocortisone	1 (16,7)					X	
Methylprednisolone	1 (16,7)	X					
Prednisone	1 (16,7)	X					
Argipressin	1 (16,7)		X				

X represents a hospital in which one pharmacist, at least, cited the drug for treatment of patients suffering from COVID-19 in that line.



When COVID-19 was declared a global pandemic, community pharmacies noted an increased stockpiling of drugs by population, especially those that were identified as promising therapies against the disease.¹⁷⁻¹⁹ Highlighted orders for medications in anticipation of possible shortages also were observed in hospitals and other health institutions, contributing to drug scarcity related to pandemic. In this paper, at least one pharmacist of each hospital reported a lack or shortage of one or more drugs used in COVID-19 treatment (data not shown).

Table 1 indicates possible causes and potential solutions to drug shortage described by hospital participant pharmacists. Six main causes of drug shortage during COVID-19 were cited, highlighting two: increased cost of drug manufacturing and insufficient quantities of raw materials. When asked about future efforts of pharmacy services to impending drug shortages, we found: exchanging drugs to treat infected patients among hospitals, verifying alternative medicines on the basis of hospital protocols and national guidelines, adjusting drug dose, promoting return of medicines from infirmaries and relocation of those drugs, analyzing the stock of medicines for COVID-19 treatment daily and holding of waiver of bid to medicines purchase.

To identify and predict possible drugs that would be used in the treatment for COVID-19 and its complications, the majority of hospital pharmacies created a previous list of medicines (A, B, C, E and F- data not shown). This medication list was elaborated by a multidisciplinary professional team, including pharmacy staff, in only two hospitals (B and E). Meanwhile, in the other hospitals (A, C and F), pharmacists answered that an interprofessional commission was not created (data not shown). Furthermore, we questioned the hospital pharmacists about medicines they most dispensed in order to treat the disease. A total of 34 reference drugs were cited (Table 2) and ceftriaxone, azithromycin, fentanyl and midazolam were the most mentioned medicines. Considering the medicines listed in Table 2, we classified them according to anatomical therapeutic chemical (ATC) classification based on two views: (1) target organ/system (anatomical main group) and (2) therapeutic subgroup. It was observed that approximately one third of the medicines listed were related to the nervous system. When compiled by therapeutic characteristics, we found at the top antimicrobials for bacterial infections and anesthetic.

Discussion

This study showed that pharmaceutical services from six public hospitals of the city of Rio de Janeiro (Brazil) have been adjusted and redesigned to fight COVID-19. The participant pharmacists appointed that the hospital's managers developed different actions in the pharmacy department to respond to the pandemic demands, such as 1) training about the new protocols and practice; 2) relocation of hospital pharmacy staff, especially to address drug-related issues and 3) adoption of digital system for prescribing and individualized dispensing system. Indeed, hospital pharmacists mentioned drug shortage due to COVID-19 and cited possible strategies to minimize this problem, highlighted exchanging drugs among hospitals and relocation of medication. Therefore, this work can contribute to a more comprehensive vision of the pharmaceutical community about their challenges in the fight against COVID-19 and to provide positive suggestions for improving pharmacy practices.

The SARS-CoV-2 pandemic has significantly impacted public health systems around the world, overwhelming hospitals and healthcare professionals. Most countries hit by SARS-CoV-2 have suffered crowding out of health services at different levels.^{19,20} In the context, several public health strategies, such as social distancing, isolation and quarantine have been applied across countries to avoid the health system collapse.¹ Here, we observed that all the six public hospital participants had redesigned their services, especially the pharmacy department, in order to assist COVID-19 patients.

In 2019, prior to the pandemic, Brazil had 8,139 hospital establishments and 490,397 beds, corresponding to approximately 2.3 beds per 1,000 inhabitants.⁵ This scenario worsened by extra demand generated by COVID-19, leading the system to collapse, even with lower infection rates (0,1%) during the initial period of the pandemic.⁵ According to the National Health Facilities Database (CNES), in the first half of 2020, the city of Rio de Janeiro had a mean of 2,329 existing adult ICU beds and 725 COVID-19 ICU beds to 6.32 million inhabitants, among public and private hospitals. In this study, five of the six hospitals studied were capable of accommodating ICU beds to COVID-positive patients. However, the number of beds has not been enough. This observation was not surprising considering the situation of the health system in the city of Rio de Janeiro and the transmission rate of the SARS-CoV-2.^{5,21} Curiously, it was observed that hospital D had no ICU beds, possibly because it is a cancer treatment institute.

Several studies provide reference about the essential role of frontline healthcare workers in the management cycle of coronavirus outbreak.^{22,23} Professionals of different expertise, such as doctors, nurses, pharmacists, and nutritionists have worked together to optimize the patient care during the COVID-19 pandemic. Due to the fact that SARS-CoV-2 is a new coronavirus, healthcare staff needed to be trained to fight this new disease. High level of knowledge among healthcare workers has been significantly related with a positive attitude and practice towards preventive health measures.^{22,23} Zhang *et al.* reported that the lack of training and preparation among frontline healthcare workers is the causative factor for disease infection and transmission.²⁴ Therefore, we observed that the six hospitals participants in this study provided training and reliable information on the management of pharmacy operations on the new demands of COVID-19 pandemic. Moreover, multidisciplinary cooperation to fight COVID-19 was created in three of the six hospitals in order to provide an efficient and quality service. It is worth noting that pharmacists play a vital and unique role within of a healthcare team, mainly due to their pharmacological expertise.^{10,14,15,24} Thus, team working and reciprocal trust have played a central role in the unprecedented demand for health services, leading to rapid decision making and successful actions.²⁵

Community hospitals presented new demands prompted by COVID-19.²⁶ Many of these challenges were observed in the pharmacy department, especially related to staffing, drug supply and distribution in addition to the off-label use of medications.²⁶ The current pandemic created a clinical situation where unproven treatment paradigms appeared, which involved off-label use of drugs.²⁴ In Brazil, for instance, several pharmaceutical organizations pointed out a substantial increase in drug sales to analgesia, sedation, parasitic infections and mental health illness.^{27,28} Based on this panorama, many groups of clinical pharmacists around the world have created rational drug use manuals for frontline medical personnel to apply treatment of COVID-19.²⁹ Our findings show



that a list of medicines was elaborated by the majority of hospital pharmacies to optimize drug stocks and reduce waste. However, drug shortage for COVID-19 was noted in the six hospitals.

It has been shown that COVID-19 exacerbated some of the common causes of drug shortage, such as manufacturing difficulties, scarcity of raw materials, supply and demand issues, business, economic and regulatory matters as well as many other disturbances within the supply chain.³⁰ In this study, lack of bidding contracts for the purchase of medicines and reduced workforce to manage the drug stock were also mentioned causes.

In addition to that, it was pointed out by the participant pharmacists that essential ICU drugs, such as ceftriaxone, azithromycin, fentanyl and midazolam were the most prescribed. This may be due to the fact that many patients SARS-CoV-2 infected have been intubated and underwent mechanical ventilation.³¹ In the case of ventilation, patients often require sedation and/or analgesia depending on their status. Fentanyl is a commonly used drug for analgesia whereas midazolam can be infused if heavy sedation is required.³²

Curiously, the participant pharmacists of the hospitals A, C, D mentioned ivermectin as being one of the most dispensed drugs for the treatment of COVID-19. As of today, there is currently no support in the literature for the use of ivermectin in the prevention or treatment of COVID-19. However, because the development of new medicine demands many years of research, alternative treatments for COVID-19, such as repurposing of ivermectin (anti-parasitic agent), were observed during the pandemic.¹¹ Although ivermectin has been confirmed to inhibit the replication of SARS-CoV-2 *in vitro*, it is currently still in clinical trials for the treatment of COVID-19.^{33,34} In Brazil, some cities adopted primary healthcare services to fight COVID-19, which consists of a range of drug combinations, including such as ivermectin and chloroquine.³⁵ Interestingly, participant pharmacists of hospital A, in addition to ivermectin, also cited chloroquine as one of the most dispensed drugs. Although chloroquine is a drug used by many countries both prophylactically and for the direct treatment of COVID-19 patients, careful clinical examinations are still underway to validate the effects of chloroquine and hydroxychloroquine on COVID-19 patients.³⁶ In June 2020, the U.S. government suspended authorization for the emergency use of chloroquine phosphate and hydroxychloroquine sulfate for treatment of COVID-19 patients, because severe adverse side-effects were reported, including cardiac arrest and ventricular arrhythmias.³⁵

There are several ways in which health institutions can help resolve drug shortages. In the United States, the Food and Drug Administration (FDA) is responsible for protecting the public health, including medicines management.³⁰ In Brazil, the National Medicine Control System has been developed to provide advance notice about manufacturing and registration of medicines.³⁷ Along those lines, hospital pharmacists in the present study believed that other measures could play an effective role to minimize drug shortage during COVID-19 pandemic. Alternatives such as exchanging drugs to treat patients among hospitals and relocation of medication returns were the most mentioned.

Besides drug shortages, other questions related to medicines management are critical to support and enhance public health emergency operations during the coronavirus pandemic. Pharmacists and pharmacy services must also conduct active

surveillance and establish new practice to monitor the safe use of medications.³⁸ Implementing safe, organized and efficient drug-dispensing systems is essential for controlling costs and assuring that the medical prescription is safely followed as requested within the appropriate deadline.³⁹ Here, we observed that five hospitals have adopted computerized prescribing and all of them used individualized dispensing system. In the system, the hospital pharmacy dispenses drugs separately per patient, according to the medical prescription.³⁹ In Brazil, 34.8% of hospitals use this drug-dispensing system for inpatients. Furthermore, it has been shown that automated dispensers and intelligent drug storage cabinets are used by several medical institutions.^{29, 40}

Finally, the COVID-19 pandemic has proved to be a challenge for the world. The news and the knowledge about this new coronavirus change every day, generating uncertainties and fears in the population and health care professionals. Nevertheless, innovative tools and approaches have been developed to minimize the negative impacts of COVID-19 on the dynamics of health care services, including the hospital pharmacy services. For this reason, studies evaluating the knowledge, experiences and attitudes of different health professionals are essential to the medical community in the fight against COVID-19.

Due to this study was conducted during the pandemic, the first contact with public hospitals was limited to the digital tools (e-mail) and some did not respond, restricting the scope of the research. Indeed, the number of the participant pharmacists was not homogeneous among the hospital. This observation can indicate a non standardized evaluation of the date, making statistical analysis difficult. However, one of the strengths of the study is that the information acquired can help other healthcare professionals, especially those focused on hospital pharmacy practice, in the current pandemic.

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Collaborators

JT collaborated in the conception, analysis and interpretation of data, and in article writing. SS collaborated in analysis and interpretation of data, and in article writing. I and J collaborated in analysis and interpretation of data. VA collaborated in the conception, analysis and interpretation of data, and in article writing and critical review relevant to the intellectual content.

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Conflict of interest statement

The authors declare that there are no conflicts of interest regarding this article.



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