Social Science & Medicine 145 (2015) 201–208

Contents lists available at ScienceDirect

Social Science & Medicine

journal homepage: www.elsevier.com/locate/socscimed

Organizational barriers associated with the implementation of national essential medicines policy: A cross-sectional study of township hospitals in China

Lianping Yang [a], Chaojie Liu [b], J. Adamm Ferrier [b], Xinping Zhang [c, *]

[a] School of Public Health, Sun Yat-sen University, PR China
[b] School of Public Health, La Trobe University, Australia
[c] School of Medicine and Health Management, Tongji Medical College of Huazhong University of Science and Technology, PR China

ARTICLE INFO

Article history:
Received 5 January 2014
Received in revised form
18 August 2015
Accepted 26 August 2015
Available online 2 September 2015

Keywords:
China
Essential medicines
Township hospitals

ABSTRACT

This study identifies potential organizational barriers associated with the implementation of the Chinese National Essential Medicines Policy (NEMP) in rural primary health care institutions. We used a multi-stage sampling strategy to select 90 township hospitals from six provinces, two from each of eastern, middle, and western China. Data relating to eight core NEMP indicators and institutional characteristics were collected from January to September 2011, using a questionnaire. Prescription-associated indicators were calculated from 9000 outpatient prescriptions selected at random. We categorized the eight NEMP indicators using an exploratory factor analysis, and performed linear regressions to determine the association between the factor scores and institution-level characteristics. The results identified three main factors. Overall, low levels of *expenditure of medicines* (F1) and poor performance in *rational use of medicines* (F2) were evident. The *availability of medicines* (F3) varied significantly across both hospitals and regions. Factor scores had no significant relationship with hospital size (in terms of number of beds and health workers); however, they were associated with revenue and structure of the hospital, patient service load, and support for health workers. Regression analyses showed that public finance per health worker was negatively associated with the availability of medicines ($p < 0.05$), remuneration of prescribers was positively associated with higher performance in the rational use of medicines ($p < 0.05$), and drug sales were negatively associated with higher levels of drug expenditure ($p < 0.01$). In conclusion, irrational use of medicines remains a serious issue, although the financial barriers for gaining access to essential medicines may be less for prescribers and consumers. Limited public finance from local governments may reduce medicine stock lines of township hospitals and lead them to seek alternative sources of income, jeopardizing their capacity to meet the needs of local consumers.

1. Introduction

The World Health Organization (WHO) estimates an expenditure of approximately US $5.3 trillion on health services worldwide, 25% of which is medical expenditure (WHO National Health Accounts data files for 2006) (WHO, 2011). However, almost half of the global population lack regular access to essential drugs (WHO, 2004). On the basis of these data, WHO estimates that by 2015, over 10 million deaths could be avoided every year by effective health policy interventions, such as a national essential medicines policy (NEMP) (WHO, 2013).

WHO defines essential medicines as "those that satisfy the priority health care needs of the population" (WHO, 2001b). They are selected by their public health relevance, evidence of efficacy and safety, and comparative cost-effectiveness. It was also stated that essential medicines "ought to be available at all times, in the proper dosage forms, to all segments of society" (Laing et al., 2003; WHO, 2001b). The WHO guidelines on essential medicines are ratified by member states.

Government of China proposed the establishment of a NEMP, identifying it as one of the five top priorities in its recent health reform strategy (2009–2011) (State Council of China, 2009). NEMP was aimed to increase the availability of cost-effective medicines

* Corresponding author. No.13 Hangkong Road, Wuhan, Hubei Province 430030, PR China.
E-mail address: xpzhang602@163.com (X. Zhang).

http://dx.doi.org/10.1016/j.socscimed.2015.08.044
0277-9536/

(by reducing the overall drug expenditure), ensure the quality of supplied medicines, and reduce the incidence of irrational drug use (e.g., counterfeit drugs, overprescription of antibiotics, and intravenous administration routes) (Ministry of Health of the P.R.China, 2009b; WHO, 2001a). Although China embraced the concept of essential medicines in 1979 and issued a national essential medicines list (EML) in 1982, until relatively recently it lacked a comprehensive NEMP. The current NEMP was promulgated by the Ministry of Health (MOH), the National Development and Reform Commission (NDRC), and seven other agencies in 2009, with policies and procedures addressing selection, production, procurement, supply, and use of essential medicines, as well as pricing, payment, monitoring, and evaluation arrangements (Ministry of Health of the P.R.China, 2009b).

After an initial 3-year period (2009–2011), the NEMP was extended to all public primary health care institutions (mainly rural township hospitals and urban community health centers). The 2009 version of the national EML comprised 307 generic medicines, including 205 chemical and biological varieties and 102 traditional Chinese medicines (TCMs) (Ministry of Health of the P.R.China, 2009a). After the implementation of the NEMP, only essential medicines could be prescribed in primary health care institutions. Bulk purchasing was made a compulsory procurement requirement for implementing the NEMP, and a head procurement agency was established in 31 provinces and municipalities. The NEMP was also characterized with a zero-mark-up policy for the essential medicines, which decreased the average cost per clinical visit and drug cost per prescription of the consumers (L. Yang et al., 2013a).

Researchers have expressed concerns about the NEMP in China: most importantly, the 307 essential medicines are insufficient to meet all potential clinical requirements (Hu, 2013; L. Yang et al., 2013b). As a consequence, each province has expanded the range of essential medicines by developing a local supplementary list, which included an additional 64 to 381 medicines (Wang and Zhang, 2011). This will result in the implications for geographical equity of the NEMP, because the number of medicines included in the supplementary list often depends on the financial capacity of the local government. Hu (2013) argues that restriction of prescription rights of doctors (reducing drug availability) in primary health care institutions may result in patients approaching larger providers. This will skew demand, affect clinical performance, reduce income, and contribute to disincentives for health workers to remain in primary health care institutions (Hu, 2013). Another issue relates to feasibility of financial subsidies from local governments for implementing the zero-mark-up policy, as some may not be able or be willing to fully compensate the lost income from drug sales (L. Yang et al., 2013b).

This study aims to identify the organizational barriers associated with the implementation of NEMP in a representative sample of rural township hospitals. In China, there are salient disparities in health care resources and health services delivery between urban and rural populations. We selected rural facilities as the focus of this study, because the majority of primary health care institutions are located in these areas. In 2012, there were 37,707 rural township hospitals, almost four times more than the number of urban community health centers (8182) (Ministry of Health of the P. R. China, 2013). Empirical evidence showed that urban people are more likely to seek medical attention from tertiary hospitals than their rural counterparts for health problems that might otherwise be treated in a primary care setting. It is also evident that drug misuse and prescription abuse are more common in rural areas than urban settings (Chen et al., 2014; Yip et al., 2012). Behaviors of rural health workers may also differ from their urban colleagues, because of difference in consumer demands and health workforce training.

In rural areas of China, township hospitals play a pivotal role in the delivery of health care services. They are the foundation of the three-tiered health care system – village health care clinics, township hospitals, and county hospitals (Liu et al., 1996). The bottommost tier, village clinics, are usually staffed by clinicians with relatively less formal training, whereas services provided by county hospitals, the topmost tier, are comparatively expensive and often the practitioners are more specialized. In addition to primary medical services, township hospitals manage the provision of public health services and train village clinicians within their townships, effectively supervising local rural health systems (Babiarz et al., 2012). Although the NEMP has now been universally introduced in rural township hospitals, the kind of influence it may have on primary health care institutions is still unclear.

2. Methods

2.1. Data collection

A multistage random sampling method was adopted to select township hospitals. Initially, we selected six provinces – Liaoning, Shandong, Shanxi, Hubei, Sichuan, and Shaanxi – because we considered them as representatives of the eastern (most developed), central (developed), and western (least developed) regions of China. Then, we randomly selected three counties from each province. The health bureaus of each of these counties provided a list of the facilities available, from which we randomly selected five government-run township hospitals for each list, resulting in 90 township hospitals (15 for each province) for this study.

In October 2011, a questionnaire developed by the research team was distributed by the county health bureaus to their corresponding township hospitals. In each hospital, a research assistant was appointed to collect data related to the study period, January–September 2011. The following data sets were extracted from the administrative systems of the participating township hospitals: number of beds, number of health workers (consisting of those who engage in professional services in relation to patient care, such as doctors, nurses, pharmacists, medical imaging and laboratory technicians, and allied health professionals; and excluding those who support patient care activities, either administrative (e.g., financial and human resources) or other support (e.g., cleaning, hotel services, catering, and supply)), medical revenue, public finance, drug sales revenue, total number of outpatients, total number of inpatients, number of health worker training regarding NEMP, average remuneration of doctors, date of NEMP implementation at the site, and the range of drugs from EML held in stock.

The prescribing patterns were studied using de-identified prescription samples. Research assistants were asked to randomly select from 10 to 15 prescriptions from each month during the eligible study period (i.e., January–September 2011), which totaled 100 prescriptions from each township hospital. The expenditure, contents (e.g., hormones and antibiotics), and drug administration routes (e.g., intravenous injections) of each prescription were examined.

2.2. Data analysis

Following a thorough literature review and a seminar attended by rural health specialists from government and academia resulted in the identification of eight core indicators that reflect the intended outcomes of the NEMP. These indicators were selected because they are closely associated with the NEMP goals – increasing the availability and rational use of essential medicines and reducing drug expenditure. We did not include “supply of quality medicines”

in the indicators, because primary health care institutions do not have control over the supply of medicines, which is determined only at the provincial level due to the centralized bulk purchasing.

2.3. The eight selected indicators were:

- Drug expenditure of outpatient per visit (X1)
- Drug expenditure of inpatient per episode (X2)
- Average expenditure per prescription (X3)
- Percentage of prescriptions requiring intravenous injections (X4)
- Percentage of prescriptions containing hormone (X5)
- Percentage of prescriptions requiring two or more antibiotics (X6)
- Varieties of drugs from national EML available for use (X7)
- Varieties of drugs from provincial supplemental list available for use (X8).

X1, X2, and X3 were chosen to reflect the drug expenditure burden from a patient perspective. X4, X5, and X6 were adapted from WHO/INRUD (International Network for Rational Use of Drugs) prescription indicator system (WHO, 1993) to reflect prescribing behaviors. WHO/INRUD (1993) recommends a maximum of 30% of visits prescribed with antibiotics. In hospitals of China, the rate of intravenous drug administration is very high (Xiang et al., 2012) for perverting financial incentives to favor the provider (Li et al., 2012). Similar to other researchers (Li et al., 2012), we found the occurrence of high frequency, that is, two or more antibiotics were concurrently prescribed (X6), as being suggestive of antibiotic misuse. X7 and X8 were chosen to explore the extent of essential drug availability (YAO et al., 2013).

Exploratory factor analysis (EFA) was applied to extract the main factors and to calculate factor scores from the eight core NEMP outcome indicators. Factor analysis is a statistical method widely used to describe variations in observed variables in terms of fewer unobserved variables, denoted as factors. Observed variables with high interdependencies are grouped as one factor, and each resultant factor thus acquires a clearer aggregated meaning. Before performing EFA, we transformed some original data (for X1, X2, X3 using a reciprocal method and for X4, X5, X6 with 1 minus) so that all variables point to the same direction (Hoyle, 1973): a large score indicating a better outcome.

The *Bartlett unit matrix* ($\chi^2 = 181.333$, $p < 0.001$) and *goodness-of-fit* test of Kaiser–Meyer–Olson (KMO = 0.697) justified our decision to adopt the EFA (Kaiser and Rice, 1974). Using principal component extraction and the "rough rule" for selecting the number of common factors (Abdi, 2003; Kim and Mueller, 1978), three common factors are retained. As illustrated in Table 1, the first three factors have an eigenvalue >1, and a below 10% of the variance explained was found after the third factor. Overall, the three factors account for 68.97% of the variance explained (Table 1).

The factor load matrix (varimax rotation, Table 2) indicates that the first common factor (F1) explained the expenditure level of medicines under NEMP coverage, with the patient drug expenditure (X1, X2, and X3) loading explicitly high (>0.7); the second common factor (F2) associated with the rational use of medicines, with prescribing behaviors (X4, X5, and X6) explicitly loading high (>0.5); and the third common factor (F3) associated with the availability of essential medicines, with X7 and X8 explicitly loading high (>0.7).

In order to analyze the outcome indicators of NEMP, we calculated a factor score matrix for every institution (DiStefano et al., 2009). Factor scores were obtained using the Bartlett method to produce consistent estimations for all parameters (Skrondal and Laake, 2001). The three factor scores, as dependent variables, are normally distributed (with an average score of 0) and divided equally into high, medium, and low for further analyses.

We described means (normally distributed data) or medians (skewed distributed data) of the independent variables across the groups of institutions categorized by the factor scores. Those independent variables reflected institutional characteristics of the participating township hospitals. Differences in the institutional characteristics among the township hospitals with different NEMP outcome indicators (factor scores) were tested using analysis of variance (ANOVA) (a logarithmic transformation applied to the data not normally distributed before ANOVA was performed).

We developed linear regression models with the three factor scores as dependent variables and the institutional characteristics as independent variables (enter approach).

The regression models were built on a conceptual framework, and the independent variables entered into the regression models were categorized into four groups as follows:

(1) Workforce support
   - occurrence of NEMP training per 100 health workers
   - monthly remuneration of doctors
   - number of outpatients per health worker
   - number of inpatient separations per health worker

(2) Revenue structure and financial incentives of township hospitals
   - public finance per health worker (public finance/number of health workers)
   - medical revenue per health worker (medical revenue/number of health workers)
   - drug sales per health worker (drug sales revenue/number of health workers)
   - proportion of drug sales in hospital revenue (drug sales revenue/(public finance + medical revenue + drug sales) × 100%)
   - proportion of public finance in hospital income (public finance/(public finance + medical revenue + drug sales) × 100%)

Table 1
Proportion of total variance explained by the common factors (principal component extraction).

Common factor	Extraction sums of squared loading			Rotation sums of squared loadings		
	Eigen value	% Of variance	Cumulative %	Eigen value	% Of variance	Cumulative %
1	2.466	30.821	30.821	2.080	26.005	26.005
2	1.721	21.519	52.339	1.747	21.835	47.839
3	1.330	16.627	68.966	1.690	21.127	68.966
4	0.698	8.728	77.694			
5	0.642	8.027	85.721			
6	0.479	5.993	91.714			
7	0.436	5.456	97.170			
8	0.226	2.830	100.000			

Table 2
Rotated factor load matrix (varimax rotation) of core outcome indicators of NEMP.

Core indicators of NEMP	Factor one	Factor two	Factor three	Commonality
Drug expenditure of outpatient per visit (X1)	0.888	0.119	0.037	0.803
Drug expenditure of inpatient per episode (X2)	0.787	−0.197	−0.119	0.673
Average expense per prescription (X3)	0.777	0.387	0.015	0.753
Percentage of prescriptions requiring injections (X4)	0.121	0.837	0.199	0.755
Percentage of prescriptions containing hormone (X5)	−0.038	0.755	−0.272	0.646
Percentage of prescriptions containing two or more antibiotics (X6)	0.182	0.517	−0.419	0.569
Varieties of national essential medicines (X7)	0.101	0.028	0.812	0.670
Varieties of provincial supplemental essential medicines (X8)	−0.103	−0.070	0.795	0.647

(3) Patient mix
- ratio of outpatients to inpatients (number of outpatients:number of inpatients)

(4) Township hospital scale
- number of beds
- number of health workers.

In theory, the NEMP (including EML, restriction in supply of medicines and zero-profit pharmaceutical service policy) should alter incentive mechanisms for organizations and the prescribing doctors. When pharmaceutical services could no longer bring profit to organizations because of the NEMP, health workers might shift their attention to other revenue-generating activities. Meanwhile, it was hoped that more patients would benefit by being able to afford medical care in township hospitals if drug costs could be kept low (Ministry of Health of the P.R.China, 2009b). However, reduction of medicine stocks may limit prescription choices, leading some patients to approach larger providers (Hu, 2013), altering health care demand and clinician workloads. Indeed, health worker support and "buy-in" are critical for the successful implementation of the NEMP. Training has been considered essential to help improve the knowledge and understanding of prescribers about the NEMP (Ministry of Health of the P.R.China, 2009b).

The NEMP is intended to change the revenue structure in terms of financial incentives of primary health care institutions (Ministry of Health of the P.R.China, 2009b). Earlier, drug sales comprised more than half of the income revenue of township hospitals (L. Yang et al., 2013a). With the reduction of revenue streams as a result of NEMP, it was hoped that medical revenues and governmental subsidies would compensate for the loss of drug revenue. In the regression models, we explored the relationship between "revenue available to health workers" from various sources and the intended outcomes of NEMP. Because the number of health workers varied across township hospitals, revenue was calculated based on "per health worker" to reflect the true level of revenue available to health workers and to make it more comparable across institutions. The variables associated with "proportion of revenue in hospital income" from different sources did not enter into the regression models, because they were derived from the variables associated with "revenue available to health workers."

Patient mix and hospital scale were also included in the regression models. It is important to note that an ideal regression model should involve case-mix adjustment; however, these adjustments are challenging for studies within primary health care settings. Unlike episodic care in hospital admissions, where a principal diagnosis and length of stay may be determined, primary care patients usually present with multiple morbidities and they demand for relevant services for a long duration, by infrequent visits to a range of facilities (Starfield et al., 2003). The Adjusted Clinical Group (ACG) system development by John Hopkins University is perhaps the most widely used case-mix adjustment instrument for ambulatory care (Starfield and Kinder, 2011). It involves a combination of ambulatory diagnostic groups over a 1-year period to prepare a good predictor for ambulatory medical care expenditure (Starfield and Kinder, 2011; Starfield et al., 2003). Unfortunately, we are not able to obtain required data for ACG classifications, for many reasons: (1) Many township hospitals do not retain medical records related to ambulatory care; (2) a patient may visit multiple facilities for ambulatory care of a certain condition, sometimes including visits to tertiary hospitals without formal referral; (3) many patients may not consult a doctor when required, because of cost constraints; and (4) heath facilities in China do not share patient care information. In this study, we therefore considered outpatient to inpatient ratio as a proxy indicator to reflect the complexities of services provided by township hospitals. All statistical analyses were performed using SPSS version 12.0.

Ethics approval of this study was obtained from Tongji Medical College, Huazhong University of Science and Technology. We did not intentionally collect, analyze, and report any identifiable information of human subjects anywhere.

3. Results

The participating township hospitals had implemented the NEMP for 1–12 months (median 2 months) before January 2011 when the research data were collected for the purpose of this study. The hospitals were generally small in size, with a median of 30 beds and 30.5 health workers. Drug sales contributed approximately 30% of total hospital revenue, slightly lower than the proportion of public finance (39%). The township hospitals in the eastern region of China had more number of beds and a higher proportion of drug sales in their revenue mix compared with their western and central counterparts ($p < 0.05$). The remuneration of doctors averaged approximately ¥2000 CNY per month, although doctors in the western township hospitals earned slightly more than those in the central region ($p = 0.03$). Regular NEMP training was provided to hospital staff, with each health worker attending an average of 1.5 workshops (Table 3).

3.1. Implementation of NEMP by regions

Overall, western township hospitals performed better in F1 (expenditure level of medicines) and F2 (rational use of medicines), but worse in F3 (availability of medicines) than their counterparts (Table 4).

The township hospitals in the eastern region exhibited higher outpatient and inpatient drug expenditure. These hospitals had higher levels of outpatient drug expenditure (¥19.3 vs. ¥27.3 CNY per visit) and average prescription costs (¥27.1 vs. ¥40.0 CNY per prescription) ($p < 0.05$) than those in the western region. The inpatient drug expenditure in eastern township hospitals reached ¥774 CNY per episode, significantly higher than those in the western (¥435 CNY) and central (¥569 CNY) ($p < 0.05$) regions.

Table 3
Characteristics of surveyed township hospitals.[a]

Indicator	Statistics	Western (n = 30)	Central (n = 30)	Eastern (n = 30)	Total (n = 90)	*p*
Accumulated months covered by NEMP prior to the study period	Median (95% CI)	**3.0 (2.0, 9.0)**	2.5 (1.0, 9.0)	**1.0 (1.0, 2.0)**	2.0 (1.0, 3.0)	0.010
Number of training per hundred health worker	Median (95% CI)	143.1 (75.7, 272.7)	165.8 (106.2, 228.6)	189.8 (65.4, 350.0)	149.4 (105.9, 214.3)	0.763
Monthly remuneration of doctors	Mean (95% CI)	**2504.5 (2312.5, 2696.5)**	**2089.1 (1844.2, 2334.0)**	2280.8 (2053.0, 2508.7)	2291.5 (2162.9, 2420.0)	0.030
Numbers of outpatients per health worker	Median (95% CI)	498.5 (425.4, 749.7)	542.9 (391.5, 615.2)	509.1 (384.2, 606.8)	537.2 (425.4, 600.8)	0.917
Numbers of inpatients per health worker	Median (95% CI)	18.8 (14.5, 27.1)	19.5 (14.3, 22.9)	14.3 (9.4, 19.6)	18.2 (14.7, 19.8)	0.165
Public finance per health worker (thousand)	Median (95% CI)	28.0 (18.8, 41.9)	20.0 (14.7, 32.3)	23.5 (19.0, 31.7)	24.0 (19.2, 29.7)	0.239
Medical revenue per health worker (thousand)	Median (95% CI)	26.0 (19.1, 31.0)	19.3 (15.3, 27.3)	20.3 (14.3, 23.6)	21.0 (18.6, 25.1)	0.649
Drug sales per health worker (thousand)	Median (95% CI)	21.6 (16.5, 24.3)	18.2 (12.9, 26.4)	26.3 (19.2, 33.5)	22.0 (18.4, 24.27)	0.131
Proportion of public finance in hospital income (%)	Mean (95% CI)	41.7 (33.5, 49.9)	39.7 (31.2, 48.2)	36.4 (29.2, 43.6)	39.2 (34.8, 43.7)	0.628
Proportion of drug sales in hospital income (%)	Mean (95% CI)	**26.2 (22.0, 30.5)**	29.5 (23.9, 35.0)	**35.4 (30.2, 40.5)**	30.4 (27.5, 33.3)	0.031
Outpatient/inpatient ratio	Median (95% CI)	26.8 (17.6, 44.2)	26.2 (22.1, 40.2)	35.5 (20.8, 50.1)	29.5 (23.5, 37.6)	0.340
Number of beds	Median (95% CI)	**28.0 (20.0, 35.0)**	29.0 (20.0, 40.0)	**37.5 (30.0, 50.0)**	30.0 (26.0, 35.0)	0.015
Number of health workers	Median (95% CI)	31.5 (14.0, 42.0)	24.0 (15.0, 33.0)	36.5 (25.0, 49.0)	30.5 (24.0, 38.0)	0.135

[a] Note: data in bold indicate significant statistical differences in paired comparisons ($p < 0.05$).

The regional differences in F2 (rational use of medicines) appeared mainly between the western and central township hospitals. The central township hospitals had higher levels of prescriptions administered via intravenous route and containing hormones than their western counterparts ($p < 0.05$). The percentage of prescriptions containing two or more antibiotics in the central township hospitals reached 28%, significantly higher than those of their western (11%) and eastern (13%) ($p < 0.05$) counterparts.

A greater range or variety of drugs was available to prescribers in the central township hospitals (225 for national EML drugs and 116 for provincial list drugs) than those of the western (179 and 54, respectively) and eastern township hospitals (177 and 85, respectively) ($p < 0.05$).

3.2. Institutional characteristics associated with the implementation of NEMP

No difference in hospital size (in terms of number of beds and health workers) was found between the three groups of institutions categorized by the factor scores (Table 5).

Hospital revenue and structure were found to be associated with NEMP outcomes. Public finance per health worker was positively associated with the rational use of medicines (F2, $p < 0.05$) and negatively associated with the availability of medicines (F3, $p < 0.01$). A lower contribution of drug sales to hospital revenue was associated with lower levels of drug expenditure (F1, $p < 0.05$).

Table 4
NEMP outcome indicators by regions.[a]

Indicators	Statistics	Western (n = 30)	Central (n = 30)	Eastern (n = 30)	Total (n = 90)	LSD, $P < 0.05$
Factor One (F1)	Mean (95% CI)	0.427 (−0.085, 0.939)	−0.041 (−0.313, 0.232)	−0.386 (−0.594, −0.179)	0.000 (−0.209, 0.209)	Eastern vs Western
Drug expenditure of outpatient (CNY per visit) (X1)	Median (95% CI)	19.3 (16.5, 27.6)	22.5 (17.0, 25.0)	27.3 (24.0, 35.4)	24.0 (20.0, 25.7)	Eastern vs Western
Drug expenditure of inpatient (CNY per visit) (x2)	Mean (95% CI)	434.8 (345.7, 523.8)	569.3 (479.4, 659.3)	773.7 (614.9, 932.5)	592.6 (521.2, 663.9)	Eastern vs Western Eastern vs Central
Average expenditure of per prescription (CNY) (X3)	Mean (95% CI)	27.1 (21.0, 33.2)	33.0 (28.4, 37.7)	40.0 (32.3, 47.7)	33.4 (29.7, 37.0)	Eastern vs Western
Factor Two (F2)	Mean (95% CI)	0.361 (0.073, 0.649)	−0.354 (−0.803, 0.095)	−0.007 (−0.334, 0.319)	0.000 (−0.209, 0.209)	Central vs Western
Percentage of prescription requiring injection (X4)	Mean (95% CI)	30.0 (22.4, 37.6)	44.2 (35.4, 53.0)	40.5 (33.4, 47.7)	38.2 (33.68, 42.79)	Central vs Western
Percentage of prescription requiring hormones (X5)	Median (95% CI)	5.0 (4.0, 6.0)	9.5 (7.0, 15.0)	8.5 (5.0, 11.0)	7.0 (6.0, 10.0)	Central vs Western
Percentage of prescription requiring two and more antibiotics (X6)	Median (95% CI)	11.0 (7.0, 17.0)	28.0 (15.0, 43.0)	12.5 (8.0, 18.0)	15.0 (12.0, 19.0)	Eastern vs Central Central vs Western
Factor Three (F3)	Mean (95% CI)	−0.440 (−0.703, −0.178)	0.672 (0.251, 1.093)	−0.232 (−0.517, 0.052)	0.000 (−0.209, 0.209)	Eastern vs Central Central vs Western
Number of drugs storage from NEML (X7)	Mean (95% CI)	178.5 (160.9, 196.1)	225.0 (203.6, 246.4)	176.7 (154.7, 198.7)	193.4 (181.1, 205.0)	Eastern vs Central Central vs Western
Number of drugs storage from provincial list (X8)	Mean (95% CI)	54.4 (37.5, 71.4)	115.6 (96.2, 135.0)	85.3 (68.9, 101.8)	85.1 (74.0, 96.2)	Eastern vs Western Eastern vs Central Central vs Western

[a] Note: Data highlighted in shade indicate that significant statistical differences were found between the western and other regions ($p < 0.05$).

Table 5
Institutional characteristics of surveyed township hospitals by factor scores.[a]

Institutional characteristics	Value	Factor one (level of drug expenditure)				Factor two (rational use of medicines)				Factor three (availability of medicines)			
		Low (n = 30)	Middle (n = 30)	High (n = 30)	P	Low (n = 30)	Middle (n = 30)	High (n = 30)	P	Low (n = 30)	Middle (n = 30)	High (n = 30)	P
Occurrence of training per hundred staff	Median	118.4	132.5	195.8	0.259	158.3	136.1	214.3	0.329	93.0*	218.0	185.5	0.005
	95% CI	75.7, 220.0	46.2, 345.0	106.2, 300.0		45.5, 342.6	95.2, 200.0	100.0, 388.9		28.6, 200.0	140.0, 345.0	105.9, 284.7	
Monthly remuneration of doctors	Mean	2386.8	2182.3	2305.3	0.435	2003.4	2267.9	2603.2*	0.001	2535.7	2371.8	1966.9*	0.001
	95% CI	2170.1, 2603.5	1943.4, 2421.2	2072.6, 2537.9		1805.1, 2201.7	2051.3, 2484.5	2382.0, 2824.4		2335.5, 2735.8	2143.2, 2600.5	1756.8, 2177.1	
Numbers of outpatients per health worker	Median	408.0*	481.7	682.8	0.003	424.2	509.1	566.3	0.202	445.0	600.0*	495.0	0.020
	95% CI	300.0, 555.6	386.8, 689.5	539.5, 824.9		384.2, 615.2	306.8, 673.3	445.1, 788.3		282.4, 599.0	462.6, 748.4	370.1, 689.5	
Numbers of inpatients per health worker	Median	16.7	15.7	19.3	0.074	18.9	16.0	18.6	0.313	13.1	18.8	19.5	0.698
	95% CI	10.0, 22.2	9.0, 21.1	15.9, 26.6		13.8, 24.0	9.4, 22.2	13.8, 22.9		9.14, 19.6	14.5, 22.7	15.0, 24.0	
Public finance per health worker	Median	24.8	20.7	25.7	0.341	19.0**	26.0	32.2**	0.036	35.1	26.9	18.1*	0.002
	95% CI	19.0, 29.7	14.2, 27.5	17.9, 34.6		15.8, 24.3	19.0, 34.3	20.6, 55.7		20.4, 51.9	19.2, 32.8	14.2, 24.6	
Medical revenue per health worker	Median	18.0	20.5	24.3	0.062	21.9	19.2	22.6	0.090	21.8	24.6	18.0	0.777
	95% CI	9.5, 24.4	16.4, 26.9	19.5, 36.6		18.6, 31.2	9.2, 26.8	16.9, 25.8		18.1, 29.1	19.1, 27.7	14.2, 26.9	
Drug sales per health worker	Median	23.2	22.6	20.2	0.394	22.8	22.7	19.2	0.926	22.7	21.9	19.3	0.984
	95% CI	16.3, 30.7	16.1, 28.6	12.4, 24.2		19.2, 27.3	11.7, 33.0	16.3, 27.3		19.2, 29.1	16.3, 26.4	14.4, 27.9	
Proportion of drug sales in hospital income	Mean	32.8	33.4	24.9*	0.027	32.0	31.3	27.8	0.449	28.7	28.7	33.7	0.268
	95% CI	27.1, 38.5	28.0, 38.7	21.0, 28.7		27.1, 36.9	25.8, 36.8	22.7, 32.9		22.6, 34.8	24.1, 33.3	29.1, 38.4	
Proportion of public finance in hospital income	Mean	42.5	36.3	39.0	0.533	32.0	42.8	42.9	0.068	43.3	40.2	34.3	0.250
	95% CI	34.8, 50.0	28.2, 44.4	30.8, 47.2		25.8, 38.2	34.9, 50.9	34.1, 51.7		35.4, 51.0	32.8, 47.6	25.9, 42.7	
Outpatient/inpatient ratio	Median	24.2	33.2	33.8	0.777	24.6	26.1	37.5	0.211	24.7	33.9	28.5	0.449
	95% CI	15.0, 37.2	21.4, 44.9	24.4, 44.2		20.8, 37.6	21.8, 44.9	23.8, 46.3		17.5, 44.2	21.6, 44.9	21.9, 40.2	
Number of beds	Median	30.0	37.5	28.0	0.587	32.0	30.0	30.0	0.532	30.0	25.5	32.0	0.108
	95% CI	26, 35.0	25.0, 50.0	24.0, 31.0		25.0, 50.0	20.0, 40.0	20.0, 40.0		25.0, 40.0	20.0, 35.0	26.0, 50.0	
Number of health workers	Median	24.5	39.0	29.0	0.289	33.0	25.5	33.0	0.233	32.0	28.0	36.5	0.706
	95% CI	11.0, 38.0	26.0, 50.0	19.0, 42.0		23.0, 38.0	11.0, 42.0	14.0, 42.0		15.0, 42.0	19.0, 37.0	22.0, 54.0	

[a] Note: Data highlight in shade indicate those with significant differences; *p < 0.05 compared with the other two groups;**p < 0.05 compared between the two groups.

Support for health workers was also found to be associated with NEMP outcomes. Remuneration of doctors was positively associated with the rational use of medicines (F2), but negatively associated with the availability of medicines (F3). NEMP training was not found to be associated with expenditure levels and rational use of medicines; however, the township hospitals in the lower range of F3 had the lowest incidence of training per health worker compared with those in the middle and higher ranges ($p < 0.05$).

Although the association between inpatient service load and NEMP outcomes was not significant, outpatient service load was found to be significantly associated with the expenditure levels of medicines (F1) and availability of medicines (F3). A higher outpatient service load was associated with lower levels of drug expenditure ($p < 0.01$). The township hospitals in the middle range of F3 had the largest outpatient service load compared with those in the lower and higher ranges ($p < 0.05$).

After controlling the confounding effect of regional locations and other factors on the regression analyses, few independent variables remained in significant association with the NEMP outcome indicators (Table 6).

Both outpatient and inpatient service loads were proved to be positively associated with lower levels of drug expenditure ($p < 0.05$). Drug sales per health worker was negatively associated with lower levels of drug expenditure ($p = 0.001$). A higher remuneration of doctors was associated with better performance in the rational use of medicines ($p < 0.05$). Public finance per health worker was negatively associated with a higher availability of medicines ($p < 0.05$).

4. Discussion

This study demonstrated that the overall level of drug expenditure of the participating township hospitals was relatively low. The average expenditure per prescription was only ¥33.4 CNY, and the proportion of drug sales in hospital income (22%) had more than halved compared with the national average of all township hospitals (48%) before the implementation of NEMP (China's Ministry of Health Statics Centre, 2010). Higher levels of average expenditure per prescription before the implementation of NEMP were demonstrated in other studies. For example, YAO et al. (2013) revealed an average expenditure of ¥48.3 CNY per prescription in 2009 for Shanghai, Shanxi, Jiangxi, and Sichuan, and Chen et al. (2014) revealed an average of ¥80.9 CNY per prescription in 2007 for 83 counties and cities sampled from 31 provinces over mainland China. The lower amounts of drug expenditure found in this study are likely to be a result of combined effects of restricted availability of drugs, zero profit of drug sales, and reduction in the prices of drugs because of stricter pricing regulations imposed by NDRC and bulk procurement arrangements.

The township hospitals participated in this study were supplied with an average of 193 drugs from the national EML and 86 drugs from the provincial supplementary list. According to the current regulations (Ministry of Health of the P.R.China, 2009b), the township hospitals must sell those essential medicines at zero mark-up (Wang and Zhang, 2011). In September 2009, NDRC issued a policy, regulating the retail prices of 2349 products in 296 generic names of drugs. The regulated prices were 45% lower than the market prices, representing an average drop of 12% in prices (Guan et al., 2011). Empirical evidence shows that the reduction of prices of drugs may reduce the financial burden on consumers (Yoongthong et al., 2012).

Irrational use of medicines remains a serious issue. This study revealed that 38.2% of prescriptions of the participating township hospitals required intravenous administration, which is two to three times higher than the WHO standard (13.4–24.1%) (Li et al.,

Table 6
Institutional characteristics associated with NEMP outcome indicators: results of linear regression analyses.

Institutional characteristics	Factor one (level of drug expenditure)		Factor two (rational use of medicines)		Factor three (availability of medicines)	
	Standard β	*p*	Standard β	*p*	Standard β	*p*
Region						
Eastern	−0.195	0.121	−0.199	0.142	−0.010	0.935
Central	−0.156	0.194	**−0.265**	**0.042**	**0.433**	**0.000**
Western (reference group)	–	–	–	–	–	–
Occurrence of NEMP training per hundred health workers	−0.028	0.795	0.066	0.568	0.014	0.892
Monthly remuneration of doctors	−0.073	0.496	**0.264**	**0.024**	−0.175	0.096
Number of outpatients per health worker	**0.336**	**0.005**	0.096	0.445	0.040	0.724
Number of inpatient separations per health worker	**0.267**	**0.020**	−0.155	0.202	0.021	0.846
Public finance per health worker	−0.008	0.942	0.086	0.477	**−0.236**	**0.033**
Medical revenue per health worker	0.181	0.113	−0.005	0.967	−0.122	0.272
Drug sales per health worker	**−0.449**	**0.001**	0.046	0.741	0.078	0.538
Ratio of outpatient and inpatients	−0.013	0.901	0.070	0.542	−0.028	0.788
Number of beds	−0.046	0.766	0.160	0.341	0.025	0.867
Number of health workers	0.079	0.618	−0.096	0.574	−0.003	0.985

Note: Bold indicates variables with statistical significance ($p < 0.05$) in the regression models.

2012). This rate is even higher than that of rural primary health care institutions (22.9–31.2%) before the implementation of NEMP, that is, from 2005 to 2009 (Chen et al., 2014; Dong et al., 2011; Yao et al., 2013). The percentage of prescriptions containing two or more antibiotics (15%) is also high, similar to that (14.1–14.9%) before the implementation of NEMP (Chen et al., 2014; Yao et al., 2013). This level is higher than that of the urban medical facilities (10%) (Li et al., 2012).

Overuse and irrational use of medicines deserve urgent attention, because reduced cost constraints of medicines may stimulate the demands of consumers for medicines and exacerbate the problems (Chen et al., 2014; Li et al., 2012; Reynolds and McKee, 2009; L. Yang et al., 2013a). Chen M. et al. *(2014)* argue that only the removal of perverse financial incentives would not be enough to improve the prescribing patterns of medical workers. There is in fact a lack of consideration on the role of consumers in the NEMP (Reynolds and McKee, 2009).

The potential influence of NEMP on remuneration of prescribers has been debated ever since the introduction of NEMP (Hu, 2013; Hu et al., 2012; Xiao et al., 2012; L. P. Yang et al., 2012). Some argue that doctors might try to find other ways of compensating the loss of revenue from drug sales (L. Yang et al., 2013b). For example, they may charge patients for a fee for parenteral administration of drugs, or prescribe more unprocessed traditional Chinese herbs for a profit (L. Yang et al., 2013b). Indeed, the results of our study showed that a higher income of doctors is no longer associated with a higher availability of drugs. Despite this, high levels of irrational prescribing behaviors persist, which include the excessive use of parenteral administration.

Certainly, the importance of public subsidies cannot be underestimated. In recent decades, hospitals in China have considered drug sales as their main source of income, because of the reduction of governmental funding (Kahler, 2011; Reynolds and McKee, 2009). With the sudden removal of this source, township hospitals are dependent on local governments for financial subsidies. Unfortunately, there is no national regulation or legislation that defines the financial responsibility and accountability of local governments toward compensating this lost revenue source for township hospitals (Hu, 2013). This study revealed that the level of public finance in the participating township hospitals remains low (~25,000 CNY), comprising about 40% of hospital revenue. With limited public subsidies, some township hospitals may reduce the range of available medicines to remain viable. Public finance is also an important determinant of income of health workers, because drug sales, the biggest single source of income in the past, is no longer able to support the revenue streams that ultimately affect health workers. As discussed earlier, there is a risk of hospital staff overserving to compensate for the loss of drug revenue. This study revealed that a higher level of public finance or income of doctors is associated with better performance of prescriptions. Understandably, the quality use of medicines will be very difficult to improve if prescribers believe that public financial subsidies are insufficient to compensate for their loss of income from drug sales.

Training was not a determinant of any of the outcome indicators in the regression models. Unfortunately, we are unable to perform further analysis on the reasons for an absence of information on those training programs.

This study also revealed inequality in anticipated NEMP outcome indicators. Drug costs are higher in eastern township hospitals than those in the central and western regions. Interestingly, the central region has a greater range of drugs available to prescribers than the more economically developed eastern region. It is important to note that irrational use of medicines is more frequent in the central region than the others, which may be because of its higher availability of medicines.

5. Limitations

Our analyses were not adjusted by local income and case mix of township hospitals because of data unavailability. The use of EFA for calculating factor scores is controversial; however, it allows us to gain a clear understanding of the overall performance of participating township hospitals in relation to the NEMP. This study adopted a cross-sectional design, which prevents us from comparing pre- and postimplementation, or concluding a causal relationship between the NEMP and outcome indicators. Because of a lack of consumer demand information, we do not know whether the supply and demand of essential medicines has been balanced. Further studies are warranted. It is also important to note that this study was conducted in rural settings, and the findings of this study may not be applicable to urban populations.

6. Conclusions

The implementation of NEMP has significant organizational barriers. Although financial barriers of prescribers and consumers for gaining access to medicines may be effectively reduced, the irrational use of medicines remains a serious issue. Limited public finance from local governments may reduce medicine stock lines of township hospitals and lead them to seek alternative revenue

sources, jeopardizing their capacity to meet the needs of local consumers.

Acknowledgments

Our sincere appreciation to all facility directors who participated in this study, to the assistance of county health bureaus from Liaoning, Shandong, Shanxi, Hubei, Sichuan and Shaanxi province in the fieldwork.

References

Abdi, H.E., 2003. Factor rotations in factor analyses. Encyclopedia for research methods for the social sciences. Sage Thousand Oaks, CA 792–795.
Babiarz, K.S., Miller, G., Yi, H., Zhang, L., Rozelle, S., 2012. China's new cooperative medical scheme improved finances of township health centers but not the number of patients served. Health Aff. 31, 1065–1074.
Chen, M., Wang, L., Chen, W., Zhang, L., Jiang, H., Mao, W., 2014. Does economic incentive matter for rational use of medicine? China's experience from the essential medicines program. Pharmacoeconomics 32, 245–255.
China's Ministry of Health Statics Centre, 2010. China's Health Statics Year Book in 2010. China's Ministry of Health Statics Centre, Beijing.
DiStefano, C., Zhu, M., Mîndrilă, D., 2009. Understanding and using factor scores: considerations for the applied researcher. Pract. Assess. Res. Eval. 14, 1–11.
Dong, L., Yan, H., Wang, D., 2011. Drug prescribing indicators in village health clinics across 10 provinces of Western China. Fam. Pract. 28, 63–67.
Guan, X., Liang, H., Xue, Y., Shi, L., 2011. An analysis of China's national essential medicines policy. J. Public Health Policy 32, 305–319.
Hoyle, M.H., 1973. Transformations: an introduction and a bibliography. Int. Stat. Rev. 41, 203–223.
Hu, S., 2013. Essential medicine policy in China: pros and cons. J. Med. Econ. 16, 289–294.
Hu, S., Zhang, Y., He, J.J., 2012. The implementation of essential medicine policy in China: pros and cons. Value Health 15, A611–A612.
Kahler, C., 2011. China's healthcare reform: how far has it come? China Bus. Rev. 38, 50–55.
Kaiser, H.F., Rice, J., 1974. Little Jiffy, Mark IV. Educational and Psychological Measurement, vol. 34, pp. 111–117.
Kim, J.-O., Mueller, C.W., 1978. Introduction to Factor Analysis: What it Is and How to Do it. Sage, Newbury Park, London, New Deli.
Laing, R., Waning, B., Gray, A., Ford, N., Hoen, E., 2003. 25 years of the WHO essential medicines lists: progress and challenges. Lancet 361, 1723–1729.
Li, Y., Xu, J., Wang, F., Wang, B., Liu, L., Hou, W., et al., 2012. Overprescribing in China, driven by financial incentives, results in very high use of antibiotics, injections, and corticosteroids. Health Aff. 31, 1075–1082.
Liu, X., Xu, L., Wang, S., 1996. Reforming China's 50,000 township hospitals—effectiveness, challenges and opportunities. Health Policy 38, 13–29.
Ministry of Health of the P. R. China, 2013. Health Statistics Digest 2012. Ministry of Health, Beijing.
Ministry of Health of the P.R.China, 2009a. National Essential Medicines List (Primary Care Section) 2009 Edition. China Ministry of Health, Beijing.
Ministry of Health of the P.R.China, 2009b. Opinions on the Implementation of National Essential Medicines Policies. Ministry of Health, Beijing, China.
Reynolds, L., McKee, M., 2009. Factors influencing antibiotic prescribing in China: an exploratory analysis. Health Policy 90, 32–36.
Skrondal, A., Laake, P., 2001. Regression among factor scores. Psychometrika 66, 563–575.
Starfield, B., Kinder, K., 2011. Multimorbidity and its measurement. Health Policy 103, 3–8.
Starfield, B., Lemke, K.W., Bernhardt, T., Foldes, S.S., Forrest, C.B., Weiner, J.P., 2003. Comorbidity: implications for the importance of primary care in 'case' management. Ann. Fam. Med. 1, 8–14.
State Council of China, 2009. Implementation Plan for the Recent Priorities of the Health Care System Reform (2009–2011). State Council, Beijing.
Wang, D., Zhang, X., 2011. The selection of essential medicines in China: progress and the way forward. South. Med. 4, 22–28.
WHO, 1993. How to Investigate Drug Use in Health Facilities: Selected Drug Use Indicators. (DAP Research Series No 7.WHO/DAP/93.1). WHO Press, Geneva.
WHO, 2001a. How to Develop and Implement a National Drug Policy, second ed. World Health Organization, Geneva, pp. 6–7.
WHO, 2001b. WHO Medicines Strategy – Revised Procedure for Updating WHO's Model List of Essential Drugs. World Health Organization, Geneva, p. 3.
WHO, 2004. Equitable access to essential medicines: a framework for collective action. World Health Organization, Geneva.
WHO, 2011. The World Medicines Situation 2011–Medicines Prices, Availability and Affordability. World Health Organization, Geneva.
WHO, 2013. 10 Facts on Essential Medicines. World Health Organization, Geneva.
Xiang, X.X., Yang, C.Y., Wang, D.F., Ye, J., Zhang, X.P., 2012. Effects of China's National Essential Medicines Policy on the use of injection in primary health facilities. J. Huazhong Univ. Sci. Technology-Medical Sci. 32, 626–629.
Xiao, Y., Zhao, K., Bishai, D.M., Peters, D.H., 2012. Essential drugs policy in three rural counties in China: what does a complexity lens add? Soc. Sci. Med. 220–228.
Yang, L.P., Zhang, X.P., Liu, W.B., Wang, H.T., 2012. Multifactor analysis on the income of primary health care institutions implementing EMS in Hubei Province, China: a cross-sectional study. J. Health Manag. 14, 259–268.
Yang, L., Liu, C., Ferrier, J.A., Zhou, W., Zhang, X., 2013a. The impact of the National Essential Medicines Policy on prescribing behaviours in primary care facilities in Hubei Province of China. Health Policy Plan. 28, 750–760.
Yang, L., Ying, C., Sufang, G., Brant, P., Bin, L., Hipgrave, D., 2013b. Evaluation, in three provinces, of the introduction and impact of China's National Essential Medicines Scheme. Bull. World Health Organ 91, 184–194.
Yao, Q., Yao, L., Luo, F., Ji, W., Liu, H., 2013. Effectiveness evaluation of national essential medicine system in China from the perspective of rational drug use: an empirical study from Shanghai, Jiangxi, Sichuan and Chongqing province. Chin. J. Hosp. Admin 29, 343–346.
Yip, W.C.-M., Hsiao, W.C., Chen, W., Hu, S., Ma, J., Maynard, A., 2012. Early appraisal of China's huge and complex health-care reforms. Lancet 379, 833–842.
Yoongthong, W., Hu, S., Whitty, J.A., Wibulpolprasert, S., Sukantho, K., Thienthawee, W., et al., 2012. National drug policies to local formulary decisions in Thailand, China, and Australia: drug listing changes and opportunities. Value Health 15, S126–S131.