BMJ Open

BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (http://bmjopen.bmj.com).

If you have any questions on BMJ Open's open peer review process please email info.bmjopen@bmj.com

BMJ Open

Patients' preferences for health insurance coverage of new technologies for treating chronic diseases in China: a discrete choice experiment

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2020-038051
Article Type:	Original research
Date Submitted by the Author:	27-Feb-2020
Complete List of Authors:	Geng, JinSong; Nantong University Medical School, Department of Medical Informatics Chen, Xiaowei; Nantong University Medical School, Department of Medical Informatics; Zhejiang University School of Medicine First Affiliated Hospital, Library and Reference Department Bao, Haini; Nantong University Medical School, Department of Medical Informatics Qian, Danmin; Nantong University Medical School, Department of Medical Informatics Shao, Yuting; Tongji University School of Medicine, Department of Ophthalmology Yu, Hao; Harvard Medical School, Department of Population Medicine; Harvard Pilgrim Health Care Institute
Keywords:	Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, International health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health & safety < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

SCHOLARONE™
Manuscripts

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

For peer review only

Patients' preferences for health insurance coverage of new technologies for treating chronic diseases in China: a discrete choice experiment

Jinsong Geng[1*], Xiaowei Chen[1, 2], Haini Bao[1], Danmin Qian[1,] Yuting Shao[3], Hao Yu[4, 5]

[1]Department of Medical Informatics, Nantong University Medical School, Nantong, China

[2]Library and Reference Department, Zhejiang University School of Medicine First Affiliated Hospital, Hangzhou, China

[3]Department of Ophthalmology, Tongji University School of Medicine, Shanghai, China

[4]Department of Population Medicine, Harvard Medical School, Boston, USA

[5]Harvard Pilgrim Health Care Institute, Boston, USA

*Correspondence: Jinsong Geng, Department of Medical Informatics, Nantong University Medical School, 19 Qixiu Road, Nantong 226001, China; Email gjs@ntu.edu.cn; Tel: +86 513 85051891; Fax: +86 513 85051876

Word count: 4055

For peer review only

ABSTRACT

Objectives

Our study aimed to inform insurance decision-making in China by investigating patients' preferences for insurance coverage of new technologies for treating chronic diseases.

Design

We identified six attributes of new medical technologies for treating chronic diseases and used Bayesian-efficient design to generate choice sets for a discrete choice experiment (DCE). After conducting the DCE, we analyzed the data by estimating conditional logistic regressions to examine patient-reported preference for each attribute.

Setting

The DCE was conducted with patients in six tertiary hospitals from four cities in Jiangsu Province.

Participants

Patients aged 18 years or older with a history of diabetes or hypertension and taking medications regularly for more than one year were recruited (N=408).

Results

The technology attributes regarding expected gains in health outcomes from the treatment (P<0.001), high likelihood of effective treatment (P<0.001), and low incidence of serious adverse events (P<0.001) were significant, positive predictors of choice by the study patients. These results hold for the entire sample and for the subgroup analyses. Most of the study patients did not seem to care about whether there were alternative technologies currently covered by insurance (P>0.05). Out-of-pocket costs were a significant, negative attribute for the entire study sample (β = -0.122, P<0.001) and for the patients with Urban and Rural Residents Basic Health Insurance (URRBMI) (β = -0.212, P<0.001), but not for all the patients with Urban Employees Basic Health Insurance (UEBMI) (β = -0.041, P>0.05).

For peer review only

Conclusions

Patients valued most the health benefits and risks of new technologies, which were closely related to their own experiences and feelings. However, there existed heterogeneity in preferences between URRBMI and UEBMI patients. Further efforts should be made to reduce the gap between insurance schemes and make safe and cost-effective new technologies as priority for health insurance reimbursement.

Keywords: discrete choice experiment, patient preferences, chronic diseases, health insurance

For peer review only

Strengths and limitations of this study

- This is the first study that provides evidence regarding patients' preferences for insurance coverage of new technologies for treating chronic diseases in China.
- It is also the first study that identified differential preferences among chronic disease patients with different types of insurance in China.
- Since our sample was from one wealthy province in China, future studies of nationally representative samples are needed.
- While this study focused on hypertension and diabetes, two of the most prevalent chronic diseases in China, future studies need to examine other types of chronic diseases.

For peer review only

INTRODUCTION

Non-communicable chronic diseases (chronic diseases) are health conditions or diseases with long-term accumulation, non-self-healing, and difficult to cure. Nowadays, the prevalence and mortality of chronic diseases are on the rise around the world.[1] Chronic diseases present a particularly daunting challenge to China. It was estimated that among Chinese adults aged 35 to 75 years, nearly half had hypertension.[2] The overall prevalence of diabetes in Chinese adults was about 10.9%.[3] Furthermore, comorbidities are highly prevalent among patients with chronic diseases, which have a negative impact on the patient's quality of life and impede the efficacy of treatment.[4-6] Chronic diseases lead to heavy financial burden on patients' families and health insurance programs. It was estimated that the total economic burden associated with chronic diseases in China over the period 2010-2030 could be as high as US$16 trillion (measured in 2010 US Dollars).[7] Further adding to the challenges to China's health insurance programs' financing capacity, new technologies for treating chronic diseases continue to enter the market, which can be very expensive and contribute to rising healthcare costs. Deciding on which new technology to cover and by which insurance program has become a key issue facing policy-makers in China in the context of universal health insurance coverage.

As part of its goal of providing timely, acceptable and affordable basic healthcare of appropriate quality to its residents, China successfully achieved universal health insurance coverage in 2011, increasing demand for and expenditures on healthcare. China's total health expenditures grew at an average annual rate of 12.2% in 2008-2017, much higher than its GDP's average annual growth rate (8.1%).[8] In recent years, Chinese policy-makers have struggled to keep a balance between expenditure control and meeting patients' demand for healthcare, including the demand for new technologies by patients with chronic diseases.

After China reached universal health insurance coverage, there were still considerable disparities in benefit coverage and reimbursement ratio among the three

For peer review only

major public insurance programs that together covered more than 95% of Chinese people, including New Rural Cooperative Medical Scheme (NRCMS), Urban Residents Basic Health insurance (URBMI), and Urban Employees Basic Health insurance (UEBMI). For details of differences in health insurance eligibility, premiums and benefits among the three programs, see the paper published by Yu.[9] Generally speaking, UEBMI has the best benefit package and the lowest out-of-pocket costs among the three public insurance programs,[10 11] and UEBMI enrollees had higher likelihood of healthcare utilization.[12] To improve administrative efficiency and reduce inequality in insurance benefits, China State Council issued the policy in January 2016 on merging the NRCMS and URBMI to form the Urban Rural and Residents Basic Health Insurance (URRBMI).[13] While the newly formed URRBMI helped equalize insurance benefits between urban and rural residents, gaps remained between URRBMI and UEBMI. Even among the UEBMI enrollees, insurance benefit is not equal since some of the enrollees enjoy civil servant subsidies.[14] Whereas disparities in China's insurance programs and patient's utilization of healthcare have been well-documented in the literature, no studies have yet examined whether patient preferences for new medical technology vary by type of insurance. This study aimed to fill the gap. Eliciting patients' preferences and involving patients in health insurance decision-making can be helpful to increase satisfaction of patients and is an integral part of patient-centered care, which is defined as providing care that is respectful of, and responsive to individual patient preferences, needs and values.[15] Although patient-centered approach and value-based care has been long advocated in China, there still a lack of evidence from patients that reflect their preferences to inform health insurance coverage decision-making. This study added new information to the literature by conducting a discrete choice experiment (DCE), which is an attribute-based method to measure the preferences and trade-off of responders and becomes a recognized scientific approach to elicit preferences.[16] Prior research showed that DCE was fruitful and reliable to effectively improve healthcare decision-making.[17] Our DCE focused on

For peer review only

chronic disease patients, and its goal was to support evidence-informed insurance policy-making in China. Specifically, we used the DCE data to test the following hypotheses: (1) new technology attributes regarding health benefits are most preferred by chronic disease patients for health insurance coverage; (2) patients' preferences differ by type of disease and type of insurance.

METHODS

Identification of technology attributes and levels

Our DEC design, implementation, and analysis followed the user guide developed jointly by the World Bank, World Health Organization, and U.S. Agency for International Development.[18] We used a three-step approach to complete the preliminary stage of our DCE, which aimed to identity and define the attributes and levels of new medical technologies. First, a systematic review was conducted to select attributes which were often used in multi-criteria decision analyses of health insurance decision-making. The systematic review was performed according to the framework for evidence-based decision-making as defined by EVIDEM.[19] We found that the most commonly mentioned dimensions were comparative outcomes (effectiveness, safety/tolerability), economic consequences (costs and cost-effectiveness) and needs of new technologies (severity of target disease, size of affected population, unmet needs related to the already reimbursed technologies), and knowledge of new technologies (quality of evidence, expert consensus/clinical practice guideline). Results of the systematic review were published in a separate paper.[20]

Second, both focus group discussions with physicians and patients and expert consultation were carried out to determine attributes used in our research. Since there was no consensus among experts about the criteria to determine the level of attributes of new technologies to treat diabetes and hypertension, we searched the famous health technology assessment database established by Canadian Agency for Drugs and Technologies in Health (CADTH) to help select potential new technologies and find

For peer review only

reasons for recommendation of reimbursement. We found 68 reports regarding hypertension and diabetes which were published before March 2018. Data extraction form was developed and attributes of new technologies were extracted. We further searched the database founded by China National Medical Products Administration (NMPA, formerly China Food and Drug Administration or CFDA) according to the generic name of new technologies to see if they were approved and available in China. We also referred to the list published by city governments in Jiangsu Province about the medical technologies which were already covered by the public health insurance programs. After completing the database search, we defined new medical technologies in this study as the therapeutics for hypertension and diabetes, which had been marketed in China but were not covered by the public health insurance programs in Jiangsu in 2018. We also determined the range of out-of-pocket costs according to the retail prices of new technologies and the current level of reimbursement by the public health insurance programs.

Third, we chose unlabeled over labeled DCE. Unlabeled DCE was widely used to investigate patients' preferences for treatment techniques.[21-23] Respondents of unlabeled DCEs found that they were not subject to the psychological cues of the technology labels, thus reflecting the real-world choice situation.[24] In addition, in our research, new medical technologies to treat chronic disease continue to emerge. Therefore, an unlabeled DCE was considered appropriate for our study. Attributes and levels of new medical technologies which were used in our research were listed in Table 1.

For peer review only

Table 1. Technology attributes and levels included in the DCE

Attributes	Levels	Variables coding
Expected gains in health outcomes from the treatment	Not as expected; As expected	Binary
Likelihood of effective treatment	30%-90%	Continuous
Severity of target disease	Not severe; Severe but not lethal; Lethal	Categorical
Incidence of serious adverse events	Often; Occasionally; Never or rarely	Categorical
Alternative technologies currently covered by insurance	Yes; No	Binary
Out-of-pocket costs per month (if not reimbursed)	CNY 300-3500	Continuous

The average exchange rate of US Dollars to Chinese Yuan (CNY) in 2018 was about 6.56. Therefore, CNY 300 was approximately US$46; CNY 3500 were about US$533.

Experimental design and development of the questionnaire

D-efficiency experimental design that maximized the precision of estimated choice-model parameters for a given number of choice questions[25] was created by Ngene1.1.2 software (Choice-Metrics, Sydney, Australia). Prior coefficients were set to zero during the pilot. After obtaining priors of the attributes from the pilot, Bayesian-efficient design was used to generate the final choice sets, which consisted of 30 pairs of scenarios and were divided into five blocks, with six pairs in each block. Examples of scenarios were shown in Appendix 1. Our final questionnaire contained two sections. Section A listed questions regarding participants' socio-demographic characteristics, past medical history, reasons for hospital visit, and health insurance information; Section B was the DCE task.

DCE implementation and data collection

Our DCE was carried out from September 15th to October 15th, 2018 in six tertiary public hospitals from four cities in Jiangsu Province. Inclusion criteria for patients including inpatients aged 18 years or older, participating in a public health insurance program, with a history of diabetes or hypertension, and taking medications regularly for more than one year. Patients were enrolled consecutively during the study period.

For peer review only

A total of 410 patients were consented to take part in the DCE survey, and the data from 408 patients were available for analysis with two patients excluded from the analysis due to non-compliance with the inclusion criteria or incomplete data (For details about number of patients in each sample hospital, see Appendix 2). There was no general standard on the ideal sample size required for a DCE[26]. The published research indicated that model estimate precision increased rapidly for DCEs with sample sizes greater than 150 and then flattened out at around a sample of 300.[27] The minimum sample size of 200 respondents per subgroup could be good for studies investigating heterogeneity among subgroups.[28] Therefore, our sample satisfies the DCE sample size requirement as suggested by most researchers.

The DCE questionnaire was administered through one-to-one, face-to-face interviews to ensure validity and quality of the investigation. Our interviewers consisted of 13 medical students, all of whom were in hospitals doing their internships during the research period. For quality assurance, the interviewers were trained before the experiment. We compiled a survey training manual, provided detailed descriptions of how to interpret each scenario, and asked each interviewer to make explanations to patients. The interviewers were required to check whether the entire questionnaire was complete immediately after each interview. If any information was missing, they had to go back to ask patients to provide the information on site. For patients with blurred vision or illiteracy, the interviewers explained the meaning of the questionnaire item by item until the patients fully understood each item.

Patient involvement

Verbal informed consent was obtained from all patients prior to both the pilot and the final survey. Patients were made aware that the participation in the survey was voluntary. All data and information collected from patients were anonymous. We did a pilot study that included 90 patients with diabetes or hypertension. Intelligibility, acceptability and reliability of the questionnaire were tested during the pilot. After the

For peer review only

questionnaire was finalized, we conducted the DCE survey, during which patients had to make a decision based on the assumption that only one technology can be covered due to limited health insurance funds. They were asked to think carefully and trade-off between two new medical technologies. The survey time ranged from 20 minutes to one hour. We prepared a packed cotton towel for each patient as a gift (CNY 10, or US$1.4). Results of this study were not disseminated to the included patients.

Data analysis

Our empirical analysis of the DCE data was based on the random utility model and assumed that the utility of two scenarios was equal. Like prior research,[18] we considered the utility, U, that patient, i, assigned to choice, j, from J alternative choices, as the sum of two parts: fixed and random utility. The equation was developed as follows:

$$U_{ij} = V_{ij} + \varepsilon_{ij} = \beta_0 + \beta_1 x_{1ij} + \beta_2 x_{2ij} + \ldots + \beta_m x_{mij} + \varepsilon_{ij}$$

where V_{ij} was the fixed utility determined by patients' preferences of attributes ($x_1, \ldots, x_m$), ε_{ij} was the random utility which was a function of unobserved attributes and individual-level variation, and β quantified the strength of preference for each attribute level.[18]

We implemented the above equation by estimating conditional logistic regressions using STATA 14.2 SE (StatCorp LP, College Station, Texas, USA). The choice of patients was the dependent variable, and the selected technology attributes were independent variables. Dummy coding was used for categorical variables of our DCE data. Subgroup analysis was performed by type of disease and type of insurance. In each regression model, attribute level with a negative coefficient indicates that patients would prefer not to move from the reference level to that level, while an attribute level with a positive coefficient indicates that patients would prefer to move to that level from the reference level.[29] We first ran the regression model on the entire sample and then on the patients with hypertension and diabetes. We compared the subgroups and entire sample

For peer review only

to examine whether the results changed.

To examine preference heterogeneity across different insurance schemes in China, we ran the regression models by type of insurance (URRBMI vs. UEBMI). Given the variations in benefit coverage, reimbursement rate, and subsidies among patients with UEBMI, we conducted further analysis by excluding those UEBMI patients who enjoyed extra health insurance benefits, i.e., who enjoyed public servant subsidies and the retired veteran cadres.

RESULTS

Characteristics of patients

Table 2 presented demographic and clinical characteristics of the included patients. The sample had more males than females (53.92% vs. 46.08%). The patients had a mean age of 62.34 years (ranging from 28 to 96 years). They were almost evenly split between UEBMI and URRBMI (49.26% vs. 50.73%). Most of the patients had hypertension (63.97%) with 14.22% of them having both hypertension and diabetes while 21.81% of them had diabetes only. There was no statistically significant difference between hypertension and diabetes patients in terms of insurance types (P=0.618) (For details about the types of insurance for hypertension and diabetes patients, see Appendix 3). Among the180 patients who had chronic comorbid conditions other than hypertension and diabetes, cardiovascular disease was the most common comorbidity (98 patients) (For details about the comorbidities, see Appendix 4).

For peer review only

Table 2. Characteristics of patients (n=408)

Characteristics	n (%)
Gender	
Male	220 (53.92)
Female	188 (46.08)
Age groups	
18～45	30 (7.35)
45～59	131 (32.11)
60～74	184 (45.10)
≥75	63 (15.44)
Urban vs. rural household registration	
Urban	210 (51.47)
Rural	198 (48.53)
Education	
Unschooled	39 (9.56)
Primary school	108 (26.47)
Junior high school	110 (26.96)
High school	89 (21.81)
Junior college or higher vocational college	31 (7.60)
Bachelor's degree or above	31 (7.60)
Employment	
Rural farmer	105 (25.74)
Urban employee	140 (34.31)
Urban retiree	112 (27.45)
Urban unemployed	51 (12.50)
Type of insurance [#]	
UEBMI	201 (49.26)
URRBMI	207 (50.74)
Family monthly income (CNY)[△]	
< 2000	83 (20.34)
2001～4000	81 (19.85)
4001～6000	93 (22.79)
6001～8000	69 (16.91)
8001～10000	41 (10.05)
>10000	41(10.05)
Type of patients	
Outpatients	83 (20.34)
Inpatients	325 (79.66)
Type of chronic diseases	
Hypertension	261 (63.97)
Diabetes	89 (21.81)
Both	58 (14.22)
Comorbidities other than hypertension or diabetes	
Yes	180 (44.12)
No	228 (55.88)

[#]1 UEBMI patients, 6 URRBMI patients also enrolled in commercial health insurance

[△] The average exchange rate between US Dollars and Chinese Yuan (CNY) in 2018 was 6.56.

For peer review only

Regression analysis of the DCE data

As presented in Table 3, our analysis found that the study patients valued most the new technologies with never or rare incidence of serious adverse events ($\beta = 0.442$, $P<0.001$), followed by the expected gains in health outcomes from the treatment ($\beta = 0.376$, $P<0.001$). Likelihood of effective treatment was also a significant, positive predictor of patients' choice of new technologies ($\beta = 0.241$, $P<0.001$) while out-of-pocket costs were a significant, negative predictor of patients' choice ($\beta = -0.122$, $P<0.001$). In comparison, whether there were alternative technologies currently covered by insurance seemed not to be an important factor for the patients ($P>0.05$).

Table 3 also presented the results from the subgroup analysis by type of disease (hypertension versus diabetes). While the two groups had similar results, there were two notable differences. One was that, although out-of-pocket costs remained a significant, negative predictor, their coefficient for hypertension patients was -0.075 ($P<0.001$), not as important as it was for patients with diabetes ($\beta = -0.210$, $P<0.001$). The other was that the expected gains in health outcomes from the treatment seemed to be more important for diabetes patients ($\beta = 0.553$, $P<0.001$) when compared with those who only had hypertension ($\beta = 0.287$, $P<0.001$).

For peer review only

Table 3. DCE results from conditional logistic regression

Attributes	All patients		Hypertension patients		Diabetes patients[#]	
	Coefficients	SE	Coefficients	SE	Coefficients	SE
Expected gains in health outcomes from the treatment						
Not as expected (reference)						
As expected	0.376***	0.057	0.287***	0.071	0.553***	0.098
Increasing likelihood of effective treatment (per 10%)	0.241***	0.015	0.265***	0.020	0.205***	0.025
Severity of target disease						
Not severe (reference)						
Severe	0.156*	0.075	0.179	0.093	0.106	0.129
Lethal	0.129	0.075	0.123	0.093	0.124	0.129
Incidence of serious adverse events						
Often (reference)						
Occasionally	0.292***	0.071	0.364***	0.091	0.176	0.117
Never or rarely	0.442***	0.077	0.497***	0.097	0.383**	0.132
Alternative technologies currently covered by insurance						
Yes (reference)						
No	-0.032	0.055	-0.023	0.069	-0.045	0.090
Out-of-pocket costs (thousand CNY per month increase)	-0.122***	0.020	-0.075**	0.025	-0.210***	0.034
Log likelihood	-1483.373		-943.674		-528.381	
Participants	408		261		147	
Observations	4896		3132		1764	

[#]Patients with diabetes only and those who had both diabetes and hypertension

***P<0.001, **P<0.01, *P<0.05

Results from a separate analysis focusing exclusively on inpatients were similar to the results for all patients in Table 3 (For details about the inpatients' results, see Appendix 5).

Subgroup analysis by type of insurance

Table 4 summarized the subgroup analyses by type of insurance. The expected gains in health outcomes from the treatment, likelihood of effective treatment, and low incidence of serious adverse events were significant, positive predictors of technology

For peer review only

choice (P<0.001) for both URRBMI and UEBMI patients. Whether there were alternative technologies currently covered by insurance was statically insignificant for both groups (P>0.05). However, these two groups differed remarkably in two technology attributes. The coefficient of out-of-pocket costs was significant for URRBMI patients (β = -0.212, P<0.001), but not for UEBMI patients (β = -0.041, P>0.05). Severity of target disease also had significant coefficients for URRBMI patients, but not for UEBMI patients.

We conducted further analysis of the UEBMI patients by excluding those UEBMI patients who enjoyed extra health insurance benefits, including who enjoyed public servant subsidies and the retired veteran cadres, and as indicated by Table 4 Column (3), we found that out-of-pocket costs were a meaningful attribute for the remaining UEBMI patients (β = -0.109, P<0.01) although not so important as viewed by URRBMI patients (β = -0.109 vs. β = -0.212). On the other hand, severity of target disease remained statistically insignificant after excluding those UEBMI patients with extra insurance benefits.

For peer review only

Table 4. Subgroup analysis according to insurance types and benefits

Attributes	(1) URRBMI patients		(2) UEBMI patients		(3) UEBMI patients without extra insurance benefits[#]	
	Coefficients	SE	Coefficients	SE	Coefficients	SE
Expected gains in health outcomes from the treatment						
Not as expected (reference)						
As expected	0.307***	0.082	0.445***	0.081	0.428***	0.093
Increasing likelihood of effective treatment (per 10%)	0.257***	0.023	0.239***	0.022	0.261***	0.025
Severity of target disease						
Not severe (reference)						
Severe	0.269*	0.107	0.037	0.107	-0.021	0.123
Lethal	0.381***	0.111	-0.070	0.106	-0.133	0.123
Incidence of serious adverse events						
Often (reference)						
Occasionally	0.339**	0.105	0.218*	0.099	0.243*	0.114
Never or rarely	0.468***	0.109	0.409***	0.111	0.381**	0.127
Alternative technologies currently covered by insurance						
Yes (reference)						
No	-0.014	0.082	-0.090	0.075	-0.184*	0.088
Out-of-pocket costs (thousand CNY per month increase)	-0.212***	0.029	-0.041	0.029	-0.109**	0.033
Log likelihood	-716.487		-747.063		-568.155	
Participants	207		201		158	
Observations	2484		2412		1896	

***P<0.001, **P<0.01, *P<0.05

[#]This subgroup did not include those UEBMI patients who enjoyed extra health insurance benefits, including who enjoyed public servant subsidies and the retired veteran cadres who enjoyed free medical service.[30]

DISCUSSION

Summary of the findings

Our study found that key technology attributes, including expected gains in health outcomes from the treatment, high likelihood of effective treatment, and low incidence of serious adverse events were significant, positive predictors of patient choice for health insurance coverage. These results hold for the entire study sample and for the subgroup analyses.

For peer review only

Out-of-pocket costs were a significant, negative predictor for the entire sample, showing that patients preferences decreased as the out-of-pocket costs increased. We also found that out-of-pocket costs were a significant, negative predictor for both hypertension patients and diabetes patients although they were less important for the former group than for the latter group.

When it came to different insurance types, we identified preference heterogeneity as previous studies of DCE suggested.[31] Specifically, we found that out-of-pocket costs were a significant, negative predictor for URRBMI patients' preference for insurance coverage while severity of target disease was a significant, positive predictor for this group of patients. But neither of these two attributes was a significant predictor for UEBMI patients. Our further analysis of the UEBMI patients by excluding those UEBMI patients who enjoyed extra health insurance benefits revealed that the remaining UEBMI patients regarded out-of-pocket costs as a significant, negative factor for coverage although severity of target disease stayed statistically insignificant for them.

Comparison with other studies

Our findings of patients' valuing most the effectiveness and safety of medical technologies were consistent with the results by prior studies from other countries which aimed to investigate patients' preferences for the treatment of chronic diseases.[32-36] Our study confirmed that patients preferred new technologies which could increase health benefits and minimize potential risks.

However, variation in patient preferences existed and mainly depended on patients' own experiences of the disease. Previous research found that the median hospitalization cost for patients with hypertension was lower than patients with diabetes,[37 38] which supported our findings that out-of-pocket costs were not as important for hypertension patients as they were for patients with diabetes.

We also identified preference heterogeneity among patients with different types of insurance. Although China's successful health insurance expansion during the past

For peer review only

decade led to the country's universal health insurance coverage, variations in benefit coverage were manifested among different health insurance schemes,[11] resulting in inequalities in accessibility and affordability of medical services.[39] Such inequalities affected patient preferences across different types of insurance. For example, we found that out-of-pocket costs were a significant, negative predictor for URRBMI patients' preference, but not for all the UEBMI patients in our sample. The finding reflected the fact that, compared with URRBMI, UEBMI had better benefit coverage and higher reimbursement level, especially for those UEBMI patients with extra benefits, such as the retired veteran cadres and those who enjoyed public servant subsidies. The finding also fitted into the big picture of disparities across insurance schemes in China that were illustrated by prior research. The earlier pilot of URRBMI attempting to integrate health insurance for urban and rural residents and increase benefit coverage was not able to substantially reduce the inequality between URRBMI and UEMBI patients.[40]

We found that URRBMI patients attached importance to severity of disease. However, the coefficient for severity of disease was non-significant for either hypertension patients or diabetes patients. The patient distribution by insurance type in our research was also similar between hypertension and diabetes patients. Therefore, we concluded that it was very likely that the importance of severity of disease mainly depended on types of insurance. Previous studies found that chronic disease patients with URRBMI had lower health service utilization.[41] Furthermore, URRBMI patients had significantly higher adjusted in-hospital mortality rate and shorter length of stay when compared with concurrent UEBMI patients.[42 43] These findings suggested that a plausible explanation for the importance of severity of disease for URRBMI patients might be mainly due to their medical experiences and their concern about the potential severe or lethal consequences of chronic diseases.

Implications of the study findings

The rising prevalence of chronic diseases in China has major implications on its

For peer review only

ability to provide timely, acceptable and affordable healthcare service for its citizens. To meet the demand for new medical technologies for treating chronic diseases, it is important for China's policy-makers to consider patient preferences when they decide on insurance coverage of new medical technologies. Specifically our findings that patients valued most new medical technologies with substantial health benefits and low risks suggested such technologies should be the priority of health insurance coverage.

Our findings that out-of-pocket costs were a significant concern for URRBMI patients but not for all the UEBMI patients suggested that policymakers need to take further efforts to reduce disparities in benefit coverage and reimbursement level between these two types of insurance and between subgroups with UEBMI. The efforts will not only enhance financial protections for URRBMI patients and subgroups within UEBMI patients, but also contribute to China's long-term goal of equalizing benefit coverage across insurance programs.[9]

We also found that URRBMI patients did not care about alternative technologies currently covered by insurance, a result that was the opposite of that for the UEBMI patients without extra insurance benefits. Since URRBMI patients on average had a lower education level than UEBMI patients, one plausible explanation was the lack of knowledge by URRBMI patients about the alternative technologies currently covered by insurance. If confirmed by further analysis, then one implication would be that policymakers and clinicians may need to implement communication and education strategies to improve URRBMI patients' understanding about the alternative therapies and reimbursement policies under the current insurance system to increase appropriate use of the existing therapies.

Strengths and limitations

To our knowledge, this is the first study that used DCE to elicit preferences from chronic disease patients on insurance coverage of new medical technologies in China. It was also the first study that identified preference heterogeneity among patients with different types of insurance. Our research was helpful for applying a patient-centered

For peer review only

approach to policy-making and generated evidence that could potentially inform insurance coverage decision-making.

Nevertheless, there are several limitations with our study. First, our samples were from tertiary hospitals in Jiangsu Province. Those patients who sought medical service from tertiary hospitals generally have serious and/or complex medical conditions with higher demand for healthcare services than other patients, and may cautiously consider the issue of medical insurance coverage and reimbursement. Jiangsu is an eastern, coastal province and one of the most economically developed regions in China. Future studies are needed to have a nationally representative sample by including patients at secondary and primary hospitals, and especially by including the economically underdeveloped regions in China.

Second, our study included patients with a history of diabetes or hypertension. Due to differences in disease nature and characteristics, the results may not represent preferences from patients with other types of chronic diseases, although prior DCEs[32-36] made conclusions that were similar to ours in terms of the relative importance of technology attributes regarding benefits and risks. Future studies need to enroll patients with other diseases, and performing subgroup analysis to find variations of patient preferences across different types of diseases.

Third, there were only 43 UEBMI patients who enjoyed additional privileges of health insurance, and the limited sample size prevented us from conducting a separate analysis of this subgroup. Similarly, our sample included 89 patients with diabetes and 58 patients with both diabetes and hypertension, not allowing for a reliable analysis for each of these two subgroups. Further research is still needed to focus on these subgroups.

CONCLUSION

Chronic disease patients valued most the health benefits and risks of new technologies, which were closely related to their own experiences and feelings.

For peer review only

Policymakers need to consider new technologies with high therapeutic effectiveness and benefit and low risk for treating chronic diseases as a priority for health insurance coverage. Further efforts should also be made to reduce the gaps in benefit coverage and reimbursement level between insurance schemes to promote equal access to healthcare services in China.

Ethics approval

This study, including the patient consent process, was approved by the Medical Ethics Committee in Affiliated Hospitals of Nantong University (Ethical Approval-2016031), and conforms to the ethical guidelines of the Declaration of Helsinki.

Acknowledgments

We acknowledge the important contributions of out interviewers who did one-to-one, face-to-face interviews with the patients. We are also grateful to all the patients for their time and efforts.

At the time of drafting the manuscript, Jinsong Geng was a fellow at the Fellowship in Health Policy and Insurance Research, Department of Population Medicine, Harvard Medical School and Harvard Pilgrim Healthcare Institute.

Author contributions

Geng JS, Chen XW, and Yu H led the design and analysis of the discrete choice experiment. Geng JS, Chen XW contributed to literature search and data interpretation. Bao HN, Qian DM, Shao YT contributed to implementing the discrete choice experiment. Geng JS and Yu H performed statistical analysis and wrote the manuscript.

Funding

This work was supported by National Natural Science Foundation of China (Grant No. 71603138) and Jiangsu Overseas Visiting Scholar Program for University Prominent Young & Middle-aged Teachers and Presidents.

For peer review only

The funders provided financial support for the conduct of the study. The funders had no role in the design, implementation, data collection and statistical analysis, data interpretation, or writing of the manuscript.

Disclosure

The authors report no conflict of interest in this research.

Data sharing statement

Data will be available upon reasonable request to corresponding author.

References

1. World Health Organization. *Global action plan for the prevention and control of noncommunicable diseases 2013-2020*. Geneva: World Health Assembly, 2013:5-9.

2. Lu J, Lu Y, Wang X, *et al*. Prevalence, awareness, treatment, and control of hypertension in China: data from 1.7 million adults in a population-based screening study (China PEACE Million Persons Project). *Lancet* 2017;390:2549-58.

3. Wang L, Gao P, Zhang M, *et al*. Prevalence and ethnic pattern of diabetes and prediabetes in China in 2013. *JAMA* 2017;317:2515-23.

4. Adriaanse MC, Drewes HW, van der Heide I, *et al*. The impact of comorbid chronic conditions on quality of life in type 2 diabetes patients. *Qual Life Res* 2016;25:175-82.

5. Aubert CE, Fankhauser N, Marques-Vidal P, *et al*. Patterns of multimorbidity in internal medicine patients in Swiss university hospitals: a multicentre cohort study. *Swiss Med Wkly* 2019;149:w20094.

6. Wang J, Ma JJ, Liu J, *et al*. Prevalence and risk factors of comorbidities among hypertensive patients in China. *Int J Med Sci* 2017;14:201-12.

7. Bloom DE, Chen S, Kuhn M, *et al*. The economic burden of chronic diseases: estimates and projections for China, Japan, and South Korea. *JEoA* 2018:100163.

8. Yip W, Fu H, Chen AT, *et al*. 10 years of health-care reform in China: progress and gaps in Universal Health Coverage. *Lancet* 2019;394:1192-204.

9. Yu H. Universal health insurance coverage for 1.3 billion people: what accounts for China's success? *Health Policy* 2015;119:1145-52.

10. Li Y, Zhao Y, Yi D, *et al*. Differences exist across insurance schemes in China post-consolidation. *PloS One* 2017;12:e0187100.

11. Xiong X, Zhang Z, Ren J, *et al*. Impact of universal medical insurance system on the accessibility of medical service supply and affordability of patients in China. *PloS One* 2018;13:e0193273.

12. Xian W, Xu X, Li J, *et al*. Health care inequality under different medical insurance schemes

For peer review only

in a socioeconomically underdeveloped region of China: a propensity score matching analysis. *BMC Public Health* 2019;19:1373.

13. The State Council of the People's Republic of China. Opinion of the State Council on integrating the basic health insurance system for urban and rural residents, 2016. Available: http://www.gov.cn/zhengce/content/2016-01/12/content_10582.htm

14. General Office of the State Council of the People's Republic of China. Notice of the General Office of the State Council on transmitting the opinions from the Ministry of Labor and Social Security and the Ministry of Finance on the implementation of medical subsidies for national civil servants, 2000. Available: http://www.gov.cn/gongbao/content/2000/content_60249.htm

15. Institute of Medicine Committee on Quality of Health Care in America. *Crossing the quality chasm: a new health system for the 21st century*. Washington, D.C.: The National Academies Press, 2001.

16. Lancsar E, Fiebig DG, Hole AR. Discrete choice experiments: a guide to model specification, estimation and software. *Pharmacoeconomics* 2017;35:697-716.

17. Clark MD, Determann D, Petrou S, *et al*. Discrete choice experiments in health economics: a review of the literature. *Pharmacoeconomics* 2014;32:883-902.

18. World Health Organization. *How to conduct a discrete choice experiment for health workforce recruitment and retention in remote and rural areas: a user guide with case studies.* Geneva:World Health Organization Press, 2012.

19. Goetghebeur MM, Wagner M, Khoury H, *et al*. Evidence and value: impact on DEcisionMaking--the EVIDEM framework and potential applications. *BMC Health Serv Res* 2008;8:270.

20. Chen XW, Chen Q, Geng JS, *et al*. The application of multi-criteria decision analysis in medical insurance reimbursement: a systematic review. *Chinese Health Resources* 2018;21:218-23.

21. Nichols E, O'Hara NN, Degani Y, *et al*. Patient preferences for nutritional supplementation to improve fracture healing: a discrete choice experiment. *BMJ Open* 2018;8:e019685.

22. van Dijk JD, Groothuis-Oudshoorn CG, Marshall DA, *et al*. An empirical comparison of discrete choice experiment and best-worst scaling to estimate stakeholders' risk tolerance for hip replacement surgery. *Value Health* 2016;19:316-22.

23. Bhattarai N, McMeekin P, Price CI, *et al*. Preferences for centralised emergency medical services: discrete choice experiment. *BMJ Open* 2019;9:e030966.

24. Kløjgaard ME, Bech M, Søgaard R. Designing a stated choice experiment: the value of a qualitative process. *J Choice Model* 2012;5:1-18.

25. Hensher DA, Rose JM, Greene WH. *Applied Choice Analysis (2nd Edition)*. Cambridge: Cambridge University Press, 2015.

26. de Bekker-Grob EW, Donkers B, Jonker MF, *et al*. Sample size requirements for discrete-choice experiments in healthcare: a practical guide. *Patient* 2015;8:373-84.

27. Reed Johnson F, Lancsar E, Marshall D, *et al*. Constructing experimental designs for discrete-choice experiments: report of the ISPOR Conjoint Analysis Experimental Design Good Research Practices Task Force. *Value Health* 2013;16:3-13.

28. Orme B. *Getting started with conjoint analysis: strategies for product design and pricing research (2nd Edition)*. Madison, Wisconsin: Research Publishers LLC, 2010.

29. Oluboyede Y, Ternent L, Vale L, *et al*. Using a discrete-choice experiment to estimate the

For peer review only

preferences of clinical practitioners for a novel non-invasive device for diagnosis of peripheral arterial disease in primary care. *Pharmacoecon Open* 2019;3:571-81.

30. The State Council of the People's Republic of China. Decision of the State Council on establishing a basic health insurance system for urban employees, 1998. Available: http://www.gov.cn/banshi/2005-08/04/content_20256.htm

31. de Bekker-Grob EW, Swait JD, Kassahun HT, *et al*. Are healthcare choices predictable? The impact of discrete choice experiment designs and models. *Value Health* 2019;22:1050-62.

32. Brockelmann PJ, McMullen S, Wilson JB, *et al*. Patient and physician preferences for first-line treatment of classical Hodgkin lymphoma in Germany, France and the United Kingdom. *Br J Haematol* 2019;184:202-14.

33. Forsander G, Stallknecht S, Samuelsson U, *et al*. Preferences for treatment among adolescents with Type 1 diabetes: a national study using a discrete choice experiment model. *Diabet Med* 2018;35:621-29.

34. Havrilesky LJ, Lim S, Ehrisman JA, *et al*. Patient preferences for maintenance PARP inhibitor therapy in ovarian cancer treatment. *Gynecol Oncol* 2020 doi: 10.1016/j.ygyno.2020.01.026.

35. Ho KA, Acar M, Puig A, *et al*. What do Australian patients with inflammatory arthritis value in treatment? A discrete choice experiment. *Clin Rheumatol* 2019 doi: 10.1007/s10067-019-04843-4.

36. Thieu VT, Robinson S, Kennedy-Martin T, *et a*l. Patient preferences for glucagon-like peptide 1 receptor-agonist treatment attributes. *Patient Prefer Adherence* 2019;13:561-76.

37. Mutowo MP, Lorgelly PK, Laxy M, *et al*. The hospitalization costs of diabetes and hypertension complications in Zimbabwe: estimations and correlations. *J Diabetes Res* 2016;2016:9754230.

38. Rosa MQM, Rosa RDS, Correia MG, *et al*. Disease and economic burden of hospitalizations attributable to diabetes mellitus and its complications: a nationwide study in Brazil. *Int J Environ Res Public Health* 2018;15: E294.

39. Zhao C, Wang C, Shen C, *et al.* China's achievements and challenges in improving health insurance coverage. *Drug Discov Ther* 2018;12:1-6.

40. Zhao M, Liu B, Shan L, *et al*. Can integration reduce inequity in healthcare utilization? Evidence and hurdles in China. *BMC Health Serv Res* 2019;19:654.

41. Xie X, Wu Q, Hao Y, *et al*. Identifying determinants of socioeconomic inequality in health service utilization among patients with chronic non-communicable diseases in China. *PloS One* 2014;9:e100231.

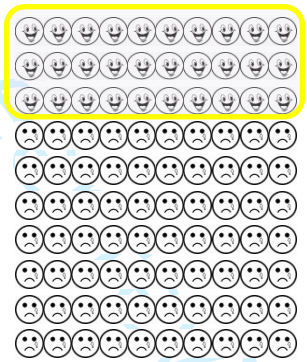
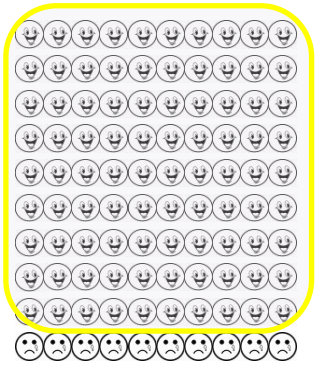
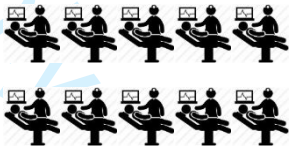
42. Chen H, Shi L, Xue M, *et al*. Geographic variations in in-hospital mortality and use of percutaneous coronary intervention following acute myocardial infarction in China: a nationwide cross-sectional analysis. *J Am Heart Assoc* 2018;7:e008131.

43. Lin X, Cai M, Tao H, *et al*. Insurance status, inhospital mortality and length of stay in hospitalised patients in Shanxi, China: a cross-sectional study. *BMJ Open* 2017;7:e015884.

For peer review only

Appendix 1: Examples of DCE choice sets

Medical interventions A and B are used to treat chronic diseases, and currently they were not covered in the social insurance reimbursement list. If you are forced to make a choice, which intervention should be reimbursed by social insurance? There is no right or wrong answers; please make the choice according to your own opinion.

Attributes	New technology A	New technology B
Expected gains in health outcomes from the treatment	 **As expected**	 **Not as expected**
Likelihood of effective treatment	 **30%**	 **90%**
Severity of target disease	 **Severe, not lethal**	 **Not severe**
Incidence of serious adverse events (life-threatening)	 **Never or rarely**	 **Often**
Alternative technologies currently covered by insurance	**Yes**	**No**
Out-of-pocket costs for new technology (if not reimbursed)	**1500 CNY per month**	**3500 CNY per month**
Which one should be covered by medical insurance? Your choice	☐	☐

For peer review only

Notes: Explanations to attributes and levels, investigators were required to convey the following definitions to patients

- 'Expected gains in health outcomes from the treatment' means the ideal treatment objectives mentioned in domestic evidence-based guidelines for specific patients can be achieved; 'Not as expected' indicates that there can be some treatment effects, however, the ideal treatment targets cannot be fully achieved.
- 'Increasingly probability of the effective treatment' equals to the attribute 'gains in health outcomes from the treatment' in choice sets: a new medical technology which can reach its expected gains in health outcomes is effective.
- For the severity of target disease, 'not severe' means the target disease of new technology is none fatal and has no impact on patients' quality of life; 'severe' suggests the target disease of new technology is none fatal, however, patients' quality of life was significantly reduced; 'lethal' means the target disease of new technology is fatal and patients will probably die from the disease.
- For Incidence of serious adverse events, 'often' equals to or a little bit higher than 10%; occasionally was about 3%.
- 'Serious adverse events' means life-threatening adverse events caused by the new technology, like severe hypoglycemia, severe hypersensitivity reaction, kidney or liver damage, etc.

For peer review only

Appendix 2: Number of patients included in sample hospitals

Supplemental Table 1 Number of patients in each sample hospital

Name of hospital	City	Number of patients
Taizhou People's Hospital	Taizhou	60
Jiangyin People's Hospital	Wuxi	40
First People's Hospital of Wujiang District	Suzhou	60
Nantong First People's Hospital	Nantong	23
Nantong Third People's Hospital	Nantong	100
Affiliated Hospital of Nantong University	Nantong	125

For peer review only

Appendix 3: Distribution of patients by type of disease and type of health insurance

Supplemental Table 2 Types of insurance for patients with hypertension and diabetes

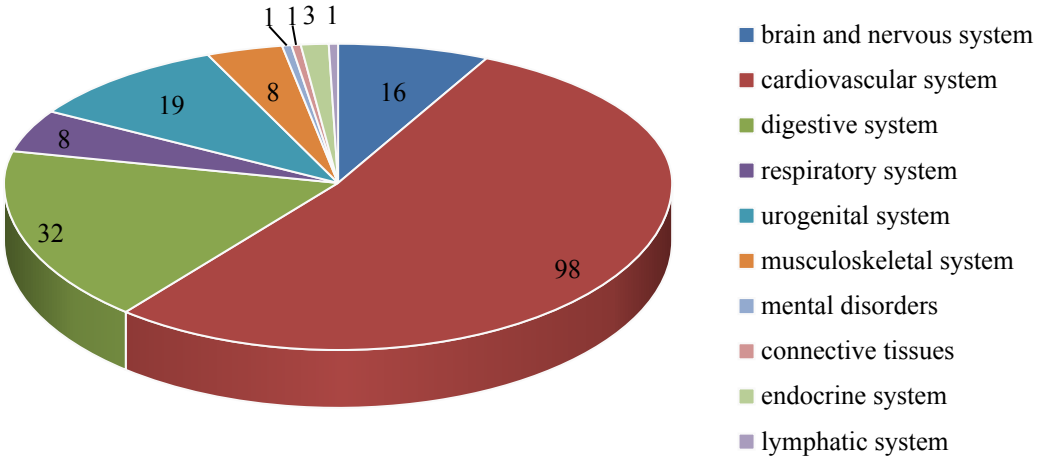
Insurance	Hypertension	Diabetes[#]
URRBMI	130	77
UEBMI	131	70
Total	261	147

χ^2=0.249, P=0.618

[#]Patients with diabetes only and those who had both diabetes and hypertension

For peer review only

Appendix 4: Types of chronic commodities for the included patients



Supplemental Figure 1 Number of patients with chronic commodities

For peer review only

Appendix 5: DCE results for inpatients

Supplemental Table 3 DCE results for inpatients

Attributes	Coefficients	SE
Expected gains in health outcomes from the treatment		
Not as expected (reference)		
As expected	0.381***	0.066
Increasing likelihood of effective treatment (per 10%)	0.260***	0.018
Severity of target disease		
Not severe (reference)		
Severe	0.091	0.085
Lethal	0.031	0.088
Incidence of serious adverse events		
Often (reference)		
Occasionally	0.313***	0.081
Never or rarely	0.578***	0.088
Alternative technologies currently covered by insurance		
Yes (reference)		
Not available	-0.019	0.063
Out-of-pocket costs (thousand CNY per month increase)	-0.190***	0.023
Log likelihood	-1141.407	
Participants	325	
Observations	3900	

***P<0.001, **P<0.01, *P<0.05

For peer review only

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Page 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 6-7
Objectives	3	State specific objectives, including any pre-specified hypotheses	Page 8 (line 5-13)
Methods			
Study design	4	Present key elements of study design early in the paper	Page 8 (line 22-30)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 8-10
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	Page 10 (line 51-59)
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	Not applicable
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 9 (line 32-44); Page 10 (line 5-22)
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 11; Page 12 (line 5-14)
Bias	9	Describe any efforts to address potential sources of bias	Page 11 (line 24-44)
Study size	10	Explain how the study size was arrived at	Page 11 (line 5-23)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 12 (line 41-47)
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 12 (line 22-40)
		(*b*) Describe any methods used to examine subgroups and interactions	Page 12 (line 48-59); Page 13 (line 5-9)
		(*c*) Explain how missing data were addressed	Page 11 (line 36-44)

For peer review only

		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	Not applicable
		(*e*) Describe any sensitivity analyses	Page 13 (line 10-17)
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Page 11 (line 5-12)
		(b) Give reasons for non-participation at each stage	Not applicable
		(c) Consider use of a flow diagram	Not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 13 (line 26-46); Page 14
		(b) Indicate number of participants with missing data for each variable of interest	Not applicable
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	Not applicable
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	Page 15-18
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Page 16 (Table 3); Page 18 (Table 4)
		(*b*) Report category boundaries when continuous variables were categorized	Not applicable
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Page 16 (Table 3); Page 18 (Table 4)
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 18 (line 50-59); Page 19 (line 5-32)
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 21 (line 49-59); Page 22 (line 5-50)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 19 (line 34-59); Page 20 (line 5-59); Page 21 (line 5-48)
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 22 (line 9-50)
Other information			

For peer review only

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 23 (line 53-59); Page 24 (line 5-9)

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

For peer review only

BMJ Open

Patients' preferences for health insurance coverage of new technologies for treating chronic diseases in China: a discrete choice experiment

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2020-038051.R1
Article Type:	Original research
Date Submitted by the Author:	15-Jun-2020
Complete List of Authors:	Geng, JinSong; Nantong University Medical School, Department of Medical Informatics Chen, Xiaowei; Nantong University Medical School, Department of Medical Informatics; Zhejiang University School of Medicine First Affiliated Hospital, Library and Reference Department Bao, Haini; Nantong University Medical School, Department of Medical Informatics Qian, Danmin; Nantong University Medical School, Department of Medical Informatics Shao, Yuting; Tongji University School of Medicine, Department of Ophthalmology Yu, Hao; Harvard Medical School, Department of Population Medicine; Harvard Pilgrim Health Care Institute
Primary Subject Heading:	Health policy
Secondary Subject Heading:	Health services research
Keywords:	Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, International health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health & safety < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

SCHOLARONE™
Manuscripts

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

For peer review only

Patients' preferences for health insurance coverage of new technologies for treating chronic diseases in China: a discrete choice experiment

Jinsong Geng[1*], Xiaowei Chen[1, 2], Haini Bao[1], Danmin Qian[1,] Yuting Shao[3], Hao Yu[4, 5]

[1]Department of Medical Informatics, Nantong University Medical School, Nantong, China

[2]Library and Reference Department, Zhejiang University School of Medicine First Affiliated Hospital, Hangzhou, China

[3]Department of Ophthalmology, Tongji University School of Medicine, Shanghai, China

[4]Department of Population Medicine, Harvard Medical School, Boston, USA

[5]Harvard Pilgrim Health Care Institute, Boston, USA

*Correspondence: Jinsong Geng, Department of Medical Informatics, Nantong University Medical School, 19 Qixiu Road, Nantong 226001, China; Email gjs@ntu.edu.cn; Tel: +86 513 85051891; Fax: +86 513 85051876

Word count: 4790

For peer review only

ABSTRACT

Objectives

Our study aimed to inform insurance decision-making in China by investigating patients' preferences for insurance coverage of new technologies for treating chronic diseases.

Design

We identified six attributes of new medical technologies for treating chronic diseases and used Bayesian-efficient design to generate choice sets for a discrete choice experiment (DCE). After conducting the DCE, we analyzed the data by mixed logit regression to examine patient-reported preference for each attribute.

Setting

The DCE was conducted with patients in six tertiary hospitals from four cities in Jiangsu Province.

Participants

Patients aged 18 years or older with a history of diabetes or hypertension and taking medications regularly for more than one year were recruited (N=408).

Results

The technology attributes regarding expected gains in health outcomes from the treatment (P<0.01), high likelihood of effective treatment (P<0.01), and low incidence of serious adverse events (P<0.01) were significant, positive predictors of choice by the study patients. Out-of-pocket costs was a significant, negative attribute for the entire study sample ($\beta = -0.258$, P<0.01) and for the patients with Urban and Rural Residents Basic Health Insurance (URRBMI) ($\beta = -0.511$, P<0.01), but not for all the patients with Urban Employees Basic Health Insurance (UEBMI) ($\beta = -0.071$, P>0.05). Severity of target disease was valued by patients with lower EQ-5D-5L index value as well as URRBMI enrollees.

Conclusions

Patients valued most the health benefits and risks of new technologies, which were

For peer review only

closely related to their own feelings of disease and perceptions of health-related quality of life. However, there existed heterogeneity in preferences between URRBMI and UEBMI patients. Further efforts should be made to reduce the gap between insurance schemes and make safe and cost-effective new technologies as priority for health insurance reimbursement.

Keywords: discrete choice experiment, patient preferences, chronic diseases, health insurance

For peer review only

Strengths and limitations of this study

- Our study provides evidence regarding patients' preferences for insurance coverage of new technologies for treating chronic diseases and will be helpful for applying a patient-centered approach to policy-making.
- We identified differential preferences among chronic disease patients with different types of social health insurance, and different levels of health-related quality of life in China.
- Since our sample was from one wealthy province in China, future studies of nationally representative samples are needed.
- While this study focused on hypertension and diabetes, two of the most prevalent chronic diseases, future studies need to examine other types of chronic diseases.

For peer review only

INTRODUCTION

Non-communicable chronic diseases (chronic diseases) are health conditions or diseases with long-term accumulation, non-self-healing, and difficult to cure. Nowadays, the prevalence and mortality of chronic diseases are on the rise around the world.[1] Chronic diseases present a particularly daunting challenge to China. It was estimated that among Chinese adults aged 35 to 75 years, nearly half had hypertension.[2] The overall prevalence of diabetes in Chinese adults was about 10.9%.[3] Furthermore, comorbidities are highly prevalent among patients with chronic diseases, which have a negative impact on the patient's quality of life and impede the efficacy of treatment.[4-6] Chronic diseases lead to heavy financial burden on patients' families and health insurance programs. It was estimated that the total economic burden associated with chronic diseases in China over the period 2010-2030 could be as high as US$16 trillion (measured in 2010 US Dollars).[7] Further adding to the challenges to China's health insurance programs' financing capacity, new technologies for treating chronic diseases continue to enter the market, which can be very expensive and contribute to rising healthcare costs. Deciding on which new technology to cover and by which insurance program has become a key issue facing policy-makers in China in the context of universal health insurance coverage.

As part of its goal of providing timely, acceptable and affordable basic healthcare of appropriate quality to its residents, China successfully achieved universal health insurance coverage in 2011, increasing demand for and expenditures on healthcare. China's total health expenditures grew at an average annual rate of 12.2% in 2008-2017, much higher than its GDP's average annual growth rate (8.1%).[8] In recent years, Chinese policy-makers have struggled to keep a balance between expenditure control and meeting patients' demand for healthcare, including the demand for new technologies by patients with chronic diseases. China's National Healthcare Security Administration is promoting the health insurance payment based on diagnosis-related groups (DRGs), a patient classification for standardizing payment in the national health

For peer review only

insurance schemes. Accordingly, medical fees and insurance payments will be based on DRG classification, which includes chronic diseases such as diabetes and hypertension.[9]

After China reached universal health insurance coverage, there were still considerable disparities in benefit coverage and reimbursement ratio among the three major public insurance programs that together covered more than 95% of Chinese people, including New Rural Cooperative Medical Scheme (NRCMS), Urban Residents Basic Health insurance (URBMI), and Urban Employees Basic Health insurance (UEBMI). For details of differences in health insurance eligibility, premiums and benefits among the three programs, see the paper published by Yu.[10] Generally speaking, UEBMI has the best benefit package and the lowest out-of-pocket costs among the three public insurance programs,[11 12] and UEBMI enrollees had higher likelihood of healthcare utilization.[13] To improve administrative efficiency and reduce inequality in insurance benefits, China State Council issued the policy in January 2016 on merging the NRCMS and URBMI to form the Urban Rural and Residents Basic Health Insurance (URRBMI).[14] While the newly formed URRBMI helped equalize insurance benefits between urban and rural residents, gaps remained between URRBMI and UEBMI. For example, according to the 2018 statistical bulletin issued by China's National Healthcare Security Administration, the average per capita hospitalization cost for inpatients was 11,181 CNY (about US$1704) for UEBMI enrollees, and 6577 CNY (about US$1003) for URRBMI enrollees.[15] The average inpatient reimbursement ratio for UEBMI enrollees was 71.8%, and the reimbursement ratio for URRBMI enrollees was 56.1%.[15] Even among the UEBMI enrollees, insurance benefit is not equal since some of the enrollees enjoy civil servant subsidies.[16] For example, if the medical expenditure exceeds the ceiling of health insurance reimbursement, outpatients and inpatients that enjoy civil servant subsidies may still be subsidized by 70% and 80% respectively for the exceeding parts.[17] Whereas disparities in China's insurance programs and patient's utilization of healthcare have been well-documented in the literature, no studies have yet examined whether patient preferences for new medical

For peer review only

technology vary by type of insurance. This study aimed to fill the gap.

Patient-reported outcome measures, such as health-related quality of life (HRQoL), are useful for understanding the impact of disease on their functional status and well-being.[18] EQ-5D series are among the most widely used multi-attribute utility instruments to measure HRQoL. EQ-5D-5L uses a health-state classification system which defines health in 5 areas,[19] has been proved to have the validity and discriminatory power to measure HRQoL in patients with chronic diseases.[20-22] Although HRQoL is an essential measure of health status to inform public health and health policy, whether patients' preferences on reimbursement differ from HRQoL remains unclear.

Eliciting patients' preferences and involving patients in health insurance decision-making can be helpful to increase satisfaction of patients and is an integral part of patient-centered care, which is defined as providing care that is respectful of, and responsive to individual patient preferences, needs and values.[23] Although patient-centered approach and value-based care has been long advocated in China, there still a lack of evidence from patients that reflect their preferences to inform health insurance coverage decision-making. This study added new information to the literature by conducting a discrete choice experiment (DCE), which is an attribute-based method to measure the preferences and trade-off of responders and becomes a recognized scientific approach to elicit preferences.[24] Prior research showed that DCE was fruitful and reliable to effectively improve healthcare decision-making.[25] Our DCE focused on chronic disease patients, and its goal was to support evidence-informed insurance policy-making in China. Specifically, we used the DCE data to test the following hypotheses: (1) new technology attributes regarding health benefits are more important than other attributes for health insurance coverage; (2) patients' preferences differ by type of disease and type of insurance.

For peer review only

METHODS

Identification of technology attributes and levels

Our DCE design, implementation, and analysis followed the user guide developed jointly by the World Bank, World Health Organization, and U.S. Agency for International Development.[26] We used a three-step approach to complete the preliminary stage of DCE, which aimed to identity and define the attributes and levels of new medical technologies. First, a systematic review was conducted to select attributes which were often used in multi-criteria decision analyses of health insurance decision-making. The systematic review was performed according to the framework for evidence-based decision-making as defined by EVIDEM.[27] We found that the most commonly mentioned dimensions were comparative outcomes (effectiveness, safety/tolerability), economic consequences (costs and cost-effectiveness) and needs of new technologies (severity of target disease, size of affected population, unmet needs related to the already reimbursed technologies), and knowledge of new technologies (quality of evidence, expert consensus/clinical practice guideline). Results of these findings were published in a separate paper.[28]

Second, both focus group discussions with physicians and expert consultation were carried out to determine attributes used in our research. There was no consensus among physicians about the criteria to determine the level of attributes of new technologies to treat diabetes and hypertension in our evidence-based clinical practice workshop. Then, we did focus group discussion and expert consultation on attributes and levels regarding reimbursement of new medical technologies. 14 experts (from 6 provinces in China) in reimbursement, health economics, healthcare service and evidence-based medicine were consulted. Results were published in another separate paper.[29] Criteria regarding needs of the technology (severity, benefit type of technology, unmet needs of reimbursed technology), comparative outcomes (effectiveness, safety/tolerability, patient-perceived/patient-reported outcomes), and economic aspects of the technology

For peer review only

(costs and cost-effectiveness) were needed in health insurance reimbursement decision-making. We also searched the famous health technology assessment database established by Canadian Agency for Drugs and Technologies in Health (CADTH) to select potential new technologies and find reasons for recommendation of reimbursement to better define the levels of attributes. We found 68 reports regarding hypertension and diabetes which were published before March 2018. Data extraction form was developed and attributes of new technologies were extracted. We further searched the database founded by China National Medical Products Administration (NMPA, formerly China Food and Drug Administration or CFDA) according to the generic name of new technologies to see if they were approved and available in China. We also referred to the list published by city governments in Jiangsu Province about the medical technologies which were already covered by the public health insurance programs. After completing the database search, we defined new medical technologies in this study as the therapeutics for hypertension and diabetes, which had been marketed in China but were not covered by the public health insurance programs in Jiangsu in 2018. We determined the range of out-of-pocket costs according to the retail price of new technologies.

Attributes and levels of new medical technologies which were used in our research were listed in Table 1. Details of the explanation of attributes and levels were shown in Appendix 1.

For peer review only

Table 1. Attributes and levels of new medical technology in the DCE

Attributes	Levels	Variables coding
Expected gains in health outcomes from the treatment	Not as expected; As expected	Binary
Likelihood of effective treatment	30%-90%	Continuous
Severity of target disease	Not severe; Severe but not lethal; Lethal	Categorical
Incidence of serious adverse events	Often; Occasionally; Never or rarely	Categorical
Alternative technologies currently covered by insurance	Yes; No	Binary
Out-of-pocket costs per month (if not reimbursed)	CNY 300-3500	Continuous

Note: New medical technologies which were mentioned in our research were already in use in clinical practice. However, they had not yet been included in the catalogs of social health insurance including Urban and Rural Residents Basic Health Insurance (URRBMI) and Urban Employees Basic Health Insurance (UEBMI).

The average exchange rate of US Dollars to Chinese Yuan (CNY) in 2018 was about 6.56. Therefore, CNY 300 was approximately US$46; CNY 3500 were about US$533.

Experimental design and development of the questionnaire

D-efficiency experimental design that maximized the precision of estimated choice-model parameters for a given number of choice questions[30] was created by Ngene1.1.2 software (Choice-Metrics, Sydney, Australia). Prior coefficients were set to zero during the pilot. After obtaining priors of the attributes from the pilot, Bayesian-efficient design was used to generate the final choice sets, which consisted of 30 pairs of scenarios and were divided into five blocks, with six pairs in each block. Blocking mainly ensures that the level balance of attributes within each block is satisfied, so that respondents are not only faced with low or high attribute levels for a certain attribute.

We chose unlabeled over labeled DCE. Unlabeled DCE was widely used to investigate patients' preferences for treatment techniques.[31-33] Respondents of unlabeled DCEs found that they were not subject to the psychological cues of the technology labels, thus reflecting the real-world choice situation.[34] In addition, in our research, new medical technologies to treat chronic disease continue to emerge. Therefore, an unlabeled DCE was considered appropriate for our study. The forced choice sets were

For peer review only

used in our DCE because when no option had a definitive advantage, it was assumed that forced choice under preference uncertainty would favor options that were easier to justify and associated with a lower likelihood of error and regret, such as compromise and asymmetrically dominating options.[35]

Examples of scenarios were shown in Appendix 2. Our final questionnaire contained two sections. Section A listed questions regarding participants' socio-demographic characteristics, past medical history, reasons for hospital visit, and health insurance information, EQ-5D-5L dimensions and levels. EQ-5D-5L used a health-state classification system defining health in 5 dimensions, mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each of the 5 dimensions was divided into five levels of perceived problems, no problem, mild problems, moderate problems, severe problems, and unable to/extreme problems. Section B was the DCE task.

DCE implementation and data collection

Our DCE was carried out from September 15th to October 15th, 2018 in six tertiary public hospitals from four cities in Jiangsu Province. Due to the high prevalence, serious complications and heavy burden of hypertension and diabetes, we selected patients with these diseases as participants. Inclusion criteria for patients including those aged 18 years or older, participating in a social health insurance program, with a history of diabetes or hypertension, and taking medications regularly for more than one year. Patients were enrolled consecutively during the study period.

There was no general standard on the ideal sample size required for a DCE[36]. Generally speaking, a less efficient design may also require a larger sample size, resulting in increased costs.[37] Estimates of the sample size were usually determined on the basis of previous research, rules of thumb and budget constraints. DCE studies showed that reliable models could be estimated in samples with more than 50 participants.[38 39]

For peer review only

The DCE questionnaires were administered through one-to-one, face-to-face interviews to ensure validity and quality of the investigation. Our interviewers consisted of 13 medical students, all of whom were in hospitals doing their internships during the research period. For quality assurance, the interviewers were trained before the experiment. We compiled a survey training manual, provided detailed descriptions of how to interpret each scenario, and asked each interviewer to make explanations to patients. The interviewers were required to check whether the entire questionnaire was complete immediately after each interview. If any information was missing, they had to go back to ask patients to provide the information on site. For patients with blurred vision or illiteracy, the interviewers explained the meaning of the questionnaire item by item until the patients fully understood each item. Patients were asked about how confident they felt in completing the choice sets. The score of confidence ranged from 0 (not confident at all) to 10 (extremely confident) (Appendix 3). We excluded the DCE questionnaire with a score of less than 8.

Patient involvement

Patients participated in both the pilot and formal DCE survey. Verbal informed consent was obtained from all patients prior to both the pilot and the final survey. Patients were made aware that the participation in the survey was voluntary. All data and information collected from patients were anonymous. The pilot survey included 90 patients with diabetes or hypertension. Intelligibility, acceptability and reliability of the questionnaire were tested during the pilot. At the beginning of the pilot, we found that several patients were illiterate, and a few patients with diabetes were nearly invisible. Then, the detailed description for the choice sets was made and interviewers were required to read and explain the description to these patients with enough patience. Patients thought the questionnaire was clear. After the pilot was finalized, we conducted the formal survey. During the pilot and formal survey, patients had to make a decision based on the assumption that only one technology can be covered due to limited health

For peer review only

insurance funds. They were asked to think carefully and trade-off between two new medical technologies. The survey time ranged from 20 minutes to one hour. We prepared a packed cotton towel for each patient as a gift (CNY 10, or US$1.4). Summary of main findings will be sent to the study participants who wish to be informed.

Data analysis

Our empirical analysis of the DCE data was based on the random utility model. Like prior research,[26] we considered the utility, U, that patient, i, assigned to choice, j, from J alternative choices, as the sum of two parts: utility component and random component. The equation was developed as follows:

$$U_{ij} = V_{ij} + \varepsilon_{ij} = \beta_0 + \beta_1 x_{1i\,\mathrm{j}} + \beta_2 x_{2\mathrm{ij}} + \ldots + \beta_m x_{\mathrm{mij}} + \varepsilon_{ij}$$

where V_{ij} was the utility component determined by patients' preferences of attributes ($x_1, \ldots, x_m$), ε_{ij} was the random component which was a function of unobserved attributes and individual-level variation, and β quantified the strength of preference for each attribute level.[26]

We implemented the above equation by estimating mixed logit regression using STATA 14.2 SE (StatCorp LP, College Station, Texas, USA) and was specified with 500 Halton draws. Mixed logit model allows for unknown heterogeneity in individual preferences and estimates both the mean preference weight and the standard deviation. We assumed that all variables of the attributes, except for the constant, had a random component and that the weights of preference were normally distributed. The choice of patients was the dependent variable, and the selected technology attributes were independent variables. Dummy coding was used for categorical variables of our DCE data. For dummy variable coding, each model-estimated coefficient is a measure of the strength of preference of that level relative to the omitted level of that attribute.[40 41] Subgroup analysis was performed by type of disease, type of insurance, HRQoL, and

For peer review only

gender. In each regression model, attribute level with a negative coefficient indicates that patients would prefer not to move from the reference level to that level, while an attribute level with a positive coefficient indicates that patients would prefer to move to that level from the reference level.[38]

RESULTS

Characteristics of patients

A total of 410 patients were consented to take part in the DCE survey, and the data from 408 patients were available for analysis with two patients excluded from the analysis due to non-compliance with the inclusion criteria, incomplete data and not confident. The mean score for confidence was 8.80 (95%CI 8.69-8.90), which suggested patients were confident in their choice. For details about number of patients in each sample hospital, see Appendix 4.

Table 2 presented demographic and clinical characteristics of the included patients. The sample had more males than females (53.92% vs. 46.08%). The patients had a mean age of 62.34 years (ranging from 28 to 96 years). They were almost evenly split between UEBMI and URRBMI (49.26% vs. 50.73%). Most of the patients had hypertension (63.97%) with 14.22% of them having both hypertension and diabetes while 21.81% of them had diabetes only. There was no statistically significant difference between hypertension and diabetes patients in terms of insurance types (UEBMI vs URRBMI, P=0.392) and benefits (UEBMI with extra benefit vs UEBMI without extra benefit, P=0.598) (Appendix 5). Among the180 patients who had chronic comorbid conditions other than hypertension and diabetes, cardiovascular disease was the most common comorbidity (98 patients) (Appendix 6).

For peer review only

Table 2. Characteristics of patients (n=408)

Characteristics	n (%)
Gender	
Male	220 (53.92)
Female	188 (46.08)
Age groups	
18～45	30 (7.35)
45～59	131 (32.11)
60～74	184 (45.10)
≥75	63 (15.44)
Urban vs. rural household registration	
Urban	210 (51.47)
Rural	198 (48.53)
Education	
Unschooled	39 (9.56)
Primary school	108 (26.47)
Junior high school	110 (26.96)
High school	89 (21.81)
Junior college or higher vocational college	31 (7.60)
Bachelor's degree or above	31 (7.60)
Employment	
Farmer	105 (25.74)
Urban employee	140 (34.31)
Retiree	112 (27.45)
Freelancers	32 (7.84)
Unemployed	19 (4.66)
Type of insurance[#]	
UEBMI	201 (49.26)
URRBMI	207 (50.74)
Family monthly income (CNY)[△]	
< 2000	83 (20.34)
2001～4000	81 (19.85)
4001～6000	93 (22.79)
6001～8000	69 (16.91)
8001～10000	41 (10.05)
>10000	41 (10.05)
Type of patients	
Outpatients	83 (20.34)
Inpatients	325 (79.66)
Type of chronic diseases	
Hypertension	261 (63.97)
Diabetes	89 (21.81)
Both	58 (14.22)
Comorbidities other than hypertension or diabetes	
Yes	180 (44.12)
No	228 (55.88)
EQ-5D-5L index value[※]	
⩽0.8	127
>0.8	281

[#]1 UEBMI patients, 6 URRBMI patients also enrolled in commercial health insurance

For peer review only

△ The average exchange rate between US Dollars and Chinese Yuan (CNY) in 2018 was 6.56.

※The utility index was derived from the Chinese value sets.[42] Currently, the well accepted threshold of the EQ-5D-5L index value still lacks. However, in most cases, the EQ-5D-5L index value for patients with serious complications of diabetes and hypertension was equal to or less than 0.8, as shown by studies carried out in China.[20 22] EQ-5D-5L index value≤0.8 group: Median 0.6718, IQR -0.0818～0.7998; EQ-5D-5L index value>0.8 group: Median 0.9507, IQR 0.8410～1.

Regression analysis of the DCE data

Our analysis found that the study patients valued most the new technologies with never or rare incidence of serious adverse events (β = 0.884, P<0.01), followed by the expected gains in health outcomes from the treatment (β = 0.809, P<0.01) (Table 3). Likelihood of effective treatment was also a significant, positive predictor of patients' choice of new technologies (β = 0.455, P<0.01) while out-of-pocket costs was a significant, negative predictor of patients' choice (β = -0.258, P<0.01). In comparison, whether there were alternative technologies currently covered by insurance seemed not to be an important factor for the patients (P>0.05).

Subgroup analysis by type of disease

Appendix 7 presented the results from the subgroup analysis by type of disease (hypertension versus diabetes). While the two groups had similar results, there were two notable differences. One was that, although out-of-pocket costs remained a significant, negative predictor, their coefficient for hypertension patients was -0.178 (P<0.05), not as important as it was for patients with diabetes (β = -0.395, P<0.01). The other was that the expected gains in health outcomes from the treatment seemed to be more important for diabetes patients (β = 0.965, P<0.01) when compared with those who only had hypertension (β = 0.716, P<0.01).

For Peer Review Only

Table 3. DCE results from mixed logit model

Attributes	All patients	
	Mean(SE)	SD(SE)
Expected gains in health outcomes from the treatment		
Not as expected (reference)		
As expected	0.809**(0.123)	0.554* (0.275)
Increasing likelihood of effective treatment (per 10%)	0.455**(0.044)	0.375**(0.055)
Severity of target disease		
Not severe (reference)		
Severe	0.291*(0.123)	0.316(0.431)
Lethal	0.208(0.147)	1.264**(0.199)
Incidence of serious adverse events		
Often (reference)		
Occasionally	0.575**(0.116)	0.035(0.694)
Never or rarely	0.884**(0.142)	0.900(0.206)
Alternative technologies currently covered by insurance		
Yes (reference)		
No	0.087(0.104)	0.095(0.501)
Out-of-pocket costs (thousand CNY per month increase)	-0.258**(0.061)	0.898**(0.090)
Log likelihood	-1485.761	
Participants	408	
Observations	4896	

*P<0.05; **P<0.01; SD: Standard Deviation estimates reflect preference heterogeneity in the participants; SE: Standard Error

Subgroup analysis by type of insurance

Appendix 8 summarized the subgroup analyses by type of insurance. The expected gains in health outcomes from the treatment, likelihood of effective treatment, and low incidence of serious adverse events were significant, positive predictors of technology choice (P<0.01) for both URRBMI and UEBMI patients. Whether there were alternative technologies currently covered by insurance was statically insignificant for both groups (P>0.05). However, these two groups differed remarkably in two technology attributes. The coefficient of out-of-pocket costs was significant for URRBMI patients (β = -0.511, P<0.01), but not for UEBMI patients (β = -0.071, P>0.05). Severity of target disease also had significant coefficients for URRBMI patients (P<0.01), but not for UEBMI patients.

For peer review only

We conducted further analysis of the UEBMI patients by excluding those UEBMI patients who enjoyed extra health insurance benefits, including who enjoyed public servant subsidies and the retired veteran cadres, and as indicated by Column (3), we found that out-of-pocket costs was a meaningful attribute for the remaining UEBMI patients ($\beta = -0.211$, $P<0.05$) although not so important as viewed by URRBMI patients ($\beta = -0.211$ vs. $\beta = -0.511$). On the other hand, severity of target disease remained statistically non-significant after excluding those UEBMI patients with extra insurance benefits.

Subgroup analysis by HRQoL

Appendix 9 demonstrated the results from the subgroup analysis by EQ-5D-5L index value, which was a meaningful measurement for HRQoL. Severity of target disease, both severe and lethal, was important for patients with EQ-5D-5L index value less than or equal to 0.8 ($P<0.01$). However, it was statistically non-significant for patients with EQ-5D-5L index value higher than 0.8 ($P>0.05$). Although patients' preferences for attributes including expected gains in health outcomes from the treatment, and incidence of serious adverse events were statistically significant for both groups, they were less important as viewed by the group with lower EQ-5D-5L index value.

Since severity of target disease was an important attribute for URRBMI patients ($P<0.01$), but not for UEBMI patients. We did the chi-square test and results showed that the proportion of patients with lower EQ-5D-5L index value was significantly higher in URRBMI group ($P<0.01$) (Appendix 10).

Subgroup analysis by gender

We found that patients in both groups valued the new technologies with expected gains in health outcomes from the treatment, likelihood of effective treatment, low incidence of serious adverse event, and low out-of-pocket cost ($P<0.01$) (Appendix 11).

For peer review only

However, the differences in preferences for attributes were not obvious between male and female.

DISCUSSION

Summary of the findings

Our study found that key technology attributes, including expected gains in health outcomes from the treatment, high likelihood of effective treatment, and low incidence of serious adverse events were significant, positive predictors of patient choice for health insurance coverage. These results hold for the entire study sample and for the subgroup analyses.

Out-of-pocket costs was a significant, negative predictor for the entire sample, showing that patients preferences decreased as the out-of-pocket costs increased. We also found that out-of-pocket costs was a significant, negative predictor for both hypertension patients and diabetes patients although they were less important for the former group than for the latter group.

When it came to different insurance types, we identified preference heterogeneity as previous studies of DCE suggested.[43] Specifically, we found that out-of-pocket costs was a significant, negative predictor for URRBMI patients' preference for insurance coverage while severity of target disease was a significant, positive predictor for this group of patients. But neither of these two attributes was a significant predictor for UEBMI patients. Our further analysis of the UEBMI patients by excluding those UEBMI patients who enjoyed extra health insurance benefits revealed that the remaining UEBMI patients regarded out-of-pocket costs as a significant, negative factor for coverage although severity of target disease stayed statistically insignificant for them.

Patients' HRQoL was measured in our research and results suggested that patients

For peer review only

with lower HRQoL tended to prefer new technologies which could have effects on severe or lethal diseases. The findings on importance of disease severity regarding patients with lower HRQoL coincide with URRBMI patients. In fact, the reimbursement level and the hospitalization rate of URRBMI patients were lower than UEBMI patients.[15] Further analysis showed the relatively higher proportion of URRBMI patients with lower HRQoL. In addition, our results indicate that gender is not a decisive factor for the preference of new technologies for reimbursement.

Comparison with other studies

Our findings of patients' valuing most the effectiveness and safety of medical technologies were consistent with the results by prior studies from other countries which aimed to investigate patients' preferences for the treatment of chronic diseases.[44-48] Our study confirmed that patients preferred new technologies which could increase health benefits and minimize potential risks.

However, variation in patient preferences existed and mainly depended on patients' own feelings of the disease. Previous research found that the median hospitalization cost for patients with hypertension was lower than patients with diabetes,[49 50] which supported our findings that out-of-pocket costs was not as important for hypertension patients as they were for patients with diabetes.

We also identified preference heterogeneity among patients with different types of insurance. Although China's successful health insurance expansion during the past decade led to the country's universal health insurance coverage, variations in benefit coverage were manifested among different health insurance schemes,[12] resulting in inequalities in accessibility and affordability of medical services.[51] Such inequalities affected patient preferences across different types of insurance. For example, we found that out-of-pocket costs was a significant, negative predictor for URRBMI patients' preference, but not for all the UEBMI patients in our sample. The finding reflected the fact that, compared with URRBMI, UEBMI had better benefit coverage and higher reimbursement level, especially for those UEBMI patients with extra benefits. The

For peer review only

finding also fitted into the big picture of disparities across insurance schemes in China that were illustrated by prior research.

We found that URRBMI patients attached importance to severity of disease. We also found the association between lower HRQoL and preference on technologies treating severe or lethal disease. Previous studies found that chronic disease patients with URRBMI had lower health service utilization.[52] Furthermore, URRBMI patients had significantly higher adjusted in-hospital mortality rate and shorter length of stay when compared with concurrent UEBMI patients.[53 54] These findings suggested that a plausible explanation for the importance of severity of disease for URRBMI patients might be mainly due to their perception of HRQoL and their concern about the potential severe or lethal consequences of chronic diseases.

Implications of the study findings

The rising prevalence of chronic diseases in China has major implications on its ability to provide timely, acceptable and affordable healthcare service for its citizens. To meet the demand for new medical technologies for treating chronic diseases, it is important for China's policy-makers to consider patient preferences when they decide on insurance coverage of new medical technologies. Specifically our findings that patients valued most new medical technologies with substantial health benefits and low risks suggested such technologies should be the priority of health insurance coverage. Policy-makers are suggested to make evidence-based comparisons among technologies according to the attributes patients preferred to achieve patient-centered and evidence-informed reimbursement decision-making.

Our findings that out-of-pocket costs was a significant concern for URRBMI patients but not for all the UEBMI patients suggested that policymakers need to take further efforts to reduce disparities in benefit coverage and reimbursement level between these two types of insurance and between subgroups with UEBMI. The efforts will not only enhance financial protections for URRBMI patients and subgroups within

For peer review only

UEBMI patients, but also contribute to China's long-term goal of equalizing benefit coverage across insurance programs.[10]

We found that patients did not care about alternative technologies currently covered by insurance. However, it is an essential attribute in reimbursement decision-making. Decision makers need to compare the new technologies with available alternative technologies and determine whether to cover new medical technologies or obsolete the alternatives. Policymakers and clinicians may need to implement communication strategies to improve patients' understanding about the alternative therapies and reimbursement policies under the current insurance system to increase appropriate use of the existing therapies.

Strengths and limitations

Our study used DCE to elicit preferences from chronic disease patients on insurance coverage of new medical technologies in China. We identified preference heterogeneity among patients with different types of insurance. Patients' HRQoL was measured and the potential impact on preferences for reimbursement of new technologies was analyzed. Our research was helpful for applying a patient-centered approach to policy-making and generated evidence that could inform insurance coverage decision-making.

Nevertheless, there are several limitations with our study. First, our samples were from tertiary hospitals in Jiangsu Province. Those patients who sought medical service from tertiary hospitals generally have serious and/or complex medical conditions with higher demand for healthcare services than other patients, and may cautiously consider the issue of medical insurance coverage and reimbursement. Jiangsu is an eastern, coastal province and one of the most economically developed regions in China. Future studies are needed to have a nationally representative sample by including patients at secondary and primary hospitals, and especially by including the economically underdeveloped regions in China.

Second, our study included patients with a history of diabetes or hypertension. Due

For peer review only

to differences in disease nature and characteristics, the results may not represent preferences from patients with other types of chronic diseases, although prior DCEs[44-48] made conclusions that were similar to ours in terms of the relative importance of technology attributes regarding benefits and risks. Future studies need to enroll patients with other diseases, and performing subgroup analysis to find variations of patient preferences across different types of diseases.

Third, there were only 43 UEBMI patients who enjoyed additional privileges of health insurance, and the limited sample size prevented us from conducting a separate analysis of this subgroup. Further research is still needed to focus on these subgroups.

CONCLUSION

Chronic disease patients valued most the health benefits and risks of new technologies, which were closely related to their own perception and feelings. Policymakers need to consider new technologies with high therapeutic effectiveness and benefit and low risk for treating chronic diseases as a priority for health insurance coverage. Further efforts should also be made to reduce the gaps in benefit coverage and reimbursement level between insurance schemes to promote equal access to healthcare services in China.

Ethics approval

This study, including the patient consent process, was approved by the Medical Ethics Committee in Affiliated Hospitals of Nantong University (Ethical Approval-2016031), and conforms to the ethical guidelines of the Declaration of Helsinki.

Acknowledgments

We acknowledge the important contributions of our interviewers who did one-to-one, face-to-face interviews with the patients. We are also grateful to all the

For peer review only

patients for their time and efforts.

At the time of drafting the manuscript, Jinsong Geng was a fellow at the Fellowship in Health Policy and Insurance Research, Department of Population Medicine, Harvard Medical School and Harvard Pilgrim Healthcare Institute.

Author contributions

Geng JS, Chen XW, and Yu H led the design and analysis of the discrete choice experiment. Geng JS, Chen XW contributed to literature search and data interpretation. Bao HN, Qian DM, Shao YT contributed to implementing the discrete choice experiment. Geng JS and Yu H performed statistical analysis and wrote the manuscript.

Funding

This work was supported by National Natural Science Foundation of China (Grant No. 71603138) and Jiangsu Overseas Visiting Scholar Program for University Prominent Young & Middle-aged Teachers and Presidents.

The funders provided financial support for the conduct of the study. The funders had no role in the design, implementation, data collection and statistical analysis, data interpretation, or writing of the manuscript.

Disclosure

The authors report no conflict of interest in this research.

Data sharing statement

Data will be available upon reasonable request to corresponding author.

References

1. World Health Organization. *Global action plan for the prevention and control of noncommunicable diseases 2013-2020*. Geneva: World Health Assembly, 2013:5-9.

2. Lu J, Lu Y, Wang X, *et al*. Prevalence, awareness, treatment, and control of hypertension in China: data from 1.7 million adults in a population-based screening study (China PEACE Million Persons Project). *Lancet* 2017;390:2549-58.

For peer review only

3. Wang L, Gao P, Zhang M, *et al*. Prevalence and ethnic pattern of diabetes and prediabetes in China in 2013. *JAMA* 2017;317:2515-23.

4. Adriaanse MC, Drewes HW, van der Heide I, *et al*. The impact of comorbid chronic conditions on quality of life in type 2 diabetes patients. *Qual Life Res* 2016;25:175-82.

5. Aubert CE, Fankhauser N, Marques-Vidal P, *et al*. Patterns of multimorbidity in internal medicine patients in Swiss university hospitals: a multicentre cohort study. *Swiss Med Wkly* 2019;149:w20094.

6. Wang J, Ma JJ, Liu J, *et al*. Prevalence and risk factors of comorbidities among hypertensive patients in China. *Int J Med Sci* 2017;14:201-12.

7. Bloom DE, Chen S, Kuhn M, *et al*. The economic burden of chronic diseases: estimates and projections for China, Japan, and South Korea. *JEoA* 2018:100163.

8. Yip W, Fu H, Chen AT, *et al*. 10 years of health-care reform in China: progress and gaps in Universal Health Coverage. *Lancet* 2019;394:1192-204.

9. China's National Healthcare Security Administration. *China Healthcare Security Diagnosis Related Groups (CHS-DRG)*. Beijing, 2019:44-46.10. Yu H. Universal health insurance coverage for 1.3 billion people: what accounts for China's success? *Health Policy* 2015;119:1145-52.

11. Li Y, Zhao Y, Yi D, *et al*. Differences exist across insurance schemes in China post-consolidation. *PloS One* 2017;12:e0187100.

12. Xiong X, Zhang Z, Ren J, *et al*. Impact of universal medical insurance system on the accessibility of medical service supply and affordability of patients in China. *PloS One* 2018;13:e0193273.

13. Xian W, Xu X, Li J, *et al*. Health care inequality under different medical insurance schemes in a socioeconomically underdeveloped region of China: a propensity score matching analysis. *BMC Public Health* 2019;19:1373.

14. The State Council of the People's Republic of China. Opinion of the State Council on integrating the basic health insurance system for urban and rural residents, 2016. Available: http://www.gov.cn/zhengce/content/2016-01/12/content_10582.htm

15. China's National Healthcare Security Administration. Statistical Bulletin of National Social Medical Insurance Development in 2018. Available: http://www.nhsa.gov.cn/art/2019/6/30/art_7_1477.html

16. General Office of the State Council of the People's Republic of China. Notice of the General Office of the State Council on transmitting the opinions from the Ministry of Labor and Social Security and the Ministry of Finance on the implementation of medical subsidies for national civil servants, 2000. Available: http://www.gov.cn/gongbao/content/2000/content_60249.htm

17. Wuxi No.2 People's Hospital. Medical insurance policy (the latest version of 2020). Available: https://www.wx2h.com/ywzc/ywzcdetail/index/id/4/tid/6.html.

18. Makovski TT, Schmitz S, Zeegers MP, *et al*. Multimorbidity and quality of life: systematic literature review and meta-analysis. *Ageing Res Rev* 2019;53:100903.

19. van Reenen M, Janssen B. *EQ-5D-5L user guide: basic information on how to use the EQ-5D-5L instrument.* Rotterdam: EuroQol Research Foundation, 2015.

20. Pan CW, Sun HP, Zhou HJ, *et al*. Valuing health-related quality of life in type 2 diabetes patients in China. *Med Decis Making* 2016;36:234-41.

21. Wang P, Luo N, Tai ES, *et al*. The EQ-5D-5L is more discriminative than the EQ-5D-3L in

For peer review only

patients with diabetes in Singapore. *Value Health Reg Issues* 2016;9:57-62.

22. Liang Z, Zhang T, Lin T, *et al*. Health-related quality of life among rural men and women with hypertension: assessment by the EQ-5D-5L in Jiangsu, China. *Qual Life Res* 2019;28:2069-80.

23. Institute of Medicine Committee on Quality of Health Care in America. *Crossing the quality chasm: a new health system for the 21st century*. Washington, D.C.: The National Academies Press, 2001.

24. Lancsar E, Fiebig DG, Hole AR. Discrete choice experiments: a guide to model specification, estimation and software. *Pharmacoeconomics* 2017;35:697-716.

25. Clark MD, Determann D, Petrou S, *et al*. Discrete choice experiments in health economics: a review of the literature. *Pharmacoeconomics* 2014;32:883-902.

26. Ryan M, Kolstad J, Rockers P, *et al*.. *How to conduct a discrete choice experiment for health workforce recruitment and retention in remote and rural areas: a user guide with case studies.* Geneva:World Health Organization Press, 2012.

27. Goetghebeur MM, Wagner M, Khoury H, *et al*. Evidence and value: impact on DEcisionMaking--the EVIDEM framework and potential applications. *BMC Health Serv Res* 2008;8:270.

28. Chen XW, Chen Q, Geng JS, *et al*. The application of multi-criteria decision analysis in medical insurance reimbursement: a systematic review. *Chinese Health Resources* 2018;21:218-23.

29. Geng JS, Chen XW, Yu XL, *et al*. Study on the evidence-based decision-making framework for reimbursement of new technologies in view of EVIDEM. *Chinese Journal of Health Policy* 2018;11:50-54.

30. Hensher DA, Rose JM, Greene WH. *Applied Choice Analysis (2nd Edition)*. Cambridge: Cambridge University Press, 2015.

31. Nichols E, O'Hara NN, Degani Y, *et al*. Patient preferences for nutritional supplementation to improve fracture healing: a discrete choice experiment. *BMJ Open* 2018;8:e019685.

32. van Dijk JD, Groothuis-Oudshoorn CG, Marshall DA, *et al*. An empirical comparison of discrete choice experiment and best-worst scaling to estimate stakeholders' risk tolerance for hip replacement surgery. *Value Health* 2016;19:316-22.

33. Bhattarai N, McMeekin P, Price CI, *et al*. Preferences for centralised emergency medical services: discrete choice experiment. *BMJ Open* 2019;9:e030966.

34. Kløjgaard ME, Bech M, Søgaard R. Designing a stated choice experiment: the value of a qualitative process. *J Choice Model* 2012;5:1-18.

35. Dhar R, Simonson I. The Effect of Forced Choice on Choice. *JMR* 2003;40:146-60.

36. de Bekker-Grob EW, Donkers B, Jonker MF, *et al*. Sample size requirements for discrete-choice experiments in healthcare: a practical guide. *Patient* 2015;8:373-84.

37. Vanniyasingam T, Cunningham CE, Foster G, *et al*. Simulation study to determine the impact of different design features on design efficiency in discrete choice experiments. *BMJ Open* 2016;6:e011985.

38. Oluboyede Y, Ternent L, Vale L, *et al*. Using a discrete-choice experiment to estimate the preferences of clinical practitioners for a novel non-invasive device for diagnosis of peripheral arterial disease in primary care. *Pharmacoecon Open* 2019;3:571-81.

39. Shanahan M, Seddon J, Ritter A, *et al*. Valuing families' preferences for drug treatment: a discrete choice experiment. *Addiction* 2020;115:690-99.

For peer review only

40. Hauber AB, Gonzalez JM, Groothuis-Oudshoorn CG, *et al*. Statistical methods for the analysis of discrete choice experiments: a report of the ISPOR Conjoint Analysis Good Research Practices Task Force. *Value Health* 2016;19:300-15.

41. Kløjgaard ME, Manniche C, Pedersen LB, *et al*. Patient preferences for treatment of low back pain-a discrete choice experiment. *Value Health* 2014;17:390-6.

42. Luo N, Liu G, Li M, et al. Estimating an EQ-5D-5L Value Set for China. *Value Health* 2017;20:662-69.

43. de Bekker-Grob EW, Swait JD, Kassahun HT, *et al*. Are healthcare choices predictable? The impact of discrete choice experiment designs and models. *Value Health* 2019;22:1050-62.

44. Brockelmann PJ, McMullen S, Wilson JB, *et al*. Patient and physician preferences for first-line treatment of classical Hodgkin lymphoma in Germany, France and the United Kingdom. *Br J Haematol* 2019;184:202-14.

45. Forsander G, Stallknecht S, Samuelsson U, *et al*. Preferences for treatment among adolescents with Type 1 diabetes: a national study using a discrete choice experiment model. *Diabet Med* 2018;35:621-29.

46. Havrilesky LJ, Lim S, Ehrisman JA, *et al*. Patient preferences for maintenance PARP inhibitor therapy in ovarian cancer treatment. *Gynecol Oncol* 2020 doi: 10.1016/j.ygyno.2020.01.026.

47. Ho KA, Acar M, Puig A, *et al*. What do Australian patients with inflammatory arthritis value in treatment? A discrete choice experiment. *Clin Rheumatol* 2019 doi: 10.1007/s10067-019-04843-4.

48. Thieu VT, Robinson S, Kennedy-Martin T, *et al*. Patient preferences for glucagon-like peptide 1 receptor-agonist treatment attributes. *Patient Prefer Adherence* 2019;13:561-76.

49. Mutowo MP, Lorgelly PK, Laxy M, *et al*. The hospitalization costs of diabetes and hypertension complications in Zimbabwe: estimations and correlations. *J Diabetes Res* 2016;2016:9754230.

50. Rosa MQM, Rosa RDS, Correia MG, *et al*. Disease and economic burden of hospitalizations attributable to diabetes mellitus and its complications: a nationwide study in Brazil. *Int J Environ Res Public Health* 2018;15: E294.

51. Zhao C, Wang C, Shen C, *et al.* China's achievements and challenges in improving health insurance coverage. *Drug Discov Ther* 2018;12:1-6.

52. Xie X, Wu Q, Hao Y, *et al*. Identifying determinants of socioeconomic inequality in health service utilization among patients with chronic non-communicable diseases in China. *PloS One* 2014;9:e100231.

53. Chen H, Shi L, Xue M, *et al*. Geographic variations in in-hospital mortality and use of percutaneous coronary intervention following acute myocardial infarction in China: a nationwide cross-sectional analysis. *J Am Heart Assoc* 2018;7:e008131.

54. Lin X, Cai M, Tao H, *et al*. Insurance status, inhospital mortality and length of stay in hospitalised patients in Shanxi, China: a cross-sectional study. *BMJ Open* 2017;7:e015884.

For peer review only

Appendix 1: Explanations to attributes and levels

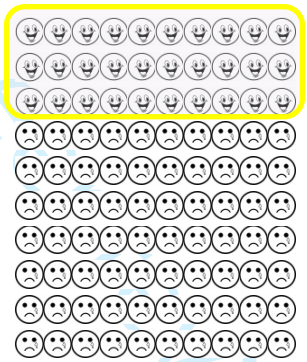
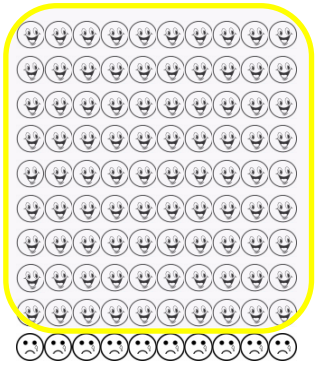
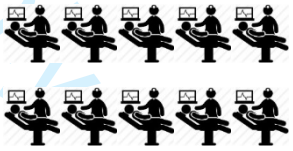
Investigators were required to convey the following definitions to patients:

- 'Expected gains in health outcomes from the treatment' means the ideal treatment objectives mentioned in domestic evidence-based guidelines for specific patients can be achieved; 'Not as expected' indicates that there can be some treatment effects, however, the ideal treatment targets cannot be fully achieved. This attribute is the qualitative aspect of effectiveness.
- Increasingly probability of the effective treatment: 'effective treatment' equals to the attribute 'gains in health outcomes from the treatment' in choice sets: a new medical technology which can reach its expected gains in health outcomes is effective. The attribute 'increasingly probability of the effective treatment' is the quantitative aspect of effectiveness.
- For the severity of target disease, 'not severe' means the target disease of new technology is not fatal and has no impact on patients' quality of life; 'severe' suggests the target disease of new technology is not fatal, however, patients' quality of life was significantly reduced; 'lethal' means the target disease of new technology is fatal and patients will probably die from the disease.
- For incidence of serious adverse events, 'often' equals to or a little bit higher than 10%; occasionally was about 3%.
- 'Serious adverse events' means life-threatening adverse events caused by the new technology, like severe hypoglycemia, severe hypersensitivity reaction, kidney or liver damage, etc.
- Alternative technologies already reimbursed have similar effectiveness and safety to the new technology (Level: Yes); no alternatives already reimbursed have similar effectiveness and safety to the new technology (Level: No).
- The cost of the technology is the out-of-pocket costs if not reimbursed. The hypothesis is that the technology never been reimbursed unless you make the choice.

For peer review only

Appendix 2: Examples of DCE choice sets

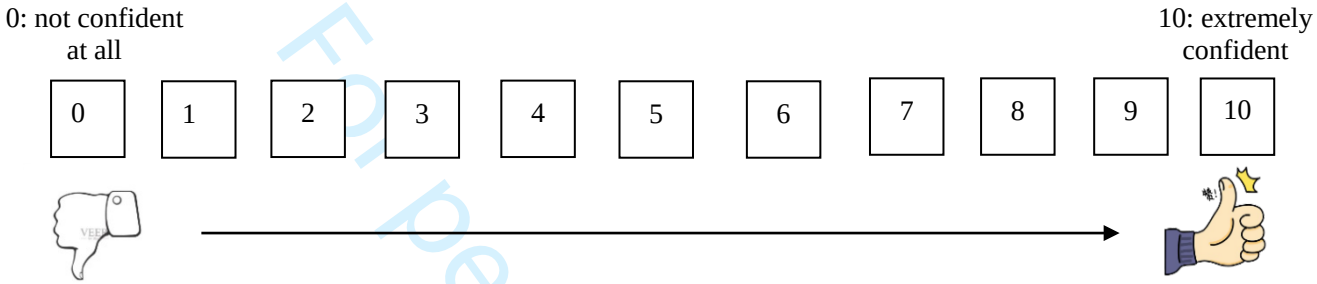
Medical interventions A and B are used to treat chronic diseases, and currently they were not covered in the social insurance reimbursement list. If you are forced to make a choice, which intervention should be reimbursed by social insurance? There is no right or wrong answers; please make the choice according to your own opinion.

Attributes	New technology A	New technology B
Expected gains in health outcomes from the treatment	 **As expected**	 **Not as expected**
Likelihood of effective treatment	 **30%**	 **90%**
Severity of target disease	 **Severe, not lethal**	 **Not severe**
Incidence of serious adverse events (life-threatening)	 **Never or rarely**	 **Often**
Alternative technologies currently covered by insurance	**Yes**	**No**
Out-of-pocket costs for new technology (if not reimbursed)	**1500 CNY per month**	**3500 CNY per month**
Which one should be covered by medical insurance? Your choice	☐	☐

For peer review only

Appendix 3: Evaluation of confidence

The following statements refer to the questions that asked about how confident you feel in completing the choice sets. Please select your confident level from 1 to 10 and give a tick ' √ ' in the score to represent your selection:



For peer review only

Appendix 4: Number of patients included in sample hospitals

Supplemental Table 1 Number of patients in each sample hospital

Name of hospital	City	Number of patients
Taizhou People's Hospital	Taizhou	60
Jiangyin People's Hospital	Wuxi	40
First People's Hospital of Wujiang District	Suzhou	60
Nantong First People's Hospital	Nantong	23
Nantong Third People's Hospital	Nantong	100
Affiliated Hospital of Nantong University	Nantong	125

For peer review only

Appendix 5: Distribution of patients by type of disease and type of insurance

Supplemental Table 2. Types of insurance for patients with hypertension and diabetes

Disease	URRBMI	UEBMI
Hypertension	130	131
Diabetes	49	40
Total	179	171

Urban and Rural Residents Basic Health Insurance (URRBMI); Urban Employees Basic Health Insurance (UEBMI)

χ^2 =0.732 P= 0.392

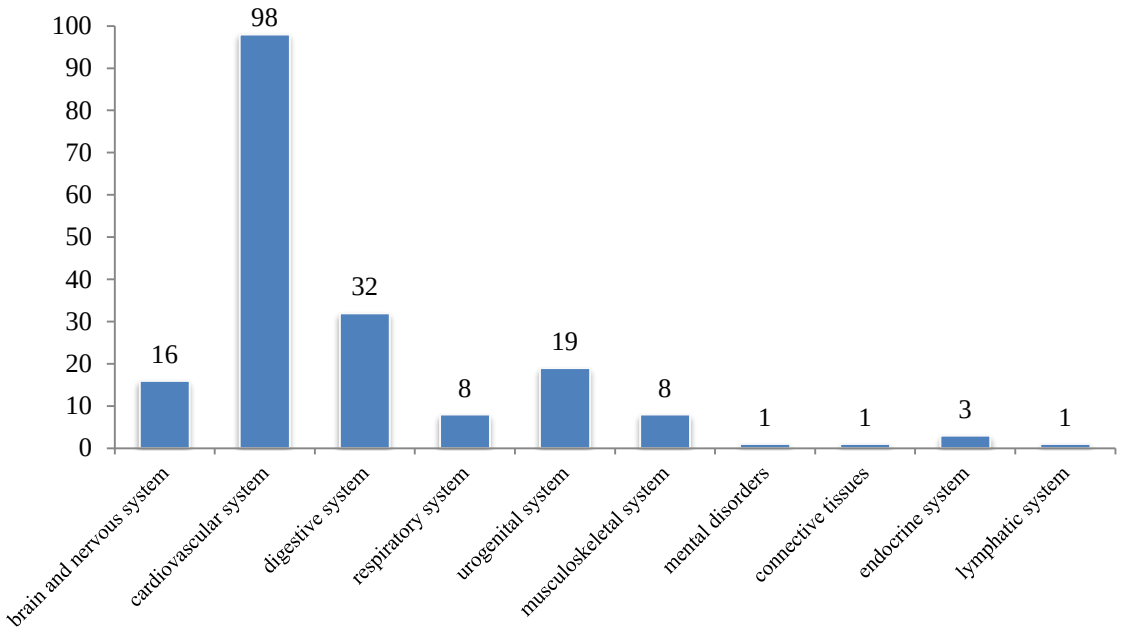
Supplemental Table 3. Types of benefits for UEBMI patients with hypertension and diabetes

Disease	UEBMI with extra benefits	UEBMI without extra benefits
Hypertension	27	104
Diabetes	11	29
Total	38	133

χ^2 =0.842 P= 0.359

For peer review only

Appendix 6: Types of chronic commodities for the included patients



Supplemental Figure 1 Number of patients with chronic commodities

For peer review only

Appendix 7: Subgroup analysis according to disease

Supplemental Table 4. Subgroup analysis according to disease

Attributes	Hypertension		Diabetes	
	Mean (SE)	SD (SE)	Mean (SE)	SD (SE)
Expected gains in health outcomes from the treatment				
Not as expected (reference)				
As expected	0.716**(0.158)	0.443(0.496)	0.965**(0.259)	0.125(0.497)
Increasing likelihood of effective treatment (per 10%)	0.519**(0.064)	0.375**(0.086)	0.420**(0.093)	0.401**(0.119)
Severity of target disease				
Not severe (reference)				
Severe	0.328*(0.162)	0.056(0.495)	0.100(0.273)	0.441(0.834)
Lethal	0.215(0.196)	1.189**(0.276)	0.304(0.311)	1.146**(0.395)
Incidence of serious adverse events				
Often (reference)				
Occasionally	0.767**(0.164)	0.014*(0.381)	0.553*(0.266)	0.337(0.548)
Never or rarely	0.995**(0.195)	1.126(0.271)	0.938**(0.349)	0.989*(0.459)
Alternative technologies currently covered by insurance				
Yes (reference)				
No	0.152(0.158)	0.978**(0.315)	0.089(0.248)	0.019(0.383)
Out-of-pocket costs (thousand CNY per month increase)	-0.178*(0.084)	1.024**(0.128)	-0.395**(0.126)	0.774**(0.190)
Log likelihood	-929.220		-311.029	
Participants	261		89	
Observations	2484		2412	

*P<0.05; **P<0.01; SD: Standard Deviation estimates reflect preference heterogeneity in the participants; SE: Standard Error

Patients who had both hypertension and diabetes were excluded to ensure the homogeneity.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Appendix 8: Subgroup analysis according to insurance types

Supplemental Table 5. Subgroup analysis according to insurance types

Attributes	(1) URRBMI patients		(2) UEBMI patients		(3) UEBMI patients without extra insurance benefits[#]	
	Mean (SE)	SD (SE)	Mean (SE)	SD (SE)	Mean (SE)	SD (SE)
Expected gains in health outcomes from the treatment						
Not as expected (reference)						
As expected	0.977**(0.204)	0.811*(0.325)	0.732**(0.166)	0.320(0.641)	0.652**(0.193)	0.609(0.420)
Increasing likelihood of effective treatment (per 10%)	0.512**(0.069)	0.384**(0.075)	0.444**(0.066)	0.383**(0.082)	0.450**(0.074)	0.271**(0.085)
Severity of target disease						
Not severe (reference)						
Severe	0.519**(0.189)	0.247(0.887)	0.062(0.171)	0.138(0.609)	-0.09(0.194)	0.193(0.615)
Lethal	0.761**(0.230)	1.112**(0.316)	-0.217(0.211)	1.321**(0.289)	-0.385(0.242)	1.387**(0.333)
Incidence of serious adverse events						
Often (reference)						
Occasionally	0.704**(0.181)	0.08(0.389)	0.462**(0.165)	0.501(0.401)	0.526**(0.196)	0.70(0.381)
Never or rarely	0.928**(0.214)	1.013**(0.301)	0.876**(0.206)	0.881**(0.317)	0.792**(0.232)	0.858*(0.361)
Alternative technologies currently covered by insurance						
Yes (reference)						
No	0.142(0.161)	0.242(0.516)	-0.003(0.148)	0.556(0.380)	-0.143(0.158)	0.106(0.679)
Out-of-pocket costs (thousand CNY per month increase)	-0.511**(0.112)	1.041**(0.152)	-0.071(0.078)	0.818**(0.125)	-0.211*(0.090)	0.790**(0.146)
Log likelihood	-706.268		-707.710		-562.183	
Participants	207		201		158	
Observations	2484		2412		1896	

*P<0.05; **P<0.01; SD: Standard Deviation estimates reflect preference heterogeneity in the participants; SE: Standard Error; Urban and Rural Residents Basic Health Insurance (URRBMI); Urban Employees Basic Health Insurance (UEBMI)

[#]This subgroup did not include those UEBMI patients who enjoyed extra health insurance benefits, including who enjoyed public servant subsidies and who enjoyed free medical service.

Appendix 9: Subgroup analysis according to health related quality of life

Supplemental Table 6. Subgroup analysis according to health related quality of life (HRQoL)

Attributes	EQ-5D-5L index value ≤0.8		EQ-5D-5L index value >0.8	
	Mean (SE)	SD (SE)	Mean (SE)	SD (SE)
Expected gains in health outcomes from the treatment	0.554*(0.228)	0.971*(0.423)	0.953**(0.165)	0.466(0.493)
Not as expected (reference)				
As expected				
Increasing likelihood of effective treatment (per 10%)	0.606**(0.093)	0.450**(0.098)	0.405**(0.054)	0.320**(0.074)
Severity of target disease				
Not severe (reference)				
Severe	0.874**(0.240)	0.043(0.408)	0.106(0.156)	0.349(0.533)
Lethal	0.724**(0.254)	0.773*(0.347)	-0.064(0.195)	1.499**(0.281)
Incidence of serious adverse events				
Often (reference)				
Occasionally	0.131(0.202)	0.007*(0.461)	0.815**(0.166)	0.431(0.357)
Never or rarely	0.516*(0.236)	0.453(0.519)	1.120**(0.200)	1.103**(0.275)
Alternative technologies currently covered by insurance	0.007(0.179)	0.142(0.466)	0.093(0.140)	0.560(0.458)
Yes (reference)				
No				
Out-of-pocket costs (thousand CNY per month increase)	-0.233*(0.109)	0.909**(0.157)	-0.283**(0.083)	0.979**(0.135)
Log likelihood	-438.402		-954.540	
Participants	127		281	
Observations	1524		3372	

*P<0.05; **P<0.01; SD: Standard Deviation estimates reflect preference heterogeneity in the participants; SE: Standard Error

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Appendix 10: Health-related quality of life by type of insurance

Supplemental Table 7. Health-related quality of life for patients by type of insurance

Type of insurance	EQ-5D-5L index value ≤0.8	EQ-5D-5L index value >0.8
URRBMI	90	117
UEBMI	37	164
Total	127	281

Urban and Rural Residents Basic Health Insurance (URRBMI); Urban Employees Basic Health Insurance (UEBMI)

χ^2 =29.898 P=0.000

For peer review only

Appendix 11: Subgroup analysis according to gender

Supplemental Table 8. Subgroup analysis according to gender

Attributes	Male		Female	
	Mean (SE)	SD (SE)	Mean (SE)	SD (SE)
Expected gains in health outcomes from the treatment	0.805**(0.174)	0.754*(0.357)	0.921**(0.200)	0.193(0.512)
Not as expected (reference)				
As expected				
Increasing likelihood of effective treatment (per 10%)	0.476**(0.065)	0.409**(0.077)	0.456**(0.069)	0.362**(0.089)
Severity of target disease				
Not severe (reference)				
Severe	0.303(0.177)	0.541(0.425)	0.346(0.191)	0.333(0.435)
Lethal	0.249(0.199)	1.077**(0.282)	0.182(0.241)	1.582**(0.319)
Incidence of serious adverse events				
Often (reference)				
Occasionally	0.680**(0.167)	0.471(0.371)	0.528**(0.187)	0.007(0.417)
Never or rarely	0.953**(0.204)	0.768*(0.338)	0.897**(0.232)	1.146**(0.306)
Alternative technologies currently covered by insurance				
Yes (reference)				
No	0.127(0.144)	0.288(0.650)	0.093(0.168)	0.202(0.643)
Out-of-pocket costs (thousand CNY per month increase)	-0.246**(0.084)	0.893**(0.131)	-0.281**(0.098)	0.979**(0.153)
Log likelihood	-780.85		-667.657	
Participants	220		188	
Observations	2640		2256	

*P<0.05; **P<0.01; SD: Standard Deviation estimates reflect preference heterogeneity in the participants; SE: Standard Error

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Page 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 6-8
Objectives	3	State specific objectives, including any pre-specified hypotheses	Page 8 (line 47-54)
Methods			
Study design	4	Present key elements of study design early in the paper	Page 9 (line 11-20)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 9-12
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	Page 12 (line 34-46)
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	Not applicable
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 10 (line 38-42); Page 11 (line 5-21)
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 13; Page 14 (line 5-13)
Bias	9	Describe any efforts to address potential sources of bias	Page 13 (line 3-31)
Study size	10	Explain how the study size was arrived at	Page 12 (line 39-52)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 14 (line 41-47)
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 14 (line 20-37)
		(*b*) Describe any methods used to examine subgroups and interactions	Page 14 (line 58); Page 15 (line 5)
		(*c*) Explain how missing data were addressed	Page 13 (line 16-24)

For peer review only

		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	Not applicable
		(*e*) Describe any sensitivity analyses	Page 14 (line 58); Page 15 (line 5) Page 15 (line 43-54)
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Page 15 (line 22-32)
		(b) Give reasons for non-participation at each stage	Not applicable
		(c) Consider use of a flow diagram	Not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 15 (line 33-58); Page 16
		(b) Indicate number of participants with missing data for each variable of interest	Not applicable
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	Not applicable
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	Page 17 (line 17-60)
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Page 15 (line 43-54); Page 19 (line 33-39)
		(*b*) Report category boundaries when continuous variables were categorized	Not applicable
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Page 18-19
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 20 (line 10-60); Page 21 (line 5-7)
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 23 (line 31-59); Page 24 (line 5-11)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 22 (line 19-59); Page 23 (line 5-13)
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 23 (line 17-29) Page 24 (line 16-28)

For peer review only

Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 25 (line 18-30)

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

For peer review only

BMJ Open

Patients' preferences for health insurance coverage of new technologies for treating chronic diseases in China: a discrete choice experiment

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2020-038051.R2
Article Type:	Original research
Date Submitted by the Author:	29-Jul-2020
Complete List of Authors:	Geng, JinSong; Nantong University Medical School, Department of Medical Informatics Chen, Xiaowei; Nantong University Medical School, Department of Medical Informatics; Zhejiang University School of Medicine First Affiliated Hospital, Library and Reference Department Bao, Haini; Nantong University Medical School, Department of Medical Informatics Qian, Danmin; Nantong University Medical School, Department of Medical Informatics Shao, Yuting; Tongji University School of Medicine, Department of Ophthalmology Yu, Hao; Harvard Medical School, Department of Population Medicine; Harvard Pilgrim Health Care Institute
Primary Subject Heading:	Health policy
Secondary Subject Heading:	Health services research
Keywords:	Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, International health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health & safety < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

SCHOLARONE™
Manuscripts

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

For peer review only

Patients' preferences for health insurance coverage of new technologies for treating chronic diseases in China: a discrete choice experiment

Jinsong Geng[1*], Xiaowei Chen[1, 2], Haini Bao[1], Danmin Qian[1,] Yuting Shao[3], Hao Yu[4]

[1]Department of Medical Informatics, Nantong University Medical School, Nantong, China

[2]Library and Reference Department, Zhejiang University School of Medicine First Affiliated Hospital, Hangzhou, China

[3]Department of Ophthalmology, Tongji University School of Medicine, Shanghai, China

[4]Department of Population Medicine, Harvard Medical School and Harvard Pilgrim Health Care Institute, Boston, USA

*Correspondence: Jinsong Geng, Department of Medical Informatics, Nantong University Medical School, 19 Qixiu Road, Nantong 226001, China; Email gjs@ntu.edu.cn; Tel: +86 513 85051891; Fax: +86 513 85051876

Word count: 5065

For peer review only

ABSTRACT

Objectives

Our study aimed to inform insurance decision-making in China by investigating patients' preferences for insurance coverage of new technologies for treating chronic diseases.

Design

We identified six attributes of new medical technologies for treating chronic diseases and used Bayesian-efficient design to generate choice sets for a discrete choice experiment (DCE). After conducting the DCE, we analyzed the data by mixed logit regression to examine patient-reported preference for each attribute.

Setting

The DCE was conducted with patients in six tertiary hospitals from four cities in Jiangsu Province.

Participants

Patients aged 18 years or older with a history of diabetes or hypertension and taking medications regularly for more than one year were recruited (N=408).

Results

The technology attributes regarding expected gains in health outcomes from the treatment (P<0.01), high likelihood of effective treatment (P<0.01), and low incidence of serious adverse events (P<0.01) were significant, positive predictors of choice by the study patients. Out-of-pocket costs was a significant, negative attribute for the entire study sample ($\beta = -0.258$, P<0.01) and for the patients with Urban and Rural Residents Basic Medical Insurance (URRBMI) ($\beta = -0.511$, P<0.01), but not for all the patients with Urban Employees Basic Medical Insurance (UEBMI) ($\beta = -0.071$, P>0.05). Severity of target disease was valued by patients with lower EQ-5D-5L index value as well as URRBMI enrollees.

Conclusions

Patients valued most the health benefits and risks of new technologies, which were

For peer review only

closely related to their own feelings of disease and perceptions of health-related quality of life. However, there existed heterogeneity in preferences between URRBMI and UEBMI patients. Further efforts should be made to reduce the gap between insurance schemes and make safe and cost-effective new technologies as priority for health insurance reimbursement.

Keywords: discrete choice experiment, patient preferences, chronic diseases, health insurance

For peer review only

Strengths and limitations of this study

- Our study provides evidence regarding patients' preferences for insurance coverage of new technologies for treating chronic diseases and will be helpful for applying a patient-centered approach to policy-making.
- Discrete choice experiment is a rigorous method that enables us to identify differential preferences among chronic disease patients by type of social health insurance and by level of health-related quality of life in China.
- Bayesian-efficient design was used to improve statistical efficiency of the choice design, and blocking technique was used to increase response efficiency of patients.
- Since our sample was from one wealthy province in China, future studies of nationally representative samples are needed.
- While this study focused on hypertension and diabetes, two of the most prevalent chronic diseases, future studies need to examine other types of chronic diseases.

For peer review only

INTRODUCTION

Non-communicable chronic diseases (chronic diseases) are health conditions or diseases with long-term accumulation, non-self-healing, and difficult to cure. Nowadays, the prevalence and mortality of chronic diseases are on the rise around the world.[1] Chronic diseases present a particularly daunting challenge to China. It was estimated that among Chinese adults aged 35 to 75 years, nearly half had hypertension.[2] The overall prevalence of diabetes in Chinese adults was about 10.9%.[3] Furthermore, comorbidities are highly prevalent among patients with chronic diseases, which have a negative impact on the patient's quality of life and impede the efficacy of treatment.[4-6] Chronic diseases lead to heavy financial burden on patients' families and health insurance programs. It was estimated that the total economic burden associated with chronic diseases in China over the period 2010-2030 could be as high as US$16 trillion (measured in 2010 US Dollars).[7] Further adding to the challenges to China's health insurance programs' financing capacity, new technologies for treating chronic diseases continue to enter the market, which can be very expensive and contribute to rising healthcare costs. Deciding on which new technology to cover and by which insurance program has become a key issue facing policy-makers in China in the context of universal health insurance coverage.

As part of its goal of providing timely, acceptable and affordable basic healthcare of appropriate quality to its residents, China successfully achieved universal health insurance coverage in 2011, increasing demand for and expenditures on healthcare. China's total health expenditures grew at an average annual rate of 12.2% in 2008-2017, much higher than its GDP's average annual growth rate (8.1%).[8] In recent years, Chinese policy-makers have struggled to keep a balance between expenditure control and meeting patients' demand for healthcare, including the demand for new technologies by patients with chronic diseases. China's National Healthcare Security Administration is promoting the health insurance payment based on diagnosis-related groups (DRGs), a patient classification for standardizing payment in the national health

For peer review only

insurance schemes. Accordingly, medical fees and insurance payments will be based on DRG classification, which includes chronic diseases such as diabetes and hypertension.[9]

After China reached universal health insurance coverage, there were still considerable disparities in benefit coverage and reimbursement ratio among the three major public insurance programs that together covered more than 95% of Chinese people, including New Rural Cooperative Medical Scheme (NRCMS), Urban Residents Basic Medical insurance (URBMI), and Urban Employees Basic Medical insurance (UEBMI). For details of differences in health insurance eligibility, premiums and benefits among the three programs, see the paper published by Yu.[10] Generally speaking, UEBMI has the best benefit package and the lowest out-of-pocket costs among the three public insurance programs,[11 12] and UEBMI enrollees had higher likelihood of healthcare utilization.[13] To improve administrative efficiency and reduce inequality in insurance benefits, China State Council issued the policy in January 2016 on merging the NRCMS and URBMI to form the Urban Rural and Residents Basic Medical Insurance (URRBMI).[14] While the newly formed URRBMI helped equalize insurance benefits between urban and rural residents, gaps remained between URRBMI and UEBMI. For example, according to the 2018 statistical bulletin issued by China's National Healthcare Security Administration, the average per capita hospitalization cost for inpatients was 11,181 CNY (about US$1704) for UEBMI enrollees, and 6577 CNY (about US$1003) for URRBMI enrollees.[15] The average inpatient reimbursement ratio for UEBMI enrollees was 71.8%, and the reimbursement ratio for URRBMI enrollees was 56.1%.[15] Even among the UEBMI enrollees, insurance benefit is not equal since some of the enrollees enjoy civil servant subsidies.[16] For example, if the medical expenditure exceeds the ceiling of health insurance reimbursement, outpatients and inpatients that enjoy civil servant subsidies may still be subsidized by 70% and 80% respectively for the exceeding parts.[17] Whereas disparities in China's insurance programs and patient's utilization of healthcare have been well-documented in the literature, no studies have yet examined whether patient preferences for new medical

For peer review only

technology vary by type of insurance. This study aimed to fill the gap.

Patient-reported outcome measures, such as health-related quality of life (HRQoL), are useful for understanding the impact of disease on their functional status and well-being.[18] EQ-5D series are among the most widely used multi-attribute utility instruments to measure HRQoL. EQ-5D-5L uses a health-state classification system which defines health in 5 areas,[19] has been proved to have the validity and discriminatory power to measure HRQoL in patients with chronic diseases.[20-22] Although HRQoL is an essential measure of health status to inform public health and health policy, whether patients' preferences on reimbursement differ from HRQoL remains unclear.

Eliciting patients' preferences and involving patients in health insurance decision-making can be helpful to increase satisfaction of patients and is an integral part of patient-centered care, which is defined as providing care that is respectful of, and responsive to individual patient preferences, needs and values.[23] Although patient-centered approach and value-based care has been long advocated in China, there still a lack of evidence from patients that reflect their preferences to inform health insurance coverage decision-making. This study added new information to the literature by conducting a discrete choice experiment (DCE), which is an attribute-based method to measure the preferences and trade-off of responders and becomes a recognized scientific approach to elicit preferences.[24] Prior research showed that DCE was fruitful and reliable to effectively improve healthcare decision-making.[25] Our DCE focused on chronic disease patients, and its goal was to support evidence-informed insurance policy-making in China. Specifically, we used the DCE data to test the following hypotheses: (1) new technology attributes regarding health benefits are more important than other attributes for health insurance coverage; (2) patients' preferences differ by type of disease and type of insurance.

For peer review only

METHODS

Identification of technology attributes and levels

Our DCE design, implementation, and analysis followed the user guide developed jointly by the World Bank, World Health Organization, and U.S. Agency for International Development.[26] We used a three-step approach to complete the preliminary stage of DCE, which aimed to identity and define the attributes and levels of new medical technologies. First, a systematic review was conducted to select attributes which were often used in multi-criteria decision analyses of health insurance decision-making. The systematic review was performed according to the framework for evidence-based decision-making as defined by EVIDEM.[27] We found that the most commonly mentioned dimensions were comparative outcomes (effectiveness, safety/tolerability), economic consequences (costs and cost-effectiveness) and needs of new technologies (severity of target disease, size of affected population, unmet needs related to the already reimbursed technologies), and knowledge of new technologies (quality of evidence, expert consensus/clinical practice guideline). Results of these findings were published in a separate paper.[28]

Second, both focus group discussions with physicians and expert consultation were carried out to determine attributes used in our research. There was no consensus among physicians about the criteria to determine the level of attributes of new technologies to treat diabetes and hypertension in our evidence-based clinical practice workshop. Then, we did focus group discussion and expert consultation on attributes and levels regarding reimbursement of new medical technologies. 14 experts (from 6 provinces in China) in reimbursement, health economics, healthcare service and evidence-based medicine were consulted. Results were published in another separate paper.[29] Criteria regarding needs of the technology (severity, benefit type of technology, unmet needs of reimbursed technology), comparative outcomes (effectiveness, safety/tolerability, patient-perceived/patient-reported outcomes), and economic aspects of the technology

For peer review only

(costs and cost-effectiveness) were needed in health insurance reimbursement decision-making. We also searched the famous health technology assessment database established by Canadian Agency for Drugs and Technologies in Health (CADTH) to select potential new technologies and find reasons for recommendation of reimbursement to better define the levels of attributes. We found 68 reports regarding hypertension and diabetes which were published before March 2018. Data extraction form was developed and attributes of new technologies were extracted. We further searched the database founded by China National Medical Products Administration (NMPA, formerly China Food and Drug Administration or CFDA) according to the generic name of new technologies to see if they were approved and available in China. We also referred to the list published by city governments in Jiangsu Province about the medical technologies which were already covered by the public health insurance programs. After completing the database search, we defined new medical technologies in this study as the therapeutics for hypertension and diabetes, which had been marketed in China but were not covered by the public health insurance programs in Jiangsu in 2018. We determined the range of out-of-pocket costs according to the retail price of new technologies.

Attributes and levels of new medical technologies which were used in our research were listed in Table 1. Details of the explanation of attributes and levels were shown in Appendix 1. Because our purpose was to identify the specific technology attributes and levels that were preferred by patients, not a specific technology for treating a specific disease, the scenarios in our DCE were not restricted to a specific type of disease.

For peer review only

Table 1. Attributes and levels of new medical technology in the DCE

Attributes	Levels	Variables coding
Expected gains in health outcomes from the treatment	Not as expected; As expected	Binary
Likelihood of effective treatment	30%-90%	Continuous
Severity of target disease	Not severe; Severe but not lethal; Lethal	Categorical
Incidence of serious adverse events	Often; Occasionally; Never or rarely	Categorical
Alternative technologies currently covered by insurance	Yes; No	Binary
Out-of-pocket costs per month (if not reimbursed)	CNY 300-3500	Continuous

Note: We defined new medical technologies according to research objectives. New medical technologies referred to new technologies that entered into the market recently before our study but were not included in the reimbursement lists of social health insurance programs, such as URRBMI and UEBMI.

The average exchange rate of US Dollars to Chinese Yuan (CNY) in 2018 was about 6.56. Therefore, CNY 300 was approximately US$46; CNY 3500 were about US$533.

Experimental design and development of the questionnaire

D-efficiency experimental design that maximized the precision of estimated choice-model parameters for a given number of choice questions[30] was created by Ngene1.1.2 software (Choice-Metrics, Sydney, Australia). Prior coefficients were set to zero during the pilot. After obtaining priors of the attributes from the pilot, Bayesian-efficient design was used to generate the final choice sets, which consisted of 30 pairs of scenarios and were divided into five blocks, with six pairs in each block. Blocking design promoted response efficiency by reducing the potential cognitive burden to respondents.[31]

We chose unlabeled over labeled DCE. Unlabeled DCE was widely used to investigate patients' preferences for treatment techniques.[32-34] Respondents of unlabeled DCEs found that they were not subject to the psychological cues of the technology labels, thus reflecting the real-world choice situation.[35] In addition, in our research, new medical technologies to treat chronic disease continue to emerge. Therefore, an unlabeled DCE was considered appropriate for our study. The forced choice sets were used in our DCE because when no option had a definitive advantage, it was assumed

For peer review only

that forced choice under preference uncertainty would favor options that were easier to justify and associated with a lower likelihood of error and regret, such as compromise and asymmetrically dominating options.[36]

Examples of scenarios were shown in Appendix 2. Our final questionnaire contained two sections. Section A listed questions regarding participants' socio-demographic characteristics, past medical history, reasons for hospital visit, and health insurance information, EQ-5D-5L dimensions and levels. EQ-5D-5L used a health-state classification system defining health in 5 dimensions, mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each of the 5 dimensions was divided into five levels of perceived problems, no problem, mild problems, moderate problems, severe problems, and unable to/extreme problems. Section B was the DCE task.

DCE implementation and data collection

Our DCE was carried out from September 15th to October 15th, 2018 in six tertiary public hospitals from four cities in Jiangsu Province. Since our DCE aimed to inform decision-making on patient-centered care by identifying patients' preferences, our study sample consisted of patients with chronic diseases, not the general population, which did not necessarily understand or reflect the preferences of patients. Due to the high prevalence, serious complications and heavy burden of hypertension and diabetes, we selected patients with these diseases as participants. Inclusion criteria for patients including those aged 18 years or older, participating in a social health insurance program, with a history of diabetes or hypertension, and taking medications regularly for more than one year. Patients were enrolled consecutively during the study period.

There was no general standard on the ideal sample size required for a DCE[37]. Generally speaking, a less efficient design may also require a larger sample size, resulting in increased costs.[38] Estimates of the sample size were usually determined on the basis of previous research, rules of thumb and budget constraints. DCE studies

For peer review only

showed that reliable models could be estimated in samples with more than 50 participants.[39 40]

The DCE questionnaires were administered through one-to-one, face-to-face interviews to ensure validity and quality of the investigation. Our interviewers consisted of 13 medical students, all of whom were in hospitals doing their internships during the research period. For quality assurance, the interviewers were trained before the experiment. We compiled a survey training manual, provided detailed descriptions of how to interpret each scenario, and asked each interviewer to make explanations to patients. The interviewers were required to check whether the entire questionnaire was complete immediately after each interview. If any information was missing, they had to go back to ask patients to provide the information on site. For patients with blurred vision or illiteracy, the interviewers explained the meaning of the questionnaire item by item until the patients fully understood each item.

Verbal informed consent was obtained from all patients prior to both the pilot and the final survey. Patients were made aware that the participation in the survey was voluntary. All data and information collected from patients were anonymous. During the pilot and formal survey, patients had to make a decision based on the assumption that only one technology can be covered due to limited health insurance funds. They were asked to think carefully and trade-off between two new medical technologies. The survey time ranged from 20 minutes to one hour. We prepared a packed cotton towel for each patient as a gift (CNY 10, or US$1.4). Patients were asked about how confident they felt in completing the choice sets. The score of confidence ranged from 0 (not confident at all) to 10 (extremely confident) (Appendix 3). We excluded the DCE questionnaire with a score of less than 8.

Patient and public involvement

90 patients with diabetes or hypertension were engaged in the pilot survey to provide feedback on intelligibility, acceptability and reliability of the questionnaire.

For peer review only

Response from patients led to more explicit and apprehensible description of the survey questions. Patients were not involved in the recruitment of study participants or the conduct of the study. Findings of the study would be disseminated through publication and social media.

Data analysis

Our empirical analysis of the DCE data was based on the random utility model. Like prior research,[26] we considered the utility, U, that patient, i, assigned to choice, j, from J alternative choices, as the sum of two parts: observable component and unobservable component. The equation was developed as follows:

$$U_{ij} = V_{ij} + \varepsilon_{ij} = \beta_0 + \beta_1 x_{1ij} + \beta_2 x_{2ij} + \ldots + \beta_m x_{mij} + \varepsilon_{ij}$$

where V_{ij} was the observable component determined by patients' preferences of attributes ($x_1, \ldots, x_m$), ε_{ij} was the unobservable component which was a function of unobserved attributes and individual-level variation, and β quantified the strength of preference for each attribute level.[26]

We implemented the above equation by estimating mixed logit regression using STATA 14.2 SE (StatCorp LP, College Station, Texas, USA) and was specified with 500 Halton draws. Mixed logit model allows for unknown heterogeneity in individual preferences and estimates both the mean preference weight and the standard deviation. We assumed that all variables of the attributes, except for the constant, had a random component and that the weights of preference were normally distributed. The choice of patients was the dependent variable, and the selected technology attributes were independent variables. Dummy coding was used for categorical variables of our DCE data. For dummy variable coding, each model-estimated coefficient is a measure of the strength of preference of that level relative to the omitted level of that attribute.[41 42] Subgroup analysis was performed by type of disease, type of insurance, HRQoL, and gender. In each regression model, attribute level with a negative coefficient indicates

For peer review only

that patients would prefer not to move from the reference level to that level, while an attribute level with a positive coefficient indicates that patients would prefer to move to that level from the reference level.[39]

RESULTS

Characteristics of patients

A total of 410 patients were consented to take part in the DCE survey, and the data from 408 patients were available for analysis with two patients excluded from the analysis due to non-compliance with the inclusion criteria, incomplete data and not confident. The mean score for confidence was 8.80 (95%CI 8.69-8.90), which suggested patients were confident in their choice. For details about number of patients in each sample hospital, see Appendix 4.

Table 2 presented demographic and clinical characteristics of the included patients. The sample had more males than females (53.92% vs. 46.08%). The patients had a mean age of 62.34 years (ranging from 28 to 96 years). They were almost evenly split between UEBMI and URRBMI (49.26% vs. 50.73%). Most of the patients had hypertension (63.97%) with 14.22% of them having both hypertension and diabetes while 21.81% of them had diabetes only. There was no statistically significant difference between hypertension and diabetes patients in terms of insurance types (UEBMI vs URRBMI, P=0.392) and benefits (UEBMI with extra benefit vs UEBMI without extra benefit, P=0.598) (Appendix 5). Among the180 patients who had chronic comorbid conditions other than hypertension and diabetes, cardiovascular disease was the most common comorbidity (98 patients) (Appendix 6).

For peer review only

Table 2. Characteristics of patients (n=408)

Characteristics	n (%)
Gender	
Male	220 (53.92)
Female	188 (46.08)
Age groups	
18～45	30 (7.35)
45～59	131 (32.11)
60～74	184 (45.10)
≥75	63 (15.44)
Urban vs. rural household registration	
Urban	210 (51.47)
Rural	198 (48.53)
Education	
Unschooled	39 (9.56)
Primary school	108 (26.47)
Junior high school	110 (26.96)
High school	89 (21.81)
Junior college or higher vocational college	31 (7.60)
Bachelor's degree or above	31 (7.60)
Employment	
Farmer	105 (25.74)
Urban employee	140 (34.31)
Retiree	112 (27.45)
Freelancers	32 (7.84)
Unemployed	19 (4.66)
Type of insurance[#]	
UEBMI	201 (49.26)
URRBMI	207 (50.74)
Family monthly income (CNY)[△]	
< 2000	83 (20.34)
2001～4000	81 (19.85)
4001～6000	93 (22.79)
6001～8000	69 (16.91)
8001～10000	41 (10.05)
>10000	41 (10.05)
Type of patients	
Outpatients	83 (20.34)
Inpatients	325 (79.66)
Type of chronic diseases	
Hypertension	261 (63.97)
Diabetes	89 (21.81)
Both	58 (14.22)
Comorbidities other than hypertension or diabetes	
Yes	180 (44.12)
No	228 (55.88)
EQ-5D-5L index value[※]	
⩽0.8	127
>0.8	281

[#]1 UEBMI patients, 6 URRBMI patients also enrolled in commercial health insurance

For peer review only

△ The average exchange rate between US Dollars and Chinese Yuan (CNY) in 2018 was 6.56.

※The utility index was derived from the Chinese value sets.[43] Currently, the well accepted threshold of the EQ-5D-5L index value still lacks. However, in most cases, the EQ-5D-5L index value for patients with serious complications of diabetes and hypertension was equal to or less than 0.8, as shown by studies carried out in China.[20 22] EQ-5D-5L index value≤0.8 group: Median 0.6718, IQR -0.0818～0.7998; EQ-5D-5L index value>0.8 group: Median 0.9507, IQR 0.8410～1.

Regression analysis of the DCE data

Our analysis found that the study patients valued most the new technologies with never or rare incidence of serious adverse events (β = 0.884, P<0.01), followed by the expected gains in health outcomes from the treatment (β = 0.809, P<0.01) (Table 3). Likelihood of effective treatment was also a significant, positive predictor of patients' choice of new technologies (β = 0.455, P<0.01) while out-of-pocket costs was a significant, negative predictor of patients' choice (β = -0.258, P<0.01). In comparison, whether there were alternative technologies currently covered by insurance seemed not to be an important factor for the patients (P>0.05). Unobservable preference heterogeneity as indicated by the estimated standard deviation (SD) of the mean coefficients, were identified for four variables— expected gains in health outcomes from the treatment, likelihood of effective treatment, out-of-pocket costs, and lethal disease.

Subgroup analysis by type of disease

Appendix 7 presented the results from the subgroup analysis by type of disease (hypertension versus diabetes). While the two groups had similar results, there were two notable differences. One was that, although out-of-pocket costs remained a significant, negative predictor, their coefficient for hypertension patients was -0.178 (P<0.05), not as important as it was for patients with diabetes (β = -0.395, P<0.01). The other was that the expected gains in health outcomes from the treatment seemed to be more important for diabetes patients (β = 0.965, P<0.01) when compared with those who only had hypertension (β = 0.716, P<0.01). The SD revealed coefficient heterogeneity within both subgroups for the random parameters of three variables—likelihood of effective

For peer review only

treatment, lethal disease, and out-of-pocket costs.

Table 3. DCE results from mixed logit model

Attributes	All patients	
	Mean(SE)	SD(SE)
Expected gains in health outcomes from the treatment		
Not as expected (reference)		
As expected	0.809**(0.123)	0.554* (0.275)
Increasing likelihood of effective treatment (per 10%)	0.455**(0.044)	0.375**(0.055)
Severity of target disease		
Not severe (reference)		
Severe	0.291*(0.123)	0.316(0.431)
Lethal	0.208(0.147)	1.264**(0.199)
Incidence of serious adverse events		
Often (reference)		
Occasionally	0.575**(0.116)	0.035(0.694)
Never or rarely	0.884**(0.142)	0.900(0.206)
Alternative technologies currently covered by insurance		
Yes (reference)		
No	0.087(0.104)	0.095(0.501)
Out-of-pocket costs (thousand CNY per month increase)	-0.258**(0.061)	0.898**(0.090)
Log likelihood	-1485.761	
Participants	408	
Observations	4896	

*P<0.05; **P<0.01; SD: Standard Deviation estimates reflect preference heterogeneity in the participants; SE: Standard Error

Subgroup analysis by type of insurance

Appendix 8 summarized the subgroup analyses by type of insurance. The expected gains in health outcomes from the treatment, likelihood of effective treatment, and low incidence of serious adverse events were significant, positive predictors of technology choice (P<0.01) for both URRBMI and UEBMI patients. Whether there were alternative technologies currently covered by insurance was statically insignificant for both groups (P>0.05). However, these two groups differed remarkably in two technology attributes. The coefficient of out-of-pocket costs was significant for URRBMI patients (β = -0.511, P<0.01), but not for UEBMI patients (β = -0.071, P>0.05). Severity of target disease also had significant coefficients for URRBMI patients (P<0.01), but not for UEBMI

For peer review only

patients.

We conducted further analysis of the UEBMI patients by excluding those UEBMI patients who enjoyed extra health insurance benefits, including who enjoyed public servant subsidies and the retired veteran cadres, and as indicated by Column (3), we found that out-of-pocket costs was a meaningful attribute for the remaining UEBMI patients ($\beta = -0.211$, $P<0.05$) although not so important as viewed by URRBMI patients ($\beta = -0.211$ vs. $\beta = -0.511$). On the other hand, severity of target disease remained statistically non-significant after excluding those UEBMI patients with extra insurance benefits. Preference heterogeneity for the lowest incidence of serious adverse events was identified.

Subgroup analysis by HRQoL

Appendix 9 demonstrated the results from the subgroup analysis by EQ-5D-5L index value, which was a meaningful measurement for HRQoL. Severity of target disease, both severe and lethal, was important for patients with EQ-5D-5L index value less than or equal to 0.8 ($P<0.01$). However, it was statistically non-significant for patients with EQ-5D-5L index value higher than 0.8 ($P>0.05$). Although patients' preferences for attributes including expected gains in health outcomes from the treatment, and incidence of serious adverse events were statistically significant for both groups, they were less important as viewed by the group with lower EQ-5D-5L index value. For patients with EQ-5D-5L index value less than or equal to 0.8, expected gains in health outcomes from the treatment had more variation in heterogeneity than other attributes. However, the heterogeneity for lethal disease was most significant for patients with EQ-5D-5L index value greater than 0.8.

Since severity of target disease was an important attribute for URRBMI patients ($P<0.01$), but not for UEBMI patients. We did the chi-square test and results showed that the proportion of patients with lower EQ-5D-5L index value was significantly higher in URRBMI group ($P<0.01$) (Appendix 10).

For peer review only

Subgroup analysis by gender

We found that patients in both groups valued the new technologies with expected gains in health outcomes from the treatment, likelihood of effective treatment, low incidence of serious adverse event, and low out-of-pocket cost (P<0.01) (Appendix 11). However, the differences in preferences for attributes were not obvious between male and female.

DISCUSSION

Summary of the findings

Our study found that key technology attributes, including expected gains in health outcomes from the treatment, high likelihood of effective treatment, and low incidence of serious adverse events were significant, positive predictors of patient choice for health insurance coverage. These results hold for the entire study sample and for the subgroup analyses.

Out-of-pocket costs was a significant, negative predictor for the entire sample, showing that patients preferences decreased as the out-of-pocket costs increased. We also found that out-of-pocket costs was a significant, negative predictor for both hypertension patients and diabetes patients although they were less important for the former group than for the latter group.

When it came to different insurance types, we identified preference heterogeneity as previous studies of DCE suggested.[44] Specifically, we found that out-of-pocket costs was a significant, negative predictor for URRBMI patients' preference for insurance coverage while severity of target disease was a significant, positive predictor for this group of patients. But neither of these two attributes was a significant predictor for UEBMI patients. Our further analysis of the UEBMI patients by excluding those UEBMI patients who enjoyed extra health insurance benefits revealed that the remaining UEBMI patients regarded out-of-pocket costs as a significant, negative factor

For peer review only

for coverage although severity of target disease stayed statistically insignificant for them.

Patients' HRQoL was measured in our research and results suggested that patients with lower HRQoL tended to prefer new technologies which could have effects on severe or lethal diseases. The findings on importance of disease severity regarding patients with lower HRQoL coincide with URRBMI patients. In fact, the reimbursement level and the hospitalization rate of URRBMI patients were lower than UEBMI patients.[15] Further analysis showed the relatively higher proportion of URRBMI patients with lower HRQoL. In addition, our results indicate that gender is not a decisive factor for the preference of new technologies for reimbursement.

The degree to which respondent preferences were heterogeneous was described by the estimated SD around each mean preference estimate. Heterogeneity was found mainly for four variables—expected gains in health outcomes from the treatment, likelihood of effective treatment, out-of-pocket costs, and lethal disease. Although heterogeneity existed, the preferences for new technologies with expected gains in health outcomes from the treatment, and likelihood of effective treatment remained significant in all patients and each subgroup, suggesting that these attributes were generally valued by patients. Variations in preferences over out-of-pocket costs and lethal disease had implications for the optimal design of insurance reimbursement schemes and should be analyzed in future research.

Comparison with other studies

Our findings of patients' valuing most the effectiveness and safety of medical technologies were consistent with the results by prior studies from other countries which aimed to investigate patients' preferences for the treatment of chronic diseases.[45-49] Our study confirmed that patients preferred new technologies which could increase health benefits and minimize potential risks.

However, variation in patient preferences existed and mainly depended on patients' own feelings of the disease. Previous research found that the median hospitalization cost

For peer review only

for patients with hypertension was lower than patients with diabetes,[50 51] which supported our findings that out-of-pocket costs was not as important for hypertension patients as they were for patients with diabetes.

We also identified preference heterogeneity among patients with different types of insurance. Although China's successful health insurance expansion during the past decade led to the country's universal health insurance coverage, variations in benefit coverage were manifested among different health insurance schemes,[12] resulting in inequalities in accessibility and affordability of medical services.[52] Such inequalities affected patient preferences across different types of insurance. For example, we found that out-of-pocket costs was a significant, negative predictor for URRBMI patients' preference, but not for all the UEBMI patients in our sample. The finding reflected the fact that, compared with URRBMI, UEBMI had better benefit coverage and higher reimbursement level, especially for those UEBMI patients with extra benefits. The finding also fitted into the big picture of disparities across insurance schemes in China that were illustrated by prior research.

We found that URRBMI patients attached importance to severity of disease. We also found the association between lower HRQoL and preference on technologies treating severe or lethal disease. Previous studies found that chronic disease patients with URRBMI had lower health service utilization.[53] Furthermore, URRBMI patients had significantly higher adjusted in-hospital mortality rate and shorter length of stay when compared with concurrent UEBMI patients.[54 55] These findings suggested that a plausible explanation for the importance of severity of disease for URRBMI patients might be mainly due to their perception of HRQoL and their concern about the potential severe or lethal consequences of chronic diseases.

Implications of the study findings

The rising prevalence of chronic diseases in China has major implications on its ability to provide timely, acceptable and affordable healthcare service for its citizens. To meet the demand for new medical technologies for treating chronic diseases, it is

For peer review only

important for China's policy-makers to consider patient preferences when they decide on insurance coverage of new medical technologies. Specifically our findings that patients valued most new medical technologies with substantial health benefits and low risks suggested such technologies should be the priority of health insurance coverage. Policy-makers are suggested to make evidence-based comparisons among technologies according to the attributes patients preferred to achieve patient-centered and evidence-informed reimbursement decision-making.

Our findings that out-of-pocket costs was a significant concern for URRBMI patients but not for all the UEBMI patients suggested that policymakers need to take further efforts to reduce disparities in benefit coverage and reimbursement level between these two types of insurance and between subgroups with UEBMI. The efforts will not only enhance financial protections for URRBMI patients and subgroups within UEBMI patients, but also contribute to China's long-term goal of equalizing benefit coverage across insurance programs.[10]

We found that patients did not care about alternative technologies currently covered by insurance. However, it is an essential attribute in reimbursement decision-making. Decision makers need to compare the new technologies with available alternative technologies and determine whether to cover new medical technologies or obsolete the alternatives. Policymakers and clinicians may need to implement communication strategies to improve patients' understanding about the alternative therapies and reimbursement policies under the current insurance system to increase appropriate use of the existing therapies.

Strengths and limitations

Our study used DCE to elicit preferences from chronic disease patients on insurance coverage of new medical technologies in China. We identified preference heterogeneity among patients with different types of insurance. Patients' HRQoL was measured and the potential impact on preferences for reimbursement of new technologies was analyzed. Our research was helpful for applying a patient-centered

For peer review only

approach to policy-making and generated evidence that could inform insurance coverage decision-making.

Nevertheless, there are several limitations with our study. First, our samples were from tertiary hospitals in Jiangsu Province. Those patients who sought medical service from tertiary hospitals generally have serious and/or complex medical conditions with higher demand for healthcare services than other patients, and may cautiously consider the issue of medical insurance coverage and reimbursement. Jiangsu is an eastern, coastal province and one of the most economically developed regions in China. Future studies are needed to have a nationally representative sample by including patients at secondary and primary hospitals, and especially by including the economically underdeveloped regions in China.

Second, our study included patients with a history of diabetes or hypertension. Due to differences in disease nature and characteristics, the results may not represent preferences from patients with other types of chronic diseases, although prior DCEs[45-49] made conclusions that were similar to ours in terms of the relative importance of technology attributes regarding benefits and risks. Future studies need to enroll patients with other diseases, and performing subgroup analysis to find variations of patient preferences across different types of diseases.

Third, there were only 43 UEBMI patients who enjoyed additional privileges of health insurance, and the limited sample size prevented us from conducting a separate analysis of this subgroup. Further research is still needed to focus on these subgroups.

CONCLUSION

Chronic disease patients valued most the health benefits and risks of new technologies, which were closely related to their own perception and feelings. Policymakers need to consider new technologies with high therapeutic effectiveness and benefit and low risk for treating chronic diseases as a priority for health insurance

For peer review only

coverage. Further efforts should also be made to reduce the gaps in benefit coverage and reimbursement level between insurance schemes to promote equal access to healthcare services in China.

Ethics approval

This study, including the patient consent process, was approved by the Medical Ethics Committee in Affiliated Hospitals of Nantong University (Ethical Approval-2016031), and conforms to the ethical guidelines of the Declaration of Helsinki.

Acknowledgments

We acknowledge the important contributions of our interviewers who did one-to-one, face-to-face interviews with the patients. We are also grateful to all the patients for their time and efforts. We sincerely thank reviewers for providing us valuable comments and suggestions on drafts of the manuscript.

At the time of drafting the manuscript, Jinsong Geng was a fellow at the Fellowship in Health Policy and Insurance Research, Department of Population Medicine, Harvard Medical School and Harvard Pilgrim Healthcare Institute.

Author contributions

Geng JS, Chen XW, and Yu H led the design and analysis of the discrete choice experiment. Geng JS, Chen XW contributed to literature search and data interpretation. Bao HN, Qian DM, Shao YT contributed to implementing the discrete choice experiment. Geng JS and Yu H performed statistical analysis and wrote the manuscript.

Funding

This work was supported by National Natural Science Foundation of China (Grant No. 71603138) and Jiangsu Overseas Visiting Scholar Program for University Prominent Young & Middle-aged Teachers and Presidents.

For peer review only

The funders provided financial support for the conduct of the study. The funders had no role in the design, implementation, data collection and statistical analysis, data interpretation, or writing of the manuscript.

Disclosure

The authors report no conflict of interest in this research.

Data sharing statement

Data will be available upon reasonable request to corresponding author.

References

1. World Health Organization. *Global action plan for the prevention and control of noncommunicable diseases 2013-2020*. Geneva: World Health Assembly, 2013:5-9.

2. Lu J, Lu Y, Wang X, *et al*. Prevalence, awareness, treatment, and control of hypertension in China: data from 1.7 million adults in a population-based screening study (China PEACE Million Persons Project). *Lancet* 2017;390:2549-58.

3. Wang L, Gao P, Zhang M, *et al*. Prevalence and ethnic pattern of diabetes and prediabetes in China in 2013. *JAMA* 2017;317:2515-23.

4. Adriaanse MC, Drewes HW, van der Heide I, *et al*. The impact of comorbid chronic conditions on quality of life in type 2 diabetes patients. *Qual Life Res* 2016;25:175-82.

5. Aubert CE, Fankhauser N, Marques-Vidal P, *et al*. Patterns of multimorbidity in internal medicine patients in Swiss university hospitals: a multicentre cohort study. *Swiss Med Wkly* 2019;149:w20094.

6. Wang J, Ma JJ, Liu J, *et al*. Prevalence and risk factors of comorbidities among hypertensive patients in China. *Int J Med Sci* 2017;14:201-12.

7. Bloom DE, Chen S, Kuhn M, *et al*. The economic burden of chronic diseases: estimates and projections for China, Japan, and South Korea. *JEoA* 2018:100163.

8. Yip W, Fu H, Chen AT, *et al*. 10 years of health-care reform in China: progress and gaps in Universal Health Coverage. *Lancet* 2019;394:1192-204.

9. China's National Healthcare Security Administration. *China Healthcare Security Diagnosis Related Groups (CHS-DRG)*. Beijing, 2019:44-46.10. Yu H. Universal health insurance coverage for 1.3 billion people: what accounts for China's success? *Health Policy* 2015;119:1145-52.

10. Yu H. Universal health insurance coverage for 1.3 billion people: what accounts for China's success? *Health Policy* 2015;119:1145-52.

11. Li Y, Zhao Y, Yi D, *et al*. Differences exist across insurance schemes in China post-consolidation. *PloS One* 2017;12:e0187100.

12. Xiong X, Zhang Z, Ren J, *et al*. Impact of universal medical insurance system on the

For peer review only

accessibility of medical service supply and affordability of patients in China. *PloS One* 2018;13:e0193273.

13. Xian W, Xu X, Li J, *et al*. Health care inequality under different medical insurance schemes in a socioeconomically underdeveloped region of China: a propensity score matching analysis. *BMC Public Health* 2019;19:1373.

14. The State Council of the People's Republic of China. Opinion of the State Council on integrating the basic health insurance system for urban and rural residents, 2016. Available: http://www.gov.cn/zhengce/content/2016-01/12/content_10582.htm

15. China's National Healthcare Security Administration. Statistical Bulletin of National Social Medical Insurance Development in 2018. Available: http://www.nhsa.gov.cn/art/2019/6/30/art_7_1477.html

16. General Office of the State Council of the People's Republic of China. Notice of the General Office of the State Council on transmitting the opinions from the Ministry of Labor and Social Security and the Ministry of Finance on the implementation of medical subsidies for national civil servants, 2000. Available: http://www.gov.cn/gongbao/content/2000/content_60249.htm

17. Wuxi No.2 People's Hospital. Medical insurance policy (the latest version of 2020). Available: https://www.wx2h.com/ywzc/ywzcdetail/index/id/4/tid/6.html.

18. Makovski TT, Schmitz S, Zeegers MP, *et al*. Multimorbidity and quality of life: systematic literature review and meta-analysis. *Ageing Res Rev* 2019;53:100903.

19. van Reenen M, Janssen B. *EQ-5D-5L user guide: basic information on how to use the EQ-5D-5L instrument.* Rotterdam: EuroQol Research Foundation, 2015.

20. Pan CW, Sun HP, Zhou HJ, *et al*. Valuing health-related quality of life in type 2 diabetes patients in China. *Med Decis Making* 2016;36:234-41.

21. Wang P, Luo N, Tai ES, *et al*. The EQ-5D-5L is more discriminative than the EQ-5D-3L in patients with diabetes in Singapore. *Value Health Reg Issues* 2016;9:57-62.

22. Liang Z, Zhang T, Lin T, *et al*. Health-related quality of life among rural men and women with hypertension: assessment by the EQ-5D-5L in Jiangsu, China. *Qual Life Res* 2019;28:2069-80.

23. Institute of Medicine Committee on Quality of Health Care in America. *Crossing the quality chasm: a new health system for the 21st century*. Washington, D.C.: The National Academies Press, 2001.

24. Lancsar E, Fiebig DG, Hole AR. Discrete choice experiments: a guide to model specification, estimation and software. *Pharmacoeconomics* 2017;35:697-716.

25. Clark MD, Determann D, Petrou S, *et al*. Discrete choice experiments in health economics: a review of the literature. *Pharmacoeconomics* 2014;32:883-902.

26. Ryan M, Kolstad J, Rockers P, *et al*.. *How to conduct a discrete choice experiment for health workforce recruitment and retention in remote and rural areas: a user guide with case studies.* Geneva:World Health Organization Press, 2012.

27. Goetghebeur MM, Wagner M, Khoury H, *et al*. Evidence and value: impact on DEcisionMaking--the EVIDEM framework and potential applications. *BMC Health Serv Res* 2008;8:270.

28. Chen XW, Chen Q, Geng JS, *et al*. The application of multi-criteria decision analysis in medical insurance reimbursement: a systematic review. *Chinese Health Resources* 2018;21:218-23.

29. Geng JS, Chen XW, Yu XL, *et al*. Study on the evidence-based decision-making framework

For peer review only

for reimbursement of new technologies in view of EVIDEM. *Chinese Journal of Health Policy* 2018;11:50-54.

30. Hensher DA, Rose JM, Greene WH. *Applied Choice Analysis (2nd Edition)*. Cambridge: Cambridge University Press, 2015.

31. Reed Johnson F, Lancsar E, Marshall D, *et al*. Constructing experimental designs for discrete-choice experiments: report of the ISPOR Conjoint Analysis Experimental Design Good Research Practices Task Force. *Value Health* 2013;16:3-13.

32. Nichols E, O'Hara NN, Degani Y, *et al*. Patient preferences for nutritional supplementation to improve fracture healing: a discrete choice experiment. *BMJ Open* 2018;8:e019685.

33. van Dijk JD, Groothuis-Oudshoorn CG, Marshall DA, *et al*. An empirical comparison of discrete choice experiment and best-worst scaling to estimate stakeholders' risk tolerance for hip replacement surgery. *Value Health* 2016;19:316-22.

34. Bhattarai N, McMeekin P, Price CI, *et al*. Preferences for centralised emergency medical services: discrete choice experiment. *BMJ Open* 2019;9:e030966.

35. Kløjgaard ME, Bech M, Søgaard R. Designing a stated choice experiment: the value of a qualitative process. *J Choice Model* 2012;5:1-18.

36. Dhar R, Simonson I. The Effect of Forced Choice on Choice. *JMR* 2003;40:146-60.

37. de Bekker-Grob EW, Donkers B, Jonker MF, *et al*. Sample size requirements for discrete-choice experiments in healthcare: a practical guide. *Patient* 2015;8:373-84.

38. Vanniyasingam T, Cunningham CE, Foster G, *et al*. Simulation study to determine the impact of different design features on design efficiency in discrete choice experiments. *BMJ Open* 2016;6:e011985.

39. Oluboyede Y, Ternent L, Vale L, *et al*. Using a discrete-choice experiment to estimate the preferences of clinical practitioners for a novel non-invasive device for diagnosis of peripheral arterial disease in primary care. *Pharmacoecon Open* 2019;3:571-81.

40. Shanahan M, Seddon J, Ritter A, *et al*. Valuing families' preferences for drug treatment: a discrete choice experiment. *Addiction* 2020;115:690-99.

41. Hauber AB, Gonzalez JM, Groothuis-Oudshoorn CG, *et al*. Statistical methods for the analysis of discrete choice experiments: a report of the ISPOR Conjoint Analysis Good Research Practices Task Force. *Value Health* 2016;19:300-15.

42. Kløjgaard ME, Manniche C, Pedersen LB, *et al*. Patient preferences for treatment of low back pain-a discrete choice experiment. *Value Health* 2014;17:390-6.

43. Luo N, Liu G, Li M, et al. Estimating an EQ-5D-5L Value Set for China. *Value Health* 2017;20:662-69.

44. de Bekker-Grob EW, Swait JD, Kassahun HT, *et al*. Are healthcare choices predictable? The impact of discrete choice experiment designs and models. *Value Health* 2019;22:1050-62.

45. Brockelmann PJ, McMullen S, Wilson JB, *et al*. Patient and physician preferences for first-line treatment of classical Hodgkin lymphoma in Germany, France and the United Kingdom. *Br J Haematol* 2019;184:202-14.

46. Forsander G, Stallknecht S, Samuelsson U, *et al*. Preferences for treatment among adolescents with Type 1 diabetes: a national study using a discrete choice experiment model. *Diabet Med* 2018;35:621-29.

47. Havrilesky LJ, Lim S, Ehrisman JA, *et al*. Patient preferences for maintenance PARP

For peer review only

inhibitor therapy in ovarian cancer treatment. *Gynecol Oncol* 2020 doi: 10.1016/j.ygyno.2020.01.026.

48. Ho KA, Acar M, Puig A, *et al*. What do Australian patients with inflammatory arthritis value in treatment? A discrete choice experiment. *Clin Rheumatol* 2019 doi: 10.1007/s10067-019-04843-4.

49. Thieu VT, Robinson S, Kennedy-Martin T, *et al*. Patient preferences for glucagon-like peptide 1 receptor-agonist treatment attributes. *Patient Prefer Adherence* 2019;13:561-76.

50. Mutowo MP, Lorgelly PK, Laxy M, *et al*. The hospitalization costs of diabetes and hypertension complications in Zimbabwe: estimations and correlations. *J Diabetes Res* 2016;2016:9754230.

51. Rosa MQM, Rosa RDS, Correia MG, *et al*. Disease and economic burden of hospitalizations attributable to diabetes mellitus and its complications: a nationwide study in Brazil. *Int J Environ Res Public Health* 2018;15: E294.

52. Zhao C, Wang C, Shen C, *et al.* China's achievements and challenges in improving health insurance coverage. *Drug Discov Ther* 2018;12:1-6.

53. Xie X, Wu Q, Hao Y, *et al*. Identifying determinants of socioeconomic inequality in health service utilization among patients with chronic non-communicable diseases in China. *PloS One* 2014;9:e100231.

54. Chen H, Shi L, Xue M, *et al*. Geographic variations in in-hospital mortality and use of percutaneous coronary intervention following acute myocardial infarction in China: a nationwide cross-sectional analysis. *J Am Heart Assoc* 2018;7:e008131.

55. Lin X, Cai M, Tao H, *et al*. Insurance status, inhospital mortality and length of stay in hospitalised patients in Shanxi, China: a cross-sectional study. *BMJ Open* 2017;7:e015884.

For peer review only

Appendix 1: Explanations to attributes and levels

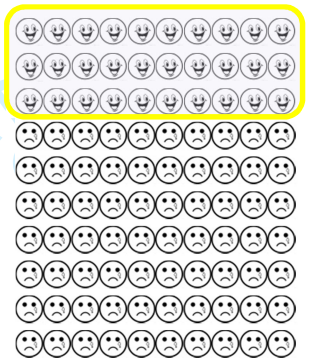
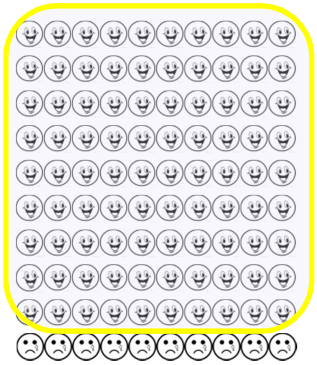
Investigators were required to convey the following definitions to patients:

- 'Expected gains in health outcomes from the treatment' means the ideal treatment objectives mentioned in domestic evidence-based guidelines for specific patients can be achieved; 'Not as expected' indicates that there can be some treatment effects, however, the ideal treatment targets cannot be fully achieved. This attribute is the qualitative aspect of effectiveness.
- Increasingly probability of the effective treatment: 'effective treatment' equals to the attribute 'gains in health outcomes from the treatment' in choice sets: a new medical technology which can reach its expected gains in health outcomes is effective. The attribute 'increasingly probability of the effective treatment' is the quantitative aspect of effectiveness.
- For the severity of target disease, 'not severe' means the target disease of new technology is not fatal and has no impact on patients' quality of life; 'severe' suggests the target disease of new technology is not fatal, however, patients' quality of life was significantly reduced; 'lethal' means the target disease of new technology is fatal and patients will probably die from the disease.
- For incidence of serious adverse events, 'often' equals to or a little bit higher than 10%; occasionally was about 3%.
- 'Serious adverse events' means life-threatening adverse events caused by the new technology, like severe hypoglycemia, severe hypersensitivity reaction, kidney or liver damage, etc.
- Alternative technologies already reimbursed have similar effectiveness and safety to the new technology (Level: Yes); no alternatives already reimbursed have similar effectiveness and safety to the new technology (Level: No).
- The cost of the technology is the out-of-pocket costs if not reimbursed. The hypothesis is that the technology never been reimbursed unless you make the choice.

For peer review only

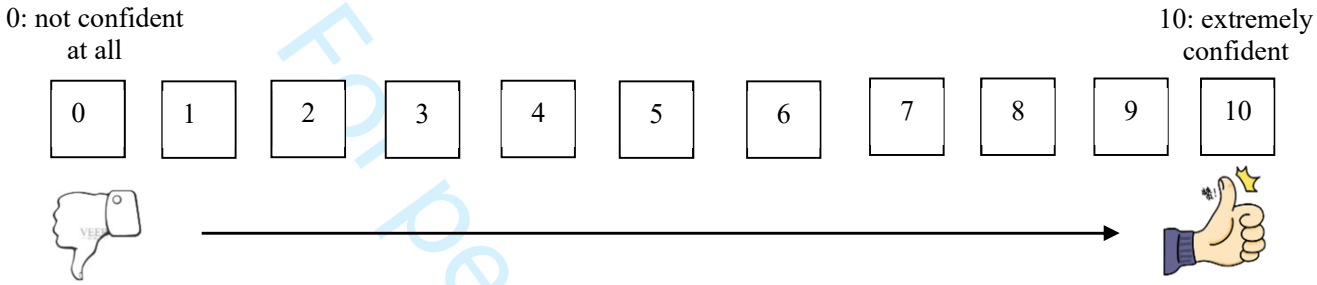
Appendix 2: Examples of DCE choice sets

Medical interventions A and B are used to treat chronic diseases, and currently they were not covered in the social insurance reimbursement list. If you are forced to make a choice, which intervention should be reimbursed by social insurance? There is no right or wrong answers; please make the choice according to your own opinion.

Attributes	New technology A	New technology B
Expected gains in health outcomes from the treatment	 **As expected**	 **Not as expected**
Likelihood of effective treatment	 **30%**	 **90%**
Severity of target disease	 **Severe, not lethal**	 **Not severe**
Incidence of serious adverse events (life-threatening)	 **Never or rarely**	 **Often**
Alternative technologies currently covered by insurance	**Yes**	**No**
Out-of-pocket costs for new technology (if not reimbursed)	**1500 CNY per month**	**3500 CNY per month**
Which one should be covered by medical insurance? Your choice	☐	☐

Appendix 3: Evaluation of confidence

The following statements refer to the questions that asked about how confident you feel in completing the choice sets. Please select your confident level from 1 to 10 and give a tick ' √ ' in the score to represent your selection:



For peer review only

Appendix 4: Number of patients included in sample hospitals

Supplemental Table 1 Number of patients in each sample hospital

Name of hospital	City	Number of patients
Taizhou People's Hospital	Taizhou	60
Jiangyin People's Hospital	Wuxi	40
First People's Hospital of Wujiang District	Suzhou	60
Nantong First People's Hospital	Nantong	23
Nantong Third People's Hospital	Nantong	100
Affiliated Hospital of Nantong University	Nantong	125

For peer review only

Appendix 5: Distribution of patients by type of disease and type of insurance

Supplemental Table 2. Types of insurance for patients with hypertension and diabetes

Disease	URRBMI	UEBMI
Hypertension	130	131
Diabetes	49	40
Total	179	171

Urban and Rural Residents Basic Medical Insurance (URRBMI); Urban Employees Basic Medical Insurance (UEBMI)

χ^2 =0.732 P= 0.392

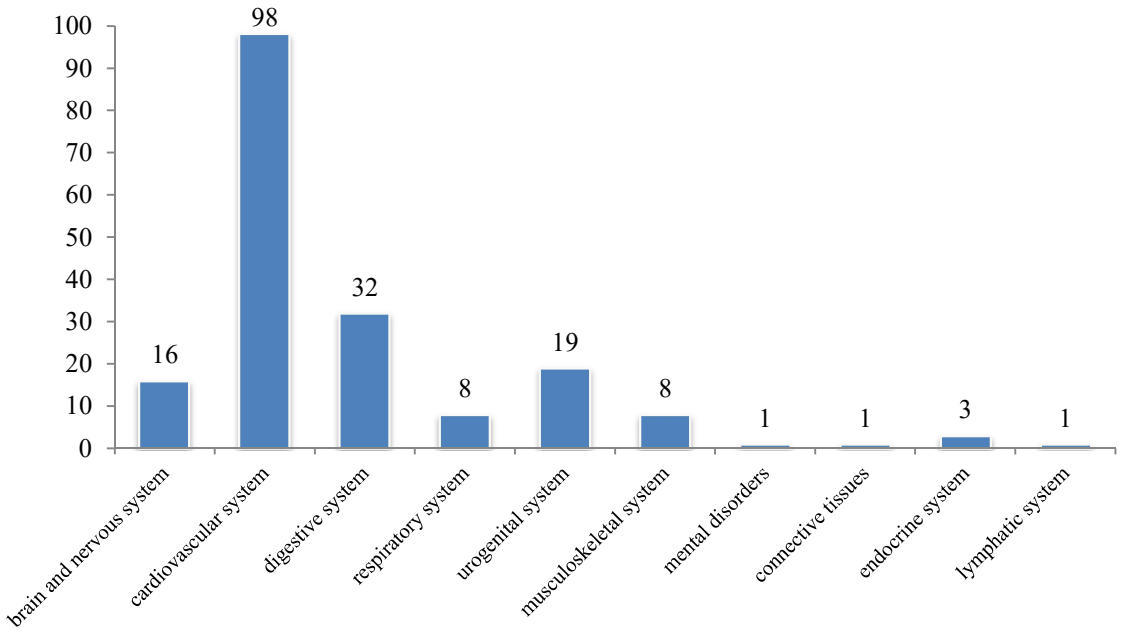
Supplemental Table 3. Types of benefits for UEBMI patients with hypertension and diabetes

Disease	UEBMI with extra benefits	UEBMI without extra benefits
Hypertension	27	104
Diabetes	11	29
Total	38	133

χ^2 =0.842 P= 0.359

For peer review only

Appendix 6: Types of chronic commodities for the included patients



Supplemental Figure 1 Number of patients with chronic commodities

For peer review only

Appendix 7: Subgroup analysis according to disease

Supplemental Table 4. Subgroup analysis according to disease

Attributes	Hypertension		Diabetes	
	Mean (SE)	SD (SE)	Mean (SE)	SD (SE)
Expected gains in health outcomes from the treatment				
Not as expected (reference)				
As expected	0.716**(0.158)	0.443(0.496)	0.965**(0.259)	0.125(0.497)
Increasing likelihood of effective treatment (per 10%)	0.519**(0.064)	0.375**(0.086)	0.420**(0.093)	0.401**(0.119)
Severity of target disease				
Not severe (reference)				
Severe	0.328*(0.162)	0.056(0.495)	0.100(0.273)	0.441(0.834)
Lethal	0.215(0.196)	1.189**(0.276)	0.304(0.311)	1.146**(0.395)
Incidence of serious adverse events				
Often (reference)				
Occasionally	0.767**(0.164)	0.014*(0.381)	0.553*(0.266)	0.337(0.548)
Never or rarely	0.995**(0.195)	1.126(0.271)	0.938**(0.349)	0.989*(0.459)
Alternative technologies currently covered by insurance				
Yes (reference)				
No	0.152(0.158)	0.978**(0.315)	0.089(0.248)	0.019(0.383)
Out-of-pocket costs (thousand CNY per month increase)	-0.178*(0.084)	1.024**(0.128)	-0.395**(0.126)	0.774**(0.190)
Log likelihood	-929.220		-311.029	
Participants	261		89	
Observations	2484		2412	

*P<0.05; **P<0.01; SD: Standard Deviation estimates reflect preference heterogeneity in the participants; SE: Standard Error

Patients who had both hypertension and diabetes were excluded to ensure the homogeneity.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Appendix 8: Subgroup analysis according to insurance types

Supplemental Table 5. Subgroup analysis according to insurance types

Attributes	(1) URRBMI patients		(2) UEBMI patients		(3) UEBMI patients without extra insurance benefits[#]	
	Mean (SE)	SD (SE)	Mean (SE)	SD (SE)	Mean (SE)	SD (SE)
Expected gains in health outcomes from the treatment						
Not as expected (reference)						
As expected	0.977** (0.204)	0.811* (0.325)	0.732** (0.166)	0.320(0.641)	0.652** (0.193)	0.609(0.420)
Increasing likelihood of effective treatment (per 10%)	0.512** (0.069)	0.384** (0.075)	0.444** (0.066)	0.383** (0.082)	0.450** (0.074)	0.271** (0.085)
Severity of target disease						
Not severe (reference)						
Severe	0.519** (0.189)	0.247(0.887)	0.062(0.171)	0.138(0.609)	-0.09(0.194)	0.193(0.615)
Lethal	0.761** (0.230)	1.112** (0.316)	-0.217(0.211)	1.321** (0.289)	-0.385(0.242)	1.387** (0.333)
Incidence of serious adverse events						
Often (reference)						
Occasionally	0.704** (0.181)	0.08(0.389)	0.462** (0.165)	0.501(0.401)	0.526** (0.196)	0.70(0.381)
Never or rarely	0.928** (0.214)	1.013** (0.301)	0.876** (0.206)	0.881** (0.317)	0.792** (0.232)	0.858* (0.361)
Alternative technologies currently covered by insurance						
Yes (reference)						
No	0.142(0.161)	0.242(0.516)	-0.003(0.148)	0.556(0.380)	-0.143(0.158)	0.106(0.679)
Out-of-pocket costs (thousand CNY per month increase)	-0.511** (0.112)	1.041** (0.152)	-0.071(0.078)	0.818** (0.125)	-0.211* (0.090)	0.790** (0.146)
Log likelihood	-706.268		-707.710		-562.183	
Participants	207		201		158	
Observations	2484		2412		1896	

*P<0.05; **P<0.01; SD: Standard Deviation estimates reflect preference heterogeneity in the participants; SE: Standard Error;

[#]This subgroup did not include those UEBMI patients who enjoyed extra health insurance benefits.

Appendix 9: Subgroup analysis according to health related quality of life

Supplemental Table 6. Subgroup analysis according to health related quality of life (HRQoL)

Attributes	EQ-5D-5L index value ≤0.8		EQ-5D-5L index value >0.8	
	Mean (SE)	SD (SE)	Mean (SE)	SD (SE)
Expected gains in health outcomes from the treatment				
Not as expected (reference)				
As expected	0.554*(0.228)	0.971*(0.423)	0.953**(0.165)	0.466(0.493)
Increasing likelihood of effective treatment (per 10%)	0.606**(0.093)	0.450**(0.098)	0.405**(0.054)	0.320**(0.074)
Severity of target disease				
Not severe (reference)				
Severe	0.874**(0.240)	0.043(0.408)	0.106(0.156)	0.349(0.533)
Lethal	0.724**(0.254)	0.773*(0.347)	-0.064(0.195)	1.499**(0.281)
Incidence of serious adverse events				
Often (reference)				
Occasionally	0.131(0.202)	0.007*(0.461)	0.815**(0.166)	0.431(0.357)
Never or rarely	0.516*(0.236)	0.453(0.519)	1.120**(0.200)	1.103**(0.275)
Alternative technologies currently covered by insurance				
Yes (reference)				
No	0.007(0.179)	0.142(0.466)	0.093(0.140)	0.560(0.458)
Out-of-pocket costs (thousand CNY per month increase)	-0.233*(0.109)	0.909**(0.157)	-0.283**(0.083)	0.979**(0.135)
Log likelihood	-438.402		-954.540	
Participants	127		281	
Observations	1524		3372	

*P<0.05; **P<0.01; SD: Standard Deviation estimates reflect preference heterogeneity in the participants; SE: Standard Error

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Appendix 10: Health-related quality of life by type of insurance

Supplemental Table 7. Health-related quality of life for patients by type of insurance

Type of insurance	EQ-5D-5L index value ≤0.8	EQ-5D-5L index value >0.8
URRBMI	90	117
UEBMI	37	164
Total	127	281

χ^2 =29.898 P=0.000

For peer review only

Appendix 11: Subgroup analysis according to gender

Supplemental Table 8. Subgroup analysis according to gender

Attributes	Male		Female	
	Mean (SE)	SD (SE)	Mean (SE)	SD (SE)
Expected gains in health outcomes from the treatment				
Not as expected (reference)				
As expected	0.805**(0.174)	0.754*(0.357)	0.921**(0.200)	0.193(0.512)
Increasing likelihood of effective treatment (per 10%)	0.476**(0.065)	0.409**(0.077)	0.456**(0.069)	0.362**(0.089)
Severity of target disease				
Not severe (reference)				
Severe	0.303(0.177)	0.541(0.425)	0.346(0.191)	0.333(0.435)
Lethal	0.249(0.199)	1.077**(0.282)	0.182(0.241)	1.582**(0.319)
Incidence of serious adverse events				
Often (reference)				
Occasionally	0.680**(0.167)	0.471(0.371)	0.528**(0.187)	0.007(0.417)
Never or rarely	0.953**(0.204)	0.768*(0.338)	0.897**(0.232)	1.146**(0.306)
Alternative technologies currently covered by insurance				
Yes (reference)				
No	0.127(0.144)	0.288(0.650)	0.093(0.168)	0.202(0.643)
Out-of-pocket costs (thousand CNY per month increase)	-0.246**(0.084)	0.893**(0.131)	-0.281**(0.098)	0.979**(0.153)
Log likelihood	-780.85		-667.657	
Participants	220		188	
Observations	2640		2256	

*P<0.05; **P<0.01; SD: Standard Deviation estimates reflect preference heterogeneity in the participants; SE: Standard Error

For peer review only

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Page 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 6-8
Objectives	3	State specific objectives, including any pre-specified hypotheses	Page 8 (line 47-54)
Methods			
Study design	4	Present key elements of study design early in the paper	Page 9 (line 11-20)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 9-12
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	Page 12 (line 32-50)
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	Not applicable
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 10 (line 38-42); Page 11 (line 5-21)
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 13; Page 14 (line 5-11)
Bias	9	Describe any efforts to address potential sources of bias	Page 13 (line 9-28)
Study size	10	Explain how the study size was arrived at	Page 12 (line 51-58); Page 13 (line 5-7)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 14 (line 37-54)
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 14 (line 18-35)
		(*b*) Describe any methods used to examine subgroups and interactions	Page 14 (line 56-58)
		(*c*) Explain how missing data were addressed	Page 13 (line 16-24)

For peer review only

		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	Not applicable
		(*e*) Describe any sensitivity analyses	Page 14 (line 56-58); Page 15 (line 42-48)
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Page 15 (line 20-30)
		(b) Give reasons for non-participation at each stage	Not applicable
		(c) Consider use of a flow diagram	Not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 15 (line 32-52); Page 16
		(b) Indicate number of participants with missing data for each variable of interest	Not applicable
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	Not applicable
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	Page 17 (line 17-38)
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Page 15 (line 42-48); Page 19 (line 52-59)
		(*b*) Report category boundaries when continuous variables were categorized	Not applicable
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Page 17 (line 40-59); Page 18; Page 19; Page 20 (line 5-15)
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 20 (line 23-59); Page 21 (line 5-7)
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 24 (line 9-44)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 21 (line 43-58); Page 22 (line 5-50)
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 22 (line 52-58);

For peer review only

			Page 23 (line 5-46)
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 25 (line 52-59)

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

For peer review only

BMJ Open

Patients' preferences for health insurance coverage of new technologies for treating chronic diseases in China: a discrete choice experiment

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2020-038051.R3
Article Type:	Original research
Date Submitted by the Author:	31-Aug-2020
Complete List of Authors:	Geng, JinSong; Nantong University Medical School, Department of Medical Informatics Chen, Xiaowei; Nantong University Medical School, Department of Medical Informatics; Zhejiang University School of Medicine First Affiliated Hospital, Library and Reference Department Bao, Haini; Nantong University Medical School, Department of Medical Informatics Qian, Danmin; Nantong University Medical School, Department of Medical Informatics Shao, Yuting; Tongji University School of Medicine, Department of Ophthalmology Yu, Hao; Harvard Medical School, Department of Population Medicine; Harvard Pilgrim Health Care Institute
Primary Subject Heading:	Health policy
Secondary Subject Heading:	Health services research
Keywords:	Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, International health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health & safety < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

SCHOLARONE™
Manuscripts

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

For peer review only

Patients' preferences for health insurance coverage of new technologies for treating chronic diseases in China: a discrete choice experiment

Jinsong Geng[1*], Xiaowei Chen[1, 2], Haini Bao[1], Danmin Qian[1,] Yuting Shao[3], Hao Yu[4]

[1]Department of Medical Informatics, Nantong University Medical School, Nantong, China

[2]Library and Reference Department, First Affiliated Hospital of Zhejiang University School of Medicine, Hangzhou, China

[3]Department of Ophthalmology, Tongji University School of Medicine, Shanghai, China

[4]Department of Population Medicine, Harvard Medical School and Harvard Pilgrim Health Care Institute, Boston, USA

*Correspondence: Jinsong Geng, Department of Medical Informatics, Nantong University Medical School, 19 Qixiu Road, Nantong 226001, China; Email gjs@ntu.edu.cn; Tel: +86 513 85051891; Fax: +86 513 85051876

Word count: 4992

For peer review only

ABSTRACT

Objectives

Our study aimed to inform insurance decision-making in China by investigating patients' preferences for insurance coverage of new technologies for treating chronic diseases.

Design

We identified six attributes of new medical technologies for treating chronic diseases and used Bayesian-efficient design to generate choice sets for a discrete choice experiment (DCE). After conducting the DCE, we analyzed the data by mixed logit regression to examine patient-reported preferences for each attribute.

Setting

The DCE was conducted with patients in six tertiary hospitals from four cities in Jiangsu Province.

Participants

Patients aged 18 years or older with a history of diabetes or hypertension and taking medications regularly for more than one year were recruited (N=408).

Results

The technology attributes regarding expected gains in health outcomes from the treatment, high likelihood of effective treatment, and low incidence of serious adverse events were significant, positive predictors of choice by the study patients ($P<0.01$). The out-of-pocket cost was a significant, negative attribute for the entire study sample ($\beta = -0.258$, $P<0.01$) and for the patients with Urban-Rural Residents Basic Medical Insurance (URRBMI) ($\beta = -0.511$, $P<0.01$), but not for all the patients with Urban Employees Basic Medical Insurance (UEBMI) ($\beta = -0.071$, $P>0.05$). The severity of target disease was valued by patients with lower EQ-5D-5L index value as well as URRBMI enrollees.

Conclusions

Patients highly valued the health benefits and risks of new technologies, which were

For peer review only

closely linked to their feelings of disease and perceptions of health-related quality of life. However, there existed heterogeneity in preferences between URRBMI and UEBMI patients. Further efforts should be made to reduce the gap between insurance schemes and make safe and cost-effective new technologies as a priority for health insurance reimbursement.

Keywords: discrete choice experiment, patient preferences, chronic diseases, health insurance

For peer review only

Strengths and limitations of this study

- Our study provides evidence regarding patients' preferences for insurance coverage of new technologies for treating chronic diseases and will be helpful for applying a patient-centered approach to policy-making.
- The discrete choice experiment is a rigorous method that enables us to identify differential preferences among chronic disease patients by types of social health insurance and by the level of health-related quality of life in China.
- The bayesian-efficient design was used to improve the statistical efficiency of the choice design, and a blocking technique was used to increase the response efficiency of patients.
- Since our sample was from a wealthy province in China, future studies of nationally representative samples are needed.
- While this study focused on hypertension and diabetes, two of the most prevalent chronic diseases, future studies need to examine other types of chronic diseases.

For peer review only

INTRODUCTION

Non-communicable chronic diseases (chronic diseases) are health conditions or diseases with long-term accumulation, non-self-healing, and difficult to cure. Nowadays, the prevalence and mortality of chronic diseases are on the rise around the world.[1] Chronic diseases present a particularly daunting challenge to China. It was estimated that among Chinese adults aged 35 to 75 years, nearly half had hypertension.[2] The overall prevalence of diabetes in Chinese adults was about 10.9%.[3] Furthermore, comorbidities are highly prevalent among patients with chronic diseases, which harm the patient's quality of life and impede the efficacy of treatment.[4-6] Chronic diseases lead to a heavy financial burden on patients' families and health insurance programs. It was estimated that the total economic burden associated with chronic diseases in China over the period 2010-2030 could be as high as US$16 trillion (measured in 2010 US Dollars).[7] Further adding to the challenges to China's health insurance programs' financing capacity, new technologies for treating chronic diseases continue to enter the market, which can be very expensive and contribute to rising healthcare costs. Deciding on which new technology to cover and by which insurance program has become a key issue facing policy-makers in China in the context of universal health insurance coverage.

As part of its goal of providing timely, acceptable, and affordable basic healthcare of appropriate quality to its residents, China successfully achieved universal health insurance coverage in 2011, increasing demand for and expenditures on healthcare. China's total health expenditures grew at an average annual rate of 12.2% from 2008 to2017, which was much higher than its GDP's average annual growth rate (8.1%).[8] In recent years, Chinese policy-makers have struggled to keep a balance between expenditure control and meeting patients' demand for healthcare, including the demand for new technologies by patients with chronic diseases. China's National Healthcare Security Administration is promoting the health insurance payment based on diagnosis-related groups (DRGs), a patient classification for standardizing payment in

For peer review only

the national health insurance schemes. Consequently, medical fees and insurance payments will be determined in accordance with the DRG classification, which includes chronic diseases such as diabetes and hypertension.[9]

After China had reached universal health insurance coverage, there were still considerable disparities in benefit coverage and reimbursement ratio among the three major public insurance programs that together covered more than 95% of Chinese people, including New Rural Cooperative Medical Scheme (NRCMS), Urban Residents Basic Medical Insurance (URBMI), and Urban Employees Basic Medical Insurance (UEBMI). For further details on differences in health insurance eligibility, premiums, and benefits among the three programs, see Yu 2015.[10] Generally speaking, UEBMI has the best benefits package and the lowest out-of-pocket cost among the three public insurance programs,[11 12] and UEBMI enrollees had a higher likelihood of healthcare utilization.[13] To improve administrative efficiency and reduce inequality in insurance benefits, the China State Council issued a policy in January 2016 merging the NRCMS and URBMI to form the Urban-Rural Residents Basic Medical Insurance (URRBMI).[14] While the newly formed URRBMI helped equalize insurance benefits between urban and rural residents, gaps remained between URRBMI and UEBMI. For example, according to the 2018 statistical bulletin issued by China's National Healthcare Security Administration, the average per capita inpatient hospitalization cost was 11,181 CNY (about US$1704) for UEBMI enrollees and 6577 CNY (about US$1003) for URRBMI enrollees.[15] The average inpatient reimbursement ratio for UEBMI enrollees was 71.8%, and the reimbursement ratio for URRBMI enrollees was 56.1%.[15] Even among the UEBMI enrollees, the insurance benefit is not comparable, as some of the enrollees enjoy civil servant subsidies.[16] For example, if the medical expenditure exceeds the ceiling of health insurance reimbursement, outpatients and inpatients that enjoy civil servant subsidies may still be subsidized by 70% and 80% respectively for the exceeding parts.[17] Whereas disparities in China's insurance programs and patients' utilization of healthcare have been well-documented in the literature, no studies have

For peer review only

yet examined whether patients' preferences for new medical technology vary by type of insurance. This study aimed to fill the gap.

Patient-reported outcome measures, such as health-related quality of life (HRQoL), are useful for understanding the impact of the disease on their functional status and well-being.[18] EQ-5D series are among the most widely used multi-attribute utility instruments to measure HRQoL. EQ-5D-5L uses a health-state classification system that defines health in 5 areas,[19] has been proved to have the validity and discriminatory power to measure HRQoL in patients with chronic diseases.[20-22] Although HRQoL is an essential measure of health status to inform public health and health policy, whether patients' preferences on reimbursement differ from HRQoL remains unclear.

Eliciting patients' preferences and involving patients in health insurance decision-making can be helpful to increase the satisfaction of patients and is an integral part of patient-centered care. This is defined as providing care that is respectful of, and responsive to individual patient's preferences, needs, and values.[23] Although the patient-centered approach and value-based care have long been advocated in China, there still a lack of evidence from patients reflecting their preferences to inform health insurance coverage decision-making. This study adds new information to the literature by conducting a discrete choice experiment (DCE), which is an attribute-based method to measure the preferences and trade-offs of respondents and becomes a recognized scientific approach to elicit preferences.[24] Prior research showed that DCE was fruitful and reliable to improve healthcare decision-making effectively.[25] Our DCE focused on chronic disease patients, and its goal was to support evidence-informed insurance policy-making in China. Specifically, we used the DCE data to test the following hypotheses: (1) new technology attributes regarding health benefits are more important than other attributes for health insurance coverage; (2) patients' preferences differ by type of disease and type of insurance.

For peer review only

METHODS

Identification of technology attributes and levels

Our DCE design, implementation, and analysis followed the user guide developed jointly by the World Bank, World Health Organization, and U.S. Agency for International Development.[26] We used a three-step approach to complete the preliminary stage of DCE, which aimed to identify and define the attributes and levels of new medical technologies. First, a systematic review was conducted to select attributes that were often used in multi-criteria decision analyses of health insurance decision-making. The systematic review was performed according to the framework for evidence-based decision-making as defined by EVIDEM.[27] We found that the most commonly mentioned dimensions were comparative outcomes (effectiveness, safety/tolerability), economic consequences (costs and cost-effectiveness) and needs of new technologies (severity of target disease, size of the affected population, unmet needs related to the already reimbursed technologies), and knowledge of new technologies (quality of evidence, expert consensus/clinical practice guideline).[28]

Second, both focus group discussions with physicians and expert consultation were carried out to determine the attributes used in our research. There was no consensus among physicians about the criteria to determine the level of attributes of new technologies to treat diabetes and hypertension in our evidence-based clinical practice workshop. Then, we did focus group discussion and expert consultation on attributes and levels regarding reimbursement of new medical technologies. 14 experts (from 6 provinces in China) in reimbursement, health economics, healthcare service, and evidence-based medicine were consulted. Criteria regarding needs of the technology (severity, benefit type of technology, unmet needs of reimbursed technology), comparative outcomes (effectiveness, safety/tolerability, patient-perceived/patient-reported outcomes), and economic aspects of the technology (costs and cost-effectiveness) were required for health insurance reimbursement

For peer review only

decisions.[29] To better define the levels of attributes, we searched the famous health technology assessment database established by Canadian Agency for Drugs and Technologies in Health (CADTH) to select potential new technologies and find reasons for the recommendation of reimbursement. We found 68 reports regarding hypertension and diabetes which were published before March 2018. Data extraction form was developed and the attributes of new technologies were extracted. We further searched the database founded by China National Medical Products Administration (NMPA, formerly China Food and Drug Administration or CFDA) according to the generic name of new technologies to see if they were licensed and available in China. We also referred to the list of medical technologies already covered by the public health insurance programs in Jiangsu province. After completing the database search, we defined new medical technologies in this study as the therapeutics for hypertension and diabetes, which had been marketed in China but were not covered by the public health insurance programs in Jiangsu in 2018. We determined the range of out-of-pocket costs according to the retail price of new technologies.

Attributes and levels of new medical technologies that were used in our research were listed in Table 1. Details of the explanation of attributes and levels were shown in Appendix 1. Our purpose was to identify the specific technology attributes and levels that were preferred by patients, not the special technology used to treat a specific disease. Therefore, the scenarios in our DCE were not restricted to a particular type of disease.

For peer review only

Table 1. Attributes and levels of new medical technology in the DCE

Attributes	Levels	Variables coding
Expected gains in health outcomes from the treatment	Not as expected; As expected	Binary
Likelihood of effective treatment	30%-90%	Continuous
Severity of target disease	Not severe; Severe but not fatal; Fatal	Categorical
Incidence of serious adverse events	Often; Occasionally; Never or rarely	Categorical
Alternative technologies currently covered by insurance	Yes; No	Binary
Out-of-pocket cost per month (if not reimbursed)	CNY 300-3500	Continuous

Note: We defined new medical technologies according to research objectives. New medical technologies referred to new technologies that entered into the market recently before our study but were not included in the reimbursement lists of social health insurance schemes, such as URRBMI and UEBMI.

The average exchange rate of US Dollars to Chinese Yuan (CNY) in 2018 was about 6.56. Therefore, CNY 300 was approximately US$46; CNY 3500 was about US$533.

Experimental design and development of the questionnaire

D-efficiency experimental design that maximized the precision of estimated choice-model parameters for a given number of choice questions[30] was created by Ngene1.1.2 software (Choice-Metrics, Sydney, Australia). Prior coefficients were set to zero during the pilot. After obtaining priors of the attributes from the pilot, Bayesian-efficient design was used to generate the final choice sets, which consisted of 30 pairs of scenarios and were divided into five blocks, with six pairs in each block. Blocking design promoted response efficiency by reducing the potential cognitive burden on respondents.[31]

We chose unlabeled over labeled DCE. Unlabeled DCE was widely used to investigate patients' preferences for treatment techniques.[32-34] Respondents of unlabeled DCEs found that they were not subject to the psychological cues of the technology labels, thus reflecting the real-world choice situation.[35] Also, in our research, new medical technologies to treat chronic diseases continue to emerge. Therefore, the unlabeled DCE was considered appropriate for our study. The forced-choice sets were used in our DCE because when no option had a definitive advantage, it was assumed that forced-choice under preference uncertainty would favor options that were easier to

For peer review only

justify and associated with a lower likelihood of error and regret, such as compromise and asymmetrically dominant options.[36]

Examples of scenarios were shown in Appendix 2. Our final questionnaire contained two sections. Section A listed questions regarding participants' socio-demographic characteristics, past medical history, reasons for the hospital visit, and health insurance information, dimensions and levels of EQ-5D-5L. EQ-5D-5L used a health-state classification system defining health in 5 dimensions, mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Each of the 5 dimensions was divided into five levels of perceived problems, no problem, mild problems, moderate problems, severe problems, and unable to/extreme problems. Section B was the DCE task.

DCE implementation and data collection

Our DCE was carried out from September 15th to October 15th, 2018, in six tertiary public hospitals in four cities in Jiangsu Province. Since our DCE aimed to inform decision-making on patient-centered care by identifying patients' preferences, the study sample consisted of patients with chronic diseases, not the general population. Due to the high prevalence, serious complications, and the heavy burden of hypertension and diabetes, we selected patients with these diseases. Inclusion criteria were patients aged 18 years or older, participating in a social health insurance program, with a history of diabetes or hypertension, and taking medications regularly for more than one year. Patients were enrolled consecutively during the study period.

There was no general standard on the ideal sample size required for a DCE.[37] Generally speaking, a less efficient design may also require a larger sample size, resulting in increased costs.[38] Estimates of the sample size were usually determined based on previous research, rules of thumb, and budget constraints. DCE studies showed that reliable models could be estimated in samples with more than 50 participants.[39 40]

For peer review only

The DCE questionnaires were administered through one-to-one, face-to-face interviews to ensure the validity and quality of the investigation. Our interviewers consisted of 13 medical students, all of whom were interns during the research period. For quality assurance, the interviewers were trained before the experiment. We compiled a survey training manual and asked each interviewer to give explanations to the scenarios. The interviewers were required to check whether the entire questionnaire was complete immediately after each interview. If any information was missing, they had to go back and asked patients to provide the information on site. For patients with blurred vision or illiteracy, the interviewers explained the meaning of the questionnaire item by item until the patients fully understood each item.

Verbal informed consent was obtained from all patients before both the pilot and the final survey. Patients were made aware that participation in the survey was voluntary. All data and information collected from patients was anonymous. During the pilot and formal survey, patients had to make a decision based on the assumption that only one technology could be covered due to limited health insurance funds. They were asked to think carefully and make a trade-off between two new medical technologies. The duration of the survey ranged from 20 minutes to one hour. We prepared a packed cotton towel for each patient as a gift (CNY 10, or US$1.4). Patients were asked about how confident they felt in completing the choice sets. The confidence score ranged from 0 (not confident at all) to 10 (extremely confident) (Appendix 3). We excluded the DCE questionnaires with a confidence score of less than 8.

Patient and public involvement

Ninety patients with diabetes or hypertension were engaged in the pilot survey to provide feedback on intelligibility, acceptability, and reliability of the questionnaire. Response from the patients led to a more explicit and apprehensible description of the survey questions. The patients participating in the pilot were not included in the final survey. No patients were involved in the recruitment of study participants or the

For peer review only

conduct of the study.

Data analysis

Our empirical analysis of the DCE data was based on the random utility model. Like previous research,[26] we considered the utility, U, that patient, i, assigned to choice, j, from J alternative choices, as the sum of two parts: observable component and unobservable component. The equation was developed as follows:

$$U_{ij} = V_{ij} + \varepsilon_{ij} = \beta_0 + \beta_1 x_{1i\,\mathrm{j}} + \beta_2 x_{2\mathrm{ij}} + \ldots + \beta_m x_{\mathrm{mij}} + \varepsilon_{ij}$$

where V_{ij} was the observable component determined by patients' preferences for attributes ($x_1, \ldots, x_m$), ε_{ij} was the unobservable component of unobserved attributes and individual-level variations, and β quantified the strength of preference for each attribute level.[26]

We implemented the above equation by estimating mixed logit regression using STATA 14.2 SE (StataCorp LLC, College Station, Texas, USA) and was specified with 500 Halton draws. The mixed logit model allows for unknown heterogeneity in individual preferences and estimates both the mean preference weight and the standard deviation. We assumed that all variables of the attributes, except for the constant, had a random component and that the weights of preference were normally distributed. The choice of patients was the dependent variable, and the selected technology attributes were independent variables. Dummy coding was used for categorical variables of our DCE data. For dummy variable coding, each model-estimated coefficient is a measure of the preference strength of that level relative to the omitted level of a specific attribute.[41 42] Subgroup analysis was performed by type of disease, type of insurance, HRQoL, and gender. In each regression model, the attribute level with a negative coefficient indicates that patients would prefer not to move from the reference level to that level, while an attribute level with a positive coefficient indicates that patients would prefer to move from the reference level to that level.[39]

For peer review only

RESULTS

Characteristics of patients

A total of 410 patients were consented to participate in the DCE survey, and data from 408 patients were available for analysis with two patients excluded from the analysis due to non-compliance with the inclusion criteria, incomplete data, and lack of confidence. The mean score for confidence was 8.80 (95%CI 8.69-8.90), which suggested patients were confident in their choice. For details about numbers of patients in each sampled hospital, see Appendix 4.

Table 2 presented the demographic and clinical characteristics of the included patients. The sample had more males than females (53.92% vs. 46.08%). The mean age of the patients was 62.34 years (ranging from 28 to 96 years). They were almost evenly split between UEBMI and URRBMI (49.26% vs. 50.74%). Most of the patients had hypertension (63.97%) and 21.81% had diabetes, while 14.22% had both hypertension and diabetes. There was no statistically significant difference between hypertension and diabetes patients in terms of insurance types (UEBMI vs URRBMI, P=0.392) and benefits (UEBMI with extra benefit vs UEBMI without extra benefit, P=0.359) (Appendix 5). Cardiovascular disease (98 patients) was the most common comorbidity among 180 patients with chronic comorbid conditions other than hypertension and diabetes (Appendix 6).

For peer review only

Table 2. Characteristics of patients (n=408)

Characteristics	n (%)
Gender	
Male	220 (53.92)
Female	188 (46.08)
Age groups	
18～45	30 (7.35)
45～59	131 (32.11)
60～74	184 (45.10)
≥75	63 (15.44)
Urban vs. rural household registration	
Urban	210 (51.47)
Rural	198 (48.53)
Education	
Unschooled	39 (9.56)
Primary school	108 (26.47)
Junior high school	110 (26.96)
High school	89 (21.81)
Junior college or higher vocational college	31 (7.60)
Bachelor's degree or above	31 (7.60)
Employment	
Farmer	105 (25.74)
Urban employee	140 (34.31)
Retiree	112 (27.45)
Freelancers	32 (7.84)
Unemployed	19 (4.66)
Type of insurance[#]	
UEBMI	201 (49.26)
URRBMI	207 (50.74)
Family monthly income (CNY)[△]	
< 2000	83 (20.34)
2001～4000	81 (19.85)
4001～6000	93 (22.79)
6001～8000	69 (16.91)
8001～10000	41 (10.05)
>10000	41 (10.05)
Type of patients	
Outpatients	83 (20.34)
Inpatients	325 (79.66)
Type of chronic diseases	
Hypertension	261 (63.97)
Diabetes	89 (21.81)
Both	58 (14.22)
Comorbidities other than hypertension or diabetes	
Yes	180 (44.12)
No	228 (55.88)
EQ-5D-5L index value[※]	
≤0.8	127
>0.8	281

[#]1 UEBMI patients and 6 URRBMI patients also enrolled in commercial health insurance.

For peer review only

△ The average exchange rate between US Dollars and Chinese Yuan (CNY) in 2018 was 6.56.

※The utility index was derived from the Chinese value sets.[43] Currently, the well-accepted threshold of the EQ-5D-5L index value still lacks. However, in most cases, the EQ-5D-5L index value for patients with serious complications of diabetes and hypertension was equal to or less than 0.8, as shown in studies conducted in China.[20 22] EQ-5D-5L index value≤0.8 group: Median 0.6718, IQR -0.0818～0.7998; EQ-5D-5L index value>0.8 group: Median 0.9507, IQR 0.8410～1.

Regression analysis of the DCE data

Our analysis found that the study patients highly valued the new technologies with never or rare incidence of serious adverse events (β = 0.884, P<0.01), followed by the expected gains in health outcomes from the treatment (β = 0.809, P<0.01) (Table 3). The likelihood of effective treatment was also a significant, positive predictor of patients' choice of new technologies (β = 0.455, P<0.01) while out-of-pocket cost was a significant, negative predictor of patients' choice (β = -0.258, P<0.01). In contrast, whether there were alternative technologies currently covered by insurance did not seem to be an important consideration for the patients (P>0.05). Unobservable preference heterogeneity as indicated by the estimated standard deviation (SD) of the mean coefficients, were identified for four variables—expected gains in health outcomes from the treatment, the likelihood of effective treatment, out-of-pocket cost, and fatal disease.

Subgroup analysis by type of disease

Appendix 7 presented the results from the subgroup analysis by type of disease (hypertension versus diabetes). While the two groups had similar results, there were two notable differences. One was that, although out-of-pocket cost remained a significant negative predictor, the coefficient for hypertension patients was -0.178 (P<0.05), not as important as for patients with diabetes (β = -0.395, P<0.01). The other was that the expected gains in health outcomes from the treatment seemed to be more important for diabetes patients (β = 0.965, P<0.01) when compared with those who only had hypertension (β = 0.716, P<0.01). The SD revealed coefficient heterogeneity in both subgroups for the random parameters of three variables—the likelihood of effective treatment, fatal disease, and out-of-pocket cost.

For peer review only

Table 3. DCE results from mixed logit model

Attributes	All patients	
	Mean(SE)	SD(SE)
Expected gains in health outcomes from the treatment		
Not as expected (reference)		
As expected	0.809**(0.123)	0.554* (0.275)
Likelihood of effective treatment (per 10% increase)	0.455**(0.044)	0.375**(0.055)
Severity of target disease		
Not severe (reference)		
Severe	0.291*(0.123)	0.316(0.431)
Fatal	0.208(0.147)	1.264**(0.199)
Incidence of serious adverse events		
Often (reference)		
Occasionally	0.575**(0.116)	0.035(0.694)
Never or rarely	0.884**(0.142)	0.900(0.206)
Alternative technologies currently covered by insurance		
Yes (reference)		
No	0.087(0.104)	0.095(0.501)
Out-of-pocket cost (thousand CNY per month increase)	-0.258**(0.061)	0.898**(0.090)
Log likelihood	-1485.761	
Participants	408	
Observations	4896	

*P<0.05; **P<0.01; SD: Standard Deviation estimates reflect preference heterogeneity in the participants; SE: Standard Error

Subgroup analysis by type of insurance

Appendix 8 summarized the subgroup analyses by type of insurance. The expected gains in health outcomes from the treatment, likelihood of effective treatment, and low incidence of serious adverse events were significant, positive predictors of technology choice (P<0.01) for both URRBMI and UEBMI patients. Whether there were alternative technologies currently covered by insurance was statically insignificant for both groups (P>0.05). However, these two groups differed remarkably in two technology attributes. The coefficient of out-of-pocket cost was significant for URRBMI patients (β = -0.511, P<0.01), but not for UEBMI patients (β = -0.071, P>0.05). The severity of target disease also had significant coefficients for URRBMI patients (P<0.01), but not for UEBMI patients.

For peer review only

We conducted further analysis of the UEBMI patients by excluding those UEBMI patients who enjoyed extra health insurance benefits. As indicated by Column (3), we found that out-of-pocket cost was a meaningful attribute for the remaining UEBMI patients ($\beta = -0.211$, $P<0.05$) although not as important as shown in URRBMI patients ($\beta = -0.211$ vs. $\beta = -0.511$). On the other hand, the severity of target disease remained statistically non-significant after excluding those UEBMI patients with extra insurance benefits. Preference heterogeneity was identified for the lowest incidence of serious adverse events.

Subgroup analysis by HRQoL

Appendix 9 demonstrated the results from the subgroup analysis by EQ-5D-5L index value, which was a valid measurement for HRQoL. The severity of target disease, both severe and fatal, was important for patients with an EQ-5D-5L index value less than or equal to 0.8 ($P<0.01$). However, it was statistically non-significant for patients with an EQ-5D-5L index value higher than 0.8 ($P>0.05$). Although patients' preferences for attributes including expected gains in health outcomes from the treatment, and low incidence of serious adverse events were statistically significant for both groups, they were less important as viewed by the group with the lower EQ-5D-5L index value. In patients with an EQ-5D-5L index value less than or equal to 0.8, expected gains in health outcomes from the treatment had more variations than other attributes. However, the heterogeneity for the fatal disease was most significant in patients with an EQ-5D-5L index value greater than 0.8.

Since the severity of target disease was an important attribute for URRBMI patients ($P<0.01$), but not for UEBMI patients. We did the chi-square test and results showed that the proportion of patients with a lower EQ-5D-5L index value was significantly higher in the URRBMI group ($P<0.01$) (Appendix 10).

Subgroup analysis by gender

We found that patients in both groups valued the new technologies with expected

For peer review only

gains in health outcomes from the treatment, the likelihood of effective treatment, low incidence of serious adverse events, and low out-of-pocket cost (P<0.01) (Appendix 11). However, the differences in preferences for attributes were not obvious between males and females.

DISCUSSION

Summary of the findings

Our study found that key technology attributes, including expected gains in health outcomes from the treatment, high likelihood of effective treatment, and low incidence of serious adverse events were significant, positive predictors of patient choice for health insurance coverage. These results stand for the entire study sample and the subgroup analyses.

The out-of-pocket cost was a significant, negative predictor for the entire sample, showing that patients' preferences decreased as the out-of-pocket cost increased. We also found that out-of-pocket cost was a significant, negative predictor for both hypertension patients and diabetes patients, although it was less important for the former group than for the latter.

When it came to different insurance types, we identified preference heterogeneity as suggested by previous DCE studies.[44] Specifically, we found that out-of-pocket cost was a significant, negative predictor for URRBMI patients' preference for insurance coverage, while the severity of target disease was a significant, positive predictor for this group of patients. But none of these attributes was a significant predictor for UEBMI patients. Our further analysis of the UEBMI patients by excluding those UEBMI patients who enjoyed extra health insurance benefits revealed that the remaining UEBMI patients regarded out-of-pocket cost as a significant, negative attribute for coverage, while the severity of target disease remained statistically non-significant.

For peer review only

Patients' HRQoL was measured and results suggested that patients with lower HRQoL tended to prefer new technologies that could have effects on severe or fatal diseases. The findings on the importance of disease severity regarding patients with lower HRQoL coincided with URRBMI patients. The reimbursement level and the hospitalization rate of URRBMI patients were lower than that of UEBMI patients.[15] Further analysis showed a relatively higher proportion of URRBMI patients with lower HRQoL. Also, our results have shown that gender is not a decisive factor for the preference of new technologies for reimbursement.

The degree to which respondent preferences were heterogeneous was described by the estimated SD around each mean preference estimate. Heterogeneity was found mainly for four variables—expected gains in health outcomes from the treatment, likelihood of effective treatment, out-of-pocket cost, and fatal disease. Although heterogeneity existed, the preferences for new technologies with expected gains in health outcomes from the treatment, and the likelihood of effective treatment remained significant in all patients and each subgroup, suggesting that such attributes were generally valued by patients. Variations in preferences over out-of-pocket cost and fatal disease had implications for the optimal design of insurance reimbursement schemes and should be analyzed in future studies.

Comparison with other studies

Our findings of patients valuing the effectiveness and safety of medical technologies were consistent with the results by prior studies from other countries which aimed to investigate patients' preferences for the treatment of chronic diseases.[45-49] Our study confirmed that new technologies that could increase health benefits and minimize potential risks were preferred by patients.

However, variations in patients' preferences existed and mainly depended on patients' feelings of the disease. Previous research found that the median hospitalization cost for patients with hypertension was lower than patients with diabetes,[50 51] which supported our findings that out-of-pocket cost was not as important for hypertension

For peer review only

patients as it was for diabetes patients.

We also identified preference heterogeneity among patients with different types of insurance. Although China's successful health insurance expansion over the past decade led to the country's universal health insurance coverage, variations in benefit coverage existed among different health insurance schemes,[12] resulting in disparities in accessibility and affordability of medical services.[52] Such inequalities affected patients' preferences across different types of insurance. For example, we found that the out-of-pocket cost was a significant, negative predictor for URRBMI patients' preference, but not for all of the UEBMI patients. The finding reflected the fact that, compared with URRBMI, UEBMI had better benefits and a higher reimbursement level, especially for those UEBMI patients with extra benefits. The finding also fitted into the big picture of disparities across insurance schemes in China, as illustrated by prior research.

We found that URRBMI patients attached importance to the severity of the disease. We also found the association between lower HRQoL and preferences for technologies treating severe or fatal disease. Previous studies found that chronic disease patients with URRBMI had lower health service utilization.[53] Furthermore, URRBMI patients had significantly higher adjusted in-hospital mortality rates and shorter length of stay when compared with concurrent UEBMI patients.[54 55] These findings suggested that a plausible explanation for the importance of disease severity for URRBMI patients might be mainly attributed to their perception of HRQoL and their anxiety about the potential severe or fatal consequences of chronic diseases.

Implications of the study findings

The rising prevalence of chronic diseases in China has major implications on its ability to provide timely, acceptable, and affordable healthcare service for its citizens. To meet the demand for new medical technologies for treating chronic diseases, China's policy-makers need to consider patients' preferences when deciding on insurance coverage for new medical technologies. Specifically, our findings that patients favored

For peer review only

new medical technologies with substantial health benefits and low risks suggested such technologies should be the priority of health insurance coverage. We suggest policy-makers make evidence-based comparisons among technologies according to the attributes patients preferred.

Our findings that out-of-pocket cost was a major concern for URRBMI patients but not for all UEBMI patients suggested that policy-makers need to make further efforts to reduce disparities in benefits and reimbursement levels between these two types of insurance and between UEBMI subgroups. The efforts will not only enhance financial protections for URRBMI patients and subgroups within UEBMI patients, but will also contribute to China's long-term goal of equalizing benefits across insurance programs.[10]

We found that patients did not care about alternative technologies currently covered by insurance. However, it is an essential attribute in reimbursement decision-making. Decision-makers need to compare the new technologies with available alternative technologies and to determine whether to cover new medical technologies or replace the alternatives. Policy-makers and clinicians need to implement communication strategies to improve patients' awareness of the alternative therapies and reimbursement policies under the current insurance system to increase the appropriate use of the existing therapies.

Strengths and limitations

Our study used DCE to elicit preferences of chronic disease patients on insurance coverage of new medical technologies in China. We identified preference heterogeneity among patients with different types of insurance. Patients' HRQoL was measured, and the potential impact on preferences for reimbursement of new technologies was analyzed. Our research helped to apply a patient-centered approach to policy-making and generated evidence that could inform insurance coverage decision-making.

Nevertheless, there are several limitations in our study. First, our samples were taken from tertiary hospitals in Jiangsu Province. Patients receiving medical services from tertiary hospitals generally have serious and/or complex medical conditions. They

For peer review only

have greater demand for healthcare services than other patients and may consider the issue of medical insurance coverage and reimbursement with caution. Jiangsu is an eastern, coastal province and one of the most economically developed regions in China. Future studies are needed to have a nationally representative sample by including patients at secondary and primary hospitals and, in particular, by including the economically underdeveloped regions in China.

Second, our study included patients with a history of diabetes or hypertension. Due to differences in nature and characteristics of the disease, the results may not represent the preferences of patients with other types of chronic diseases. Although prior DCEs[45-49] made conclusions that were similar to ours in terms of the relative importance of technology attributes regarding benefits and risks. Future studies need to enroll patients with other diseases and conduct subgroup analyses to identify variations in patients' preferences across different types of diseases.

Third, there were only 43 UEBMI patients who enjoyed additional benefits of health insurance, and the limited sample size prevented us from conducting a separate analysis of this subgroup.

CONCLUSION

Chronic disease patients highly valued the health benefits and risks of new technologies, which are closely linked to their perceptions and feelings. Policy-makers need to take new technologies with high therapeutic effectiveness and low risks for treating chronic diseases as a priority for health insurance coverage. More attempts should be made to reduce the gaps in benefits and reimbursement levels between insurance schemes to promote equitable access to healthcare services in China.

Ethics approval

This study, including the patient consent process, has been approved by the

For peer review only

Medical Ethics Committee in Affiliated Hospitals of Nantong University (Ethical Approval-2016031) and conforms to the ethical guidelines of the Declaration of Helsinki.

Acknowledgments

We acknowledge the important contributions made by our interviewers who did one-to-one, face-to-face interviews with the patients. We are grateful to the patients for their time and efforts. We sincerely thank reviewers for providing valuable comments and suggestions on the manuscript.

At the time of drafting the manuscript, Jinsong Geng was a fellow at the Fellowship in Health Policy and Insurance Research, Department of Population Medicine, Harvard Medical School and Harvard Pilgrim Healthcare Institute.

Author contributions

Geng JS, Chen XW, and Yu H led the design and analysis of the discrete choice experiment. Geng JS, Chen XW contributed to the literature search and data interpretation. Bao HN, Qian DM, Shao YT contributed to implementing the discrete choice experiment. Geng JS and Yu H performed the statistical analysis and wrote the manuscript.

Funding

This work was supported by National Natural Science Foundation of China (Grant No. 71603138) and Jiangsu Overseas Visiting Scholar Program for University Prominent Young & Middle-aged Teachers and Presidents.

The funders provided financial support for the conduct of the study. The funders had no role in the design, implementation, data collection and statistical analysis, data interpretation, or writing of the manuscript.

Disclosure

The authors report no conflict of interest in this research.

For peer review only

Data sharing statement

Data will be available upon reasonable request to the corresponding author.

For peer review only

References

1. World Health Organization. *Global action plan for the prevention and control of noncommunicable diseases 2013-2020*. Geneva: World Health Assembly, 2013:5-9.

2. Lu J, Lu Y, Wang X, *et al*. Prevalence, awareness, treatment, and control of hypertension in China: data from 1.7 million adults in a population-based screening study (China PEACE Million Persons Project). *Lancet* 2017;390:2549-58.

3. Wang L, Gao P, Zhang M, *et al*. Prevalence and ethnic pattern of diabetes and prediabetes in China in 2013. *JAMA* 2017;317:2515-23.

4. Adriaanse MC, Drewes HW, van der Heide I, *et al*. The impact of comorbid chronic conditions on quality of life in type 2 diabetes patients. *Qual Life Res* 2016;25:175-82.

5. Aubert CE, Fankhauser N, Marques-Vidal P, *et al*. Patterns of multimorbidity in internal medicine patients in Swiss university hospitals: a multicentre cohort study. *Swiss Med Wkly* 2019;149:w20094.

6. Wang J, Ma JJ, Liu J, *et al*. Prevalence and risk factors of comorbidities among hypertensive patients in China. *Int J Med Sci* 2017;14:201-12.

7. Bloom DE, Chen S, Kuhn M, *et al*. The economic burden of chronic diseases: estimates and projections for China, Japan, and South Korea. *JEoA* 2018:100163.

8. Yip W, Fu H, Chen AT, *et al*. 10 years of health-care reform in China: progress and gaps in Universal Health Coverage. *Lancet* 2019;394:1192-204.

9. China's National Healthcare Security Administration. *China Healthcare Security Diagnosis Related Groups (CHS-DRG)*. Beijing, 2019:44-46.10. Yu H. Universal health insurance coverage for 1.3 billion people: what accounts for China's success? *Health Policy* 2015;119:1145-52.

10. Yu H. Universal health insurance coverage for 1.3 billion people: what accounts for China's success? *Health Policy* 2015;119:1145-52.

11. Li Y, Zhao Y, Yi D, *et al*. Differences exist across insurance schemes in China post-consolidation. *PloS One* 2017;12:e0187100.

12. Xiong X, Zhang Z, Ren J, *et al*. Impact of universal medical insurance system on the accessibility of medical service supply and affordability of patients in China. *PloS One* 2018;13:e0193273.

13. Xian W, Xu X, Li J, *et al*. Health care inequality under different medical insurance schemes in a socioeconomically underdeveloped region of China: a propensity score matching analysis. *BMC Public Health* 2019;19:1373.

14. The State Council of the People's Republic of China. Opinion of the State Council on integrating the basic health insurance system for urban and rural residents, 2016. Available: http://www.gov.cn/zhengce/content/2016-01/12/content_10582.htm

15. China's National Healthcare Security Administration. Statistical Bulletin of National Social Medical Insurance Development in 2018. Available: http://www.nhsa.gov.cn/art/2019/6/30/art_7_1477.html

16. General Office of the State Council of the People's Republic of China. Notice of the General Office of the State Council on transmitting the opinions from the Ministry of Labor and Social Security and the Ministry of Finance on the implementation of medical subsidies for national

For peer review only

civil servants, 2000. Available: http://www.gov.cn/gongbao/content/2000/content_60249.htm

17. Wuxi No.2 People's Hospital. Medical insurance policy (the latest version of 2020). Available: https://www.wx2h.com/ywzc/ywzcdetail/index/id/4/tid/6.html.

18. Makovski TT, Schmitz S, Zeegers MP, *et al*. Multimorbidity and quality of life: systematic literature review and meta-analysis. *Ageing Res Rev* 2019;53:100903.

19. van Reenen M, Janssen B. *EQ-5D-5L user guide: basic information on how to use the EQ-5D-5L instrument.* Rotterdam: EuroQol Research Foundation, 2015.

20. Pan CW, Sun HP, Zhou HJ, *et al*. Valuing health-related quality of life in type 2 diabetes patients in China. *Med Decis Making* 2016;36:234-41.

21. Wang P, Luo N, Tai ES, *et al*. The EQ-5D-5L is more discriminative than the EQ-5D-3L in patients with diabetes in Singapore. *Value Health Reg Issues* 2016;9:57-62.

22. Liang Z, Zhang T, Lin T, *et al*. Health-related quality of life among rural men and women with hypertension: assessment by the EQ-5D-5L in Jiangsu, China. *Qual Life Res* 2019;28:2069-80.

23. Institute of Medicine Committee on Quality of Health Care in America. *Crossing the quality chasm: a new health system for the 21st century*. Washington, D.C.: The National Academies Press, 2001.

24. Lancsar E, Fiebig DG, Hole AR. Discrete choice experiments: a guide to model specification, estimation and software. *Pharmacoeconomics* 2017;35:697-716.

25. Clark MD, Determann D, Petrou S, *et al*. Discrete choice experiments in health economics: a review of the literature. *Pharmacoeconomics* 2014;32:883-902.

26. Ryan M, Kolstad J, Rockers P, *et al*.. *How to conduct a discrete choice experiment for health workforce recruitment and retention in remote and rural areas: a user guide with case studies.* Geneva:World Health Organization Press, 2012.

27. Goetghebeur MM, Wagner M, Khoury H, *et al*. Evidence and value: impact on DEcisionMaking--the EVIDEM framework and potential applications. *BMC Health Serv Res* 2008;8:270.

28. Chen XW, Chen Q, Geng JS, *et al*. The application of multi-criteria decision analysis in medical insurance reimbursement: a systematic review. *Chinese Health Resources* 2018;21:218-23.

29. Geng JS, Chen XW, Yu XL, *et al*. Study on the evidence-based decision-making framework for reimbursement of new technologies in view of EVIDEM. *Chinese Journal of Health Policy* 2018;11:50-54.

30. Hensher DA, Rose JM, Greene WH. *Applied Choice Analysis (2nd Edition)*. Cambridge: Cambridge University Press, 2015.

31. Reed Johnson F, Lancsar E, Marshall D, *et al*. Constructing experimental designs for discrete-choice experiments: report of the ISPOR Conjoint Analysis Experimental Design Good Research Practices Task Force. *Value Health* 2013;16:3-13.

32. Nichols E, O'Hara NN, Degani Y, *et al*. Patient preferences for nutritional supplementation to improve fracture healing: a discrete choice experiment. *BMJ Open* 2018;8:e019685.

33. van Dijk JD, Groothuis-Oudshoorn CG, Marshall DA, *et al*. An empirical comparison of discrete choice experiment and best-worst scaling to estimate stakeholders' risk tolerance for hip replacement surgery. *Value Health* 2016;19:316-22.

34. Bhattarai N, McMeekin P, Price CI, *et al*. Preferences for centralised emergency medical services: discrete choice experiment. *BMJ Open* 2019;9:e030966.

For peer review only

35. Kløjgaard ME, Bech M, Søgaard R. Designing a stated choice experiment: the value of a qualitative process. *J Choice Model* 2012;5:1-18.

36. Dhar R, Simonson I. The Effect of Forced Choice on Choice. *JMR* 2003;40:146-60.

37. de Bekker-Grob EW, Donkers B, Jonker MF, *et al*. Sample size requirements for discrete-choice experiments in healthcare: a practical guide. *Patient* 2015;8:373-84.

38. Vanniyasingam T, Cunningham CE, Foster G, *et al*. Simulation study to determine the impact of different design features on design efficiency in discrete choice experiments. *BMJ Open* 2016;6:e011985.

39. Oluboyede Y, Ternent L, Vale L, *et al*. Using a discrete-choice experiment to estimate the preferences of clinical practitioners for a novel non-invasive device for diagnosis of peripheral arterial disease in primary care. *Pharmacoecon Open* 2019;3:571-81.

40. Shanahan M, Seddon J, Ritter A, *et al*. Valuing families' preferences for drug treatment: a discrete choice experiment. *Addiction* 2020;115:690-99.

41. Hauber AB, Gonzalez JM, Groothuis-Oudshoorn CG, *et al*. Statistical methods for the analysis of discrete choice experiments: a report of the ISPOR Conjoint Analysis Good Research Practices Task Force. *Value Health* 2016;19:300-15.

42. Kløjgaard ME, Manniche C, Pedersen LB, *et al*. Patient preferences for treatment of low back pain-a discrete choice experiment. *Value Health* 2014;17:390-6.

43. Luo N, Liu G, Li M, et al. Estimating an EQ-5D-5L Value Set for China. *Value Health* 2017;20:662-69.

44. de Bekker-Grob EW, Swait JD, Kassahun HT, *et al*. Are healthcare choices predictable? The impact of discrete choice experiment designs and models. *Value Health* 2019;22:1050-62.

45. Brockelmann PJ, McMullen S, Wilson JB, *et al*. Patient and physician preferences for first-line treatment of classical Hodgkin lymphoma in Germany, France and the United Kingdom. *Br J Haematol* 2019;184:202-14.

46. Forsander G, Stallknecht S, Samuelsson U, *et al*. Preferences for treatment among adolescents with Type 1 diabetes: a national study using a discrete choice experiment model. *Diabet Med* 2018;35:621-29.

47. Havrilesky LJ, Lim S, Ehrisman JA, *et al*. Patient preferences for maintenance PARP inhibitor therapy in ovarian cancer treatment. *Gynecol Oncol* 2020 doi: 10.1016/j.ygyno.2020.01.026.

48. Ho KA, Acar M, Puig A, *et al*. What do Australian patients with inflammatory arthritis value in treatment? A discrete choice experiment. *Clin Rheumatol* 2019 doi: 10.1007/s10067-019-04843-4.

49. Thieu VT, Robinson S, Kennedy-Martin T, *et al*. Patient preferences for glucagon-like peptide 1 receptor-agonist treatment attributes. *Patient Prefer Adherence* 2019;13:561-76.

50. Mutowo MP, Lorgelly PK, Laxy M, *et al*. The hospitalization costs of diabetes and hypertension complications in Zimbabwe: estimations and correlations. *J Diabetes Res* 2016;2016:9754230.

51. Rosa MQM, Rosa RDS, Correia MG, *et al*. Disease and economic burden of hospitalizations attributable to diabetes mellitus and its complications: a nationwide study in Brazil. *Int J Environ Res Public Health* 2018;15: E294.

52. Zhao C, Wang C, Shen C, *et al.* China's achievements and challenges in improving health

For peer review only

insurance coverage. *Drug Discov Ther* 2018;12:1-6.

53. Xie X, Wu Q, Hao Y, *et al*. Identifying determinants of socioeconomic inequality in health service utilization among patients with chronic non-communicable diseases in China. *PloS One* 2014;9:e100231.

54. Chen H, Shi L, Xue M, *et al*. Geographic variations in in-hospital mortality and use of percutaneous coronary intervention following acute myocardial infarction in China: a nationwide cross-sectional analysis. *J Am Heart Assoc* 2018;7:e008131.

55. Lin X, Cai M, Tao H, *et al*. Insurance status, inhospital mortality and length of stay in hospitalised patients in Shanxi, China: a cross-sectional study. *BMJ Open* 2017;7:e015884.

For peer review only

Appendix 1: Explanations to attributes and levels

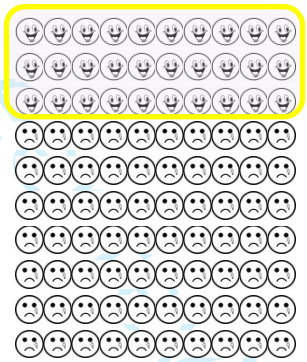
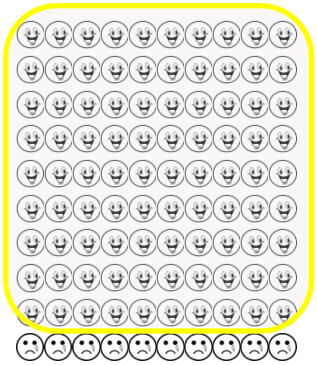
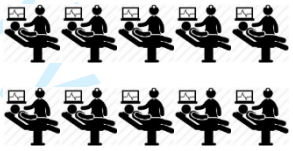
Investigators were required to convey the following definitions to patients:

- 'Expected gains in health outcomes from the treatment' suggests that the ideal treatment goals set out in the evidence-based guidelines for individual patients can be achieved; 'Not as expected' implies that there can be certain treatment effects, however, the ideal treatment targets cannot be fully achieved. This attribute is the qualitative aspect of effectiveness.
- Likelihood of effective treatment: 'effective treatment' equals the attribute 'gains in health outcomes from the treatment' in choice sets: a new medical technology that can reach its expected gains in health outcomes is effective. The attribute 'likelihood of effective treatment' is the quantitative aspect of effectiveness.
- For the severity of target disease, 'not severe' means that the target disease of the new technology is non-fatal and has no impact on patients' quality of life; 'severe' suggests that the target disease of the new technology is non-fatal, however, patients' quality of life has been significantly reduced; 'fatal' means that the target disease of the new technology is fatal and patients are likely to die from the disease.
- For incidence of serious adverse events, 'often' is equivalent to or slightly higher than 10%; 'occasionally' equals 3%.
- 'Serious adverse events' means life-threatening adverse events caused by the new technology, such as severe hypoglycemia, severe hypersensitivity reaction, kidney or liver damage, etc.
- Alternative technologies already reimbursed have similar effectiveness and safety to the new technology (Level: Yes); no alternatives already reimbursed have similar effectiveness and safety to the new technology (Level: No).
- The cost of the technology is the out-of-pocket costs if not reimbursed. The hypothesis is that technology has never been reimbursed unless you make a choice.

For peer review only

Appendix 2: Examples of DCE choice sets

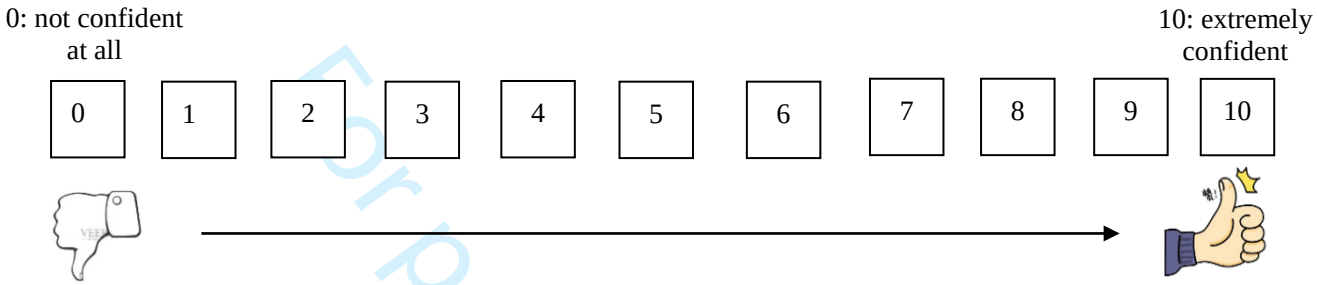
Medical technologies A and B are used to treat chronic diseases and currently not been covered by the social insurance reimbursement scheme. If you are forced to make a choice, which technology should be reimbursed by social insurance? There are no right or wrong answers; please make a choice based on your own experience.

Attributes	New technology A	New technology B
Expected gains in health outcomes from the treatment	 **As expected**	 **Not as expected**
Likelihood of effective treatment	 **30%**	 **90%**
Severity of target disease	 **Severe, non-fatal**	 **Not severe**
Incidence of serious adverse events (life-threatening)	 **Never or rarely**	 **Often**
Alternative technologies currently covered by insurance	**Yes**	**No**
Out-of-pocket cost for new technology (if not reimbursed)	**1500 CNY per month**	**3500 CNY per month**
Which one should be covered by health insurance? Your choice	☐	☐

For peer review only

Appendix 3: Evaluation of confidence

The following statements reflect how confident you feel when completing the choice sets. Please select your confident level from 0 to 10 and give a tick ' √ ' in the score to represent your selection:



For peer review only

Appendix 4: Number of participants in the sampled hospitals

Supplemental Table 1. Number of participants in the sampled hospitals

Name of hospital	City	Number of patients
Taizhou People's Hospital	Taizhou	60
Jiangyin People's Hospital	Wuxi	40
First People's Hospital of Wujiang District	Suzhou	60
Nantong First People's Hospital	Nantong	23
Nantong Third People's Hospital	Nantong	100
Affiliated Hospital of Nantong University	Nantong	125

For peer review only

Appendix 5: Distribution of patients by type of disease and type of insurance

Supplemental Table 2. Types of insurance for patients with hypertension and diabetes

Disease	URRBMI	UEBMI
Hypertension	130	131
Diabetes	49	40
Total	179	171

Urban and Rural Residents Basic Medical Insurance (URRBMI); Urban Employees Basic Medical Insurance (UEBMI)

χ^2 =0.732 P= 0.392

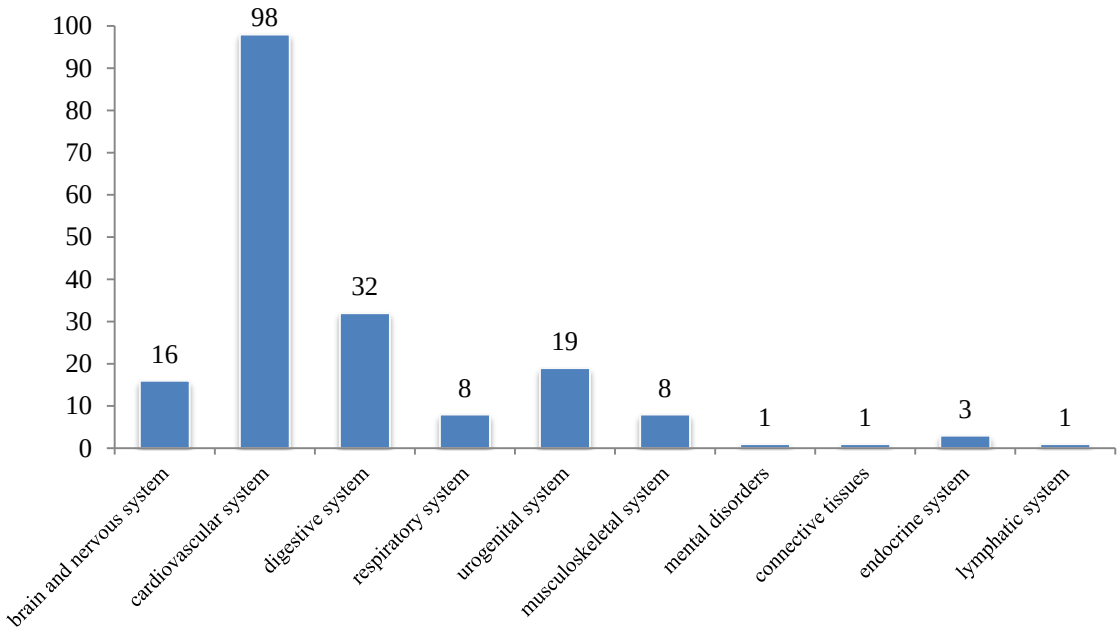
Supplemental Table 3. Types of benefits for UEBMI patients with hypertension and diabetes

Disease	UEBMI with extra benefits	UEBMI without extra benefits
Hypertension	27	104
Diabetes	11	29
Total	38	133

χ^2 =0.842 P= 0.359

For peer review only

Appendix 6: Types of chronic commodities for the included patients



Supplemental Figure 1. Number of patients with chronic commodities

For peer review only

Appendix 7: Subgroup analysis by type of disease

Supplemental Table 4. Subgroup analysis by type of disease

Attributes	Hypertension		Diabetes	
	Mean (SE)	SD (SE)	Mean (SE)	SD (SE)
Expected gains in health outcomes from the treatment				
Not as expected (reference)				
As expected	0.716**(0.158)	0.443(0.496)	0.965**(0.259)	0.125(0.497)
Likelihood of effective treatment (per 10% increase)	0.519**(0.064)	0.375**(0.086)	0.420**(0.093)	0.401**(0.119)
Severity of target disease				
Not severe (reference)				
Severe	0.328*(0.162)	0.056(0.495)	0.100(0.273)	0.441(0.834)
Fatal	0.215(0.196)	1.189**(0.276)	0.304(0.311)	1.146**(0.395)
Incidence of serious adverse events				
Often (reference)				
Occasionally	0.767**(0.164)	0.014*(0.381)	0.553*(0.266)	0.337(0.548)
Never or rarely	0.995**(0.195)	1.126(0.271)	0.938**(0.349)	0.989*(0.459)
Alternative technologies currently covered by insurance				
Yes (reference)				
No	0.152(0.158)	0.978**(0.315)	0.089(0.248)	0.019(0.383)
Out-of-pocket costs (thousand CNY per month increase)	-0.178*(0.084)	1.024**(0.128)	-0.395**(0.126)	0.774**(0.190)
Log likelihood	-929.220		-311.029	
Participants	261		89	
Observations	2484		2412	

*P<0.05; **P<0.01; SD: Standard Deviation estimates reflect preference heterogeneity in the participants; SE: Standard Error

Patients who had both hypertension and diabetes were excluded to ensure the homogeneity.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Appendix 8: Subgroup analysis by type of insurance

Supplemental Table 5. Subgroup analysis by type of insurance

Attributes	(1) URRBMI patients		(2) UEBMI patients		(3) UEBMI patients without extra insurance benefits[#]	
	Mean (SE)	SD (SE)	Mean (SE)	SD (SE)	Mean (SE)	SD (SE)
Expected gains in health outcomes from the treatment						
Not as expected (reference)						
As expected	0.977**(0.204)	0.811*(0.325)	0.732**(0.166)	0.320(0.641)	0.652**(0.193)	0.609(0.420)
Likelihood of effective treatment (per 10% increase)	0.512**(0.069)	0.384**(0.075)	0.444**(0.066)	0.383**(0.082)	0.450**(0.074)	0.271**(0.085)
Severity of target disease						
Not severe (reference)						
Severe	0.519**(0.189)	0.247(0.887)	0.062(0.171)	0.138(0.609)	-0.09(0.194)	0.193(0.615)
Fatal	0.761**(0.230)	1.112**(0.316)	-0.217(0.211)	1.321**(0.289)	-0.385(0.242)	1.387**(0.333)
Incidence of serious adverse events						
Often (reference)						
Occasionally	0.704**(0.181)	0.08(0.389)	0.462**(0.165)	0.501(0.401)	0.526**(0.196)	0.70(0.381)
Never or rarely	0.928**(0.214)	1.013**(0.301)	0.876**(0.206)	0.881**(0.317)	0.792**(0.232)	0.858*(0.361)
Alternative technologies currently covered by insurance						
Yes (reference)						
No	0.142(0.161)	0.242(0.516)	-0.003(0.148)	0.556(0.380)	-0.143(0.158)	0.106(0.679)
Out-of-pocket costs (thousand CNY per month increase)	-0.511**(0.112)	1.041**(0.152)	-0.071(0.078)	0.818**(0.125)	-0.211*(0.090)	0.790**(0.146)
Log likelihood	-706.268		-707.710		-562.183	
Participants	207		201		158	
Observations	2484		2412		1896	

*P<0.05; **P<0.01; SD: Standard Deviation estimates reflect preference heterogeneity in the participants; SE: Standard Error;

[#]This subgroup did not include those UEBMI patients who enjoyed extra health insurance benefits.

Appendix 9: Subgroup analysis by health-related quality of life

Supplemental Table 6. Subgroup analysis by health-related quality of life

Attributes	EQ-5D-5L index value ≤0.8		EQ-5D-5L index value >0.8	
	Mean (SE)	SD (SE)	Mean (SE)	SD (SE)
Expected gains in health outcomes from the treatment				
Not as expected (reference)				
As expected	0.554*(0.228)	0.971*(0.423)	0.953**(0.165)	0.466(0.493)
Likelihood of effective treatment (per 10% increase)	0.606**(0.093)	0.450**(0.098)	0.405**(0.054)	0.320**(0.074)
Severity of target disease				
Not severe (reference)				
Severe	0.874**(0.240)	0.043(0.408)	0.106(0.156)	0.349(0.533)
Fatal	0.724**(0.254)	0.773*(0.347)	-0.064(0.195)	1.499**(0.281)
Incidence of serious adverse events				
Often (reference)				
Occasionally	0.131(0.202)	0.007*(0.461)	0.815**(0.166)	0.431(0.357)
Never or rarely	0.516*(0.236)	0.453(0.519)	1.120**(0.200)	1.103**(0.275)
Alternative technologies currently covered by insurance				
Yes (reference)				
No	0.007(0.179)	0.142(0.466)	0.093(0.140)	0.560(0.458)
Out-of-pocket costs (thousand CNY per month increase)	-0.233*(0.109)	0.909**(0.157)	-0.283**(0.083)	0.979**(0.135)
Log likelihood	-438.402		-954.540	
Participants	127		281	
Observations	1524		3372	

*P<0.05; **P<0.01; SD: Standard Deviation estimates reflect preference heterogeneity in the participants; SE: Standard Error

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Appendix 10: Patients' health-related quality of life by type of insurance

Supplemental Table 7. Patients' health-related quality of life by type of insurance

Type of insurance	EQ-5D-5L index value ≤0.8	EQ-5D-5L index value >0.8
URRBMI	90	117
UEBMI	37	164
Total	127	281

χ^2 =29.898 P=0.000

For peer review only

Appendix 11: Subgroup analysis by gender

Supplemental Table 8. Subgroup analysis by gender

Attributes	Male		Female	
	Mean (SE)	SD (SE)	Mean (SE)	SD (SE)
Expected gains in health outcomes from the treatment				
Not as expected (reference)				
As expected	0.805**(0.174)	0.754*(0.357)	0.921**(0.200)	0.193(0.512)
Likelihood of effective treatment (per 10% increase)	0.476**(0.065)	0.409**(0.077)	0.456**(0.069)	0.362**(0.089)
Severity of target disease				
Not severe (reference)				
Severe	0.303(0.177)	0.541(0.425)	0.346(0.191)	0.333(0.435)
Fatal	0.249(0.199)	1.077**(0.282)	0.182(0.241)	1.582**(0.319)
Incidence of serious adverse events				
Often (reference)				
Occasionally	0.680**(0.167)	0.471(0.371)	0.528**(0.187)	0.007(0.417)
Never or rarely	0.953**(0.204)	0.768*(0.338)	0.897**(0.232)	1.146**(0.306)
Alternative technologies currently covered by insurance				
Yes (reference)				
No	0.127(0.144)	0.288(0.650)	0.093(0.168)	0.202(0.643)
Out-of-pocket costs (thousand CNY per month increase)	-0.246**(0.084)	0.893**(0.131)	-0.281**(0.098)	0.979**(0.153)
Log likelihood	-780.85		-667.657	
Participants	220		188	
Observations	2640		2256	

*P<0.05; **P<0.01; SD: Standard Deviation estimates reflect preference heterogeneity in the participants; SE: Standard Error

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Page 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 6-8
Objectives	3	State specific objectives, including any pre-specified hypotheses	Page 8 (line 47-54)
Methods			
Study design	4	Present key elements of study design early in the paper	Page 9 (line 11-20)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 9-12
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	Page 12 (line 30-46)
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	Not applicable
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 10 (line 34-44); Page 11 (line 5-24)
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 13
Bias	9	Describe any efforts to address potential sources of bias	Page 13 (line 5-22)
Study size	10	Explain how the study size was arrived at	Page 12 (line 47-58)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 14 (line 31-50)
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 14 (line 12-29)
		(*b*) Describe any methods used to examine subgroups and interactions	Page 14 (line 50-53)
		(*c*) Explain how missing data were addressed	Page 13 (line 15-19)
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed	Not applicable

For peer review only

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	Page 15 (line 33-39)
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Page 15 (line 11-21)
		(b) Give reasons for non-participation at each stage	Not applicable
		(c) Consider use of a flow diagram	Not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 15 (line 23-43); Page 16
		(b) Indicate number of participants with missing data for each variable of interest	Not applicable
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	Not applicable
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	Page 17 (line 16-36)
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Page 15 (line 33-39); Page 19 (line 48-54)
		(*b*) Report category boundaries when continuous variables were categorized	Not applicable
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Page 17 (line 38-58); Page 18; Page 19; Page 20 (line 5-11)
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 20 (line 19-58)
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 23 (line 40-59); Page 24 (line 5-35)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 21 (line 40-59); Page 22 (line 5-46)
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 22 (line 48-59); Page 23 (line 5-38)
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 25 (line 41-54)

For peer review only

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

For peer review only