

Effect of National Essential Medicine System in China  
—Empirical Study on Rural Primary Health Centers from Four  
Provinces

by

SONG Yan

Doctor of Philosophy in Biomedical Sciences

2013



Institute of Chinese Medical Sciences

University of Macau



Effect of National Essential Medicine System in China  
—Empirical Study on Rural Primary Health Centers from Four  
Provinces

by

SONG Yan

SUPERVISOR: Prof. BIAN Ying

CO-SUPERVISOR: Prof. WANG Yitao

Doctor of Philosophy in Biomedical Sciences

2013

Institute of Chinese Medical Sciences

University of Macau



Author's right 2013 by  
SONG, Yan





## **Acknowledgements**

I could not have completed this thesis without the support and guidance of so many people. I would like to take this opportunity to address my appreciation to my professors, friends and family who have shaped me, stood with me and encouraged me along the way.

First and foremost, this thesis would not have been possible without the ever-present support of my supervisor Prof. Bian Ying. In my four years at UM, not only did he teach and nurture me to become a development researcher, but he also inspired me with his intellectual curiosity. His encouragement during the most difficult times kept me going and his quality standards made me a better researcher. I am forever grateful to Prof. Bian.

At the same time, I wish to extend my sincere gratitude to Prof. Wang Yi-Tao, the director of our institute, whose support and encouragement made my PhD studies in Macao possible.

I am also deeply indebted to Dr. Cheng Li-Jen and Dr. Hu Hao, who are on my thesis advisory committee, for their extensive knowledge and instructive suggestions have enhanced the completeness of this thesis.

At the same time, I am very grateful for the education, friendship and encouragement I have received from many professors of ICMS. All of them have offered me kind help and encouragement during my study there. In particular, I wish to thank Dr. Leung Siu-Wai and Dr. Hu Yuan-Jia for their assistance on several essays in this thesis. Hattie, Chloe, Ada and other administrative staff also helped me a lot during the whole process of writing this thesis, for which I am greatly indebted to them.

Also, I would like to thank Prof. Thomas Wenzel, who supervised me when I conducted my project at the Medical University of Vienna on the Eurasia-Pacific UNINET Scholarship. His guidance has greatly broadened my academic horizon. I never forgot his insightful comments and warmhearted help on my academic studies.

I would like to express my thanks to Prof. Yin Ai-Tian, Shandong University and Prof. Li Lin-Gui, Ningxia Medical University as well as their colleagues for their coordination and personnel support during my field work for this thesis. I appreciate the help from my colleagues Yin Shi, Wang Yao, Wang Shan-Ping during my data collection process. My thanks also go to Prof. Max Petzold, University of Gothenburg, who provided me with critical comments on the statistical data analysis of my thesis. Furthermore, I especially appreciate the technical and financial support from National Center for Health System Reform, National Development and Reform Commission in this research.

Additionally, I feel lucky that my life has really become beautiful with many friends' unwavering support and care. I can honestly say I would not be the same without



every one of them. So, thank you to Li Jing, Chao Fang, Yin Heng, Rong Yi-Ran, Chen Cong, and Tan Wen.

My deepest gratitude and love go to my dear parents. They showered on me the most unconditional love, which has been the greatest motivation for my academic research. My greatest gratefulness is reserved for Mr. Wang Zhen-Hai for his unwavering love and encouragement. I could not have made it through the hardest times without his unconditional support, and I would not have wanted to celebrate the success or the best times with anyone else.



## Abstract

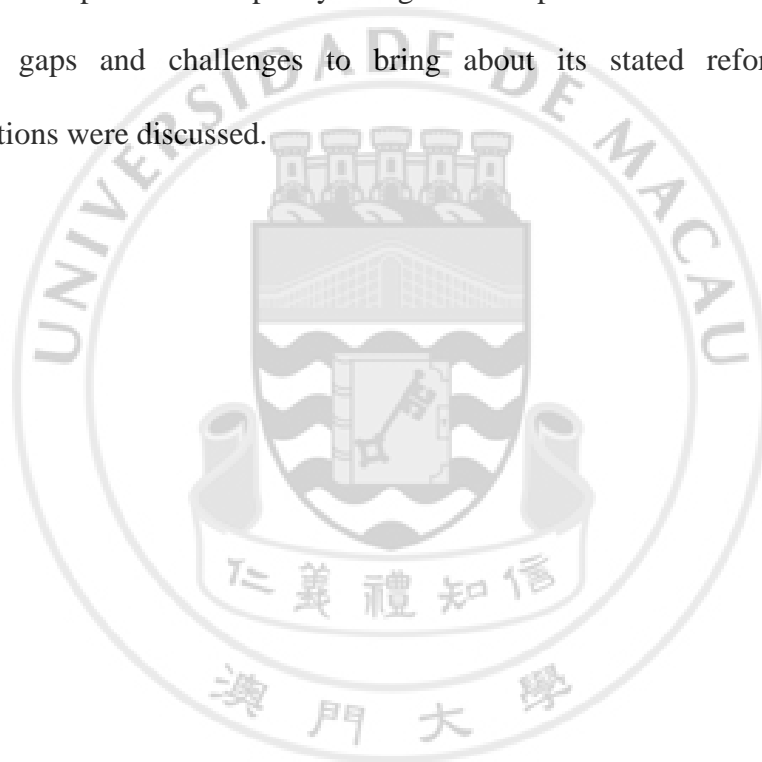
Although China came to embrace the concept of essential medicines in 1979, a comprehensive national policy is yet to be introduced. In the most recent healthcare reform (2009–2011), the Chinese government proposed the establishment of the National Essential Medicine System (NEMS, 國家基本藥物制度), with the goals to make essential medicine available, control drug prices and improve rational drug use. This study is aimed to assess whether and to what extent this NEMS has achieved its intended objectives and to explore what factors influenced its implementation.

Empirical data were obtained through questionnaire surveys, prescriptions and documents review conducted in rural primary health centers (PHCs) from four provinces (Shandong, Zhejiang, Anhui and Ningxia) of China during 2010-2011. Key informant interviews were also used.

Results showed a median decrease of 34.38% in medicine price between 2009 and 2010. The declines were also recorded in the mean number of drugs prescribed per patient (from 3.64 to 3.46) and the proportion of patients being prescribed antibiotics (from 60.26 to 58.48%). Increases in the utilization of essential medicines had occurred. The injection and hormone use were improved significantly. All these positive issues were also recorded in 2011. The availability of essential medicines had reached 66.83% at PHCs by 2011. The PHCs' income structure had changed and the proportion of drug income decreased. 93.31% patients and 92.54% PHC staffs were satisfied with the NEMS. However, current medicine prices remained high compared to international reference prices. Medicines were often unaffordable for poor residents. The new shortages of some drugs occurred. Over-prescription of

antibiotics and injections as well as poly-pharmacy remained common compared to WHO standards. More importantly, most PHCs encountered substantial financial losses. The compensation of health-care providers for NEMS-related reductions was largely ineffective.

To conclude, NEMS is heading in the right direction and has its intended impact on access to and rational use of medicines. The remaining negative outcomes might be indicative of problems in policy design and implementation. China now needs to address gaps and challenges to bring about its stated reform goals. Policy implications were discussed.



## **Declaration**

I declare that the thesis here submitted is original except for the source materials explicitly acknowledged and that this thesis as a whole, or any part of this thesis has not been previously submitted for the same degree or for a different degree.

I also acknowledge that I have read and understood the Rules on Handling Student Academic Dishonesty and the Regulations of the Student Discipline of the University of Macau.



## Table of Contents

Acknowledgements.....	i
Abstract.....	iv
Declaration.....	vi
List of Tables and Figures.....	x
List of Abbreviations.....	xii
<b>Chapter 1 Introduction.....</b>	<b>1</b>
<b>1.1 General Background .....</b>	<b>1</b>
1.1.1 Essential medicines: the great health care reform.....	1
1.1.2 Essential medicines policy .....	3
1.1.3 WHO Model List of Essential Medicines .....	7
1.1.4 International progress and achievements .....	9
1.1.5 Country experiences: three examples.....	11
<b>1.2 Specific Background.....</b>	<b>18</b>
1.2.1 The history of essential medicines in China .....	18
1.2.2 Essential medicines were not used to their full potential in China .....	19
1.2.3 Major problems of China's pharmaceutical sector.....	20
1.2.4 The establishment of NEMS under China new healthcare reform .....	22
<b>1.3 Research Questions and Hypotheses.....</b>	<b>27</b>
<b>1.4 Research Methodology and Design .....</b>	<b>28</b>
<b>1.5 Potential Contribution .....</b>	<b>28</b>
<b>1.6 Organization of the Thesis .....</b>	<b>29</b>
<b>1.7 Statement of Originality.....</b>	<b>31</b>
<b>Chapter 2 Literature Review .....</b>	<b>38</b>
<b>2.1 Definition of items.....</b>	<b>38</b>
2.1.1 Access to medicines .....	38
2.1.2 Rational use of medicines .....	38
2.1.3 Primary health centers.....	39
2.1.4 Essential medicines .....	39
<b>2.2 Theory and method of policy evaluation .....</b>	<b>39</b>
2.2.1 The concept of policy evaluation .....	39
2.2.2 Common evaluation models.....	40
<b>2.3 International practices for monitoring essential medicines policy .....</b>	<b>43</b>
2.3.1 WHO hierarchical approach.....	44
2.3.2 WHO/HAI measurement method.....	46
2.3.3 WHO/INRUD manual for drug use .....	48
<b>2.4 The implementation of NEMS in China .....</b>	<b>50</b>
2.4.1 Essential medicine list.....	51
2.4.2 Centralized procurement .....	53
2.4.3 Distribution and delivery.....	55
2.4.4 Compensation for zero-profit policy .....	56
<b>2.5 Knowledge gaps .....</b>	<b>57</b>
<b>Chapter 3 Objectives and Methodology.....</b>	<b>60</b>
<b>3.1 Research objectives.....</b>	<b>60</b>
<b>3.2 Research design.....</b>	<b>60</b>
<b>3.3 Data resources.....</b>	<b>62</b>
3.3.1 Field survey .....	62
3.3.2 Key informant interviews.....	64
3.3.3 Literature and document review.....	64
<b>3.4 Sampling and data collection.....</b>	<b>65</b>

3.4.1 Questionnaire survey on medicine prices.....	65
3.4.2 Questionnaire survey on general information of primary health centers ...	65
3.4.3 Questionnaire survey on the social's awareness, perception and satisfaction .....	66
3.4.4 Prescriptions review .....	67
3.4.5 Key informant interviews.....	67
<b>3.5 Data analysis.....</b>	<b>68</b>
3.5.1 Method used to determine the price changes .....	68
3.5.2 Method used for international price comparison.....	70
3.5.3 Measurement of medicine affordability .....	70
3.5.4 Measurement of medicine availability .....	71
3.5.5 Measurement of medicine delivery efficiency .....	71
3.5.6 Method used to assess rational medicine use .....	71
3.5.7 Method used to analyze the financing and management of primary health centers.....	73
3.5.8 Method used to define satisfaction and satisfaction rate.....	84
3.5.9 Method used to analyze the factors affecting satisfaction.....	84
<b>3.6 Data quality assurance .....</b>	<b>85</b>
<b>Chapter 4 Result I: Impact on medicine prices and affordability .....</b>	<b>87</b>
<b>4.1 Changes of drug prices .....</b>	<b>87</b>
4.1.1 Direct price comparison .....	87
4.1.2 Price elasticity of usage quantity.....	89
4.1.3 Further investigation in Shandong and Ningxia.....	91
<b>4.2 Analysis based on price index.....</b>	<b>91</b>
<b>4.3 International price comparison .....</b>	<b>93</b>
<b>4.4 Medicine affordability .....</b>	<b>94</b>
<b>4.5 Discussions.....</b>	<b>95</b>
4.5.1 NEMS and changes of medicine prices.....	95
4.5.2 The application of price index.....	96
4.5.3 Primary health centers suffered financial loss.....	97
4.5.4 Medicines unaffordable for low income population .....	98
<b>Chapter 5 Result II: Impact on medicine rational use.....</b>	<b>99</b>
<b>5.1 Medicines prescribed per encounter .....</b>	<b>99</b>
<b>5.2 Antibiotics use .....</b>	<b>100</b>
<b>5.3 Injection and hormone use.....</b>	<b>100</b>
<b>5.4 Further investigation in Shandong and Ningxia.....</b>	<b>101</b>
5.4.1 Prescribing behaviors .....	101
5.4.2 Prescription cost .....	102
<b>5.5 Discussions.....</b>	<b>104</b>
<b>Chapter 6 Result III: Impact on the financing and management of primary health centers .....</b>	<b>108</b>
<b>6.1 New characteristic of primary health centers under NEMS .....</b>	<b>108</b>
6.1.1 The availability of essential medicines .....	108
6.1.2 The efficiency of medicine delivery .....	109
6.1.3 The uptake of health services .....	109
6.1.4 Hospital income and expenditure .....	110
<b>6.2 Tentative compensation for primary health centers: a SD approach.....</b>	<b>111</b>
6.2.1 Simulation without policy intervention.....	111
6.2.2 Policy design and tentative assessment.....	113
<b>6.3 Discussions.....</b>	<b>122</b>

6.3.1 Medicines availability .....	122
6.3.2 The financing and management of primary health centers .....	123
6.3.3 Compensation for zero-profit policy .....	124
6.3.4 The SD model used in this study.....	125
<b>Chapter 7 Result IV: Awareness, perception and satisfaction towards NEMS among patients and primary health workers .....</b>	<b>126</b>
<b>7.1 Demographic characteristics of the study participants.....</b>	<b>126</b>
<b>7.2 The responses of patients .....</b>	<b>126</b>
<b>7.3 The responses of primary health workers .....</b>	<b>128</b>
<b>7.4 Factors affecting the satisfaction.....</b>	<b>130</b>
<b>7.5 Discussions.....</b>	<b>130</b>
7.5.1 Awareness.....	130
7.5.2 Perception and satisfaction.....	131
<b>Chapter 8 Conclusions .....</b>	<b>134</b>
<b>8.1 Conclusions.....</b>	<b>134</b>
8.1.1 Achievements and gaps in the policy objectives.....	134
8.1.2 Difficulties and challenges in the implementation.....	135
<b>8.2 Policy Recommendations .....</b>	<b>137</b>
8.2.1 Selection of essential medicines .....	137
8.2.2 Procurement and supply .....	139
8.2.3 Compensation for zero-profit policy .....	140
8.2.4 Usage of essential medicines .....	141
<b>8.3 Implication for Macao SAR.....</b>	<b>142</b>
<b>8.4 Limitations of Current Study .....</b>	<b>143</b>
<b>8.5 Perspectives for Future Work .....</b>	<b>145</b>
<b>References .....</b>	<b>146</b>
<b>Appendices .....</b>	<b>154</b>
<b>Appendix I: Questionnaire for medicine prices.....</b>	<b>155</b>
<b>Appendix II: Questionnaire for general information of primary health centers     .....</b>	<b>158</b>
<b>Appendix III: Questionnaire for awareness, perception and satisfaction on     NEMS (for patients) .....</b>	<b>159</b>
<b>Appendix IV: Questionnaire for awareness, perception and satisfaction on     NEMS (for primary health workers) .....</b>	<b>161</b>
<b>Appendix V: Interview outline .....</b>	<b>163</b>
<b>Curriculum Vitae .....</b>	<b>165</b>

## List of Tables and Figures

Table 1.1 Components of a national essential medicine system, linked to key policy objectives.....	4
Table 1.2 Details of national essential medicines lists by country income level .....	10
Table 1.3 Number of medicines included in China national essential medicine lists	19
Table 2.1 The Level II facility core outcome indicators in WHO hierarchical approach .....	46
Table 2.2 WHO/INRUD drug use indicators for primary health-care facilities.....	49
Table 2.3 Derived reference values for the WHO prescribing indicators .....	50
Table 2.4 Discrepancies between the WHO model list and China's NEML.....	52
Table 3.1 Key observed indicators for the effect of China's NEMS .....	62
Table 3.2 The quantity and the distribution of PHCs in the field survey .....	64
Table 3.3 The number of prescriptions collected from 146 PHCs in four provinces.	67
Table 3.4 Key variables and equations in the stock and flow diagram .....	80
Table 3.5 Variables and equations related to pharmaceutical service fee in SD model .....	84
Table 3.6 Assignments of independent variables in regression analyses of satisfaction .....	85
Table 4.1 Price differences for all drugs and for drugs in various subcategories, 2009-2010.....	88
Table 4.2 Price changes of Western medicines categorized according to pharmacological classification, 2009-2010.....	89
Table 4.3 Price changes of TCMs categorized according to functional classification, 2009-2010.....	89
Table 4.4 Quantity changes for drugs retailing at different prices, 2009-2010.....	90
Table 4.5 Median price ratios for essential medicines before and after NEMS .....	94
Table 4.6 Medicine affordability for rural residents before and after NEMS .....	95
Table 5.1 RDU indicators in 146 PHCs of the four surveyed provinces, 2009-2010	99
Table 5.2 Prescriptions by number of drugs per encounter, by year .....	100
Table 5.3 Prescriptions by number of antibiotics per encounter, by year .....	101
Table 5.4 RDU indicators in 33 PHCs of Shandong and Ningxia, 2009-2011 .....	102
Table 5.5 Prescription cost in ten yuan intervals, 2009-2011.....	103
Table 5.6 Prescription cost by different medicine use pattern .....	103
Table 6.1 The availability of essential medicines in PHCs, 2009-2011 .....	109
Table 6.2 The efficiency of medicines delivery for PHCs, 2009-2011 .....	109
Table 6.3 Income & expenditure of PHCs, 2009-2011, 10,000yuan .....	110
Table 6.4 The proportion of drug fee in medical expense for patients, 2010-2015 .	113
Table 6.5 Parameter values in policy experiment I .....	114
Table 6.6 Parameter values in policy experiment II.....	115
Table 6.7 Trends of hospital balance by different pharmaceutical service fee, 2010-2015.....	117
Table 6.8 Parameter values in policy experiment III.....	118
Table 6.9 Parameter values in policy experiment IV .....	121
Table 6.10 Trend of average medical expense per patient under cc3 compensation mechanism, 2010-2015 .....	122
Table 6.11 The proportion of drug fee in medical expense under cc3 compensation mechanism, 2010-2015 .....	122
Table 7.1 Demographic characteristic of study participants .....	127
Table 7.2 The frequency of trainings on NEMS to primary health workers .....	129



Fig. 1.1 Total medicines in WHO Model List over time (including duplicates) .....	9
Fig. 1.2 Pharmaceutical expenditure in China, 1997-2009 .....	22
Fig. 1.3 The program logic model of China's NEMS .....	26
Fig. 2.1 The concept of policy evaluation .....	40
Fig. 2.2 Common research designs in program evaluation .....	43
Fig. 2.3 Levels of core indicators in WHO hierarchical approach .....	45
Fig. 2.4 Correlation of GDP per capita and number of additional medicines .....	53
Fig. 3.1 Causal loops diagram (a) and stock and flow diagram (b) .....	74
Fig. 3.2 The hospital income and expenditure in primary health-care facilities .....	75
Fig. 3.3 Causal loop diagram of hospital financing and management in the context of NEMS .....	76
Fig. 3.4 Stock and flow diagram of hospital financing and management under NEMS .....	79
Fig. 4.1 The evolution of medicine prices in Shandong and Ningxia, 2009-2011 ....	91
Fig. 4.2 Laspeyres Index and Paasche Index in the four provinces studied, 2010.....	92
Fig. 4.3 Laspeyres Index and Paasche Index in Shandong and Ningxia, 2009-2011	93
Fig. 5.1 Trend of prescription cost in PHCs, 2009-2011 .....	102
Fig. 5.2 Frequency distribution of prescription cost (logarithms) .....	104
Fig. 6.1 The quantity of medicines stocked at PHCs, 2009-2011 .....	108
Fig. 6.2 The number of patient in PHCs, 2009-2011 .....	110
Fig. 6.3 Changing of PHCs' income structure, 2009-2011 .....	111
Fig. 6.4 Trends of hospital income and expenditure under NEMS, 2010-2015 .....	112
Fig. 6.5 Trend of average drug fees per patient under NEMS, 2010-2015 .....	112
Fig. 6.6 Trend of medical expense per patient under NEMS, 2010-2015 .....	113
Fig. 6.7 Trends of hospital balance by different government subsidy, 2010-2015 ..	114
Fig. 6.8 Trends of hospital balance with and without pharmaceutical service fee, 2010-2015 .....	115
Fig. 6.9 Trends of hospital balance by different pharmaceutical service fee, 2010-2015 .....	116
Fig. 6.10 Average medical expense for outpatient by different pharmaceutical service fee, 2010-2015 .....	117
Fig. 6.11 Average medical expense for inpatient by different pharmaceutical service fee, 2010-2015 .....	118
Fig. 6.12 Trends of hospital balance by different medical service pricing, 2010-2015 .....	119
Fig. 6.13 Trends of average medical expense for outpatient by different medical service pricing, 2010-2015 .....	119
Fig. 6.14 Trends of average medical expense for inpatient by different medical service pricing, 2010-2015 .....	120
Fig. 6.15 Trends of hospital balance by different compensation behavior, 2010-2015 .....	121
Fig. 8.1 Drug management cycle .....	137

## List of Abbreviations

ADR	Adverse drug reaction
ALOS	Average length of stay
ANAPE	Average number of antibiotics prescribed per encounter
ANDPE	Average number of drugs prescribed per encounter
AR	Arrival rate of medicines
ATM	Access to medicines
CPA	Centralized Procurement Agency, India
CPI	Consumer Price Index
DMC	Drug Management Cycle
DSPRUD	Delhi Society for the Promotion of Rational Use of Drugs, India
DSM	Dynamic Synthesis Methodology
EMs	Essential Medicines
EML	Essential Medicines List
EMLc	Essential Medicines List for Children
GDP	Gross Domestic Product
GMP	Good Manufacturing Practices
HAI	WHO Health Action Initiative on essential medicines
ICER	Incremental cost-effectiveness ratio
INRUD	International Network for the Rational Use of Drugs
IRMSF	Increase rate of medical service fee
IRP	International Reference Price
KAP	Knowledge-Attitude-Practice
LIP	Low-income population
MIP	Mid-income population
MoH	Ministry of Health
MOHRSS	Ministry of Human Resources and Social Security
MPR	Median Price Ratio
MSD	Medical stores department, Tanzania
MSH	Management Sciences for Health
NED	National Essential Drug
NEMS	National Essential Medicine System
NEML	National Essential Medicines List
NRCMS	New Rural Cooperative Medical Services
NRDC	National Reform and Development Commission
OECD	Organization for Economic Cooperation and Development
PBAC	Pharmaceutical Benefits Advisory Committee
PBPA	Pharmaceutical Benefits Pricing Authority
PBS	Pharmaceutical Benefits Schedule
PEA	Percentage of encounters with an antibiotic prescribed

PED	Provincial Supplement Essential Drug
PEH	Percentage of encounters with hormone prescribed
PEI	Percentage of encounters with an injection prescribed
PEM	Percentage of drugs prescribed from national essential medicines list
PEML	Provincial Supplemented Essential Medicines List
PHC	Rural primary health center
PHW	Primary health worker
PPP	Purchasing Power Parity
PSF	Pharmaceutical service fee
RDU	Rational Drug Use
RR	Response rate of medicine delivery
SD	System Dynamics
SES	Socio-economic status
SFDA	State Food and Drug Administration
SR	Subsidy rate
STGs	Standard treatment guidelines
TCM	Traditional Chinese medicine
TFDA	Tanzania Food and Drug Authority
TMC	Total medical cost per patient visit
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
WHA	World Health Assembly
WHO	World Health Organization
WMs	Western medicines

