Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Fighting against COVID-19: Innovative strategies for clinical pharmacists

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ABSTRACT

Background: Clinical pharmacists' routine task is carrying out pharmaceutical care to ensure patients' safe and reasonable medication use. However, under public health emergencies, such as the outbreak of COVID-19, the work strategies of clinical pharmacists need to be modified according to the rapid spread of the disease, where information and resources are usually lack to guide them.
Objective: To retrieve and investigate the prevention and control measures of clinical pharmacists during the outbreak of novel coronavirus, summarize the roles and responsibilities of clinical pharmacists, and to propose innovative strategies for developing pharmacy services under the epidemic.
Methods: The Chinese and English databases, self-media network, website of professional society or medical institution, and clinical trial center platforms were searched, and clinical pharmacists involved in the work against COVID-19 were surveyed and interviewed. Investigate the challenges and needs of frontline medical staffs for treating patients, and formulate strategies based on the actual medical environment.
Results: Clinical pharmacists play a vital role in leading the industry to formulate work instructions, provide frontline medical staff with drug information, and develop innovative pharmacy services to promote the rational use of medicines with collaborative teamwork and close communication according to the epidemic situation of COVID-19. Anti-epidemic work indeed has driven the development of remote pharmacy services.
Conclusion: Facing public health emergencies, clinical pharmacists can give full play to their professional expertise, analyze the current situation rationally, formulate telehealth strategies swiftly, and work in a united and efficient manner to provide innovative pharmacy services to ensure medication safety and rational use of medicine.

Introduction

In December 2019, a novel coronavirus (2019-nCoV) was first detected in cases of acute respiratory illness in Wuhan, Hubei Province, China, which then caused a rapid outbreak and pandemic of infection in 203 locations worldwide.[1,2] On February 11, 2020, the Coronavirus Study Group (CSG) of the International Committee on Taxonomy of Viruses, formally designates it as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). On the same day, the World Health Organization (WHO) officially named the disease caused by this virus as Coronavirus Disease 2019 (COVID-19). Following the advice of the Emergency Committee, the WHO Director-General has declared the SARS-CoV-2 outbreak as a "public health emergency of international concern" and pandemic, for the reason that the virus might spread to countries that do not have robust health systems.[3] As of April 2, 2020, SARS-CoV-2 has caused 896,450 infections and 45,526 deaths worldwide, which is a tragic milestone.[4]

With the continuous changes in the COVID-19 pandemic situation, more than 40 thousand of medical personnel nationwide rush to Hubei and several expert teams sent abroad by Chinese authorities to Italy, Iran and Iraq to aid the pandemic fighting, and a few medical teams sent clinical pharmacists to participate in the treatment of COVID-19. It's important to offer both complicated treatment of ICU patients to reduce mortality, and comprehensive treatment of mild and general patients to improve the cure rate.

In public health affairs, pharmacists have been responsible for a significant role. In flu season, the US pharmacists and physicians collaborate to make flu patients receive timely treatment.[5] In two outbreaks of severe acute respiratory syndrome (SARS), the Canadian pharmacists played a vital role in drug distribution, drug information

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and supporting direct patient care.[6] As the first SARS-CoV-2 detected location with extensive experience, Chinese pharmacists also responded quickly and carried out a variety of strategies to provide pharmaceutical care. This study retrieves and investigates related work performed by Chinese clinical pharmacists during the SARS-CoV-2 outbreak, summarizes the roles and responsibilities of clinical pharmacists, and proposes innovative strategies for developing pharmacy services, for reference by global pharmacists.

Methods

As of April 2, 2020, the Chinese (CNKI, Wanfang Data, VIP) and English (Pubmed, Embase, Cochrane Library) databases, self-media networks, website of professional society or medical institution, and clinical trial registry platforms were searched online, with the text words ("Novel Coronavirus" or "2019-nCoV" or "COVID-19" or "SARS-CoV-2")and (("pharmacy service" or "pharmaceutical care") or (guideline or guidance)). Various pharmacy-related societies and medical institutions that organized clinical pharmacists to actively participate in the work to fight the SARS-CoV-2 pandemic were investigated. The clinical characteristics of diseases, current status of medications, and clinical needs of COVID-19 patients were collected in Wuhan Huoshenshan (Fire God Mountain) Hospital, Leishenshan (Thunder God Mountain) Hospital, 16 FangcangFangcang shelter hospitals, and Wuhan Tongji Hospital's Sino-French New City Branch by interviewing the frontline clinicians and pharmacists.

Results

The timely supply of preventive and treatment medications, the emergency plans for pharmacy workforce and the provision of pharmaceutical care are particularly critical to support public health emergency operations during the COVID-19 pandemic. Specifically, pharmacy shall to work with other government agencies, other healthcare organizations, professional associations and related technical support companies, to address the innovative pharmacy services with adequate communication. The summarized clinical pharmacist's role and innovative strategies of pharmacy services is shown in Fig. 1.

Develop guidance for providing pharmacy services

Develop interim guidance for pharmacists and the pharmacy workforce

With the large scale spread of SARS-CoV-2, global researchers, clinicians, epidemiologists quickly shared their studies on the virus' genome sequence, characteristics and routes of transmission,[2,7] prevention and control strategies,[8] the clinical characteristics of the disease,[9–12] and treatment recommendations.[13,14] The Chinese pharmacists were invited to participate in the development of the International Federation of Pharmacy (FIP) health advisory for health advice for global pharmacists and the pharmacy workforce under SARS-CoV-2 outbreak,[15] and the pharmacists in Peking University Third Hospital were responsible for the translation of the Chinese version.[16] The Chinese Pharmaceutical Association (CPA) organized pharmacy experts to analyze, assess, and summarize the existing guidelines, literatures, and expert consensus, combining with their experience during SARS in 2003, and developed the expert consensus on guidance and prevention strategies for hospital pharmacy personnel[17] and retail pharmacy staff.[18] The pharmacists in Peking University Third Hospital discussed hospital and community pharmacists' role and the content of pharmaceutical care during the pandemic.[19,20] Provincial and municipal pharmacy quality control centers and medical institutions have formulated work recommendations in response to SARS-CoV-2 infection, and formulated a list of drug reserves.[21] The Chinese Wisdom Pharmaceutical Union also carried out the development recommendations about smart pharmacy services under the epidemic.[22]

Create formulary manuals and medicine News

To assist clinicians in better understanding and prescribing the drugs on the medication list, clinical pharmacists created a rational drug use manual for frontline medical personnel to apply treatment of COVID-19, including usage and dosage, solvents, precautions, adverse drug reactions and dose adjustment for special populations, such as the pregnant women, children, elderly patients, dialysis patients, ECMO patients, etc.[23,24] Pharmacy Administration Commision of Chinese Hospital Association (CHAPAC) compiled the "Fangcang shelter Hospital Drug Formulary". In addition, "National pharmacist team of supporting Hubei frontline pharmacists" updated "Anti-epidemic Medicine News" weekly (30 issues in total), including the latest international guidelines, research results and information related to COVID-19, and the answers of the questions and myth busting from frontline clinicians. During the epidemic, all the pharmacists' work files have been summarized, collated, and compiled into books.

Establish drug registration research

At present, with no targeted antiviral medicines for preventing or treating the SARS-CoV-2 infection,[25] pharmaceutical scientists, clinicians and pharmacists are actively conducting registered studies to

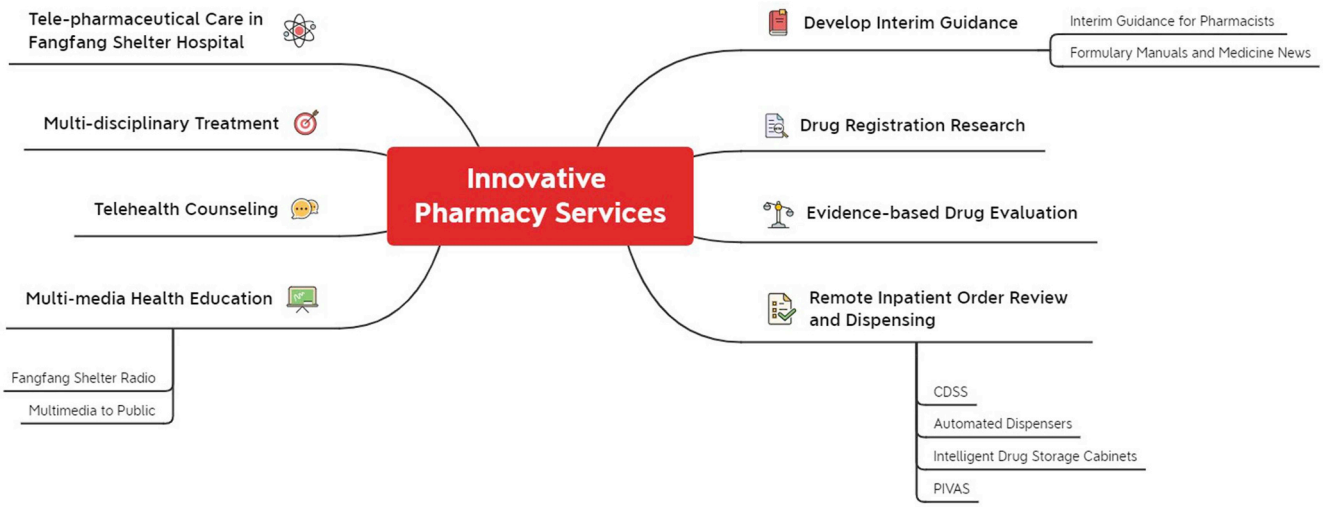

Fig. 1. Summary of innovate pharmacy services.

explore effective treatment options. There are 239 and 524 observational or interventional studies registered on international clinical trial database and the Chinese Clinical Trials Registry database respectively so far. Pharmacists in the Peking University Third Hospital participant to explore the efficacy and safety of hydroxychloroquine sulfate in comparison with phosphate chloroquine in severe patients with COVID-19 (ChiCTR2000029898), and provide data support for establishment the standardized treatment and optimized dosing regimen in clinical practice.[26] Not only can pharmacists participate in clinical trials, but also establish a database of clinical drug research in the real world based on medical records/big data, to analysis the safety and effectiveness of medication therapy in patients with different types of COVID-19 (ChiCTR2000031376).

Establish evidence-based drug evaluation and guideline

Currently, there is no specific medicine or vaccine for COVID-19 and no medicines or vaccines have been fully tested for safety and efficacy.[25] Pharmacists had conduct evidence-based evaluations of the efficacy of medications discussed in the current seventh edition national diagnosis and treatment guidance developed by The China National Health Commission (CNHC)[14] and other treatments in the SARS and Middle East Respiratory Syndrome (MERS) to provide reference for treating COVID-19. For example, evaluating the indications and effectiveness of lopinavir/ritonavir,[27] abidor, interferon,[28] chloroquine phosphate and other antiviral drugs in the prevention and treatment of COVID-19,[29] noticing the dosage and precautions of ribavirin[28] and glucocorticoids,[30] deciding which drugs can be nebulized,[31] to explore the optimal dosing regimen, route of administration to assist frontline doctors. Based on the existing evidence available, the Hospital Pharmacy Professional Committee of Chinese Pharmaceutical Association developed the “expert consensus on rational drug use in clinical practice for COVID-19”.[32] Furthermore, the pharmacists in the Peking University Third Hospital participated in the international evidence-based guideline for COVID-19 treatment drugs developed by the McMaster Evidence-based Medical Center of Canada, and were responsible for the drug evaluation and manuscript writing of the antiviral drugs. The guideline is now complete and in submission.

Remote inpatient order review and dispensing

To reduce the risk of infection, it is recommended that medical institutions use innovative methods to dispense drugs to inpatients, such as using automated dispensers and intelligent drug storage cabinets,[22] and intravenous drugs be centrally deployed in the Pharmacy Intravenous Admixture Services (PIVAS) in competent medical institutions (inpatient order review and dispensing flowchart see Fig. 2). As the responsible person, pharmacists shall review the prescriptions accurately and efficiently during the epidemic. Pharmacists in all medical institutions shall jointly establish and optimize prescription review rules and knowledge database, use rational drug of Clinical Decision Support System (CDSS) to review prescriptions, to reduce the irrational prescriptions and medication errors, and to ensure medication safety.[22] The establishment of drug knowledge base shall focus in the following areas.

- Avoid the concomitant use of lopinavir/ritonavir and other CYP3A4-metabolized drugs. Avoid concomitant use of oral antibiotics and microecologic agents (see Appendix 1, COVID-19 drug interactions).[33]
- Pay attention to the risk of duplicate use of medications, especially medications patients take from home.
- Pay attention to the compatibility and configuration of intravenous drugs (especially traditional Chinese medicine injections) and drugs that require atomization.

Tele-pharmaceutical care in Fangcang shelter hospital

A retrospective study suggests that 23.2% of the COVID-19 patients have complications.[34] Based on the characteristics of the comorbidities of the affected population, clinical pharmacists shall play a vital role in medication reconciliation and develop implement medication therapy management (MTM) for patients with chronic diseases to improve medication compliance, accuracy, and cure rates.

To support medical care, a few days after the opening of the first Fangcang shelter hospitals, health workers in Wuhan had access to electronic information systems, supported by cloud platforms and connected with higher-level hospitals, for record keeping, data transfer, and monitoring of quality of care and outcomes.[35] There are nearly 1000 beds equipped with nearly 200 drugs in a Fangcang shelter hospital, however, only three to five pharmacists are stationed at each spot. To meet the needs of pharmaceutical service for patients in Fangcang shelter hospitals, pharmacists in Tongji Medical College of Huazhong University of Science and Technology launched the “Online Pharmaceutical Monitoring” service, which is an online pharmaceutical service model mainly using WeChat App with smart mobile.[36,37] Each patient in Fangcang shelter hospital shall answer the drug information questionnaire on admission, and medication information is uploaded to the cloud platform and questions are answered promptly.[36]

The online pharmaceutical service model not only effectively reduce

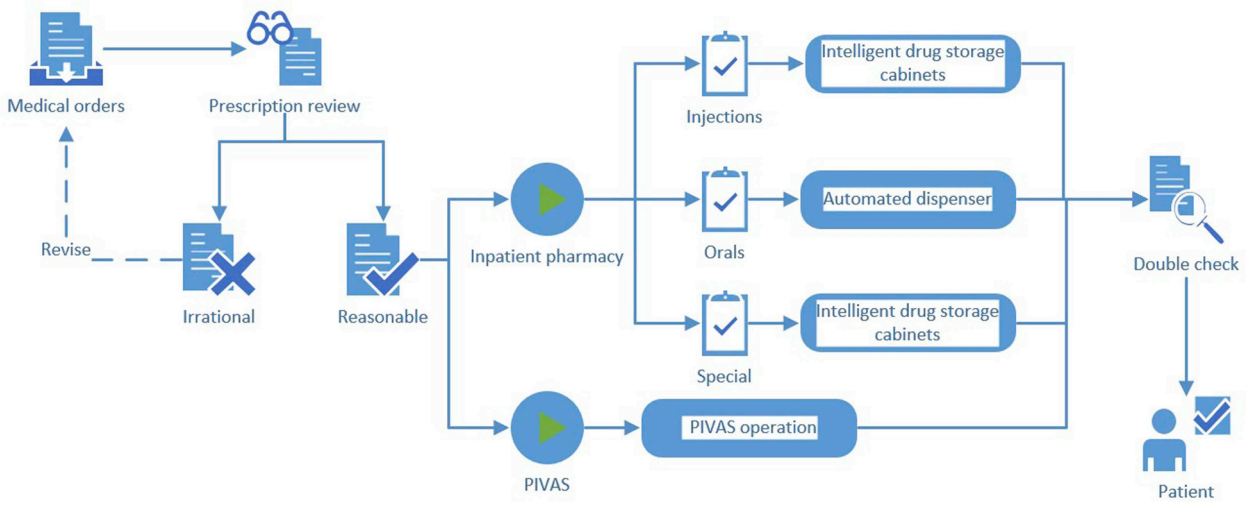

Fig. 2. Inpatient order review and dispensing flowchart.

the chance of hospital-acquired infections, but also improve the efficiency of pharmacy services, and achieve timely and effective professional medication guidance for patients throughout the entire process.

Develop individualized treatment with a multidisciplinary team

Pharmacists play an essential and unique role within the healthcare team to optimize patient care during this COVID-19 pandemic. As a member of a multi-disciplinary diagnosis and treatment team (MDT), pharmacists shall give full play to their pharmacological expertise, and consider the patient's symptoms and etiological results, combining with liver and kidney function and pharmacokinetic parameters of the drug, to formulate individualized drug regimens and to improve cure rate.[38]

In the current pandemic, financial and material resources are being consumed largely, nutritional status shall be taken as a basic vital sign, and nutritional treatment shall be considered as first-line treatment.[39] Nutritional pharmacists as members of the multidisciplinary collaborative team, had set up standardized nutrition therapy procedures for severe and critical patients with COVID-19.[40] Meanwhile, pharmacists shall assess the risk of stress-induced gastric mucosal lesions, venous thromboembolism (VTE), and be alert to the occurrence of complications among COVID-19 patients.

Telehealth counseling and patient education

Facing the truth that a large number of patients in the Fangcang shelter hospital need the medicine guidance of a pharmacist, at the same time, many home quarantine patients with chronic diseases also need consultation from professionals under the epidemic. Therefore, a variety of innovative remote pharmaceutical services have been launched quickly (see Fig. 3).

Telehealth counseling

Public transport in many regions has been suspended to lower the risk of disease transmission; thus, online health services have been widely adopted. In order to improve the effectiveness of drug therapy for mild patients, in the case of extremely limited medical care resources, pharmacists across the country actively provide medication education and MTM to patients and provide psychological counseling to the public through a variety of methods including telehealth consultation. The Beijing Pharmacist Association selected 27 pharmacist volunteers with rich clinical experience and MTM qualifications in tertiary hospitals, and established an online voluntary pharmacy service team of "cloud pharmacy care" quickly. Patients or public can consult pharmacists on "cloud pharmacy care" platform in the form of pictures, texts, or internet calls within 8 a.m.-8 p.m. on medication-related issues, including drug reformation, chronic medication management, lifestyle guidance, and psychological counseling.

Multi-media health education

In response to the need for pharmaceutical care of patients in Wuhan 16 Fangcang shelter hospitals, the CHAPAC organized more than 100 senior clinical pharmacists to support the frontline pharmacists in Wuhan about the frequently asked questions and myth busting, and provide multi-media of chronic home management popularization materials in various forms, including text, picture, animated cartoon and video are created.

The pharmacists created a Fangcang shelter radio station to popularize COVID-19 related prevention and control and medication knowledge, relieve patients' panic and nervousness about the disease, and use the educational materials above for the Fangcang shelter patients provide a series of lectures called “reasonable use of medicine, war will win” on the rational use of medicines (see Fig. 4).[41] The lectures related to medication education for patients' therapeutic drugs, COVID-19 reasonable nutrition, dietary advice, self-protection and medication instructions after discharge, targeting patients’ medication needs at admission, during hospitalization, and upon discharge.

Besides, pharmacists have a pivotal role to play not only in ensuring access to medicines and medical devices, but also in public health, namely by informing the public about preventative measures, advising about behavioural precautions and in the risk assessment, early detection and referral of individuals suspected to be at a higher risk of being infected.[15] Pharmacists shall spread and promote medical knowledge popularization the in live broadcast or recorded course through the TV program, the internet and other medias to public, such as Tik Tok, Bilibili, Youku, YouTube. It is particularly worth mentioning that through relevant science popularization, public have learned to wash hands properly and wear mask scientifically, which can greatly improve people's health awareness, and the development of such hygiene habits will benefit for life.

Discussion and conclusion

SARS-CoV-2 is a highly contagious virus, and the disease progression of infected patients happens rapidly. Frontline medical staff continuously explore suitable diagnosis and treatment schemes in practice.

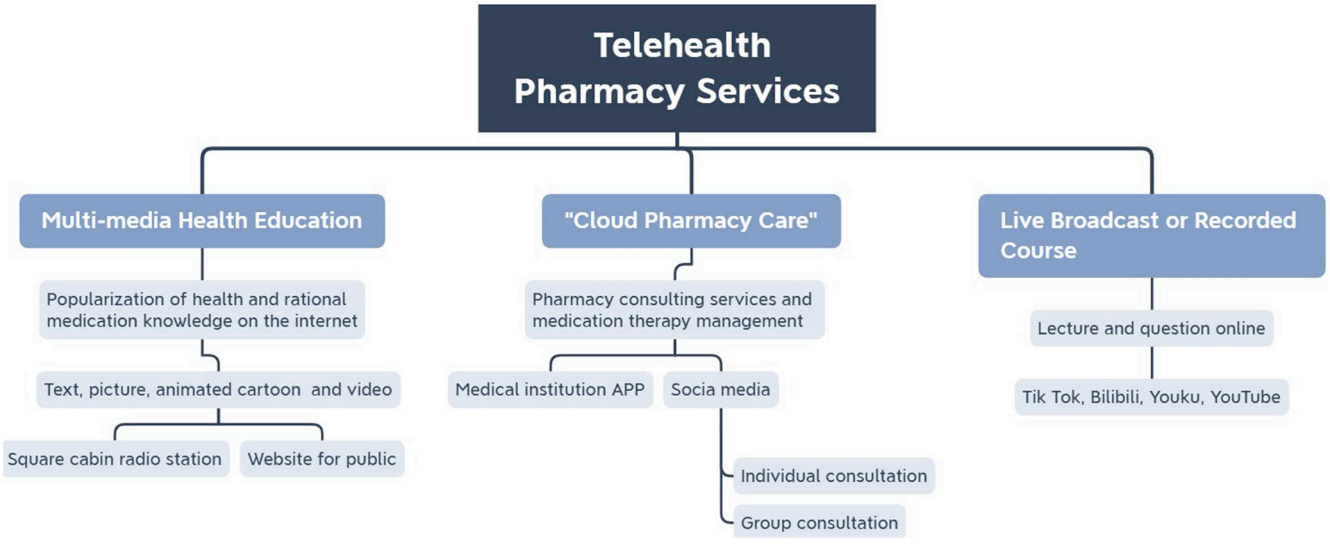

Fig. 3. Mode of telehealth pharmacy services.

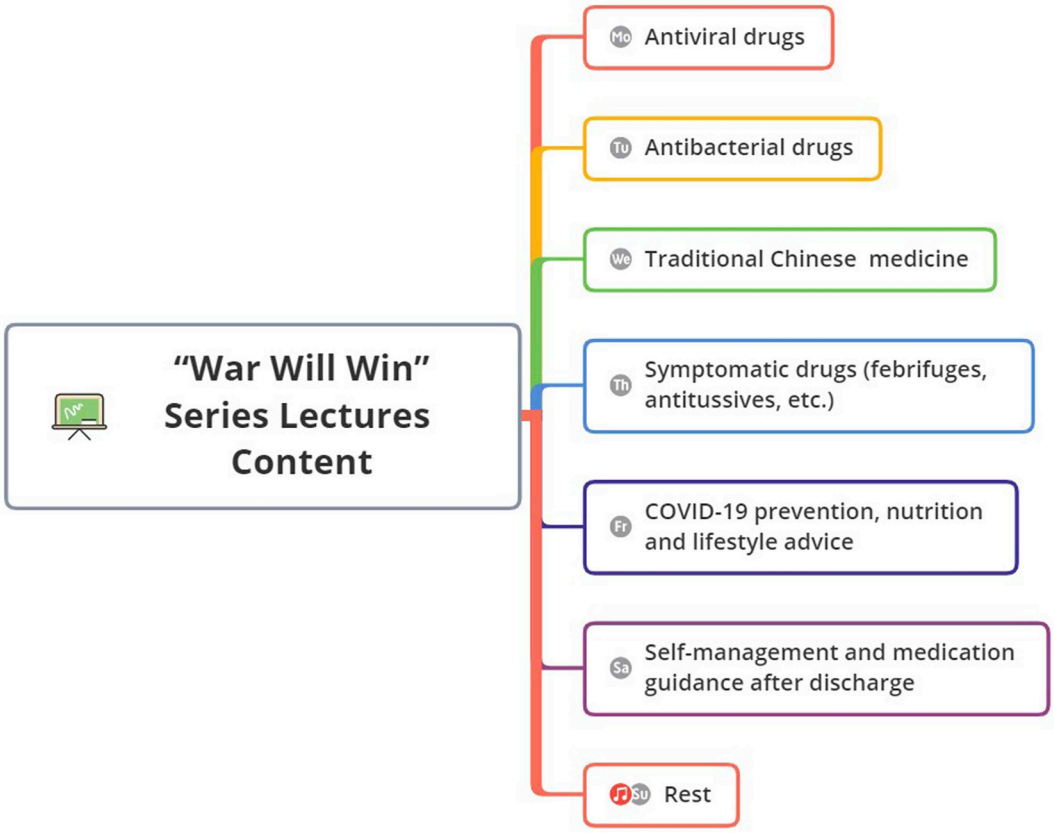

Fig. 4. Content of "war will win" series lectures.

In the face of public health emergencies, domestic and foreign clinical pharmacists collaborated together to take advantage of their pharmacology and pharmacological expertise to actively participate in the medical activities of COVID-19, and to maximize pharmacists' value and responsibility. Conclusively, the role of a clinical pharmacist is not only being an academic leader to formulate work guidance and recommendations, but also a practitioner of pharmacy services, providing medical advice to frontline medical staff and ensuring the rational use of drugs during the epidemic. At the same time, we found that the epidemic has driven the development of innovative and remote pharmacy services. The epidemic of COVID-19 is changing every day, and clinical pharmacists need to constantly update the latest progress on the treatment and explore the innovative pharmaceutical services for the current situation.

Additional retrieved pharmacy-related resources and information of COVID-19 see Appendix 1.

Contributors

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Patient consent for publication

Not required.

Data availability statement

Search syntax for all databases and all versions of citation lists are available from Li HB.

Declaration of competing interest

All authors declared that they have no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sapharm.2020.04.003.

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