




Improving access to medicines: lessons from 10 years of drug reforms in China, 2009–2020

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ABSTRACT

China initiated its healthcare reform in 2009 to provide accessible and affordable healthcare to all. We summarised China's drug reforms between 2009 and 2020 using the WHO framework. China has initiated comprehensive drug policies to address different issues, including: (1) issuing or amending major regulations with changes in institutional settings; (2) implementing the marketing authorisation holder system and bioequivalence assessment to improve the quality of drugs; (3) leveraging accelerated market approval and insurance listing to encourage needs-driven innovation and improve the access to new drugs; (4) introducing compulsory licensing to address major public health threats when needed; (5) scaling up the National Essential Medicine Policy and introducing pharmaco-economic evaluation in National Reimbursable Drug List to promote rational use of medicine and evidence-based selection; (6) applying differentiated pricing strategies and scaling up zero mark-up policies to form a new financing mechanism; (7) adapting bulk procurement and placing strict regulations on the supply chain management to ensure supply and reduce the cost; (8) empowering pharmacists to improve the rational use of medicine; and (9) using procurement and supply chain digital platforms to inform decision and improve efficiency. China's drug reform has adopted a phased and systemic approach that mobilises multiple policy levers including governance, regulation and financing. Despite the progress, emerging challenges in implementation, coordination and capacity need to be addressed. Cross-cutting lessons from China's drug reforms include aligning the drug reform with the overall health reforms, adapting a systemic approach that mobilised policy levers and stakeholders and informing policy decision by conducting pilot studies.

INTRODUCTION

Access to safe, effective, quality and affordable essential medicines and vaccines for all people is essential to sustainable development.¹ Yet, multiple barriers to achieving this have been identified, including essential medicines' unaffordability and poor quality; their inappropriate use; problems with procurement and the supply chain; and regulatory obstacles.^{2,3}

SUMMARY BOX

- ⇒ China has carried out multiple drug reforms in governance, regulation on manufacturing and distribution, insurance listing, pricing and procurement, and clinical use.
- ⇒ Innovative policies have been introduced to encourage innovation and quality improvements. Clinical needs and cost-effectiveness evidence have been prioritised to support policy decisions, and policy levers have been used to reform the financing, pricing and procurement mechanisms in China.
- ⇒ China's drug reform has adopted a phased and systemic approach that mobilises multiple policy levers and engages different stakeholders.
- ⇒ China's drug reforms also provided cross-cutting lessons, including aligning the drug reform with the overall health reforms, adapting a systemic approach that mobilises policy levers and stakeholders, and informing policy decision by conducting pilot studies.

China initiated its healthcare reform in 2009 ('2009 Reform'), aiming to provide safe, effective, accessible and affordable healthcare services to all in line with achieving the commitment set out by the United Nations Sustainable Development Goal 3.⁴ Health services, health insurance and medicines were the three foundations of China's healthcare reform. However, there were many profound challenges including the rapid growth of drug expenditure and the irrational medicine use in China before 2009.^{5–7}

With the goals of removing perverse economic incentives and improving rational use of medicine, China initiated a series of drug reforms since 2009, covering the governance, manufacturing, distribution, procurement and clinical use of drugs.^{8–14} This study aims to provide a comprehensive review of China's drug reforms and to identify cross-cutting lessons for other countries.

We used the framework from the WHO's report, *Towards Access 2030: WHO Medicines and Health Products Programme Strategic Framework*

2016–2030¹⁵ to guide our overall account of China's drug reforms. This framework comprehensively highlights the following as key components: effective regulation; quality products; needs-driven innovation; intellectual property; evidence-based selection; financing and pricing; procurement and supply; quality and appropriate use; and data, monitoring and evaluation.

We based our narrative review on policy documents, government reports and published work in both Chinese and English. Details about the review process can be found in the online supplemental appendix 1. We considered national-level initiatives and their scaling up plans implemented after 2009 in China. Policy documents and literature were screened by WM for relevance, and based on policies' primary goals, we categorised policies into key components of the WHO framework. For eligible policies, we extracted information that addresses the following: (1) goals/objectives; (2) policy instruments or policy changes; and (3) implementation progress. A list of policy documents, issuing agencies and key contents (ranked by year of issuance) can be found in the online supplemental appendix 2.

CHINA'S DRUG REFORMS FROM THE WHO FRAMEWORK PERSPECTIVE

China has undertaken a series of comprehensive reforms that addressed all components of the WHO framework. [Table 1](#) provides a summary of major drug initiatives between 2009 and 2020, their policy objectives and implementation progress.

Effective regulation

Upon the increasing demand in governance for drugs, the National Law of Pharmaceutical Products Management (NLPPM) was significantly amended in 2019 to (1) optimise the market approval process to encourage innovation and address clinical needs; and (2) implement the marketing authorisation holder (MAH) system.¹⁶ Regulation of Drug Manufacture¹⁷ and Management Plan for Drug Registration¹⁸ were issued in 2020 to regulate the qualifications for and management of drug registration and manufacture, including accelerated registration for innovative drugs.

Meanwhile, institutional setting has been evolved to streamline clearly defined and distinguished roles. The National Medical Products Administration (NMPA), the National Healthcare Security Administration (NHSA) and the National Health Commission (NHC) have been established or reorganised to oversee the production and distribution, procurement and reimbursement, and clinical use of pharmaceutical products ([figure 1](#)). The successor of the China Food and Drug Administration (CFDA), NMPA, is more specialised and entitled with authorities in marketing authorisation, manufacture and distribution management.^{16 19} Prior to the establishment of NHSA, drug retail price, insurance listing and drug procurement were managed by different government

departments.^{20–23} The NHSA was established in 2018 to collectively manage the social health insurance schemes (totally cover over 95% of Chinese population) and lead the selection of the National Reimbursable Drug List (NRDL), price negotiation for and procurement of pharmaceutical products.^{24 25} The NHC (formerly, until 2013, the Ministry of Health; and in 2013–2018, the National Health and Family Planning Commission) monitors the clinical use (including shortages and rational use) of medicines and determines the National Essential Medicines List (NEML).²⁶

Quality products

NMPA holds accountable for the quality of drugs at full life cycle while strategies have been introduced to mobilise multiple stakeholders. The MAH system was scaled up in 2019 after a 3-year pilot study. MAH takes complete responsibility for research and development (R&D), clinical trials (CTs), manufacturing, distribution, monitoring post-marketing safety and reporting adverse events.¹⁶

In terms of research, development and clinical trials, only 600 institutions authorised by NMPA were qualified to conduct CTs before 2019, which was a bottleneck for CTs. Since 2019, a national CT registration platform was established and over 10 000 secondary or higher-level hospitals have access to registered CTs.^{27 28} Meanwhile, NMPA shifted its focus from authorising CT institutions to process evaluation on registered CTs.²⁸

With regards to manufacture and distribution, Certificates of Good Manufacture Practice were introduced in 2011 to ensure the quality of manufacture and were replaced by a comprehensive and life-cycle quality assurance approach since 2019.²⁹ Specifically, drug manufacturers are required to conduct quality assurance; and the manufacturing process, along with the distribution and storage environment, are continuously monitored by NMPA using qualification checks, regular monitoring and random inspections.²⁹ Special attention is given to wholesalers and retailers with complaint records, interrupted adverse effect monitoring records or inspection failures. Same or higher quality standard was applied to drugs for export.¹⁶

The bioequivalence assessment (BA) is intended to improve the quality of generic drugs.^{13 30} Medicines on the NEML were the first cohort eligible for BA³¹ and since 2018, drugs passing BA receive favourable consideration in procurement led by NHSA.³² Additionally, drugs not passing BA would not be considered for bulk procurement if three or more similar drugs have passed BA.¹³

Needs-driven innovation

Accelerated market approval (AMA) was first introduced in 2013 on innovative pharmaceutical products with patents or addressing clinical need.³³ In 2016, the CFDA expanded the scope of AMA to breakthrough drugs, drugs for HIV/AIDS, cancer, major infectious diseases, paediatrics and rare disease.¹⁴ In 2018, five government departments jointly announced the first edition of the

Table 1 Summary of drug reforms in China

WHO framework	Major initiatives between 2009 and 2020	Policy goals/expected outcome	Implementation progress
1. Effective regulation	<p>Laws and regulations</p> <ul style="list-style-type: none"> ▶ 2019: amend the National Law of Pharmaceutical Products Management ▶ 2020: announce Regulation of Drug Manufacture and Management Plan for Drug Registration <p>Institutional reforms</p> <ul style="list-style-type: none"> ▶ 2018: establish the National Medical Products Administration (NMPA) to manage the production and distribution of drugs ▶ 2018: establish the National Healthcare Security Administration (NHSA) to collectively manage the social health insurance schemes and their related decisions such as insurance listing, reimbursable price and procurement of drugs ▶ 2018: reform the National Health Commission (NHC) to manage the clinical use of drugs 	<p>Update the laws to legalise the drug reforms</p> <p>Streamline institutional settings; new agencies execute clearly defined and distinguished roles as production and distribution (NMPA), pricing and procurement (NHSA) and use (NHC)</p>	Fully implemented
2. Quality products	<p>Marketing authorisation holder (MAH) system</p> <ul style="list-style-type: none"> ▶ Piloted in 2016 and fully scaled up in 2019; implement the MAH system that MAH takes full responsibility for the regulation of R&D, clinical trials (CTs), manufacturing, sales and distribution, and reporting adverse events <p>Full life-cycle supervision by NMPA</p> <ul style="list-style-type: none"> ▶ 2019: establish a national CT registration platform to improve the transparency of CTs and mobilise hospitals to conduct CTs ▶ 2019: NMPA monitors the manufacturing process and distribution <p>Bioequivalence assessment (BA)</p> <ul style="list-style-type: none"> ▶ 2018: drugs passing BA receive prioritised consideration in procurement led by NHSA 	<p>While mobilising stakeholders such as MAH, hospitals and manufacturers, NMPA holds accountable for monitoring the quality of drugs at full life cycle</p> <p>Introduce BA to improve the quality of generic drugs</p>	By the end of 2019, 123 generic names (323 brand names) passed BA. ¹²⁶
3. Needs-driven innovation	<p>Accelerated market approval (AMA)</p> <ul style="list-style-type: none"> ▶ 2013: introduce AMA on innovative pharmaceutical products with patents or addressing clinical need ▶ 2016: expand AMA to breakthrough drugs, drugs for HIV/AIDS, cancer, major infectious diseases, paediatrics and rare disease ▶ 2018: issue Rare Disease List to encourage the R&D of orphan drugs <p>Insurance listing (selection of National Reimbursable Drug List, NRDL)</p> <ul style="list-style-type: none"> ▶ 2016: apply pharmacoeconomic evaluation evidence in the selection of NRDL to consider both the cost and effect of innovative drugs 	<p>Use AMA and insurance listing as policy levers to encourage needs-based innovation</p> <p>AMA also improves the efficiency of market approval and access to new drugs</p>	<p>Between 2016 and 2017, 423 pharmaceutical products got AMA. About 64.8% applications addressed critical patient needs.⁸³</p> <p>8 out of 12 domestic innovative drugs listed by NRDL in 2019.¹²⁷</p>
4. Intellectual property	<p>Data protection for innovative drugs</p> <ul style="list-style-type: none"> ▶ 2018: innovative drugs can enjoy maximally 6 years of data protection period during which no similar generic drug(s) will be reviewed or approved <p>Compulsory licensing</p> <ul style="list-style-type: none"> ▶ 2018: introduce compulsory licensing mechanism to force deprivation of a patent (thereby allowing the production of generics) during infectious disease epidemic emergencies or to address major public health threats 	<p>Provide data protection period to encourage innovation</p> <p>Issue compulsory licensing policy to prepare for public health emergency</p>	<p>Compulsory licensing hasn't been applied to any product yet</p>
5. Evidence-based selection	<p>National Essential Medicine Policy (NEMP)</p> <ul style="list-style-type: none"> ▶ 2009: 1st NEML included 307 drugs selected by expert committee, implemented at government-owned primary healthcare centres (PHCs) between 2009 and 2012 ▶ 2012: 2nd NEML included 502 drugs, implemented at all PHCs ▶ 2014: 3rd NEMP at public township hospitals (rural) and public hospitals (urban) ▶ 2018: 4th NEML included 685 drugs, implemented at all public hospitals <p>NRDL</p> <ul style="list-style-type: none"> ▶ 2009: pharmacoeconomic evidence was recommended for high-priced drugs ▶ 2016: pharmacoeconomic evidence should be used to compare similar lower-priced and high-priced effective drugs addressing critical clinical needs ▶ 2019: NHSA initiated a standard process of reviewing pharmacoeconomic evidence 	<p>Through phased scale-up strategy, the NEMP attempted to improve the equitable access to essential medicines; NEML has been revised to address clinical needs</p> <p>Pharmacoeconomic evidence received increasing attention in assisting the selection of NRDL to assess cost and effectiveness at the same time</p>	<p>In 2018, 17 anticancer drugs were added to the NRDL.¹²⁸ In 2019, 70 additional drugs have been selected for NRDL.¹²⁹</p>

Continued

Table 1 Continued

WHO framework	Major initiatives between 2009 and 2020	Policy goals/expected outcome	Implementation progress
6. Financing and pricing policies	<p>Zero mark-up and compensation reform</p> <ul style="list-style-type: none"> ▲ 2009: PHCs using NEML claimed zero mark-up drug prices and received special government subsidy for reduced drug profit ▲ 2015: all county public hospitals and city public hospitals in pilot sites ▲ 2017: zero mark-up on consumable medical supplies ▲ End of 2017: all public hospitals <p>Pricing reform</p> <ul style="list-style-type: none"> ▲ Before 2015: retail price ceiling ▲ 2015: classified pricing strategies – Essential medicines and other commonly used drugs: provincial bulk bidding and procurement – Patent drugs and drugs provided by a single manufacturer only: NHSA decides whether to list on NRDL (upon negotiation on price) and reimbursable price for drugs listed on NRDL – Basic injections and commonly used low-cost drugs, and low clinical usage gynaecological, paediatric, emergency drugs: direct online procurement – Clinically necessary drugs with low usage or drugs with a high risk of being in short supply: national bulk bidding for designated manufacturers and price negotiation – Anaesthetics and psychotropic drugs, free drugs for infectious or parasitic diseases, vaccines for National Immunization Plan, family planning drugs and traditional Chinese medicine: price ceiling management and national procurement 	<p>To remove perverse revenue incentives from prescribing and to establish a sustainable, multichannel financing mechanism</p> <p>Apply a different pricing strategy to fully engage the market and to guide the price of medicines, and to better interact with procurement and insurance policies</p>	<p>The price of 45% of essential medicines decreased by an average of 12% in 2009.¹³⁶</p> <p>The new listed drugs on the NRDL through price negotiation achieved an average price decrease of 44% in 2017. 17 anticancer drugs were added to the NRDL in 2018 and a 57% price reduction was achieved on average. In 2019, 70 additional new drugs were listed through price negotiation, resulting in a 61% price drop, and 27 listed drugs successfully renewed their listing, with an overall 26% reduction in price.¹³⁰</p>
7. Procurement and supply	<p>Bulk procurement</p> <ul style="list-style-type: none"> ▲ 2009: a provincial bulk bidding and procurement platform for national essential medicines; bidding was conducted based on quality and price by the provincial government ▲ 2015, 2016 and 2018: Shanghai piloted three rounds of bulk procurement ▲ 2019: 11 cities piloted the bulk procurement policy ▲ 2019 Sep: scale up to 25 provinces <p>Shortage management</p> <ul style="list-style-type: none"> ▲ 2011: database to track NEML with shortage risk ▲ 2012: nominate manufacturers to produce essential medicines with shortage risk ▲ 2014: the bulk bidding and procurement policy was extended to all drugs with shortage risk in all government-owned county or higher-level hospitals ▲ 2016: designated manufacturers for clinically necessary drugs and those with limited supply in all government-owned PHCs and public hospitals ▲ 2017: drugs in limited supply and urgent clinical demand are entitled to AMA ▲ 2018: further improve the availability of drugs, since 2018, negotiation with pharmaceutical companies has been included within the process of adjusting the NRDL for insurance <p>Dual invoicing</p> <ul style="list-style-type: none"> ▲ 2016: dual invoicing was required in bulk procurement for all public hospitals located in over 200 pilot cities. Each drug can have no more than two wholesalers and two invoices—one from manufacturer, and another from wholesaler—that need to be submitted at the bulk procurement platform for regulation ▲ 2018: dual invoicing has been rolled out across the country 	<p>Through information transparency, bid on price and quality, and bulk procurement to reduce drug prices</p> <p>Track shortage information to guide procurement and storage decisions</p> <p>Use AMA, manufacture designation and NRDL listing as policy levers to ensure supply</p> <p>To reduce the mark-ups of wholesalers and ultimately, reduce drug prices</p>	<p>By 30 May 2022, 234 drugs have been ordered through the national bulk procurement, with 53% price reduction on average.¹³¹ Over 20 bulk procurement alliances, mostly cross-provinces, have been formed.^{132 133}</p> <p>By the end of 2022, each province would cover 350 drugs on average through bulk procurement platform at national or subnational level.¹³⁴</p>

Continued

Table 1 Continued

WHO framework	Major initiatives between 2009 and 2020	Policy goals/expected outcome	Implementation progress
8. Quality and appropriate use	<p>Administration of antibiotics and non-therapeutic drugs</p> <ul style="list-style-type: none"> ▲ 2012: apply guideline on the administration of antibacterial drugs ▲ 2018: implement classified management of antibacterial drugs for physicians in different levels of hospitals ▲ 2018: evaluate rational use of medicine as a key performance indicator for assessing hospital leaders ▲ 2019: all hospitals including those in the private sector are subject to assessment of their (ir)rational use of medicine ▲ 2019: issue monitoring catalogue for drugs of high price and high volume, or non-therapeutic auxiliary drugs; special management regimes for glucocorticoid drugs, narcotic drugs, psychotropic drugs, antibacterial drugs, and Chinese herbal medicines and other drugs <p>Pharmacist</p> <ul style="list-style-type: none"> ▲ 2016: provide annual training on rational use of antibiotics to physicians and pharmacists ▲ 2016: all retail pharmacies may only sell antibiotics to customers with prescriptions <p>Online platforms</p> <ul style="list-style-type: none"> ▲ Registration of clinical trials ▲ Monitoring of drug use ▲ Adverse drug reactions ▲ 2015: multiple policies have been announced to promote the traceability of medical product ▲ 2020: vaccine accomplished this milestone by March 2020 and drugs selected in the bulk procurement will be the next to follow 	Improve rational use of medicine	No specific information available
9. Data, monitoring and evaluation	<p>Trackable information to inform decisions</p> <p>Trackable information to inform decisions</p>	Trackable information to inform decisions	No specific information available

NEML, National Essential Medicines List; R&D, research and development.

Rare Disease List³⁴ covering 121 diseases, to encourage the R&D of orphan drugs.

The selection of NRDL also encouraged innovative drugs by considering both the cost and effect of innovative drugs. From 2016 onwards, listing of NRDL has put more emphasis on value for many and applying pharmacoeconomic evaluation evidence to encourage the R&D for new drugs.³⁵

Intellectual property

Since the end of 2017, an open platform has been used to publish patent information endorsed in China with basic information such as active ingredient, brand name, reference listed drug and MAH.³⁶ According to the Law of Intellectual Property, innovative drugs are entitled with 20-year patent protection while innovations in dosage or form enjoy a 10-year period of protection. Innovative chemical drugs can enjoy maximally a 6-year data protection period during which no similar generic drug(s) will be reviewed or approved.³⁷

Compulsory licensing was introduced in 2018 but has not been applied to any drug in China yet. The NHC, the Ministry of Industry and Information, and the NMPA will determine whether to suggest forced deprivation of a patent (thereby allowing the production of generics) to the National Bureau of Intellectual Property during infectious disease epidemic emergencies or to address major public health threats.³⁸

Evidence-based selection

The National Essential Medicine Policy (NEMP) has served as the strategy underpinning China's drug reforms to improve the equitable access to essential medicines. Three editions of NEML have been issued in 2009, 2012 and 2018, respectively. NEML was selected based on clinical necessity, safety, efficacy, cost and convenience of use³⁹ by a committee comprised of experts from the fields of medicine, pharmacy, health insurance administration, price management and the pharmaceutical manufacturing sector.⁴⁰

The development of NEML was aligned with the scale-up plan of NEMP. The first edition of NEML was to be implemented by all government-owned primary healthcare centres (PHCs) during 2009–2012.⁴¹ Considering the regional disparities, provinces are entitled to compile a Supplementary Essential Medicine List (SEML) to meet particular needs, including ethnic drugs and drugs for endemic diseases.⁴² With the improvements made by NEML in 2012, SEML is no longer needed and the NEMP was scaled up for all PHCs, public township hospitals in rural areas and public hospitals in urban areas since 2014.⁴³ In 2018, the NEMP was further scaled up for all public hospitals³¹ and the third NEML was released with comprehensive coverage to address common diseases, non-communicable diseases, major public health challenges, and paediatric, emergency, and oncology drugs at all public hospitals.⁴⁴

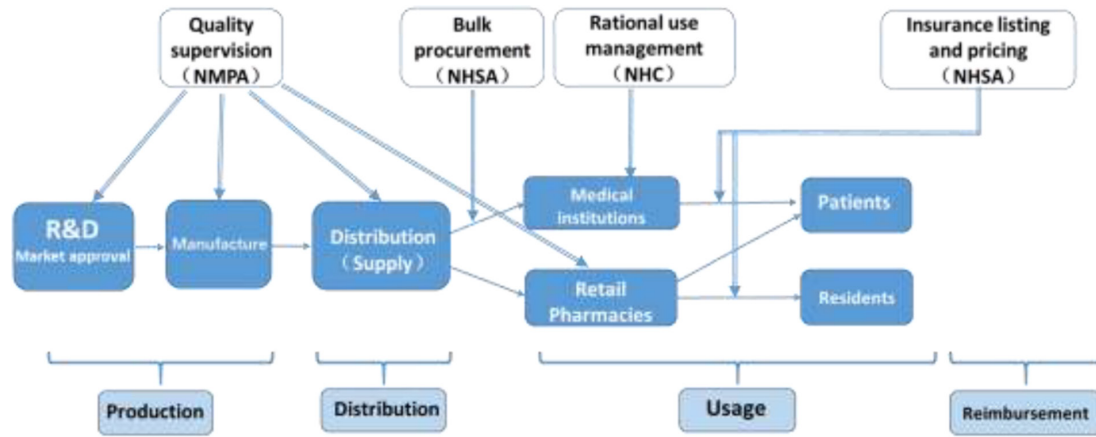


Figure 1 Regulation system of pharmaceuticals in China, 2019. NHC, National Health Commission; NHSA, National Healthcare Security Administration; NMPA, National Medical Products Administration; R&D, research and development.

The NRDL plays a critical role in defining the benefit package provided by basic insurance in China, and the role of pharmacoeconomic evidence has received increasing attention. In 2009, pharmacoeconomic evidence was recommended for high-priced drugs in the NRDL selection.⁴⁵ The revision of the NRDL in 2016 stated clearly that pharmacoeconomic evidence should be used to compare similar lower-priced and high-priced effective drugs addressing critical clinical need.⁴⁶ In 2019, NHSA initiated a standard process of reviewing pharmacoeconomic evidence to inform the decision on whether or not to list and the process of negotiation.⁴⁷

Financing and pricing policies

To remove perverse revenue incentives from prescribing and to establish a sustainable, multichannel financing mechanism at PHCs in the long term, China introduced the zero mark-up policy and compensation reform to complement the NEML first at PHCs with further scale-up plans. PHCs using the NEML were no longer entitled to mark up drug prices and a special government subsidy was allocated to compensate PHCs for reduced drug profit in the short term.⁴⁰⁻⁴⁸ Subsequently, a comprehensive reform of the economic compensation system of PHCs was introduced, including a performance-based salary plan, to ensure that their position was financially sustainable despite their loss of drug mark-up income.⁴⁹ All county public hospitals and city public hospitals in pilot sites have implemented the zero mark-up policy since 2015.⁹ This policy was further extended to include consumable medical supplies in 2017.⁵⁰ The zero mark-up policy was extended to all public hospitals nationwide by the end of 2017.¹²

Management of drug prices has shifted from direct control on the retail price ceiling to reimbursement price, which is now led by the NHSA. Before 2015, retail price ceilings were used to regulate the maximum price for retail, set based on the cost to manufacture the drug, among other factors, but this system came to an end in June 2015.²¹⁻⁵¹ Instead, classified pricing strategies were established to fully engage the market to guide the price of

drugs, and to better interact with procurement and insurance policies. The classified pricing strategies consisted of the following: (a) provincial bulk bidding and procurement for essential medicines and other commonly used drugs; (b) empowering the NHSA to decide the price covered by insurance for drugs listed on the NRDL, for patent drugs and drugs provided by a single manufacturer only, with the NHSA leading the negotiation and, once the price is agreed, listing the drugs on the NRDL; (c) direct online procurement for basic injections, and gynaecological, paediatric and emergency drugs, as well as commonly used low-cost drugs and low clinical usage drugs; (d) national bulk bidding for designated manufacturers and price negotiation for clinically necessary drugs with low usage or drugs with a high risk of being in short supply; (e) price ceiling management and national procurement for anaesthetics and psychotropic drugs, free drugs for infectious or parasitic diseases, vaccines for National Immunization Plan, family planning drugs and traditional Chinese medicine.⁵²⁻⁵³

Procurement and supply

Initially applying only to the NEML and all government-owned PHCs that were implementing the NEMP, a provincial bulk bidding and procurement platform for national essential medicines (NEMs) was established in 2009.³⁹ Bidding was conducted based on quality and price by the provincial government.⁵⁴⁻⁵⁵ In 2015, different procurement strategies were introduced to cope with the classified pricing policy (see the Financing and pricing policies section). Bulk procurement was then introduced in 2015 in an announcement from the State Council.⁵² As the first pilot study, Shanghai conducted three rounds of bulk procurement in 2015, 2016 and 2018, respectively. Starting from 2019, 11 cities were selected as pilot sites for the bulk procurement policy. Within those pilot cities, 25 pilot drugs (23 of which were generic drugs that had passed quality and BA) were selected for pricing and procurement reforms. These changes were accompanied by a bulk procurement bidding system that depends on the agreed volume of the drugs.³²⁻⁵⁶⁻⁵⁷ Then, in September

2019, the bulk procurement was rolled out to 25 provinces.⁵⁸

To manage the shortage of drugs, multiple efforts have been invested with an increasing scope. A database was established in 2011 to collect information on NEMs that had a high risk of shortage, and thereby guide drug purchasing.⁵⁹ In 2012, manufacturers were nominated for the production of essential medicines with a high risk of shortage to ensure a stable supply.⁶⁰ Meanwhile, surveillance of the drugs included on the shortage list was conducted, and central and local governments were advised to establish storage mechanisms for these drugs.⁶¹ In 2014, the bulk bidding and procurement policy was extended to all drugs (including those not on the NEML) with a high risk of shortage and commonly used, low-cost drugs in all government-owned county or higher-level hospitals.⁶² In 2016, clinically necessary drugs identified by the National Health and Family Planning Commission (NHFPC, the former of NHC) and those with limited supply were put out to tender so as to designate manufacturers for each, and all government-owned PHCs and public hospitals were required to store and use drugs from the designated manufacturer.⁶³ Since 2017, drugs in limited supply and urgent clinical demand are entitled to AMA.⁶⁴ Online supplemental box 1 provided case study on the management of drug supply shortages at the provincial level.

In 2016, to regulate the management of supply, dual invoicing was required in bulk procurement for all public hospitals located in over 200 pilot cities.⁶⁵ Since 2018, dual invoicing has been rolled out across the country.⁶⁶ The main purpose of dual invoicing is to reduce the mark-ups of wholesalers and ultimately, reduce drug prices. Each drug can have no more than two wholesalers and two invoices—one from the manufacturer, and another from the wholesaler—that need to be submitted at the bulk procurement platform for regulation.

Quality and appropriate use

Administration of antibiotics and non-therapeutic drugs was the focus of clinical management. Rational use of medicine is evaluated and ranked regularly by the health commissions and regarded as a key performance indicator for assessing hospital leaders.⁶⁷ Since 2019, all hospitals including those in the private sector are subject to assessment of their (ir)rational use of medicine.⁶⁸ In particular, the appropriate use of antibiotics has been made a management priority. In 2012, the Management of Clinical Application of Antibacterial Drugs was implemented to guide the administration of antibacterial drugs and in 2018, NHC announced regulations to implement classified management of antibacterial drugs to define different prescription requirements for physicians in different levels of hospitals.^{69 70} Monitoring specific drugs is another approach to regulating the appropriate use of medicines.¹⁰ Drugs of high price and high volume, or non-therapeutic auxiliary drugs were listed in the National Key Monitoring and Rational Drug Catalog in

2019.⁷¹ There are also special management regimes for glucocorticoid drugs, narcotic drugs, psychotropic drugs, antibacterial drugs, and Chinese herbal medicines and other drugs.^{68 72}

Pharmacists have been empowered with more responsibility for managing the rational use of medicine. Pharmacists are required to be the focal person for prescriptions, conducting prescription audits and sending feedback on rational medicine use to physicians.⁷³ Since 2016, training on rational use of antibiotics is being provided to physicians and pharmacists annually, and all retail pharmacies may only sell antibiotics to customers with prescriptions.^{74 75}

Data, monitoring and evaluation

National information systems have been widely applied in the registration of CTs, the monitoring of drug use and adverse drug reactions since 2019.⁷⁶ Since 2015, multiple policies have been announced to promote the traceability of medical products.^{77 78} Vaccine accomplished this milestone by March 2020 and drugs selected in the bulk procurement will be the next to follow.⁷⁹ Further, provincial information platforms have been established for procurement^{80 81} and monitoring shortages of drugs. Some local departments and hospitals have even developed artificial intelligence to use in managing rational medicine use, such as the auxiliary prescription comments implemented in Chongqing. However, the implementation varies across the country. Online supplemental box 2 provided case study on drug procurement platforms at provincial level.

SUMMARY OF THE REFORMS

If we revisit the timeline of China's drug reforms, we can clearly divide China's various drug reforms in the past decade into three interactive stages centred with specific objectives.

Phase 1 (2009–2014) started from the implementation of NEML in tandem with the zero mark-up policy and provincial bulk bidding in primary care. This stage aimed to ensure the availability, affordability and rational use of essential medicines by focusing on a limited number of drugs (NEML), basic care for the whole population, and covering the selection, procurement and financing mechanism. Phase 1 also piloted new financing mechanisms to replace the perverse incentives from drugs mark-ups which had been standard practice in China for decades. Phase 1 reform has thus provided equitable access to NEMs for the whole population while reducing prices.^{82–85} However, increased service use at higher levels and increased total expenditure per outpatient visit have been reported as unintended consequences of the limited scope of NEMs and the zero mark-up policy.^{86 87}

Phase 2 (2015–2017) aimed to address issues arising from phase 1 and explored innovative pricing and market approval mechanisms, as well as regulation of supply management. The zero mark-up policy was fully

scaled up at all public hospitals while the retail price ceiling was abolished. AMA was introduced as policy lever to encourage the R&D of innovative drugs or drugs addressing critical clinical demand. Quality and price were balanced via bulk procurement and BA, and a dual invoice policy was introduced to regulate the supply chain. In this second phase, innovative, high-quality pharmaceutical products were favoured and regulation of profit in the supply chain was further tightened. Although evidence on the reduction of drug expenditure is mixed, the number of wholesalers and small retailers dropped significantly, indicating the progress in regulating the distribution of drugs.^{88 89}

The establishment of NHSA marked phase 3 (2018–) of the drug reforms. With over 95% of the population covered by basic medical insurance since 2012, the NHSA is playing a critical role as a strategic purchaser for high-quality pharmaceutical products. The listing of NRDL has taken advantage of pharmacoeconomic evidence to cover innovative pharmaceutical products with better outcomes. The bulk procurement policy led by NHSA attempted to connect the bidding and procurement with volume of the drugs. To address rising expectations of healthcare, the MAH system is another attempt to mobilise resources from the pharmaceutical industry and hospitals for quality assurance. Many innovative drugs have been put on the NRDL with substantial price reductions, yet concerns about access to orphan drugs and the sustainable development of the pharmaceutical industry have emerged. The establishment of the compulsory licensing created a mechanism and opportunity to obtain access to medicines during public health threats such as the COVID-19 pandemic.

PROGRESS AND CHALLENGES

China's drug reform has covered all of the key components under the WHO framework. Impressive progress has been observed in certain areas while further improvements will be needed for some other areas.

The governance mechanism has been well defined after the institutional reform, but the current legal system is still in its nascent stages. More laws need to be developed to rule specific areas, and regulations should be accompanied with detailed implementation plans to guide the daily practice. Several new policies have been introduced to improve the quality of products. However, evidence about the quality of drugs in China is limited and there have been certain concerns from patients and providers on quality of drugs.^{87 90–92} It is important to monitor the quality of drugs and keep improving the regulations on drug quality.

AMA and compulsory licensing are two noteworthy movements that could significantly improve the innovation and intellectual property in China. The recent reform on the market approval has reduced the review period of new drugs thus the accessibility has been improved.^{93 94} However, awareness and financial burden

were reported as the leading barriers to improving access to medicines.^{95 96} Matching policies, such as the connection between AMA and insurance listing and pricing policy, preferred consideration for orphan drugs, etc and should be developed and applied gradually. Criteria for activating compulsory licensing should be developed in a transparent manner so as to prepare for the future pandemic.

Pharmacoeconomic evidence has been widely applied worldwide but there are limited high-quality pharmacoeconomic studies in China. It will take years of capacity building and data collection to generate the evidence needed for insurance listing.

China has attempted decades to reform the financing, supply and rational use of medicine, which led to various improvements and unexpected results. The proportion of pharmaceutical expenditure as a share of China's total health expenditure decreased steadily to 32.73% in 2018, the lowest in the past two decades.⁹⁷ Price of drugs decreased,^{54 84 98–101} yet early evidence on affordability of drugs seems to be mixed.^{82 102–105} Other evidence reported the total health expenditure increase because of the increased volume of services (in upper level hospitals) and increased provision of diagnostic tests and basic medical services.^{87 101 106–108} The availability of drugs has been improved but shortage still remained an issue for some drugs. Rational use of medicine has made limited improvement in selected indicators and subpopulation groups but the majority of research has concluded that irrational medicine use is still an alarming issue.^{109–118} Efficiency in drug distribution has been improved with reduced number of distributors.^{119 120}

The latest reform has to establish a sustainable financing mechanism to compensate reasonable cost for prescriptions while they remain de-linked from the unit price or sales revenue of drugs. Some early evidence has observed improved availability and affordability of drugs.^{121–125} However, it might take additional time to observe the policy impact comprehensively. Additionally, there are critical shortfalls in both the quantity and capacity of pharmacists in the short term in China.

LESSONS FOR OTHER COUNTRIES

Regardless of the differences in health systems, there are several good practices from China's drug reforms that can be beneficial for other countries that plan to start or have started their drug reforms.

China's drug reform in the past decade has been closely linked to the overall health system reform and indeed is an integral part of the health reform. It has many advantages: drug reform can serve the goals of the overall health system reform, while other sectors, interacted with drug reform, also provided sufficient support for drug reform. In this way, drug reform can receive adequate resources, political commitment as well as good coordination with other sectors of the health system. For example, the insurance has become

the largest purchaser in China's health market. Therefore, the drug reform has taken the advantage of the negotiation power of health insurance, using the listing of NRDL and procurement to secure a reasonable price of drugs for the Chinese population. Another example is the interaction between 'zero mark-up policy' and the public hospital reform. While the zero mark-up policy aimed to remove the mark-ups of drugs, the public hospital reform formed a new compensation mechanism for the hospitals.

China adopted a systemic approach that aligned multiple policy levers including governance, regulation and financing. NLPPM was amended in 2019 to provide powerful legal support for 'AMA'. The establishment of NHTSA created the largest health service purchaser to determine coordinated decisions for insurance listing and procurement. The introduction of BA provides critical foundation for the pricing and procurement reform. The implementation of the zero mark-up policy also involved multiple levers, including the financing reforms for hospitals and health providers, and the supply and distribution management (the dual invoice). Additionally, the interactions among the drug value chains should not be neglected.

China's drug reform has tailored strategies to achieve a wide range of goals. The NEMP aimed to ensure the access to, quality and affordability of the most common drugs at primary health centres. The focus on essential medicines has been expanded through the classified pricing policy which has developed special strategies for different drugs. For those inadequate drugs, ensuring the supply was the core and designated manufacturing has been applied. The bulked procurement strategy has been used for drugs with high consumption to get a better price and efficiency in distribution. All these approaches highlighted China's strategy to develop different approaches to serve a variety of reform goals.

China attempted to place more incentives for stakeholders in the whole ecosystem instead of strict regulations or direct investment by the government. The government still holds accountability in planning, issuing laws and regulations, and providing financial support; the priority shifted towards establishing a sustainable mechanism to mobilise resources and incentivise stakeholders. The government health expenditures as a share of the total government expenditures increased from 5.7% to 7.5% between 2009 and 2019. Instead of subsidising health providers, more government expenditures have been spent on establishing the health insurance schemes. To address the increasing demand and control the rapid growth of drug expense, the government has set up multiple mechanisms to encourage the R&D for innovative drugs or drugs addressing critical clinical needs, covering the market registration, insurance listing, pricing and procurement strategies on those drugs. Meanwhile, regulation on the revenues from supply, distribution and prescriptions became the priority of the drug reform.

There is no one-size-fits-all model. Instead, pilot studies can provide great information to support policy design and implementation. Several key drug reforms have selected pilot studies to observe the effects of reform, refine the policies and scale up at national level. Additionally, regions with a different socioeconomic development and capacity in governance provided additional reform options. The drug reform in China has taken another approach of piloting—developing innovative policy on small numbers of drugs and then expanding the same approach to bigger numbers of drugs. The zero mark-up policy can be regarded as the best example. In 2009, it was only implemented on the drugs on NEML at PHCs. After several years of implementation and gradual transition in the financing mechanism to replace the drug mark-ups, the zero mark-up policy was applied for all drugs at public providers.

CONCLUSION

China's drug reform has adopted a phased and systemic approach that mobilize multiple policy levers including governance, regulation and financing. Despite the progress, emerging challenges in implementation, coordination and capacity need to be addressed. Cross-cutting lessons from China's drug reforms include aligning the drug reform with the overall health reforms, adapting a systemic approach that mobilized policy levers and stakeholders and informing policy decision by conducting pilots.

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Appendix 1 Review: searching strategy

1. The websites of relevant national government departments have been systematically searched to identify relevant policy documents and government reports. We searched following government departments:

- Ministry of Commerce <http://www.mofcom.gov.cn/>
- Ministry of Education <http://www.moe.gov.cn/>
- Ministry of Finance <http://www.mof.gov.cn/index.htm>
- Ministry of Human Resources and Social Security <http://www.mohrss.gov.cn/>
- Ministry of Industry and Information Technology <https://www.miit.gov.cn/>
- Ministry of Science and Technology <https://www.most.gov.cn/index.html>
- National Administration of Traditional Chinese Medicine <http://yzs.satcm.gov.cn/>
- National Development and Reform Commission <https://www.ndrc.gov.cn/>
- National Health Commission (former National Health and Family Planning Commission, Ministry of Health) <http://www.nhc.gov.cn/>
- National Healthcare Security Administration <http://www.nhsa.gov.cn/>
- National Medical Products Administration (former National Food and Drug Administration) <https://www.nmpa.gov.cn/>
- State Administration for Market Regulation <https://www.samr.gov.cn/>
- State Taxation Administration <http://www.chinatax.gov.cn/>
- The State Council <http://www.gov.cn/guowuyuan/index.htm>

2. We searched PubMed, Google Scholar, MEDLINE, Wiley Online Library, and China Knowledge Resource Integrated Database (CNKI) for articles published between 2009 and 2020. We searched following terms (and their equivalent terms in Chinese): drug, medicine, pharmaceutical, essential medicine, drug procurement, drug supply, drug expense, market approval, insurance listing, zero mark-up, drug pricing, pharmacist, rational use of medicine.

3. We also applied snowballing approach to further search websites or publications until we reached saturation.

Appendix 2 List of policy documents, issuing agencies and key contents (ranked by year of issuance)

Year	Title of reform documents	Issuing agencies	Key contents
2009	Implementation Opinions on Establishing the National Essential Medicine Policy	Ministry of Health, National Development and Reform Commission, Ministry of Industry and Information, Ministry of Supervision, Ministry of Finance, Ministry of Human Resources and Social Securities, Ministry of Commerce, National Food and Drug Administration, National Administration of Traditional Chinese Medicine	Establishment of NEMP and its matching policies
2009	Regulation on the National Essential Medicine List (Temporary)	Ministry of Health, National Development and Reform Commission, Ministry of Industry and Information, Ministry of Supervision, Ministry of Human Resources and Social Securities, Ministry of Commerce, National Food and Drug Administration, National Administration of Traditional Chinese Medicine	Regulation on the National Essential Medicine List including selection criteria and process.
2009	Implementation of Performance-based Payment at Public Health and Primary Healthcare Institutions	Ministry of Human Resources and Social Securities, Ministry of Finance, Ministry of Health	Reform of the compensation system of PHCs, including performance-based salary plan to sustain the financial development after the implementation of Zero Mark-up Policy
2009	Notice on Strengthening Quality Supervision and Assurance for Essential Medicine	National Food and Drug Administration	Quality of essential medicines, monitor the adverse reactions from essential medicines
2010	Guiding Opinions on Establishing and Regulating the Procurement Mechanism for Essential Medicines in	Office of the State Council of China	Implementation of of provincial procurement for NEMPs

	Government-owned Primary Healthcare Institutions		
2010	Notice on Issuing the Working Standard for the Bulk Procurement of Medicines for Hospitals	Ministry of Health, National Development and Reform Commission, Ministry of Supervision, Ministry of Financing, China Food and Drug Administration, et al.	Implementation plan for the procurement of NEMP
2010	Opinions on Establishing Comprehensive Compensation Mechanism at Primary Healthcare Institutions	Office of the State Council of China	Establishment of comprehensive compensation mechanism at PHCs to sustain the financial development after the implementation of Zero Mark-Up policy
2011	Opinions on Ensuring the Supply of Essential Medicines for Infectious Diseases and Emergency Medicines	Office of Ministry of Health, Office of Ministry of Industry and Information	Shortage management for essential drugs
2011	Regulation on the clinical management of drugs	Ministry of Health, National Administration of Traditional Chinese Medicine, State Commission of Supply and Security	Special managements for glucocorticoid drugs, narcotic drugs, psychotropic drugs, antibacterial drugs and Chinese herbal medicines and other drugs
2012	Notice on the Designated Manufacture for Essential Medicines with High Risk of Shortage	Ministry of Industry and Information, Ministry of Health, National Development and Reform Commission, National Food and Drug Administration	Designation of manufacturers for essential medicines with high risk of shortage
2012	Regulation on the clinical application of antibacterial drugs	Ministry of Health	Administration of antibacterial drugs
2013	Opinions on Enhancing and Improving the National Essential Medicine and Establishing the New Operation	Office of the State Council of China	Scale up of NEMP to non-government owned PHCs

	Mechanism at Primary Healthcare Institutions		
2013	Opinions on deepening the reform of drug review and approval to further encourage drug innovation	The State Food and Drug Administration of China	Accelerated market authorization for innovative patent drugs or drugs addressing current gaps in clinical need
2014	Opinions on Ensuring the Supply of Commonly Used Medicine with Low Prices	National Health and Family Planning Commission, National Development and Reform Commission, Ministry of Industry and Information, Ministry of Finance, Ministry of Human Resources and Social Securities, Ministry of Commerce, National Food and Drug Administration, National Administration of Traditional Chinese Medicine	surveillance and storage of the drugs included on the shortage list
2014	Notice on Ensuring the Procurement of Commonly Used Medicines with Low Price	Office of National Health and Family Planning Commissions	Bulked bidding and procurement policy to all medicines
2014	Opinions on Further Strengthening the Provision, Use and Management of Medicines at Primary Healthcare Institutions	National Health and Family Planning Commission	Scale up of NEMP to public township hospitals in rural areas and public hospitals in urban areas
2015	Guiding Opinions on improving the bulked procurement for public hospitals	Office of the State Council of China	Bulked procurement with the guaranteed procurement volume of medicines
2015	Charging standards and Implementation Rules for drug and medical device registration	The State Food and Drug Administration of China	Waiver of the registration fee for innovative patent drugs

2015	Issuance of the Summary from 2014 and Work Plan for the Healthcare System Reform 2015	Office of the State Council of China	Scale up of Zero Mark-up Policy to all county public hospitals and city public hospitals in pilot sites
2015	Guiding Opinions on Improving the Bulked Procurement of Medicines in Public Hospitals	Office of the State Council of China	Classified pricing strategies
2015	Notice on Implementing and Improving the Bulked Procurement of Medicine in Public Hospitals	National Health and Family Planning Commission	Classified pricing strategies
2015	Notice on the Issuance of Clinical Guideline of Antibiotics (2015)	Office of National Health Commission, Office of National Administration of Traditional Chinese Medicine	Regulation on the retail of antibiotics
2016	Notice on the Issuance of National Action Plan for Stopping Antibiotics Resistance (2016-2020)	National Health and Family Planning Commission, National Development and Reform Commission, Ministry of Education, Ministry of Science and Technology, Ministry of Industry and Information, Ministry of Finance	Supervision on the R&D, manufacturing, distribution and use of antimicrobial drugs
2016	Opinions on Further Improving and Reforming the Manufacturing, Supplying and Using of Medicine	Office of the State Council of China	Implementation plans for the accelerated market authorization
2016	Opinions on Establishing the Quality and Bioequivalence Assessment on Generic Medicines	Office of the State Council of China	Establish Bioequivalence Assessment on Generic Medicines
2016	Notice on Establishing Designated Manufacturer for Clinical Necessary and Shortage in Supply Medicines	National Health and Family Planning Commission, Ministry of Industry and Information, National Development and Reform	Storage of shortage drugs by all government owned PHCs and public hospitals from the designated manufacturer

		Commission, National Food and Drug Administration	
2016	Notice on the Sound Implementing of National Negotiation and Bulk Procurement of Medicine	National Health and Family Planning Commission, National Development and Reform Commission, Ministry of Human Resources and Social Securities, Ministry of Commerce, National Food and Drug Administration	Classified pricing strategies
2016	Opinions on the Implementing the Dual Invoice for the Bulk Procurement of medicine in Public Hospitals	Healthcare Reform Office of the State Council, National Health and Family Planning Commission, National Food and Drug Administration, National Development and Reform Commission, Ministry of Industry and Information, Ministry of Commerce, State Taxation Administration and National Administration of Traditional Chinese Medicine	Dual invoice
2017	Notice on Promoting the Supply of Shortage Medicine	National Health and Family Planning Commission, National Development and Reform Commission, Ministry of Industry and Information, Ministry of Finance, Ministry of Human Resources and Social Securities, Ministry of Commerce, National Food and Drug Administration, et al	Accelerated market authorization for drugs with limited supply and addressing urgent clinical needs
2017	Opinions on the Fully Implementation of Price Reform	National Development and Reform Commission	Zero mark-up for medical disposable products
2017	Opinions on deepening the reform on the review and approve to encourage the innovation of drugs and medical devices	National Medical Products Administration	Patent policy for first domestic generic drug

2017	Opinions on encouraging the prioritized review and approve on innovative drugs	The State Food and Drug Administration of China	Implementation plans for the accelerated market authorization
2017	Opinions on Further Improving and Reforming the Manufacturing, Supplying and Using of Medicine	Office of the State Council of China	Implementation plans for the accelerated market authorization
2017	Issuance of the Work Plan for the Healthcare System Reform 2017	Office of the State Council of China	Scale up of Zero mark-up policy to all public hospitals national wide
2018	Issuance of the National Essential Medicine List (2018)	National Health Commission and National Administration of Traditional Chinese Medicine	Issuance of the third edition of NEML
2018	Opinions on Enhancing the Supply and Use of Generic Medicine	Office of the State Council of China	Enforced patent policy
2018	The list of rare diseases (first edition)	National Health Commission, Ministry of Science and Technology, Ministry of Industry and Information, National Medical Products Administration, National Administration of Traditional Chinese Medicine	The first edition of Rare Disease List to encourage the R&D of orphan drugs
2018	Opinions on Improving the National Essential Medicine Policy	Office of the State Council of China	Inclusion of equipment and use of essential medicines as an evaluation criterion for each province
2018	Document on 4+7 bulked procurement for drugs	United procurement office	Bulked Procurement and Reference Price policy
2018	2019 Work Plan for the Adjustment of National Insurance Reimbursable List (Exposure Draft)	National Health Insurance Administration	Accelerated market authorization for drugs with limited supply and addressing urgent clinical needs

2018	Notice on the Issuance of Prescription Audit Guideline for Hospitals	Office of National Health Commission, Office of National Administration of Traditional Chinese Medicine	Pharmacists and prescription audits
2019	Opinions on enhancing the performance assessment for public tertiary hospitals	Office of the State Council of China	Assessment of rational use of medicines for all hospitals including private sectors hospitals
2019	Notice of the performance assessment on the rational use of drugs for hospitals.	Office of National Health Commission.	Assessment of rational use of medicines for all hospitals including private sectors hospitals
2019	Notice on the continuously improving the clinical management on the antibiotics	Office of National Health Commission	Classified management on antibacterial drugs
2019	National monitoring drug list for the rational use (Chemicals and biological products) (first cohort)	Office of National Health Commission and Office of National Administration of Traditional Chinese Medicine	Issuance of National key monitoring and rational drug catalogue to regulate medicines of high price, high volume or non-therapeutic auxiliary medicines
2019	Opinions on ensuring the supply and stabilizing the price of shortage medicines	Office of the State Council of China	Integration of the shortage medicine monitoring platform with multiple sources from hospitals, NMPA, NHSA, etc.
2019	Notice on Organizing and Using the Medicines from National Bulk Procurement	Office of the State Council of China	Bulk Procurement and Reference Price policy
2019	Opinions on the Matching Strategies of Insurance for the National Bulk Procurement for Medicine	National Healthcare Security Administration	Bulk Procurement and Reference Price policy
2019	The National Law of Pharmaceutical Products Management (amendment)	The State Council	Accelerated approval for medicines and the MMAS

2019	Law of Essential Health Services and Health Promotion	The State Council	Promote the NEMP and R&D of drugs; establishment of tracking mechanism for the whole life span of drugs
2020	Notice in the issuance of the national shortage drug list management	Office of National Health Commission, Office of National Development and Reform Commission, Office of Ministry of Industry and Information, Office of Ministry of Financing, Office of Ministry of Biological Environment, Office of Ministry of Commerce, Office of National Property Commission of State Council, Office of State Administration for Market Regulation, Office of National Health Security Administration, Office of National Chinese Medicines Administration, General Office of National Medical Products Administration, Office of State Army Commission of Supply and Security	Management plan on the list of shortage medicines
2020	Regulation on the Drug Manufacture and Management Plan for Drug Registration	State Administration for Market Regulation	Qualifications, management and supervision for drug manufacture, and registration of drugs, including the accelerated registration for breakthrough new drugs.
2020	The Interim Management Plan of the Insurance Reimbursable Drugs	National Healthcare Security Administration	Selection of NIDRL and the reimbursement for drugs on NIDRL

Appendix 3 Subnational case studies

Box 1 Case study on the management of drug supply shortages

At provincial level, multiple government departments are engaged to coordinate the supply management of drugs listed on the national and provincial shortage lists. By tracking the transaction records on the provincial drug procurement platforms and reports from sentinel hospitals, multi-sectoral meetings are regularly held to discuss the causes for the shortages of drugs and potential solutions to recover the supply. Provincial government can voluntarily report the unaddressed shortages to central government.

In Chongqing Municipality, multiple mechanisms covering stock, supply, pricing, and procurement have been established to address the undersupply of drugs. Chongqing Pharmaceutical Exchange as a procurement platform recording purchasing transactions of drugs, along with the hospital medicine inventory, constitutes the main body of the shortage tracker. The Drug Administration Department of the Municipal Health Commission monitors the use of shortage medicines in healthcare facilities. The undersupplies or shortage of drugs reported by news media are also collected to track shortage. Municipal Commission of Economy and Informatization routinely reserves one-month stock for 29 shortage emergency drugs. The Municipal Medical Products Administration (MPA), with support from multiple government agencies, coordinates response to drug shortages within 10 working days. In terms of shortage caused by low price, the Municipal Healthcare Security Administration (MHSA) has the right to adjust the reimbursement price after investigation.

The Shanghai Medical Procurement Administrative Agency (SMPA), affiliated to the Shanghai MHSA, gathers shortage information by monitoring purchasing on the Sunshine Medical Procurement All-In-One website and regular reports from hospitals. Based on the monitoring information, SMPA compares the local situation to national shortage statistics and determines whether the insufficient drugs are caused by interrupted manufacturing, delayed shipment, or other reasons. SMPA announces a list of the shortage drugs online for procurements. If the supplier responds to the procurement order with quotes of reasonable price comparable to other regions, MHSA will accept the quotes and hospitals can purchase the drug accordingly.

In Guangdong Province, the Drug Administration Department of the Provincial Health Commission takes the responsibility to collect the use and stock information regarding to the 27 medicines on the provincial shortage list. Medicines for chronic diseases generally receive high priority from the Drug Administration Department and Provincial Healthcare Security Administration. With an annual subsidy of 4.5 million RMB by the provincial government, shortage medicines valued more than 30 million RMB have been reserved in Guangdong. To ensure the drug supply at PHCs in the remote areas, tertiary hospitals are required to equip emergency drugs and other commonly used drugs for PHCs nearby. Furthermore, different levels of hospital have formed consortia to increase their purchasing power and thus improve the drug supply.

Box 2 Case study on drug procurement platforms

Led by the Chongqing municipal government, the Pharmaceutical Exchange (PE) was founded in March 2010. It's a third-party trading platform to provide online services for tendering for and purchasing medical products such as pharmaceuticals, medical devices, and medical disposable products. Hospitals, manufacturers and distributors can register membership on PE after their qualifications have been reviewed and accredited. Under the ceiling price set by PE, the purchaser and suppliers directly negotiate price, select distributors, and sign electronic contracts on PE. The medical institutions are obligated to remit to the PE

within 60 days after signing the contract. Then PE performs check on all transaction procedures before settling the payment. Because the trading information on the PE website is publicly available, it significantly increases the transparency and make government regulation and public supervision more convenient.

The Shanghai Sunshine Medical Procurement All-in-One website was established in 2015 and operated by the public institution known as the Shanghai Medical Procurement Administrative Agency (SMPA). It is a municipal procurement platform connecting public hospitals, private hospitals and pharmacies designated by health insurance authority, manufacturers and distributors. The medical institutions and pharmacies are required to purchase all the medicines they need through the platform, except those hospital-made preparations and traditional Chinese medicines preparations, and to upload invoice information in a standardized format. SMPA has also developed a set of uniform codes for all medicines to monitor the volume and prices of sales.

In Guangdong province, in addition to the provincial not-for-profit bidding platform operated since 2013, Shenzhen and Guangzhou cities developed their own platforms for procurement in 2017 and 2018, respectively. In Shenzhen, the portfolio of commonly used medicines for all public hospitals with their estimated volume in one year forms a bulk procurement order. With a predetermined budget, the order was then entrusted to a third-party group purchasing organization (GPO) to complete purchase from the suppliers. The group purchasing in Guangzhou was conducted by the municipal Healthcare Security Administration and its online platform was operated by Guangzhou Public Resources Trading Center. In other prefecture-level cities in Guangdong, at least one of the three platforms had to be used to conduct drug purchase for public hospitals up to June 2019.