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Drugs supply and pharmaceutical care management practices at a designated hospital during the COVID-19 epidemic

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ABSTRACT

The coronavirus disease-19 (COVID-19) is caused by the novel severe acute respiratory syndrome coronavirus that was first detected at the end of December 2019. The epidemic has affected various regions of China in different degrees. As the situations evolve, the COVID-19 had been confirmed in many countries, and made a assessment that it can be characterized as a pandemic by the World Health Organization on March 11, 2020. Drugs are the main treatment of COVID-19 patients. Pharmaceutical service offers drug safety ensurance for COVID-19 patients.

According to COVID-19 prevention and control policy and requirements, combined with series of diagnosis and treatment plans, pharmacists in the first provincial-level COVID-19 diagnosis and treatment unit in Jilin Province in Northeast China have established the management practices of drug supply and pharmaceutical care from four aspects: personnel, drugs supply management, off-label drug use management and pharmaceutical care. During the outbreak, the pharmaceutical department of THJU completed its assigned workload to ensure drug supply. So far, no nosocomial infections and medication errors have occurred, which has stabilized the mood of the staff and boosted the pharmacists' confidence in fighting the epidemic. For the treatment of COVID-19, pharmacists conducted adverse reaction monitoring and participated in the multidisciplinary consultation of COVID-19. Up to now, the COVID-19 patients admitted to THJU have not shown any new serious adverse reactions and been cured finally. The hospital pharmacy department timely adjusted the work mode, and the formed management practices is a powerful guarantee for the prevention and control of the COVID-19 epidemic. This paper summarized the details and practices of drug supply and pharmaceutical services management to provide experience for the people who involving in COVID-19 prevention and contain in other abroad epidemic areas.

1. Introduction

An outbreak of coronavirus disease 2019 (COVID-19) began in Wuhan, Hubei Province, China in December 2019.¹ According to the *Prevention and Control of Infectious Diseases Law of P.R. China*, COVID-19 was classified as class B infectious disease, and measures had been taken according to the prevention and control standards of class A infectious disease. COVID-19 was also managed in accordance with *Frontier Health and Quarantine Law of P.R. China*.²

The Third Hospital of Jilin University (THJU) is managed by China National Health Commission (CNHC) which is a large-scale Grade III-A hospital, with an annual outpatient service of about 1.84 million patients. The hospital was specified as the first provincial-level COVID-19 diagnosis and treatment unit in Jilin Province.³ During COVID-19 outbreak-period, the pressure of medical service has increased. Efficient

pharmaceutical practices could provide support for responding to the COVID-19 pandemic.⁴ The Pharmaceutical Department of THJU has carried out a series of work in terms of drug supply and pharmaceutical service, which has provided effective support for prevention, control and treatments of COVID-19. As of March 31, 2020, the mortality rate of patients with COVID-19 in THJU was 0%, the number of infected medical staff was nil.

The epidemic attracted the attention of the international communities and was declared the coronavirus a global pandemic by the World Health Organization (WHO) on March 11, 2020. As of April 1, 2020, a total of 823,626 confirmed cases had been reported in 202 countries outside China, including 40,598 deaths.⁵ It is necessary to share practices and experience about epidemic prevention and control. This paper summarized the practices of preventing and controlling COVID-19 in the pharmacy department of THJU to provide reference for those who

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Table 1
List of THJU COVID-19 treatment drugs.⁹⁻¹¹

Type of treatment	Drug name
Antiviral drugs	Interferon α - 2b injection, Lopinavir/Ritonavir, Arbidol, Ribavirin, Paramavir, Oseltamivir
Immunomodulatory drugs	Human immunoglobulin, Thymosin, Pidomode
Antibacterial drugs	Amoxicillin, Cefoperazone/Sulbactam, Levofloxacin, Piperacillin/Tazobactam, Moxifloxacin, Meropenem
Glucocorticoid	Prednisone, Methylprednisolone, Dexamethasone
First-aid medicine	Adrenaline, Noradrenaline, Dopamine, Amiodarone, Sodium Bicarbonate
Microecological preparation	Clostridium Butyricum, Bifidobacterium triple viable preparation
Traditional Chinese medicine	Xuebijing Injection, Xiyanping Injection, Lianhuaqingwen Capsule, Yupingfeng Capsule
Nutritional support drugs	Enteral Nutrition Suspension, Amino Acid Injection, Fat Emulsion, Vitamins and Electrolytes
Antipyretic, analgesic and anti-inflammatory drugs	Ibuprofen, Paracetamol, Loxoprofen, Ibuprofen Arginine
Rehydration and electrolyte	Sodium Chloride Injection, Ringer's Injection, Potassium Chloride Injection, Calcium Gluconate Injection, Potassium Magnesium Aspartate Injection

are facing the same situation.

2. Practice1: man-management

In the global fight against the outbreak of COVID-19, countries (areas) are facing with medical staff management challenges:(1)insufficient medical staff, (2)physical and mental health,(3)limited COVID - 19 prevention and control training.

- (1) Emergency human resource mechanisms could ensure work quality and improve management efficiency.⁶ The Department of Pharmacy have developed a pharmaceutical personnel echelons system to guarantee sufficient personnel resource. The first team was composed of pharmacists with experiences in fighting against SARS, floods, earthquakes and other emergencies. The second team consisted of clinical pharmacists and laboratory pharmacists who had been responsible for drug supply and dispensing. The first team members were charged with the key responsibilities of advising and educating patients, maintaining a stable supply of pharmaceuticals, and guide suspected cases to fever clinic for screening as required. The second team members received epidemic prevention and control training, under the leadership of the first team members to carry out the work. Otherwise, the pharmaceutical department have selected pharmacists with rich working experience and strong professional abilities as candidates of Wuhan Medical Team.
- (2) Physical and mental health

The COVID-19 outbreak during the Spring Festival—the Chinese traditional festival. Many pharmacists travelled and returned hometown at that time. The pharmacy department designated a pharmacist to take charge of focusing on the staffs' health status. Pharmacists initiatively reported their status every day, including travelled destinations, transportations, temperature, cough symptoms. If anyone came back from suspected epidemic areas was recommended to stay at home 14 days for observation. During an epidemic, false information and rumors can generate serious negative effects to staffs' mental health, similar to the community prevention and control grid member measures,⁷ pharmacy department appointed grid emotion managers. Each grid member was responsible for providing emotional management advice and help them: a. Understand COVID-19 correctly; b. Accept the reality of the epidemic; c. Encourage the expression of emotions, guide pharmacists through reading, listening to music, sports and other ways to transfer emotions, to overcome depression, anxiety, insomnia, and distress.

- (3) Carrying out training.

The training mode was mainly online learning, the contents included three aspects: a. Hospital isolation rules training, including: transfer routes, transfer vehicles and dedicated elevators for COVID-19 patients, as well as related medical waste signs. Drugs, patients and

pharmacists should move along the designated routes, which help to reduce the risk of nosocomial infection and ensure the supply of drugs.⁸

b. Prevention training. Pharmacists must learn how to protect themselves from getting infected. A Systematic nosocomial infection prevention and control training have been provided for pharmacists, such as process of use and destruct hats, masks, protective clothing correctly. c. COVID-19 diagnosis and treatment plans training. From January to now, the COVID-19 diagnosis and treatment plans have been updated seven times and several diagnosis and treatment plans webinars have been organized. Through the training, pharmacists can master the isolation system, personal safety protection operation and latest treatment plans. Scientific human resource mechanisms, adequate personal protection and timely training can help employees stabilize the mood and enhance confidence in fighting against the epidemic.

By implementing the man-management guarantee practice, the pharmacology department of THJU has resolve the problem of insufficient medical staff, ensuring the physical and mental health of pharmacists and deepen understanding COVID - 19 prevention and control plans.

3. Practice 2: drug supply management

During the pandemic, drugs may be in late delivery and short supply due to logistics interruption and production disruptions for various reasons. Otherwise, safe environment is an important guarantee for normal drug supply. To conquer these problems the pharmacy department have carried out four practices:(1)establishing drug supply schemes based on treatment guidelines, (2)Implementing online drug procurement,(3)managing donated medicine,(4)managing environment.

- (1) Pharmacists have made a list of COVID-19 therapeutic drugs (Table 1) to establish COVID-19 prevention and control drug supply schemes based on diagnosis and treatment plans, and the drugs on the list have been procured at first time.

Additionally, Wechat® (the largest social communication mobile platform in China) groups were established and the director's telephone numbers of the pharmaceutical department have been released on the hospital LAN website, which can help physicians to satisfy the needs of drug supply and use.

- (2) In order to resolve drug delivery lately in the epidemic, pharmacists have made use of the information network technology, applied the "IoT Collaborative Service Platform for Drugs" to drug procurement (Fig. 1 for workflow). The platform automatically generated orders based on previous sales status from HIS ((Hospital Information System), which could be modified and submitted by pharmacists. The orders were transmitted to suppliers by Internet without delaying, then medicines were delivered according to orders timely. The platform have allowed hospitals and suppliers to share

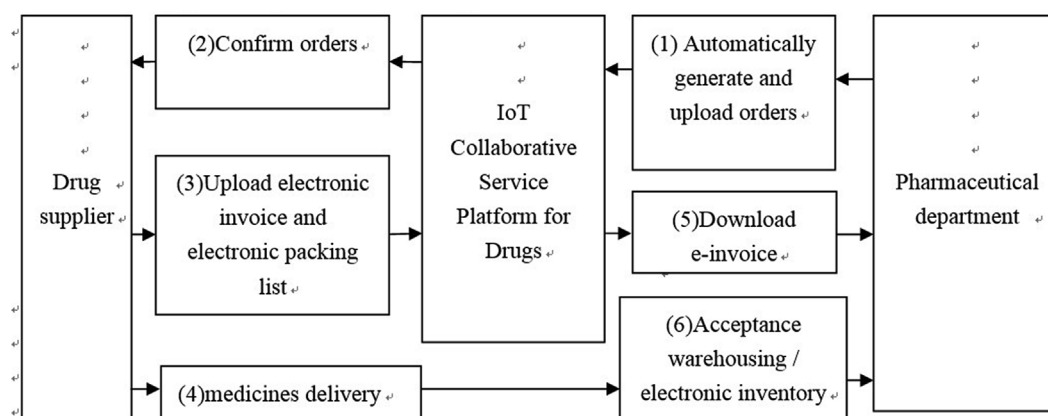


Fig. 1. Workflow.

information, optimized the drug procurement workflow, improved the efficiency, saved the labor and material resources, and reduced infectious risk caused by cross contact in the drug purchase process as much as possible.

(3) Donated medicine management

Affected by the epidemic, a shortage of drugs and protective materials has drawn public attention. THJU received a great many of donations, such as masks, protective clothing and medicine. Therefore, the management of donations is a new task. THJU had formulated a management process (Fig. 2) of donations in accordance with laws, and the pharmaceutical department was responsible for managing donated

drugs (See Table 2 for details).

Through these practices, THJU has carried out successful drug supply management without drug shortages or drug delays. Up to now, there has been no nosocomial infection related to pharmacy.

4. Practice 3: management of off-label drug use

The off-label drug use may rise greater potential drug use risks, pharmacists emphasize on adverse drug reactions (ADR), use the “Adverse Drug Reaction Monitoring System of Medical Institutions” to monitor the adverse reactions of off-label drugs, evaluate the causal relationship of adverse drug reactions¹³ and feed back the evaluation results in time.

At present, antiviral drugs for COVID-19 have not been approved for marketing, prescribing antiviral drugs, such as lopinavir/ritonavir and ribavirin, for patients with COVID-19 could be defined as off-label drug use, the treatment is lack of clinical experience. The incidence of severe ADR in off-label using was significantly higher than normal use,¹⁴ such as anaphylactic shock, drug-induced liver damage and induced epilepsy, was prone to occur in off-label drug use cases. Pharmacists carried out monitoring ADR, evaluated and analyzed the symptoms of patients, and provided doctors with ADR information. During treatment, few new serious ADR occurred. In addition, pharmacists participated in the multidisciplinary diagnosis and treatment of COVID-19 patients, conducted nutritional risk screening and designed nutritional support programs. During the outbreak, all COVID-19 patients were cured and discharged.

5. Practice 4: pharmaceutical care

Timely pharmaceutical care are critical for treatment during the coronavirus pandemic. Pharmacists have made a pharmaceutical care procedure (Fig. 3) according to needs of different groups, provided updated treatment plans, monitored potential drug interactions, focus on special population medication and implement remote pharmaceutical service.

The CNHC has released the “Diagnosis and Treatment Guidelines for the New Coronavirus Infected Pneumonia”, currently in its seventh update. To have a better grasp on the latest version of diagnosis and treatment plans for frontline physicians, pharmacists made a list of changes (Table 3).

Pharmacists also provided a list of common risk warnings of potential drug interactions and reactions according to COVID-19 diagnosis and treatment plans combined with literatures (Table 4).

Pregnant women, especially in middle and terminal pregnancy, are prone to develop into severe patients after infecting with COVID-19.¹⁸ Gestational age, and whether to terminate the pregnancy after

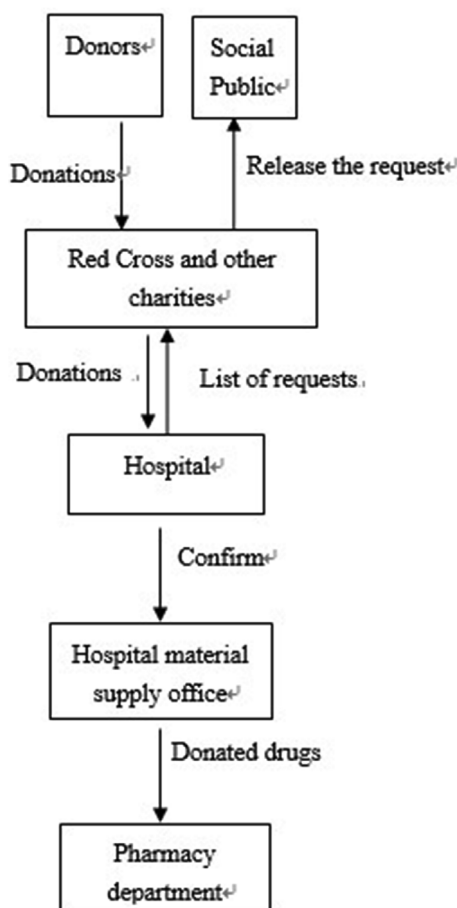


Fig. 2. Donations management process.

Table 2List of items for Management of donated drugs.¹²

(4) Safe working environment is an important condition to ensure the progress of diagnosis and treatment. In order to reduce the spread of the virus through person-to-person transmission during the coronavirus epidemic, outpatient pharmacy of THJU are disinfected 4 times everyday. Pharmacists of outpatient pharmacy also designed safety transfer devices to avoid contacting patients in drugs dispensing. Otherwise, pharmacists adjusted the route and time of drug transportation in the hospital and used designated elevators and vehicles for drug delivery.

Process	Personnel	Facilities	Work
Checking	A senior pharmacist		Check the quality and quantity of donated drugs.
Acceptance & Review	A senior pharmacist		Check the storage conditions, specifications, packaging, manufacturer, batch number and expiry date.
Input	A pharmacist	Donated medicines account books	Register the name, quantity, batch number and expiry date of donated drugs.
Storage	A pharmacist	Donated medicines storage area	Store the donated drugs
Usage management	A senior pharmacist	Donated medicines used records list	Grantees: patients with COVID-19 and front-line medical workers
Rational use	Clinical pharmacists	Guidelines	Clinical pharmacists provide medical information to doctors.
Management of remaining donated drugs	A pharmacist	List of remaining donated drugs	Record the remaining donated drugs on the list.

treatment has been considered in the therapy.¹⁶ Older adults are often associated with a variety of chronic diseases and have a higher risk of death if infected with COVID-19.¹⁹ Physiological characteristics and combination of drugs will change pharmacokinetics and affect the efficacy. Therefore, individualized pharmaceutical care have been provided in combination with physiological characteristics and disease progression.²⁰

Pharmacists used “Prescription Approval & Prospective Audit and Feedback System” to carry out online prescription reviewing. The THJU network and “Pharmacists by Your Side” (Wechat Subscription) was applied to provide free drug consultation to resolve problems of drug use. Pharmacists publicize the prevention and control of COVID-19 to the public free of charge online. These practices of online pharmacy services provide accessible pharmaceutical care and help to reduce the risk of cross-infection during unnecessary hospital visits.

6. Discussion

In the fight against the epidemic, hospitals are facing difficulties in personnel, drug supply and pharmaceutical care. The pharmaceutical

department have established effective drug supply and pharmaceutical care practices, and provided a strong guarantee for epidemic prevention, control and treatment. On March 11, WHO has made assessment that COVID-19 could be characterized as a pandemic and many countries and regions are now experiencing the difficulties that our country once faced. Pharmacists summarize the management model and experience to provide reference for those who in the same predicament. Post-epidemic era, pharmacists should remain engaged in the co-ordinated efforts and be readily adaptive to changes required in drug supplying and pharmaceutical care.^{15–17}

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Declarations of competing interest

None.

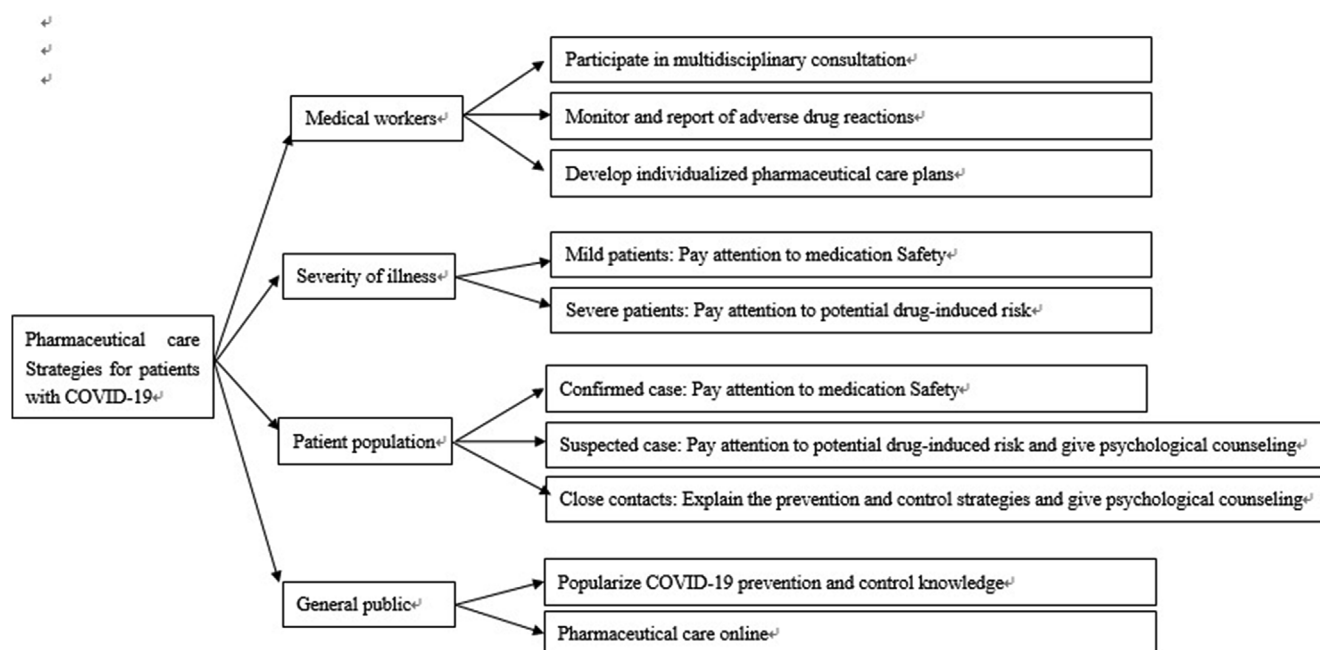


Fig. 3. Pharmaceutical care procedure.

Table 3
List of changes in diagnosis and treatment plans for COVID-19. ^{15,16}

Diagnosis and treatment of COVID-19	Antiviral therapy	Antimicrobial treatment	Hormone therapy	Immunotherapy
First edition	There is currently no specific vaccine and no effective antiviral therapy (Interferon α - 2b injection can be tried, 5 million U per time for adults, bid; Lopinavir/Ritonavir, 2 pills per time, bid; If there was a history of endemic epidemiology or other infection-related risk factors, empirical therapeutic treatment can be provided, including Oseltamivir or Abidor.	Avoid blind or inappropriate antimicrobial therapy, especially in combination with broad-spectrum antimicrobial agents. For patients with mild disease, it is recommended to take moxifloxacin or azithromycin orally or intravenously according to the patient's condition. For severe or critical patients, all possible pathogens should be empirically treated. For patients with sepsis, empirical antibiotics should be administered within 1 hour of the initial patient assessment.	Routine use of corticosteroids should be avoided except for special reasons. Glucocorticoids can be used 3–5 days according to the degree of respiratory distress and the progress of chest imaging. The dose exceed 1–2 mg kg/d equivalent of methylprednisolone is not recommended.	–
The second edition	Change: There is currently no specific vaccine and no effective antiviral therapy (Interferon α -2b injection can be tried, 5 million U per time for adults, bid; Lopinavir/Ritonavir, 2 pills per time, bid.	Avoid blind or inappropriate antimicrobial therapy, especially in combination with broad-spectrum antimicrobial agents. Strengthen acteriological surveillance and use antibiotics as soon as secondary infections occur. Same as the second edition Same as the second edition	Glucocorticoids can be used 3–5 days according to the degree of respiratory distress and the progress of chest imaging. The dose exceed 1–2mgkg/d equivalent of methylprednisolone is not recommended.	–
The Third Edition The Fourth Edition	Same as the second edition Added: The recommended dose of Lopinavir/Ritonavir is 400/100mg.	Same as the second edition Same as the second edition	Same as the second edition Same as the second edition	– –
The Fifth Edition	Added: Intravenous ribavirin, 500mg/dose for adults, bid. Note the adverse reactions and interactions associated with Lopinavir/Ritonavir, including diarrhea, nausea, vomiting, and liver impairment.	Same as the second edition	Added: High dose glucocorticoid can inhibit the immune function and delay the clearance of coronavirus.	–
The Sixth Edition	Added: Ribavirin: combined with interferon or Lopinavir/Ritonavir, 500mg/dose for adults, 2–3 times/day, no more than 10 days. Chloroquine phosphate: 500mg for adults, bid, no more than 10 days. Arbidol: 200mg/dose for adults, 3 times/day, no more than 10 days. Three or more antiviral drugs are not recommended. Stop the drug as soon as there is an intolerable side effect.	Same as the Fifth edition	Same as the Fifth edition	–
Seventh Edition	Chloroquine phosphate: adults 18–65 years old. Weight > 50 kg, 500mg/dose, bid, 7 days; Weight < 50 kg, d1–d2, 500mg/dose, bid, d3–d7, 500mg/dose, qd. Chloroquine is forbidden in patients with heart disease. The number of weeks of pregnancy should be considered. Drugs with less influence on fetus are preferred.	Same as the Sixth edition	Same as the Sixth edition	Immunotherapy. Tozumab can be used to treat patients with extensive bilateral lung lesions and severe patients with elevated I-6 levels. The recommended dosage is 400mg. The infusion time should be 1 hour at least. For patients with poor initial efficacy, additional doses can be added after 12 hours (the dose is the same as before), with a maximum of 2 cumulative times and a maximum of 800mg for a single dose. Allergic reactions need to be paid attention, meanwhile tuberculosis and other active infection is contraindicated.

Table 4List of potential drug interactions and reactions.^{16,17}

Drugs	Combined drugs	Risk
Lopinavir/Ritonavir	HMG-CoA reductase inhibitors.	Simvastatin is not recommended combination. Atorvastatin is recommended under carefully monitoring.
	Sedative-hypnotics	Combination is not recommended: midazolam, triazolam.
	Extracts of St John's wort (<i>Hypericum perforatum</i> L.)	Combination is not recommended. Combined usage may reduce the efficacy.
	Dihydropyridine Calcium Channel Blockers	Careful combination. It may lead to the increase of plasma concentration of dihydropyridine calcium channel blockers
	Oral anticoagulants	During the joint use of warfarin, it is recommended to monitor the INR (international normalized ratio).
	Amiodarone	Careful combination. It may increase the plasma concentration of amiodarone, and the heart rate should be monitored.
	Triazoles	Combination is not recommended: voriconazole and high-dose itraconazole (> 200mg/d)
	Immunosuppressant	Careful combination. It may increase the plasma concentration of immunosuppressant. It is recommended to monitor the concentration of immunosuppressant.
	Antiepileptic drugs	Combination is not recommended: sodium valproate, lamotrigine. It may be better to adjust the drug dosage according to the blood concentration.
Ribavirin	Lamivudine	Careful combination. May cause fatal or non-fatal lactic acidosis.
	Zidovudine	Careful combination. May reduce the effect of zidovudine.
Interferons	Didanosine	May cause lactic acidosis, liver injury, peripheral neuropathy and pancreatitis.
	Theophylline	The clearance of theophylline may be reduced. It is recommended to monitor the plasma concentration of theophylline and adjust the dosage of theophylline properly during the combined use.
	Hepatotoxic drugs	Combined with antiepileptics, erythromycin, minocycline and other hepatotoxic drugs may rise potential risk of liver injury.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.sapharm.2020.04.001>.

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