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Trastuzumab deruxtecan versus trastuzumab emtansine for patients with human epidermal growth factor receptor 2-positive metastatic breast cancer: A cost-effectiveness analysis

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ABSTRACT

Background: DESTINY-Breast03 (NCT03529110) was the first global phase III study to assess the antitumor activity of trastuzumab deruxtecan (T-DXd) compared to trastuzumab emtansine (T-DM1) in 2022. However, the balance between efficacy and cost of T-DXd remains unclear. As a result, the present study's goal is to investigate the cost-effectiveness of T-DXd vs T-DM1 as a second-line treatment for patients with HER2-positive MBC from the US and Chinese payer's perspectives.

Methods: A Markov model with a 20-year time horizon was developed to evaluate the overall cost of patient treatment, incremental cost-effectiveness ratio (ICER), quality-adjusted life-years (QALYs), and life-years (LYs) in the US and China at WTP levels of 150,000/QALY and 37,653/QALY, respectively (3 times GDP per capita in 2021). Key data were gathered from the US government's official website, the Xiangya Hospital of Central South University, and published literature. To determine the model's stability, a sensitivity analysis was performed. A subgroup analysis was also implemented.

Results: Compared with T-DM1, treatment with T-DXd generated an additional 1.672 QALYs (2.796 LYs), resulting in an ICER of $13,342/QALY (US) and $186,017/QALY (China). The cost of drugs is the most influential factor in the American and Chinese models. Subgroup analysis revealed that the T-DXd and T-DM1 regimens were more cost-effective at reducing the risk of death in the US and Chinese HER2-positive MBC patients.

Conclusion: T-DXd as second-line treatment could gain more health benefits for HER2-positive MBC patients in comparison with T-DM1, which is considered to be cost-effective in the US but not in China.

1. Introduction

With approximately 2.26 million new cases and 680,000 deaths each year, breast cancer (BC) is the most common malignancy and the fifth leading cause of cancer-related mortality globally [1]. The incidence and mortality of BC are still rising in both developing and developed countries [2]. In 2022, About 420,000 new cases are expected in China and 250,000 in the US [3]. Around 20% of women diagnosed with BC express HER-2 or have significant metastases [4,5]. Survival for patients with HER2-positive metastatic breast cancer (MBC) has steadily improved but is still not a complete cure [6,7].

Trastuzumab emtansine (TMD-1) is a routine treatment for patients with HER2-positive MBC who have previously had trastuzumab combination therapy [8–10]. In the EMILIA (NCT00829166) phase III trial, the median progression-free survival (PFS) after TMD-1 treatment was 9.6 months (hazard ratio [HR], 0.65; 95% confidence interval [CI], 0.55 to 0.77; $P < 0.001$) and the median overall survival (OS) of 30.9 months (HR, 0.68; 95% CI, 0.55 to 0.85; $P < 0.001$) [11].Although anti-HER2-targeted therapy improves prognosis, most patients with locally developed or metastatic disease continue to have disease progression after treatment [7]. As a result, a new therapy option for individuals with HER2-positive MBC is critical.

Trastuzumab deruxtecan (T-DXd) is an antibody-drug conjugate (ADC) consisting of an anti-HER2 antibody, a cleavable tetrapeptide linker, and a novel cytotoxic topoisomerase I inhibitor payload [12]. T-DXd therapy significantly enhanced the objective response rate in

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patients with HER2-positive MBC who had previously been treated with T-DM1 (60.9%) [12]. In the phase II DESTINY-Breast01 (NCT03248492) trial, it enhanced the median duration of response (14.8 months) and progression-free survival (16.4 months) in 2019(12). As a result, the USFDA (United States Food and Drug Administration) approved it for patients with advanced or metastatic HER2-positive BC in December of the same year [13]. This also marks the beginning of a new era in BC anti-HER2 therapy. Following that, the DESTINY-Breast03 (NCT03529110) phase III trial found that T-DXd as a second-line treatment for patients with HER2-positive MBC significantly improved PFS and had a strong trend of OS benefit (HR, 0.55; 95% CI, 0.36 to 0.86; $P = 0.007$) when compared to T-DM1 (HR, 0.28; 95% CI, 0.22 to 0.37; $P < 0.001$) [14]. Surprisingly, T-DXd also showed antitumor activity for patients with low HER2-low MBC, and DESTINY-Breast04 (NCT03734029) showed significant improvement of the median PFS (HR, 0.51; 95% CI, 0.40 to 0.64; $P < 0.001$) and OS (HR, 0.64; 95% CI, 0.48 to 0.86; $P = 0.003$) [15].

A new era in the treatment of HER2-positive MBC has begun, ushering in the true ADC era with these promising findings. T-DXd was recommended as the second-line treatment of choice for HER2-positive MBC (Evidence level I, recommendation level A) by the NCCN (National Comprehensive Cancer Network), the ABC6 (6th international consensus guidelines for advanced breast cancer), and the ESMO (European Society for Medical Oncology) Clinical Guidelines in 2021 [16–18]. The CSCO (Chinese Society of Clinical Oncology) Guidelines advocated the use of T-DXd as a class II recommendation, and it was approved for marketing by the NMPA (National Medical Products Administration) in 2022 [10,19]. As a result, T-DXd is changing the global landscape of patients with HER2-positive advanced BC.

Furthermore, given the high cost and limited prospective population, an immediate economic study is required to determine whether this recently approved treatment provides clinical benefits at a reasonable cost, which will become increasingly important as the drug becomes widely available. Therefore, the goal of our research was to evaluate the cost-effectiveness and potential financial impact of T-DXd and T-DM1 as second-line therapyfor patients with HER2-positive MBC in the US and China from the public perspective.

2. Materials and methods

The Economic Assessment Report Standard Statement (CHEERS) checklist supervised this study (Supplementary Materials eTable 1).

2.1. Population and interventions

In the DESTINY-Breast03 clinical trial, 524 patients with HER2-positive MBC were enrolled in an interim analysis from July 20, 2018, to June 23, 2020 [14]. 261 patients were randomly assigned to receive T-DM1 and 263 to receive T-DXd [14]. T-DXd and T-DM1 were administered intravenously every 3 weeks at a dose of 5.4 mg and 3.6 mg per kilogram (kg) of body weight, respectively [14]. Due to the differences in third-line treatment between China and the US, the trial showed that a patient could receive multiple post-anticancer treatments. So we didn't consider third-line treatments [14]. Tumor measurements will be performed every 6 weeks until disease progression (PD) or unacceptable adverse events (AEs) were detected and treatment was discontinued for best supportive care (BSC). About 49% and 82% of patients received BSC in the T-DXd and T-DM1 groups, respectively [14]. Finally, each patient who died received terminal care. According to relevant literature, to calculate the dose of ADC drugs, we assumed that the average weight of American and Chinese female patients was 74 kg and 65 kg, respectively [20,21]. For details of drug usage and unit price are listed in eTable 2 of supplementary materials.

2.2. Model structure and transition

To analyze the benefits of combining the treatment effect over time with transition probabilities estimated from the DESTINY-Breast03 trial's OS and PFS curves. Using TreeAge Software (TreeAge Pro 2020®, available at: https://www.treeage.com), we developed a Markov model with 3 completely independent health states: PFS, PD, and death (Supplementary Materials eFig. 1). The model cycle was 6 weeks to accommodate the intervention and follow-up regimens. Over time, the health status of patients tended to be dead, with more than 99% of patients dying over 20 years. We subsequently selected the points from the Kaplan-Meier (KM) curves of the two groups through the GetData Graph Digitizer (Version 2.26, available at: http://www.getdata-graph-digitizer.com/index.php) database. Based on the Akaike information criterion (AIC) and Bayesian information criterion (BIC) paired with a visual examination, the Weibull distribution was identified as the best-suited KM curve in the experiment (Supplementary Materials eFig. 2 and eTable 4). Finally, through R software (Version 4.1.1, available at: http://www.rproject.org), shape parameters (γ) and scale parameters (λ) were calculated, and KM curves were applied as reported by Hoyle et al. (Table 1).

2.3. Utility and cost

The models' key performance indicators were total costs, life years (LYs), quality-adjusted life years (QALYs), and incremental cost-effectiveness ratios (ICERS). Furthermore, based on published research and China's GDP (gross domestic product), the WTP thresholds were determined to be $150,000/QALY and $37,653/QALY (3 times China's GDP per capita in 2021) to evaluate the cost-effectiveness of the US and China [22,23]. Since no health utility was reported in clinical trials, the average health utility for PFS and PD status was assumed to be 0.70 and 0.50, respectively, using previously published articles [20,24,25]. We also corrected for mean health utility by disutility due to grade 3/4 AEs [20,22,26,27](Table 1).

We only examined direct expenditures, such as medications, administration, follow-up, immunohistochemistry tests, BSC, terminal care, and adverse events (AEs) (only grade 3/4 AEs with a ≥5% incidence were included (Table 1). US drug prices are derived from the official drug search website [28]. Chinese drug prices come from Xiangya Hospital of Central South University. The remaining costs are derived from published literature [20,21,27,29–35]. Based on the US Consumer Price Index (CPI), healthcare-related costs were inflated to 2021 values in the US [36]. The Chinese Yuan was converted into US dollars using the following exchange formulas: $1 = ¥6.4512 (the average exchange rate in 2021). A discount rate of 3% a year is accepted in terms of costs and results [22] (Table 1).

2.4. Sensitivity analysis

Due to the uncertainty of our model analysis, we performed one-way sensitivity analysis and probability sensitivity analysis. In one-way sensitivity analysis, the range of analytic parameters was ±20% to study the effect of our input data on the outcomes [22]. Probabilistic sensitivity analysis can evaluate the variation of multiple parameters and 10,000 Monte Carlo simulations to obtain scatter plots and good curves to test the acceptable probability of different optimal strategies at different WTP thresholds [37]. We also considered the cost-effectiveness of subgroups of US and Chinese patients. In the case of insufficient data, according to Ding et al., the PFS curves of the total population of the T-DM1 group were multiplied by the HRs of each subgroup to obtain the PFS curves T-DXd subgroups [22].

2.5. Scenario analysis

We investigated the effect of post-anticancer therapy with T-DM1

Table 1
Model parameters: baseline values, ranges, and distributions for sensitivity analysis.

Variable	Baseline value	Range		Reference	Distribution
		Minimum	Maximum		
Clinical data					
Weibull survival model for OS of T-DXd	Scale = 0.004045, Shape = 1.228729	–	–	[14]	–
Weibull survival model for OS of T-DM1	Scale = 0.0058607, Shape = 1.3286906	–	–		–
Weibull survival model for PFS of T-DXd	Scale = 1.3286906, Shape = 1.118939	–	–	[14]	–
Weibull survival model for PFS of T-DM1	Scale = 0.21063, Shape = 0.63647	–	–		–
Discountinued treatment				[14]	
T-DXd group	0.49	–	–	[14]	–
T-DM1 group	0.82	–	–	[14]	–
Risk for main AEs in T-DXd group					
Neutropenia	0.191	0.153	0.229	[14]	Beta
Thrombocytopenia	0.070	0.056	0.084	[14]	Beta
Leukopenia	0.066	0.053	0.079	[14]	Beta
Nausea	0.066	0.053	0.079	[14]	Beta
Anemia	0.058	0.046	0.070	[14]	Beta
Fatigue	0.051	0.041	0.061	[14]	Beta
Risk for main AEs in T-DM1 group					
Thrombocytopenia	0.249	0.199	0.299	[14]	Beta
Aspartate aminotransferase increased	0.050	0.040	0.060	[14]	Beta
Utility					
Utility PFS	0.70	0.56	0.84	[20,24,25]	Beta
Utility PD	0.50	0.40	0.60	[20,24,25]	Beta
Disutility due to AEs					
Thrombocytopenia	0.122	0.098	0.146	[20]	Beta
Anemia	0.120	0.096	0.144	[20]	Beta
Nausea	0.103	0.082	0.124	[20]	Beta
Leukopenia	0.090	0.072	0.108	[22]	Beta
Neutropenia	0.090	0.072	0.108	[22]	Beta
Fatigue	0.290	0.232	0.348	[26]	Beta
Aspartate aminotransferase increased	0.157	0.126	0.188	[27]	Beta
Drug cost, $ per cycle (US)					
T-DXd	20,307	16,246	24,368	[28]	Gamma
T-DM1	19,212	15,370	23,054	[28]	Gamma
Trastuzumab	9771	7817	11,725	[28]	Gamma
Lapatinib	4230	3384	5076	[28]	Gamma
Drug cost, $ per cycle (China)					
T-DXd	22,852	18,282	27,422	Local Charge	Gamma
T-DM1	5978	4782	7174	Local Charge	Gamma
Pyrotinib	111	89	133	Local Charge	Gamma
Capecitabine	85	68	102	Local Charge	Gamma
Cost of AEs, $ (US)					
T-DXd group	1473	1178	1768	[20,27,34,35]	Gamma
T-DM1 group	2903	2322	3484	[20,27]	Gamma
Cost of AEs, $ (China)					
T-DXd group	410	328	492	[21,29,32]	Gamma
T-DM1 group	893	714	1072	[21,29,32]	Gamma
Follow-up, $					
US	1207	966	1448	[29]	Gamma
China	170	136	204	[29]	Gamma
Immunohistochemical test, $					
US	112	90	134	[28]	Gamma
China	70	56	84	Local Charge	Gamma
Administration, $					
US	322	258	386	[20]	Gamma
China	19	15	23	[29]	Gamma
Best supportive care, $					
US	3071	2457	3685	[32]	Gamma
China	828	662	994	[31]	Gamma
Terminal care, $					
US	2601	2081	3121	[33]	Gamma
China	1995	1596	2394	[29]	Gamma
Body weight, kilogram					
US	74	59	89	[20]	Normal
China	65	52	78	[21]	Normal
Discount rate	0.03	0	0.05	[22]	Uniform

Abbreviation: OS, overall survival; PFS, progression-free survival; T-DXd, trastuzumab deruxtecan; T-DM1, trastuzumab emtansine; PD, progressed disease; AEs, adverse events.

and T-DXd on outcomes. 30% and 62% of patients receiving second-line therapy according to the DESTINY-Breast03 study received third-line therapy, and the remainder received BSC [14]. Following the DESTINY-Breast03 study, NCCN guidelines, and CSCO guidelines, we selected American patients to receive lapatinib plus trastuzumab and T-DM1 after receiving T-DM1 and T-DXd, respectively [10,14,38]. Chinese patients received T-DM1 and T-DXd followed by T-DM1 and pyrotinib plus capecitabine, without considering any health policy. Detailed drug prices and delivery methods are shown in Table 1 and Table 2 of supplementary materials. For capecitabine, we assumed that

the average body surface area of Chinese was 1.72 m^2 [39], and other parameters remained unchanged.

3. Results

3.1. Baseline results

The baseline results showed that T-DXd produced 4.354 QALYs (7.663 LYs) and T-DM1 produced 2.682 QALYs (4.867 LYs). The cost of T-DXd treatment is $575,978 in the US and $578,419 in China. The cost of T-DM1 therapy was $553,669 in the US and $267,389 in China. T-DXd had an ICER of $13,342/QALY ($7982/LY) in the US and $186,017/QALY ($111,270/LY) in China compared with T-DM1, which was lower than conventional WTP in the US and higher than traditional WTP in China. These results imply that T-DXd and T-DM1 may be cost-effective second-line therapies for HER2-positive MBC in the US and China, respectively (Table 2).

3.2. Sensitivity analyses

The one-way sensitivity analysis, based on the Tornado diagram (Fig. 1), revealed that the cost of T-DXd (varying from $16,246 to $24,368 each cycle, with the ICER ranging from -$46,391/QALY to $73,076/QALY), was the parameter that most influenced the study outcomes in the US. The cost of T-DM1, BSC, and AEs is then added. The cost of T-DXd ($18,282-$27,422) with the ICER increasing ($118,797/QALY-$253,237/QALY) had the most significant impact in China, followed by the PD and PFS utilization; the price of T-DM1, and the cost of BSC. The disutility of AEs had little effect on the results. The probability sensitivity analysis using the cost-effectiveness acceptability curve (Fig. 2) and scatter plot (Supplementary material Fig. 3) revealed that T-DXd and T-DM1 had acceptability rates of approximately 96% and 4%, respectively, at the WTP (Willingness-to-pay) level of 150,000/QALY in the US. T-DXd and T-DM1 had acceptance rates of around 0% and 100% in China, respectively, at the WTP level of 37,653/QALY.

3.3. Subgroup analyses

Subgroup analysis showed that T-DXd and T-DM1 were more cost-effective in reducing the risk of death for US and Chinese patients, respectively. The ICER of T-DXd versus T-DM1 ranged from $78,234/QALY to $153,950/QALY in the US and $242,738/QALY to $308,922/QALY in China. Probability sensitivity analysis indicates that T-DXd versus T-DM1 was cost-effective with probabilities of more than 57% and 0% from the US and Chinese population perspectives, respectively (Supplementary material eTable 3).

3.4. Scenario analysis

The scenario analysis results showed that T-DXd produced 4.354 QALYs (7.663 LYs) and T-DM1 produced 2.682 QALYs (4.867 LYs). The cost of T-DXd treatment is $575,978 in the US and $578,419 in China. The cost of T-DM1 therapy was $761,772 in the US and $299,452 in China. T-DXd had an ICER of -$11,1117/QALY (-$66,466/LY) in the US and $166,831/QALY ($99,799/LY) in China compared with T-DM1. These results indicate that post-anticancer therapy does not change baseline outcomes, and T-DXd remains a cost-effective second-line therapy in the US, while the opposite is true in China compared to T-DM1.

Table 2
Baseline results.

Country	Treatment	Total cost $	LYs	ICER $/LY[a]	QALYs	ICER $/QALY[b]
US	T-DM1	553,669	4.867	NA	2.682	NA
	T-DXd	575,978	7.663	7982	4.354	13,342
China	T-DM1	267,389	4.867	NA	2.682	NA
	T-DXd	578,419	7.663	111,270	4.354	186,017

Abbreviation: T-DM1, trastuzumab emtansine; T-DXd, trastuzumab deruxtecan; ICER, incremental cost-effectiveness ratio; LY, life-year; QALY, quality-adjusted life-year.

[a] Compared to T-DM1 ($/LY).

[b] Compared to T-DM1 ($/QALY) at a willing-to-pay of $150,000/QALY in the US and $37,653/QALY in China.

4. Discussion

With rising healthcare costs in the United States and China, advanced BC (ABC) continues to be a substantial economic burden. Female BC was the most expensive cancer site in 2010, costing roughly $16.50 billion, and is anticipated to climb by $20.50 billion by 2020 [40]. These costs are equivalent to 3% of China's current public health spending [41]. Although BC treatment costs are increasing in almost all countries, a focus on the efficacy of economy-based oncology drugs is necessary, and a focus on value-based oncology is needed for rising healthcare costs [40,41]. Because T-DM1 and T-DXd are the leading therapies in the ADC era, they have received much attention. Both treatments have been authorized for second-line therapy of HER2-positive MBC patients, however, physicians and cancer patients must choose the more cost-effective option. Therefore, cost-effectiveness comparisons have been revised.

So far, only a few cost-effectiveness studies of T-DM1 have been published, most of which focused on breast cancer and were undertaken from the payers' perspective in the US, China, the UK, and Spain. From the payer's perspective, Le et al. compared T-DM1 as a second-line treatment to lapatinib plus capecitabine (LC) and capecitabine (C) monotherapy. Finally, they determined that T-DM1 was more cost-effective than C monotherapy at a WTP of 150,000/QALY(14). Using data from the Taiwanese National Health Insurance Administration (TNHIA), Diaby et al. assessed the cost-effectiveness of four treatment sequences for HER2-positive MBC and found promising results with trastuzumab plus docetaxel as the first line, T-DM1, trastuzumab, and galatinib as the second line, and T-DM1, trastuzumab, and galatinib as the third line [42]. The National Institute for Health and Care Excellence (NICE) assessed T-DM1 as cost-effective compared with LC or C for HER2-positive, unresectable, locally advanced trastuzumab, and taxane after treatment for metastatic breast cancer [43]. The National Institute for Health and Care Excellence (NICE) found that T-DM1 was more cost-effective than LC or C for HER2-positive, unresectable, locally advanced trastuzumab and taxane after treatment for metastatic breast cancer [39]. T-DM1 has been proven to be clinically successful, however NICE determined that with a WTP of £30,000/QALY, it is unlikely to be a cost-effective use of NHS (National Health Service) resources [43]. The cost-effectiveness of T-DM1 against LC in the treatment of patients with HER2-positive MBC was examined by Romero et al. [44]. From a Spanish healthcare perspective, T-DM1 costs more than €120,000/QALY, so the drug would also not be considered cost-effective [44]. These studies detail how cost-effectiveness analyses can differ for payers of the same treatment regimen in the same clinical trial. The reason for this is local affordability and market evaluation programs. Therefore, when an approved drug is widely used clinically, different economic factors in other regions should be considered.

Only a cost-effectiveness analysis for T-DM1 in the second-line therapy of HER2-positive MBC has been done to our knowledge, but not for T-DXd, a new generation of ADC medicines. As a result, for the first time, we developed a 20-year Markov model to compare the cost-effectiveness of T-DXd and T-DM1 as second-line treatments for patients with HER2-positive MBC from both the US and Chinese payers' viewpoints. Current studies show that treating T-DXd generates an additional 1.672 QALYs compared to T-DM1 (4.354 QALYs versus 2.682 QALYs), resulting in ICER of $13,342/QALY in the US and $186,017/QALY in China, In the United States, it above the WTP criterion of

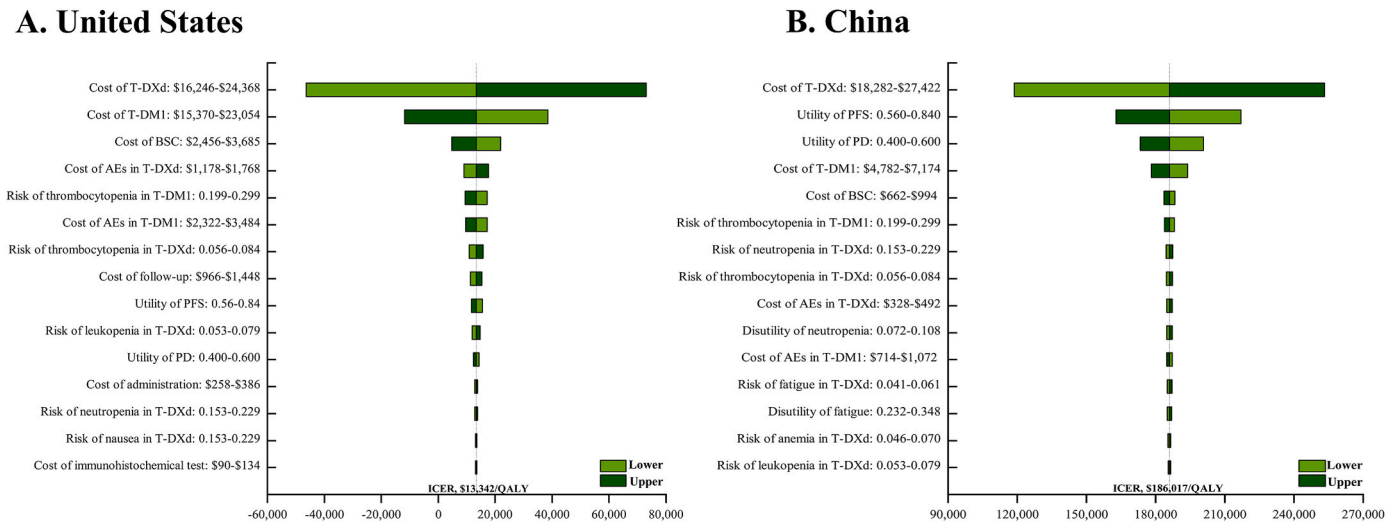

Fig. 1. The one-way sensitivity analyses of trastuzumab deruxtecan (T-DXd) strategy compared to trastuzumab emtansine (T-DM1) strategy in United States (A) and China (B). Abbreviation: T-DXd, trastuzumab deruxtecan; T-DM1, trastuzumab emtansine; BSC, best supportive care; AEs, adverse events; PFS, progression-free survival; PD, progressive disease; ICER, incremental cost-effectiveness ratio; QALY, quality-adjusted life-year.

$150,000/QALY, but in China, it was below the WTP level of $37,653/QALY. From the perspective of the US payer, T-DXd was cost-effective for second-line systemic therapy of patients with HER2-positive MBC. T-DM1 was also cost-effective for second-line systemic therapy of patients with HER2-positive MBC from the standpoint of Chinese payers. Due to China's vast territory and abundant resources, per capita GDP varies greatly. We also calculate WTP values for different regions in China. For example, the WTP values of Beijing, Shanghai, Guangdong, Hubei, Hunan, Xizang, Guizhou, Guangxi, and Gansu are $85,563/QALY, $80,787/QALY, $45,822/QALY, $40,491/QALY, $32,241/QALY, $25,416/QALY $23,609/QALY, $22,929/QALY, and $19,053/QALY, respectively [45]. Surprisingly, T-DM1 is the best choice strategy for less developed areas and relatively developed regions in China. The main reason for the difference in results between China and the US is that the prices of the two ADC drugs are different in different countries, and the WTP values of each country and region are also different. This is also consistent with previously published cost-effectiveness analyses of T-DM1, where the same intervention has different economic outcomes in different countries. That is why different economic factors in different countries should be taken into account when approving medicines.

The price of T-DXd was the most influencing factor in the one-way sensitivity analysis. If the price of T-DXd decreased by 5% or T-DM1 increased by 15% in the US, T-DXd therapy was the dominant treatment strategy compared with T-DM1. T-DXd treatment may be cost-effective when the price of T-DXd is reduced by 45% or T-DM1 multiplied five times in China. According to a new research study, even once inflation is factored in, the average cost of cancer treatment has climbed dramatically. Newer drugs are far more expensive than existing drugs [46]. As a result, choosing an effective but low-value medication becomes a difficult prescription option. However, balancing the price of drugs is the primary way to solve the problem. In the United States and China, T-DXd has a 96% and 0% probability of being cost-effective, respectively, while T-DM1 has a 4% and 100% probability of being cost-effective. Results from our subgroup analysis were consistent with baseline results, suggesting that T-DXd and T-DM1 were more cost-effective in reducing the risk of death in US and Chinese patients, respectively. T-DM1 and T-DXd are now being studied for their cost-effectiveness in treating HER2-positive patients. MBC is a revolutionary and unique method that uses sensitivity analysis to address variable structural ambiguity and the economic assessment of patient subgroups. With customized cancer diagnosis and therapy, ICER for ADC medications may be improved to identify particular groups of HER2-positive MBC patients who might benefit clinically from ADC drugs.

It should be noted that in both high-income countries and middle-income countries, the high price of anticancer drugs will bring pressing concerns, namely financial toxicity. It can lead to bearing the economic burden for the patients and health care system, leading to poor prognosis in patients with or even giving up treatment. Ensuring that patients access innovative medicines is as important as minimizing financial toxicity [47,48]. Limited transparency and a lack of federal controls may contribute to the highest drug costs in the US [49]. However, China's State Council has emphasized the critical role of economic evaluation in multilateral negotiations and formulated preferential policies for innovative drugs based on pharmacoeconomics [48]. Therefore, it provides objective data reference for national health insurance decision-making and suggests how to make more reasonable use of medical resources.

As with most cost-effectiveness analyses, our study has some limitations. First, our model does not include drug therapy after second-line therapy relapses again. All patients who stopped study therapy received optimal nursing support therapy, which may underestimate the cost of PD. However, we are sensitive that these costs will not significantly impact our findings. Secondly, as with most modeling studies, the study results were constrained by real-world constraints. Rather than using prospective data, the current analysis relied on the validity of previously published research data. Third, since the HRs and survival curves for OS were not reported in the subgroup, we used HRs for each subset of PFS and OS data for the total population. In addition, the small sample size of the subset reduces the robustness of our results. This is an inevitable limitation, so the economic estimates of subgroups need to be interpreted with caution. Lastly, since we don't have enough full quality-of-life data to determine the utility value, we adjust the average health utility value to account for the negative consequence of grade 3/4 AEs, which may result in an inflated or underestimated utility value. Nevertheless, our subsequent analysis found that the disutility of AEs had little impact on economic outcomes. Finally, we used data from the DESTINY-Breast03 trial to look at survival outcomes out of time, an unavoidable limitation. However, due to the good fitness of the model, the uncertainty of the model on long-term survival is very small. The long-term benefits of T-DXd are still an open question. When more mature data become available in the future, the model can be validated based on long-term survival data.

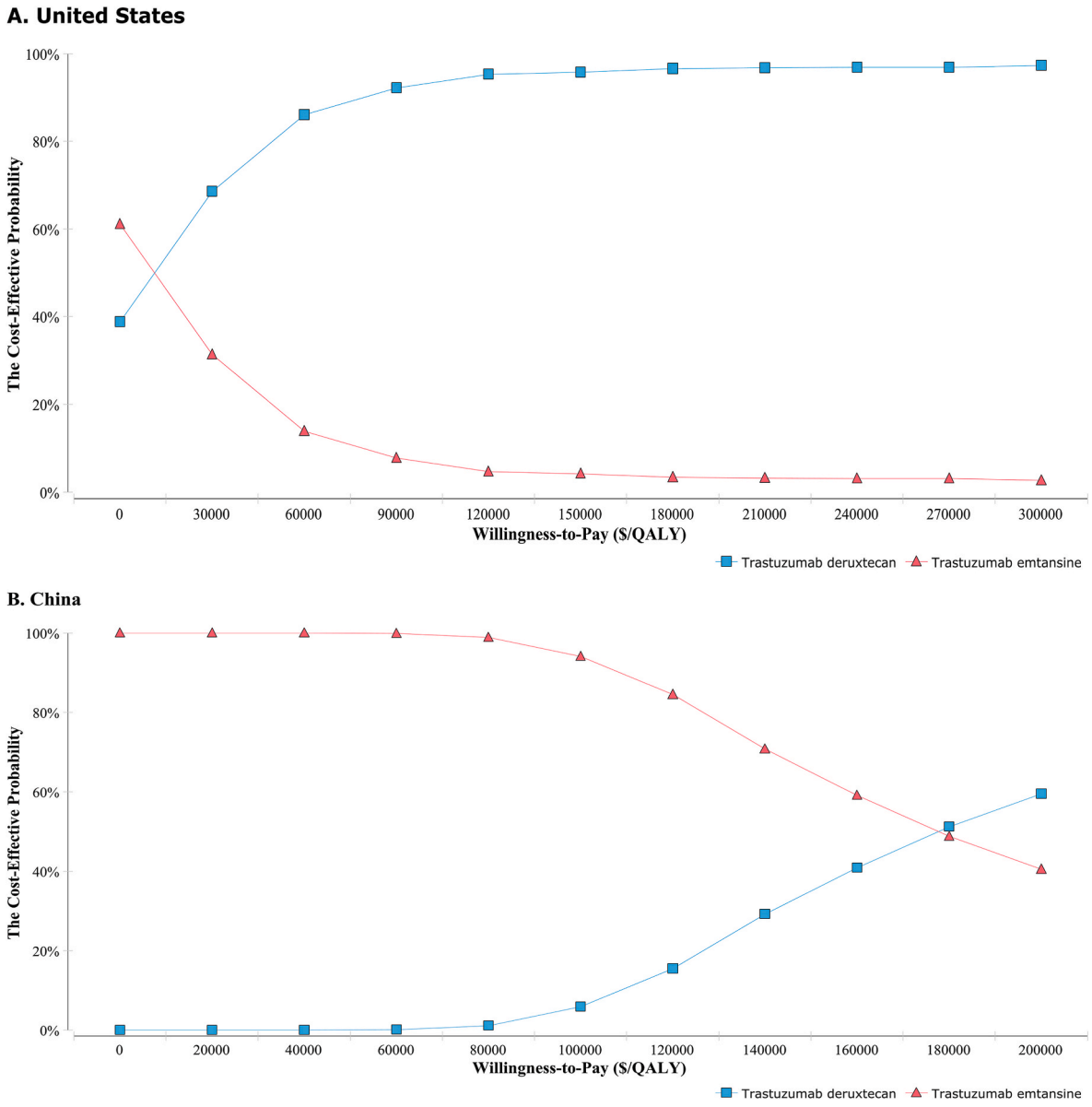

Fig. 2. The cost-effectiveness acceptability curves for trastuzumab deruxtecan (T-DXd) strategy compared to trastuzumab emtansine (T-DM1) strategy in United States (A) and China (B). Abbreviation: QALY, quality-adjusted life-year.

5. Conclusion

Our research shows that T-DXd is cost-effective as a second-line therapy for patients with HER2-positive MBC from the viewpoint of a US payer. While, From the perspective of Chinese society, T-DM1 is cost-effective as second-line therapy for patients with HER2-positive MBC. However, T-DXd provides more health benefits than T-DM1 in second-line treatment of HER2-positive MBC patients in both the US and China. Furthermore, the current study found that new, more cost-effective therapies should be customized to the individuals most likely to benefit clinically, with price balance amongst pharmaceuticals being an essential measure for obtaining the most cost-effective treatment.

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Authors contributions

Y.W.Z., K.L., M.W., W.K.L, and H.Z. performed the experiments. Y.W.Z. and K.L. analyzed the data. H.Z. contributed materials and analysis tools. Y.W.Z., K.L., M.W., K.L.W., and H.Z. wrote the manuscript. All authors have read and approved the manuscript.

Ethics approval and consent to participate

This article is based on previously conducted studies and does not contain any new studies with human participants or animals performed by any of the authors, it does not require the approval of the independent ethics committee.

Availability of data and materials

All authors had full access to all of the data in this study and take complete responsibility for the integrity of the data and accuracy of the data analysis. The datasets generated and/or analyzed during the

current study are available from the corresponding author on reasonable request.

Consent for publication

N/A.

Declaration of competing interest

All of the authors have indicated that they have no competing interests in the content of the article. This manuscript is original and has not been previously published, nor has it been simultaneously submitted to any other journal.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.breast.2022.10.010.

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