Original Article

DOI: 10.5582/bst.2017.01227

Price adjustment for traditional Chinese medicine procedures: Based on a standardized value parity model

Haiyin Wang[1,2], Chunlin Jin[2,*], Qingwu Jiang[1,*]

[1] *School of Public Health, Fudan University, Shanghai, China;*
[2] *Shanghai Health Development Research Center (Shanghai Medical Information Center), Shanghai, China.*

Summary **Traditional Chinese medicine (TCM) is an important part of China's medical system. Due to the prolonged low price of TCM procedures and the lack of an effective mechanism for dynamic price adjustment, the development of TCM has markedly lagged behind Western medicine. The World Health Organization (WHO) has emphasized the need to enhance the development of alternative and traditional medicine when creating national health care systems. The establishment of scientific and appropriate mechanisms to adjust the price of medical procedures in TCM is crucial to promoting the development of TCM. This study has examined incorporating value indicators and data on basic manpower expended, time spent, technical difficulty, and the degree of risk in the latest standards for the price of medical procedures in China, and this study also offers a price adjustment model with the relative price ratio as a key index. This study examined 144 TCM procedures and found that prices of TCM procedures were mainly based on the value of medical care provided; on average, medical care provided accounted for 89% of the price. Current price levels were generally low and the current price accounted for 56% of the standardized value of a procedure, on average. Current price levels accounted for a markedly lower standardized value of acupuncture, moxibustion, special treatment with TCM, and comprehensive TCM procedures. This study selected a total of 79 procedures and adjusted them by priority. The relationship between the price of TCM procedures and the suggested price was significantly optimized ($p < 0.01$). This study suggests that adjustment of the price of medical procedures based on a standardized value parity model is a scientific and suitable method of price adjustment that can serve as a reference for other provinces and municipalities in China and other countries and regions that mainly have fee-for-service (FFS) medical care.**

Keywords: Traditional Chinese medicine (TCM), prices of medical procedures, standardized value parity model, mechanism of price adjustment

1. Introduction

Traditional Chinese medicine (TCM) has gradually developed and advanced into a system of medical theories through long-standing medical practices. TCM is an important part of the medical system of China (*1*). TCM plays an important role in the control of infectious diseases and chronic diseases and it is widely used to treat cerebrovascular disease, bone, joint and muscle diseases, multiple sclerosis, and other conditions (*2,3*). Due to the prolonged low price of TCM procedures and the lack of an effective mechanism of dynamic price adjustment (*4-6*), traditional calculation of costs did not reflect the value of TCM care and other factors, causing the development of TCM to lag markedly behind Western medicine. In 2014, the World Health Organization (WHO) formulated the *WHO Traditional Medicine Strategy*: 2014-2023;

Released online in J-STAGE as advance publication October 24, 2017.

**Address correspondence to:*
Dr. Qingwu Jiang, School of Public Health, Fudan University, 130Dong'an Road, Shanghai, China.
E-mail: jiangqw@fudan.edu.cn

Dr. Chunlin Jin, Shanghai Health Development Research Center, Shanghai Medical Information Center, 1477 Beijing Road (west), Shanghai, China.
E-mail: jinchunlin@shdrc.org

World Health Assembly resolution WHA62.13 on traditional medicine emphasized that the Member States should actively formulate policies and implement an action plan to enhance the role of alternative and traditional medicine in maintaining public health (*7*). At the Chinese Sanitation and Health Conference in 2015, Chinese President Xi Jinping pointed out that "sustained prevention is needed first; that traditional Chinese medicine and Western medicine should both be emphasized, and that health should be integrated into all policies". In 2016, the State Council of China issued *Guidelines on Developing Traditional Chinese Medicine from 2016-2030* (*8*). *The Law of the People's Republic of China on Traditional Chinese Medicine* was enacted that same year (*9*); it clearly sought to develop TCM and it represented a major breakthrough in legislation on TCM.

In the context of this reform, establishing a scientific and appropriate mechanism for adjustment and management of the prices of TCM procedures in order to promote changes in the ways in which prices of TCM procedures are adjusted and managed is crucial to guiding the development of TCM. In 2012, the National Development and Reform Commission, the National Health and Family Planning Commission of the People's Republic of China, the State Administration of Traditional Chinese Medicine issued the *Manual on National Standards for the Prices of Medical Procedures (2012 Edition)* (denoted here as the *2012 Manual on the Prices of Medical Procedures*). The *2012 Manual on the Prices of Medical Procedures* required provinces and municipalities to organize and standardize prices of medical procedures and to apply new standards for prices of medical procedures (*10,11*). Shanghai has the highest best concentration of medical resources in China. Fees for medical procedures and their management are consistent with most provinces and municipalities in China. Shanghai is able to lead and influence the country in terms of adjusting the prices of TCM procedures. Therefore, the current study has used Shanghai, China as an example. Based on the *2012 Manual on the Prices of Medical Procedures*, this study has attempted to create a value parity model for the price of TCM procedures in order to provide evidence for creation of a mechanism of price management that accord with the characteristics of TCM practices and the characteristics of the value of TCM procedures.

2. Materials and Methods

2.1. *Sources of data and creation of a database*

Data in this study came from the *2012 Manual on the Prices of Medical Procedures* (*12*), and the *Compilation of Medical Procedures and Prices at Medical Facilities in Shanghai (2014)* (denoted here as the *Shanghai Compilation of Medical Procedures and Prices*) (*13*). Variables obtained from the *2012 Manual on the Prices of Medical Procedures* included the name of the procedure, what the procedure entailed, the unit of pricing, basic manpower expended and time spent, technical difficulty (referring to the relative degree of difficulty entailed in a given procedure through a combination of factors such as the degree of complexity, the degree of skill involved, and requirements for practitioners; difficulty was rated from 1-100), and the degree of risk (referring to a comprehensive assessment of the probability of complications and the severity of adverse outcomes as well as the degree of relative risk of a given procedure; risk was rated from 1-100). Variables obtained from the *Shanghai Compilation of Medical Procedures and Prices* included the name of the procedure, what the procedure entailed, and the unit of pricing. Based on what the procedure entailed and the unit of pricing, procedures in the *2012 Manual on the Prices of Medical Procedures* were matched with procedures in the *Shanghai Compilation of Medical Procedures and Prices*. A database of corresponding procedures (referring to matching TCM procedures in the *Shanghai Compilation of Medical Procedures* and Prices and *2012 Manual on the Prices of Medical Procedures* in terms of what the procedure entailed and the unit of pricing) was created.

2.2. *Determining indices for analysis and creation of a standardized value parity model*

Indices used to calculate the value of procedures included basic allocation of medical personnel (physicians, nurses, medical technicians, and other personnel), the duration of the basic procedure (minutes), the technical difficulty score, the risk score, the annual salary of medical personnel at different hospitals, and the proportion of different types of medical personnel.

The standardized value referred to the measured value of a procedure in terms of resources consumed in a normal flow and under normal conditions. The standardized value had two components: medical care provided and the cost of resources consumed (*14*). The standardized value of medical care provided was mainly based on determination of the basic manpower expended and time spent while also considering technical difficulty and risk. The standardized value of medical care provided involved: *i*) calculation of all salary parameters based on the *Shanghai Reform Plan for Salary Systems at Public Health Facilities*. A physician's salary was calculated as 3.2 RMB per minute; the salary ratio for a physician:nurse:medical technician:other personnel was 1:0.7:0.6:0.5; and *ii*) calculation of a model:

$$Y=\left(\sum_{1}^{n}\frac{X_i}{\text{mos.}\times\text{days}\times\text{hrs worked}}(K_i\times T\times L_i)\right)*\left(1+\lg\sqrt{\frac{\text{technical difficulty of a procedure}\times\text{technical risk}}{\text{technical difficulty of a standard procedure}\times\text{technical risk}}}\right)$$

In the above formula, X_i is the target salary of a hospital physician; K_i is the number of medical personnel

allocated; T is the duration of the procedure; L_i is the type and position of personnel. Data on the basic manpower expended, the duration of the procedure, technical difficulty, and risk were from the *2012 Manual on the Prices of Medical Procedures*. Months, days, and hours worked were determined according to the *Regulations on Public Holidays for National Annual Festivals and Memorial Days* (State Council Decree No. 513).

The cost of direct materials consumed was calculated using Activity-based Costing. The cost of resources was apportioned to medical procedures based on the resources consumed while primarily providing medical care. Medical products used and medical care provided was ultimately used to apportion costs to medical procedures. Cost data were collected from 5 pilot hospitals in Shanghai (*15*). The cost of direct materials consumed did not include separate charges for consumables, energy consumption, and premises, and it did not include expenses for administration and logistics, expenditure of financial subsidies, or depreciation of fixed assets and amortization of intangible assets.

The current price and standardized value of a TCM procedure were used to calculate the relative price ratio of the current price to the standardized value. The relative price ratio was obtained by dividing the current price ratio by the standardized value. The difference in price levels and the relative price ratio were used to comprehensively assess and select procedures for price adjustment.

$$\text{Relative price ratio} = \frac{\text{current price/average current price}}{\text{standardized value/average standardized value}}$$

2.3. *Selection of procedures for price adjustment and the suggested price*

The principle for selection of procedures for price adjustment was: *i*) a relative price ratio < 0.5 and *ii*) a current price lower than the standardized value. The formula for calculation of the suggested adjusted price was: adjusted price = the current price + (standardized value - current price) × α. A preliminary study noted a large gap between the standard value and the current price. Directly assuming the standardized value would have considerably impacted the price. In accordance with a partial adjustment strategy and budget constraints, the gap between the standardized value and the current price served as the range of price adjustment. Based on stepwise adjustment of coefficient α, α was set at 0.3. In theory, a distribution of the current price that was closed to the distribution of the standardized value would result in a symmetrical distribution with the relative price ratio tending to be 1 and less dispersion.

2.4. *Statistical analysis*

Frequency and proportion were used to describe the number of corresponding procedures in the *Shanghai Compilation of Medical Procedures and Prices* and the *2012 Manual on the Prices of Medical Procedures* and the number of parameter adjustments. The mean difference and the relative ratio were used to compare the current price and standardized value. A ladder function was used to obtain the square root of the relative price ratio of the current price and the suggested adjusted price. A kernel density curve (kdensity) was fitted to the plotted probability distribution of the relative price ratio. A paired *t*-test was used to compare differences in the distribution of the relative price ratio of the current price to the suggested adjusted price. $p < 0.05$ was considered to indicate a significant difference. The interquartile range was used to describe changes in the dispersion of the relative price ratio. Analysis was performed using the software Stata 10.0.

3. Results

3.1. *Basic information*

One hundred and forty-four procedures (45% of all TCM procedures) in the *2012 Manual on the Prices of Medical Procedures and the Shanghai Compilation of Medical Procedures and Prices* matched (for specific procedures, see Supplemental Table S1, *http://www.biosciencetrends.com/action/getSupplementalData.php?ID=14*). Corresponding procedures were categorized into a total of seven categories: topical treatment with TCM, TCM for orthopedic injuries, acupuncture and moxibustion, massage therapy, anorectal treatment with TCM, special treatment with TCM, and comprehensive TCM. Seventy-nine percent of TCM procedures for orthopedic injuries matched, 66% of the forms of massage therapy matched, and 46% of the forms of topic treatment with TCM matched (Table 1).

3.2. *Comparison of the current price and standardized value*

The standardized value of TCM procedures in a given category mainly consisted of the standardized value of medical care provided. The standardized value of medical care provided accounted for 89% of the standardized value of a TCM procedure, on average. Direct materials consumed accounted for relatively high proportion (80%) of the standardized value of anorectal treatment with TCM. Medical care provided accounted for more than 85% of the standardized value of other procedures. Medical care provided accounted for almost all (97%) of the value of acupuncture and moxibustion (Table 2).

The current price level of TCM procedures tended to be low. The current price represented 56% of the standardized value. The current price of acupuncture

Table 1. Corresponding categories in the *Shanghai Compilation of Medical Procedures and Prices and the 2012 Manual on the Prices of Medical Procedures*[*]

Procedure Category	Number of Procedures in the *2012 Manual on the Prices of Medical Procedures* (procedures)	Number of Corresponding Procedures [**](procedures)	Percentage (%)
Topical Treatment with Traditional Chinese Medicine	35	16	45.7
Traditional Chinese Medicine for Orthopedic Injuries	70	55	78.6
Acupuncture and Moxibustion	70	19	27.1
Naprapathy	67	44	65.7
Anorectal Treatment with Traditional Chinese Medicine	41	3	7.3
Special Therapy with Traditional Chinese Medicine	20	6	30.0
Comprehensive TCM	19	1	5.3
Total	322	144	44.7

[*]The *Shanghai Compilation of Medical Procedures and Prices* refers to the Compilation of Medical Procedures and Prices at Medical Facilities in Shanghai (2014). The *2012 Manual on the Prices of Medical Procedures* refers to the Manual on National Standards for the Prices of Medical Procedures (2012 Edition). [**]The Number of Corresponding Procedures refers to corresponding procedures in the *Shanghai Compilation of Medical Procedures and Prices and the 2012 Manual on the Prices of Medical Procedures*.

Table 2. The current price and standardized value of corresponding procedures in seven major categories of TCM procedures in the *Shanghai Compilation of Medical Procedures and Prices* and the *2012 Manual on the Prices of Medical Procedures*

Procedure Category	Current Price[*]	Standardized Value[**]	Standardized Value of Medical Care Provided (%)	Cost of Direct Materials Consumed (%)
Acupuncture and Moxibustion	24	142	138 (97)	5 (3)
Anorectal Treatment with Traditional Chinese Medicine	120	696	137 (20)	559 (80)
Traditional Chinese Medicine for Orthopedic Injuries	98	521	484 (93)	38 (7)
Special Therapy with Traditional Chinese Medicine	6	102	98 (96)	4 (4)
Massage Therapy with Traditional Chinese Medicine	48	58	51 (88)	7 (12)
Topical Treatment with Traditional Chinese Medicine	39	191	180 (94)	11 (6)
Comprehensive TCM	3	54	51 (94)	3 (6)
Total	62	276	246 (89)	30 (11)

[*]The Current Price is the price of the procedure in the *Shanghai Compilation of Medical Procedures and Prices and the current price* charged by public hospitals. [**]The Standardized Value is the sum of the Standardized Value of Medical Care Provided and the Cost of Direct Materials Consumed. Figures are the average for each procedure in each category. Specific procedures and the method of calculation are shown in Supplementary Table S1.

Table 3. Comparison of the current price and standardized value of corresponding procedures in seven major categories of TCM procedures in the *Shanghai Compilation of Medical Procedures and Prices and the 2012 Manual on the Prices of Medical Procedures*

Procedure Category	Sample Size	Current Price[*]		Standardized Value[**]	
		Median	Interquartile Range	Median	Interquartile Range
Acupuncture and Moxibustion	19	10	5	67	25
Anorectal Treatment with Traditional Chinese Medicine	3	100	140	751	270
Traditional Chinese Medicine for Orthopedic Injuries	55	100	90	512	471
Special Therapy with Traditional Chinese Medicine	6	6	1	96	192
Massage Therapy with Traditional Chinese Medicine	44	50	15	52	7.5
Topical Treatment with Traditional Chinese Medicine	16	11	24	63	87
Comprehensive TCM	1	2.5	0	52	0
Total	144	52.5	80	94.5	371

[*]The Current Price is the price of the procedure in the *Shanghai Compilation of Medical Procedures and Prices* and the current price charged by public hospitals. [**]The Standardized Value is the sum of the Standardized Value of Medical Care Provided and the Cost of Direct Materials Consumed. Figures are the average for each procedure in each category. Specific procedures and the method of calculation are shown in Supplementary Table S1.

and moxibustion, special treatment with TCM, TCM for orthopedic injuries, and comprehensive TCM procedures was markedly low. The lowest current price level represented only 3% of the standardized value. Closed reduction and percutaneous internal fixation of a tubular bone fracture required three physicians and one nurse, the procedure took 50 minutes, the technical difficulty score was 70 and the risk score was 58, and the coefficient to adjust for technical difficulty and risk was 0.8. The standardized value of the procedure was 1,205 RMB while the current price was only 150 RMB, so the current price represented for 12% of the standardized value. Acupuncture in the neck required one physician, it took 20 minutes, the technical

difficulty score was 53 and the risk score was 40, and the coefficient to adjust for technical difficulty and risk was 0.7. The standardized value of the procedure was 77 RMB while the current price was only 20 RMB, so current price represented 26% of the standardized value. "Nourishing" therapy required one physician and one nurse, it took 30 minutes, the technical difficulty score was 77 and the risk score was 40, and the coefficient to adjust for technical difficulty and risk was 0.7. The standardized value of the procedure was 201 RMB while the current price was only 6 RMB, so the current price represented only 3% of the standardized value. The current price of massage therapy with TCM was basically the same as its standardized value (*i.e.* the current price represented 96% of the standardized value) (Table 2 and Table 3). Massage therapy for a headache required one physician, it took 15 minutes, the technical difficulty score was 38 and the risk score was 14, and the coefficient to adjust for technical difficulty and risk was 0.4. The standardized value of the procedure was 51 RMB while the current price was only 55 RMB, so the current price was 8% higher than the standardized value (for specific procedures and the method of calculation, see Supplemental Table S1, *http://www.biosciencetrends.com/action/getSupplementalData.php?ID=14*).

3.3. *Selection of procedures for price adjustment and the suggested price*

Seventy-nine procedures (55% of all corresponding procedures) were performed less often (accounting for less than 0.5 of procedures) and those procedures had a low average price level. Many of the selected procedures involved TCM for orthopedic injuries (50.6%), acupuncture and moxibustion (20.2%), or topical treatment with TCM (17.7%). The average ratio for selected procedures was 0.27. Few of the selected procedures involved comprehensive TCM, special treatment with TCM, or acupuncture and moxibustion (the lowest proportion was 0.08). The suggested price increase was an average of 234%. The lowest increase was for massage therapy with TCM (an increase of 79%) while the highest increase was for special treatment with TCM (an increase of 713%) (Table 4). The current price of manipulative reduction of a distal radius and ulna joint dislocation was 24 RMB while its standardized value was 601 RMB; the price difference was 577 RMB. The suggested price increase was 173 RMB (30% of the difference). The suggested price was 197 RMB, representing a 721% increase. The current price of wound debridement with TCM (an especially large wound) was 192 RMB while its standardized value was 1330 RMB; the price difference was 1138 RMB. The suggested increase was 341 RMB (30% of the difference). The suggested price was 533 RMB, an increase of 178%. The current price of "thunder-fire" moxibustion was 15 RMB

Table 4. Selection of procedures by priority, suggested increases, and the adjusted relative price ratio

Procedure Category	Number (proportion in %)	Mean Current Price*	Mean Ratio of the Current Price**	Mean Standardized Value#	Mean Ratio of the Standardized Value##	Mean Relative Price Ratio&	Suggested Increase (%)	Mean Adjusted Relative Price Ratio
Acupuncture and Moxibustion	16 (20.2)	16	0.29	160	1.7	0.24	215	0.68
Anorectal Treatment with Traditional Chinese Medicine	3 (3.8)	120	2.26	696	7.4	0.31	189	0.72
Traditional Chinese Medicine for Orthopedic Injuries	40 (50.6)	94	1.77	614	6.53	0.27	228	0.69
Special Therapy with Traditional Chinese Medicine	4 (5.1)	6	0.11	149	1.58	0.08	713	0.57
Massage Therapy with Traditional Chinese Medicine	1 (1.3)	55	1.04	200	2.13	0.49	79	0.85
Topical Treatment with Traditional Chinese Medicine	14 (17.7)	34	0.64	191	2.03	0.34	132	0.74
Comprehensive TCM	1 (1.3)	3	0.05	54	0.57	0.08	618	0.57
Total	79 (100)	62	1.17	414	4.41	0.27	234	0.69

*The Mean Current Price is the mean current price of procedures by priority from among 7 major categories of corresponding procedures in traditional Chinese medicine. Current price data are from the *Shanghai Compilation of Medical Procedures and Price*. **The Mean Ratio of the Current Price is the ratio of the current price of each selected procedure to the mean current price; this index is a relative ratio. #The Mean Standardized Value is the mean standardized value of a selected procedure from among corresponding procedures. The standardized value is the sum of the standardized value of medical care provided and the cost of direct materials consumed. ##The Mean Ratio of the Standardized Value is the ratio of the standardized value of the selected procedure to the mean standardized value; this index is a relative ratio. &The Mean Relative Price Ratio is the mean ratio of the current price divided by the mean ratio of standardized value. A value less than 1 indicates that the current price is low; this ratio is an index of the price relationship. Figures are the average for each category. Specific procedures and the method of calculation are shown in Supplementary Table S1. The Suggested Increase (%) is the rate of increase (%) in the suggested price relative to the current price. The method of calculation for specific procedures and the suggested price are shown in Supplementary Table S2. The Mean Adjusted Relative Price Ratio is the mean relative price ratio of each procedure based on the suggested price. The relative price ratio based on the suggested price for a specific procedure is shown in Supplementary Table S3.

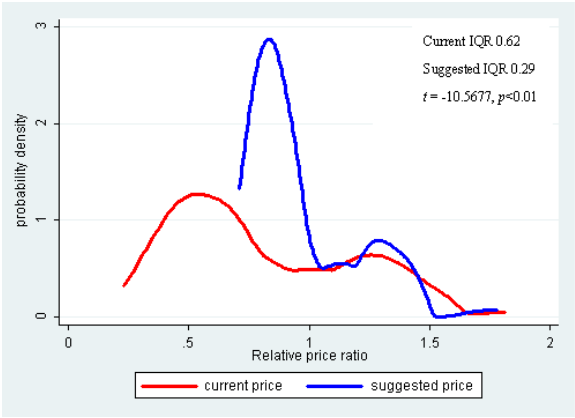

Figure 1. Current price and changes in the relative price ratio based on the suggested price. Changes in the relative price ratio of the current price to the suggested price indicated that the relative price ratio of the current price was concentrated at 0.5 and 1.4 and that the relative price ratio of the suggested price tended to be concentrated at 1, *i.e.* at 0.7 and 1.4. The interquartile range decreased from 0.62 to 0.29. Changes in the relative price ratio differed significantly (t = -10.5677, p < 0.01).

while its standardized value was 112 RMB; the price difference was 97 RMB. The suggested increase was 29 RMB (30% of the difference). The suggested price was 44 RMB, an increase of 194% (specific procedures and the method of calculation are shown in Supplemental Table S2, *http://www.biosciencetrends.com/action/getSupplementalData.php?ID=14*).

3.4. *Relationship between prices of procedures before and after adjustment*

In accordance with adjustment to the suggested price, the distribution of the price parity between procedures tended to be concentrated at 1. The distribution of the relative price ratio differed significantly (t = -10.5 677, p < 0.01) between the current price and the suggested adjusted price. After data were converted, the relative price ratio of the current price was mainly concentrated at 0.5 to 1.4 and the suggested adjusted price was concentrated at 0.8 to 1.4. There was less dispersion of the suggested adjusted price. The adjusted interquartile range was 0.29 and the current price was 0.62 (Figure 1). The relative price ratio was 0.27 of the current price and the recommended adjusted price was 0.69. The relative price ratio changed markedly for integrated traditional Chinese and Western medicine (from 0.08 to 0.57), special treatment with TCM (from 0.08 to 0.57), and acupuncture and moxibustion (from 0.24 to 0.68) (Table 4). The relative price ratio of manipulative reduction of a distal radius and ulna joint dislocation changed from 0.07 to 0.56, the relative price ratio of massage therapy for a cervical facet joint disorder changed from 1.39 to 1.34, and the relative price ratio of "nourishing" therapy changed from 0.05 to 0.55 (see Supplemental Table S3 for specific items, *http://www.biosciencetrends.com/action/getSupplementalData.php?ID=14*).

4. Discussion

Over the past few years, remuneration of public hospitals for medical care has changed as public hospitals in China have gradually been reformed (*16-18*). Remuneration has changed from three avenues - service charges, additional income from pharmaceuticals, and government subsidies - to two avenues - service fees and government subsidies (*19*). Government financing currently accounts for around 9% of the income of public hospitals, and pharmaceuticals account for a large proportion (45%) of hospital income (*20*). In 2011, public hospitals lost 55.2 billion RMB, and losses from medical procedures were directly related to the low pricing of medical procedures (*21*). A domestic study found that the prices of medical procedures at 288 medical facilities in 30 provinces and cities were not adjusted at fixed intervals or were adjusted at intervals longer than two years (89%) (*5*). Public TCM hospitals are the main provided of TCM care. Due to the small number of TCM procedures, low pricing, and prolonged lack of price adjustment, TCM hospitals have gradually adopted Western medicine instead, and the development of TCM practices is seriously lagging. A key issue that China needs to urgently address is the gradual increase in the proportion of income that TCM hospitals are receiving from laboratory diagnostic testing and surgery as the use of TCM procedures and the proportion of income they represent are gradually decreasing (*22,23*).

The current results indicated that the value of a TCM procedure is mainly the medical care provided. The value of medical care provided represents 97% of the value of acupuncture and moxibustion, 88% of the value of massage therapy with TCM, and 94% of the value of integrated traditional Chinese and Western medicine. The results were consistent with the characteristics of TCM practices. Calculating the current cost does not properly reflect the value of care provided by medical personnel, and calculations deviate widely from the value of TCM procedures (*24,25*). The current study found that the current price does not fully reflect the value of medical care provided. The average price of special therapy with TCM was 6 RMB while the value of direct materials consumed was 4 RMB and the standardized value of medical care provided was 98 RMB. The current price mainly reflects the value of materials consumed without fully taking into account the value of medical care provided. The current price of "thunder-fire" moxibustion was 15 RMB while its standardized value was 112 RMB. The cost of direct materials consumed was 11 RMB and the value of medical care provided was 101 RMB (the procedure requires 1 physician, it takes 30 minutes, and the technical difficulty score is 46 and the risk score is 24). Pricing of procedures mainly considers the price of supplies but not the value of medical care provided. China's current system of provincial pricing of medical procedures is based on a single price. There is

no distinction between the components of the value of a procedure, such as medical care provided and materials consumed. The current study analyzed the value of medical care provided and the cost of direct materials consumed, and it devised a method of adjusting the prices of medical procedures based on a standardized value parity model. The United States and other countries use a pricing theory based on relative units (*26,27*). A relative value unit (RVU) is assigned to the three components of medical services - work, practice expense, and professional liability insurance - resulting in work RVUs, practice expense RVUs, and professional liability insurance RVUs. The current study is the first to classify components of domestic prices, producing a system with two types of values: the value of medical care provided and the value of materials consumed. Since domestic medical liability insurance is in its initial stages and that liability insurance is not yet a major component of the value system, medical liability insurance was not included in the standardized value of a procedure in this study.

The current study found a large gap between the current price and the standardized value of TCM procedures; the current price was significantly lower. The value of acupuncture and moxibustion was 6.7 times its current price, the value of anorectal treatment with TCM was 7.5 times its current price, the value of TCM for orthopedic injuries was 51 times its current price, and the value of integrated traditional Chinese and Western medicine was 20 times its current price. Closed reduction and percutaneous internal fixation of a tubular bone fracture requires 3 physicians and 1 nurse, it takes 50 minutes, and the technical difficulty score is 70 and the risk score is 58. In accordance with revised salary levels in Shanghai, the standardized value of that procedure was 1,205 RMB but its current price was 150 RMB (*i.e.* 8 times the current price). A study of TCM in Shandong Province, China found that the prices of acupuncture and comprehensive TCM procedures at medical facilities were lower than the cost of those procedures. Municipal hospitals recovered 32% of the cost of moxibustion and 35% of the cost of topical treatment with TCM; township hospitals recovered only 7% of the cost of comprehensive TCM (*28*). Determination of the cost of TCM procedures in Chongqing indicated that charges for TCM were generally low, and this was especially true for surgery and treatment with TCM (*29*). Costs were 2-5 times the current price. Calculations of the standardized value in the current study were similar to the results of previous studies.

Through stepwise adjustments, the current study gradually gained insight into price parity. Based on the labor theory of value and drawing on the values and factors used in the resource-based relative value scale (RBRVS) and the concept of standard clinical pathways, this study quickly determined the value of procedures in terms of the medical care provided. That value was combined with data on price factors in the *2012 Manual on the Prices of Medical Procedures* and data on salary reform by provinces and cities. This study also focused on the relationship between the value of marginal resources invested in medical procedures and rational prices based on Ramsey's theory of pricing (*30*). The current study created a model of price adjustment based on a ratio. Theoretically, if the current price of a procedure is close to parity with its standardized value, then the ratio will mainly have a symmetrical distribution concentrated at 1. If the ratio is far below 1, then the pricing is markedly lower. Data based on the relative price ratio can be used to select procedures by priority and correct the price relationship. This study found that the current price parity was not reasonable. The current price of TCM with packets of herbs (small) was 6 RMB while its standardized value was 35 RMB. The current price ratio was 0.11, the standardized value ratio was 0.37, and the relative price ratio was 0.3. The current price of massage therapy for lumbar muscle strain was 50 RMB while its standardized value was 61 RMB. The current price ratio was 0.94, the standardized value ratio was 0.65, and the relative price ratio was 1.45.

Based on selection criteria, this study identified a total of 79 procedures that need price adjustment first. The main categories of those procedures were TCM for orthopedic injuries, topic treatment with TCM, and acupuncture and moxibustion. Consistent with the results of a preliminary study, the current study found a large gap between the current price and standardized value. Directly adjusting the current price to the standardized value could result in massive price fluctuations. The current price of wound debridement with TCM (an especially large wound) was 192 RMB while its standardized value was 1,330 RMB; the absolute price increase would be 1,138 RMB (590%) if the current price is changed to the standardized value. The current price of manipulative reduction of an ankle fracture and dislocation was 156 RMB while its standardized value was 1,208 RMB; the absolute price increase would be 1,052 RMB (670%) if the current price was changed to the standardized value. Therefore, this study suggested that the gap between the current price and the standardized value represents a range. Given a coefficient for relative adjustment, the price could be gradually adjusted to a target standardized value. As mentioned above, the adjusted price for wound debridement with TCM (an especially large wound) would be 533 RMB (an increase of 178%) and the adjusted price for manipulative reduction of an ankle fracture and dislocation would be 471 RMB (an increase of 201%). The suggested price of special treatment with TCM and topical treatment with TCM increased significantly (713% for special treatment and 618% for topical treatment), and this is related to their significantly lower current price. The price of "nourishing" therapy changed from 6 RMB to 65 RMB; its standardized

value was 201 RMB. The price increase would be 59 RMB, representing an increase of 975%. The price of a manmade decoction changed from 2.5 RMB to 18 RMB; its standardized value was 54 RMB. The price increase would be 15.5 RMB, representing an increase of 618%. The increase was substantial since the current price was markedly low. However, the absolute value of the suggested adjusted price was within the acceptable range, which is not unusual, and there is some leeway to reach the target value. Therefore, the price suggested in this study was reasonable. In terms of the price relationship based on the suggested price, the distribution of the relative price ratio tends to be 1, representing an increase from 0.27 to 0.69, and the dispersion decreases from 0.62 to 0.29. The distribution of the relative price ratio coincided with marked optimization, suggesting that the mechanism of selecting certain procedures for price adjustment mechanism and the suggested price were reasonable and feasible. Therefore, other areas can refer to this model, in conjunction with local parameters for calculation and selection, to adjust the price of medical procedures in a stepwise manner.

The current study had two limitations: *i*) this study used data parameters from the *2012 Manual on the Prices of Medical Procedures* and it did not fully create a database of procedure parameters from the *Shanghai Compilation of Medical Procedures and Prices* and *ii*) the standardized value was mainly combined with the characteristics of TCM and it measured the value of medical care provided and the value of direct materials consumed. However, material costs were not comprehensively calculated. These two aspects may have biased the results, so these aspects need to be studied further and improved in future research.

In summary, the current study matched data from the *2012 Manual on the Prices of Medical Procedures and the Shanghai Compilation of Medical Procedures and Prices* and this study created a database for calculation of the value of 144 TCM procedures. Based on the standardized value parity model, 79 procedures were selected for initial price adjustment. On average, the suggested price increase was 234%. Price parity between TCM procedures was significantly optimized at the suggested price ($p < 0.01$). The current results indicated that a strategy for adjustment of the distribution of the price ratio in a standardized value parity model is a scientific and suitable approach. Other regions should refer to the model in order to devise their own system of value and to gradually create a mechanism of dynamic price adjustment.

Acknowledgements

This work was supported by a grant from the City of Shanghai for Evidence-based Public Health Care and Health Economics (15GWZK0901), a grant from the United States China Medical Foundation for the second round of cooperative projects to transform health care research and policymaking (Establishing a Network to Transform Chinese Health Care Policy (CMB-CP 14-190), and a grant for Creation of a System to Support Health Care Decision-making based on Big Data in Shanghai (GWIV-33). The authors wish to thank Rong Yan, Wei Wang, Gong Li, and Yuanfeng He for their expert advice.

References

1. Xu Q, Bauer R, Hendry BM, Fan TP, Zhao Z, Duez P, Simmonds MS, Witt CM, Lu A, Robinson N, Guo DA, Hylands PJ. The quest for modernisation of traditional Chinese medicine. BMC Complement Altern Med. 2013; 13:132.
2. Zhu AS, Chen ZH, Pei YP, Yang GL. Review and discussion of a strategy to develop a basic theory of traditional Chinese medicine. China Journal of Traditional Chinese Medicine and Pharmacy. 2016; 7:2467-2471. (in Chinese)
3. Zhang Q, Zhu L, Wim Van der L. The importance of traditional Chinese medicine services in health care provision in China. Universitas Forum. 2011; 2:1-8.
4. Liu Y, Jiang LJ, Wang LJ, Ma Y, Xu AJ. Current status of and thoughts on the prices of traditional Chinese medicine procedures. Chinese Health Economics. 2017; 36:63-65. (in Chinese)
5. Xu T, Qi W, Huang XC, Chen X, Cao LQ. Study on the mechanism of dynamic adjustment of the prices of medical procedures. Chinese Health Economics. 2017; 36:67-69. (in Chinese)
6. Ma Y, Xu AJ. Review of the prices of Chinese medical procedures. Prices Monthly. 2017; 03:36-40. (in Chinese)
7. World Health Organization. WHO Traditional Medicine Strategy: 2014-2023. *http://www.who.int/medicines/areas/traditional/en/index.html* (accessed June 14, 2017).
8. The State Council of China. Guideline on Developing Traditional Chinese Medicine from 2016-2030. *http://www.gov.cn/zhengce/content/2016-02/26/content_5046678.htm* (accessed June 15, 2017). (in Chinese)
9. The National People's Congress (NPC) Standing Committee of China. The Law on Traditional Chinese Medicine 2016. *http://news.xinhuanet.com/english/2016-12/25/c_135931387.htm* (accessed June 16, 2017). (in Chinese)
10. Zheng GL, Zhang Y, Yang YS, Xiao MX, Chen LJ. Analysis of TCM procedures in the 2012 National Medical Fee Schedule. Chinese Health Service Management. 2014; 4:269-270, 93. (in Chinese)
11. Zou LA. Analysis of policy characteristics of the National Standards for the Prices of Medical Procedures (2012 Edition). Chinese Health Economics. 2013; 32:71-73. (in Chinese)
12. The National Development and Reform Commission, National Health and Family Planning Commission, the State Administration of Traditional Medicine of China. Notice on management of the prices of specified medical procedures and related issues. *http://www.ndrc.gov.cn/rdzt/2012xxgkgz/jgsfcxgk/201205/t20120510_499420.html* (accessed August 1, 2017). (in Chinese)
13. Shanghai Municipal Health and Family Planning

Commission. Compilation of Medical Procedures and Prices at Medical Facilities in Shanghai. *http://www.wsjsw.gov.cn/wsj/n473/n1978/index.html* (accessed August1, 2017). (in Chinese)
14. Wang HY, Jin CL, Wang W, Gong L, He YF, Peng Y. Development of a system to compare the prices of medical procedures in Shanghai. Chinese Journal of Hospital Administration. 2015; 31:635-638. (in Chinese)
15. Peng Y, Li X, Wang HY, Yang ZH, Huang LP, Jin CL. Analysis of calculations of the cost of medical procedures at 5 pilot hospitals in Shanghai. Chinese Hospital Management. 2017; 37:5-9. (in Chinese)
16. Li L, Fu H. China's health care system reform: Progress and prospects. Int J Health Plann Manage. 2017; 32:240-253.
17. Blumenthal D, Hsiao W. Lessons from the East – China's rapidly evolving health care system. N Engl J Med. 2015; 372:1281-1285.
18. Barber SL, Borowitz M, Bekedam H, Ma J.The hospital of the future in China: China's reform of public hospitals and trends from industrialized countries. Health Policy Plan. 2014; 29:367-378.
19. Liu GG, Vortherms SA, Hong X. China's health reform update. Annu Rev Public Health. 2017; 38:431-448.
20. Ministry of Health of the People's Republic of China. Public hospital income and expenditures (4-4-1). In: 2013 China Health Statistics Yearbook. Peking Union Medical College Press, Beijing, China, 2013; pp.121-24. (in Chinese)
21. Tan J, Xiang Q. Analysis of the income and expenditures and budget surpluses at public hospitals in China. Chinese Health Economics. 2014; 33:78-79. (in Chinese)
22. Shen JJ, Wang Y, Lin F, Lu J, Moseley CB, Sun M, Hao M. Trends of increase in western medical services in traditional medicine hospitals in China. BMC Health Serv Res. 2011; 11:212.
23. Wang L, Suo S, Li J, Hu Y, Li P, Wang Y, Hu H. An investigation into traditional Chinese medicine hospitals in China: Development trend and medical procedures innovation. Int J Health Policy Manag. 2017; 6:19-25.
24. Dou L, Yin AT, Liu YX, Liu Q. Study on calculation of the costs of traditional Chinese medical procedures and specific features of methods of calculation. Chinese Health Economics. 2012; 31:76-78. (in Chinese)
25. Long YX. Creation and empirical study of a model of price adjustment for traditional Chinese medicine procedures in Hubei Province. Journal Hubei University of Chinese Medicine, Wuhan, China, 2016; pp.21-36. (in Chinese)
26. Baadh A, Peterkin Y, Wegener M, Flug J, Katz D, Hoffmann JC. The relative value unit: History, current use, and controversies. Curr Probl Diagn Radiol. 2016; 45:128-132.
27. Baltic, S. Pricing Medicare services: Insiders reveal how it's done. Managed Healthcare Executive. 2013. High Beam Research. *https://www.highbeam.com/doc/1P3-3127446971.html* (accessed August 1, 2017).
28. Dou L, Liu Q, Yin AT, Liu YX. Analysis of the status of profits and losses from traditional Chinese medicine procedures and reasons for losses. Chinese Health Economics. 2012; 31:82-84. (in Chinese)
29. Huang Y, Duan XK. Study on calculation of fees for and costs of traditional Chinese medicine procedures in Chongqing. Chinese Health Resources. 2015; 18:266-267. (in Chinese)
30. Cui L. Study of price regulations for Chinese medical procedures: An analysis based on the Ramsey Pricing method. Chinese Health Economics. 2015; 34:49-51. (in Chinese)

(Received July 31, 2017; Revised September 13, 2017; Accepted October 1, 2017)