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ORIGINAL RESEARCH

Cost-Effectiveness of Secukinumab Versus Other Biologics in the Treatment of Moderate-to-Severe Plaque Psoriasis: The Chinese Healthcare System Perspective

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ABSTRACT

Introduction: This study assessed the cost-effectiveness of secukinumab compared with other biologics (adalimumab, infliximab, ustekinumab, ixekizumab, guselkumab, and Yisaipu [etanercept biosimilar]) for moderate-to-severe plaque psoriasis from the Chinese healthcare system perspective.

Methods: A decision-tree (first year)/Markov model (subsequent years), with an annual cycle, was implemented over a lifetime horizon. The Psoriasis Area and Severity Index (PASI) response rate at week 16 was used for treatment response. Efficacy inputs were obtained from a mixed-treatment comparison conducted using data from randomized controlled trials. Other clinical inputs (adverse events, dropout, and mortality rates), utility weights, and costs were derived from published literature and local Chinese sources. Both costs and outcomes were discounted at 5% per annum. Model outcomes included quality-adjusted life years (QALYs) and incremental cost-effectiveness ratio (ICER). One-way and probabilistic sensitivity analyses were conducted to test the robustness of results.

Results: For patients with moderate-to-severe psoriasis, secukinumab generated the highest QALYs (12.334) against all comparators at a lifetime cost of ¥231,477. Secukinumab dominated (higher QALYs at lower costs) all other biologics except ixekizumab in this population. Compared with secukinumab, ixekizumab incurred slightly lower costs (¥228,320) but gained lesser QALYs (12.284). Thus, secukinumab was a cost-effective treatment than ixekizumab at a willingness-to-pay (WTP) threshold of ¥257,094 per QALY gained. In the one-way sensitivity analysis, base-case results were most sensitive to changes in the PASI response at 16 weeks and year 2+ dropout rates.

Conclusion: Secukinumab is the most cost-effective treatment option for patients with moderate-to-severe psoriasis compared with other commonly used biologics from the Chinese healthcare system perspective.

Keywords: Cost-effectiveness; Psoriasis; Secukinumab; Biologics; Incremental cost-effectiveness ratio; Quality-adjusted life year; China

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Key Summary Points

This study constitutes the first comprehensive economic evaluation of secukinumab compared with other commonly used biologics for moderate-to-severe plaque psoriasis in China.

Patients receiving secukinumab generate the highest quality-adjusted life years (12.334) against all comparators at a lifetime cost of ¥231,477.

Secukinumab provides the best economic value compared with other commonly used biologics for the treatment of moderate-to-severe plaque psoriasis in China.

INTRODUCTION

Psoriasis is a chronic, immune-mediated inflammatory disease of the skin [1]. The worldwide prevalence rate of psoriasis is 0.5%, which varies widely from 0.1% in Southeast Asia to 1.9% in Western Europe [2]. In China, it affects 7.6 million individuals, resulting into age-standardized prevalence rate of 0.4% [2, 3]. Plaque psoriasis is the most common type of psoriasis, accounting for over 96.0% of all cases [4, 5]. On the basis of the body surface area (BSA) involvement, around 57.3% of patients have moderate-to-severe disease [4]. Psoriasis is associated with several comorbidities including hyperlipidemia, hypertension, diabetes, obesity, cardiovascular diseases, depression, and non-alcoholic fatty liver disease [1, 4, 6, 7]. Patients with psoriasis experience a significant functional, psychological, and social burden impacting their professional lives and leading to reduced quality of life (QoL) [8, 9]. In China, approximately 61.8% of patients with psoriasis report a severe or extremely severe impact on their QoL [10]. According to World Psoriasis Happiness Report 2018, Chinese people with self-reported psoriasis report the lowest average happiness levels (4 on a scale of 0–10) and more than 51.4% of them live in misery [11].

Treatments for psoriasis include topical agents, ultraviolet phototherapy, conventional systemic therapy (methotrexate and cyclosporine), retinoids, and biologics. The Chinese guidelines for the treatment of psoriasis recommend the use of biologics among patients with moderate-to-severe psoriasis who have not responded to, are intolerant of, or have contraindications to traditional systemic therapies [12–14]. Clinically used biologics in China include tumor necrosis factor alpha (TNFα) inhibitors (etanercept biosimilar, infliximab, and adalimumab), interleukin (IL)-12/IL-23 inhibitors (ustekinumab and guselkumab), and IL-17A inhibitors (secukinumab and ixekizumab) [14].

Patients with moderate-to-severe psoriasis usually require lifelong treatment [15]. Hence, psoriasis imposes a large economic burden on patients and their families [10, 16, 17]. In China, the total annual expenditure due to psoriasis accounts for approximately 20.0% of patients' income and results into an annual hospitalization rate of 21.3%, 15.0 days of sick leave, and an unemployment rate of 37.0% [10]. Thus, it is important to assess the cost-effectiveness of current treatments to better allocate the finite healthcare resources.

Secukinumab is a fully human monoclonal antibody that selectively neutralizes IL-17A and has been approved for moderate-to-severe plaque psoriasis in China. It has demonstrated rapid onset of action and long-lasting efficacy with a favorable safety profile in the treatment of moderate-to-severe plaque psoriasis [18–20]. Several economic evaluations have been conducted in the USA, Canada, Japan, and Europe that assessed the cost-effectiveness of different biologics including secukinumab for the treatment of psoriasis [21–32]. However, studies evaluating the cost-effectiveness of secukinumab in the Chinese setting are scarce [33]. Therefore, this study aimed to assess the cost-effectiveness of secukinumab versus other commonly used biologics (adalimumab, infliximab, ustekinumab, ixekizumab, guselkumab, and Yisaipu [etanercept biosimilar]) for moderate-to-severe plaque psoriasis in China.

METHODS

Patient Population and Interventions

The target patient population for the model was based on the pivotal phase 3 clinical trial of secukinumab (CAIN457A2318) [18]. The analysis included Chinese patients (aged ≥ 18 years) with moderate-to-severe chronic plaque psoriasis for at least 6 months who were inadequately controlled by topical agents, phototherapy, and/or conventional systemic therapy.

The following treatments and their respective dosage according to approved product label were considered for the cost-effectiveness analysis: secukinumab (150 mg for body weight < 60 kg and 300 mg for body weight ≥ 60 kg), adalimumab 40 mg, infliximab 5 mg/kg, ustekinumab 45 mg, ixekizumab 80 mg, guselkumab 100 mg, and Yisaipu 50 mg (Table 1).

Model Structure

A decision-tree (first year)/Markov model (subsequent years), with an annual cycle, was implemented in Microsoft® Excel to compare secukinumab with commonly used biologics in China (Fig. 1a, b). The model structure was adapted from the previously published cost-effectiveness studies of secukinumab for psoriasis [23–26]. Patients entered the model at 39 years, based on the average age of patients in studies evaluating secukinumab in China [18, 34]. Treatment initiation was considered as the entry point for patients with a 16-week induction period. Efficacy assessment was conducted at weeks 4, 8, 12, and 16 using the Psoriasis Area and Severity Index (PASI).

On the basis of PASI scores, patients were assigned to three PASI-defined health states: PASI < 50 (non-responder), PASI 50–74 (partial responder), and PASI ≥ 75 (responder). Different PASI levels represented the corresponding percentage reduction in the PASI score from the baseline. The decision to continue patients on biologic treatment was assessed at 16 weeks, based on a response threshold of PASI ≥ 75. At week 16, patients with a PASI ≥ 75 response continued with the same biologic treatment. Non-responders (PASI < 50) and partial responders (PASI 50–74) to biologics discontinued active treatment and switched to standard of care at week 16 assessment. Standard of care treatment included methotrexate, cyclosporine, topical corticosteroids, and phototherapy [12–14]. Switching to a second-line biologic was not considered in the current model.

Given the chronic nature of psoriasis, patients with a PASI ≥ 75 response at week 52 continued the same biologic treatment and entered the long-term Markov in the "active treatment" health state until they dropout to

Table 1 Dosage regimen for biologics

Biologics	Dosage regimen
Secukinumab	Body weight < 60 kg: 150 mg sc at weeks 0, 1, 2, 3, and 4 followed by 150 mg Q4W
	Body weight ≥ 60 kg: 300 mg sc at weeks 0, 1, 2, 3, and 4 followed by 300 mg Q4W
Adalimumab	80 mg sc at week 0 followed by 40 mg Q2W
Infliximab	5 mg/kg iv at weeks 0, 2 and 6 followed by 5 mg/kg Q8W
Ustekinumab	45 mg sc at weeks 0 and 4 followed by 45 mg Q12W
Ixekizumab	160 mg sc at week 0 followed by 80 mg at weeks 2, 4, 6, 8, 10, and 12, then 80 mg Q4W
Guselkumab	100 mg sc at weeks 0 and 4 followed by 100 mg Q8W
Yisaipu	25 mg sc twice a week or 50 mg once a week

iv intravenous, *Q2W* every 2 weeks, *Q4W* every 4 weeks, *Q8W* every 8 weeks, *Q12W* every 12 weeks, *sc* subcutaneous
Source: Chinese Society of Dermatology [14]

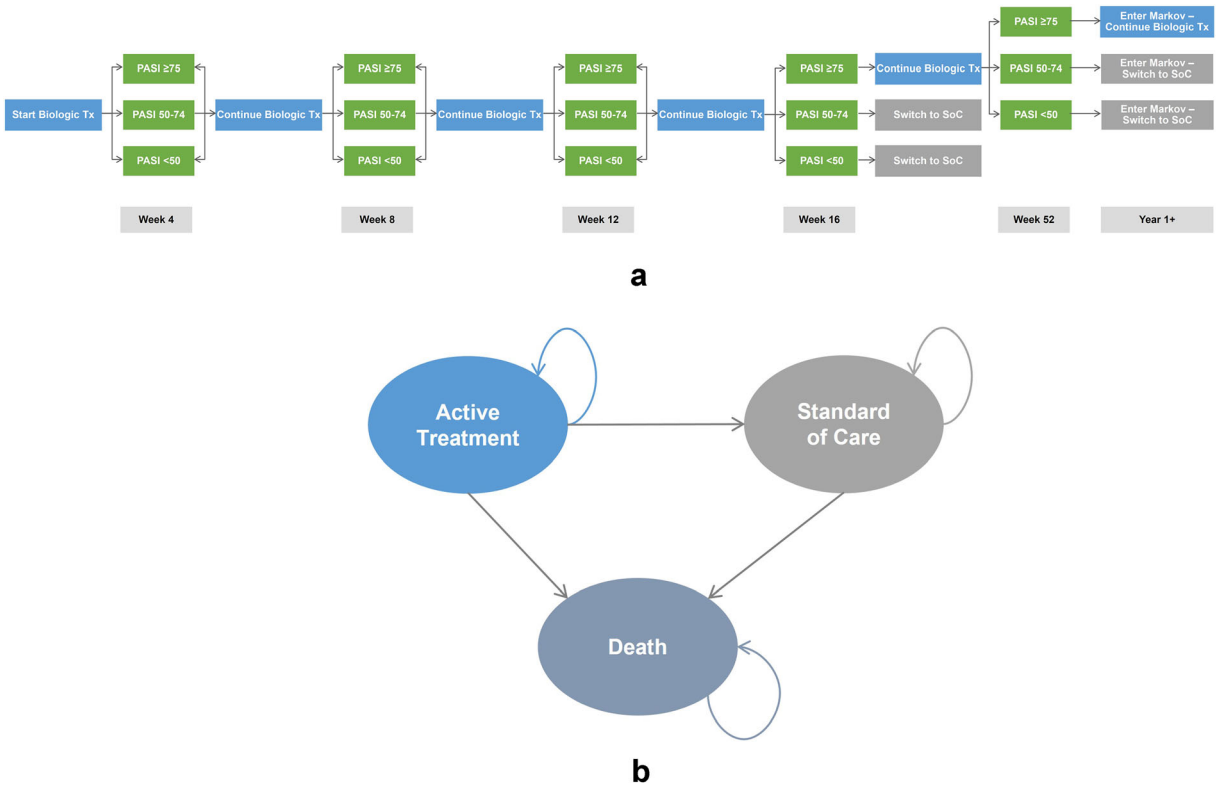

Fig. 1 **a** Model structure: short-term decision tree model. *PASI* Psoriasis Area Severity Index, *Tx* treatment, *SoC* standard of care. **b** Model structure: long-term Markov model

"standard of care" or "death". Patients who switched to standard of care treatment at any stage of model remained on it until death or the end of model time horizon. The model also considered a dropout rate for patients who were on active treatment between 16 and 52 weeks.

Model Assumptions

Non-responders (PASI < 50) to initial treatment were assumed to remain in that disease state with the standard of care until natural death. In patients with a sustained response at year 1, the PASI response state at week 16 was assumed to continue through week 52. Among patients who responded at week 16, but did not sustain their response at year 1, the PASI response state at week 16 was assumed to continue until they dropout at the midpoint between week 16 and 52. The dosing regimen for biologics was assumed to be in line with the approved label dose. No administration cost was assumed for subcutaneously (sc) administered treatment. For intravenous (iv) administration of infliximab, an additional visit cost was considered for each infusion.

Model Inputs

Efficacy Inputs

The PASI response rates at weeks 4, 8, 12, and 16 for all modeled interventions except guselkumab were obtained from a recently published mixed-treatment comparison, which compared the efficacy of secukinumab with other biologics in Chinese patients with moderate-to-severe plaque psoriasis (Table 2) [35]. For guselkumab, none of the identified studies reported data for the Chinese subpopulation at the time of analysis. Therefore, previously published network meta-analysis (NMA) by Pan et al. [36] was updated with a wider scope in January 2022 to identify the latest evidence on comparative efficacy of secukinumab and all other biologics

Table 2 Proportion of patients with PASI response rate by assessment timepoints

PASI response rate (%)[a,b]	Secukinumab[c] (%)	Adalimumab (%)	Infliximab (%)	Ustekinumab (%)	Ixekizumab[d] (%)	Guselkumab (%)	Yisaipu (%)	Standard of care (%)
4-week response								
PASI < 50	26.5	41.8	52.2	51.5	32.8	42.2	77.7	94.2
PASI 50–74	31.8	31.8	29.2	29.4	32.4	34.8	16.8	5.0
PASI 75–89	28.1	20.0	14.9	15.2	24.7	17.0	4.9	0.8
PASI 90–99	13.6	6.5	3.8	3.9	10.0	5.9	0.6	0.0
PASI 100[e]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8-week response								
PASI < 50	2.1	19.5	6.4	11.8	3.7	11.5	48.4	85.4
PASI 50–74	9.5	29.9	18.5	24.8	13.7	20.8	30.5	11.7
PASI 75–89	23.3	29.2	30.3	31.3	27.4	28.9	15.7	2.6
PASI 90–99	65.1	21.4	44.8	32.1	55.2	38.8	5.3	0.3
PASI 100[e]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12-week response								
PASI < 50	1.1	13.3	0.9	5.5	2.1	8.6	26.1	80.2
PASI 50–74	4.1	19.3	3.5	12.0	6.5	11.8	24.7	13.2
PASI 75–89	11.7	25.9	10.5	22.0	15.7	24.0	24.6	5.1
PASI 90–99	43.8	34.1	42.5	43.7	46.0	31.7	21.8	1.4
PASI 100[e]	39.3	7.5	42.6	16.8	29.7	23.9	2.8	0.0
16-week response								
PASI < 50	0.8	5.8	0.8	7.1	1.6	4.8	26.4	81.1
PASI 50–74	2.7	10.8	2.7	12.1	4.6	7.5	22.3	11.9

Table 2 continued

PASI response rate (%)[a,b]	Secukinumab[c] (%)	Adalimumab (%)	Infliximab (%)	Ustekinumab (%)	Ixekizumab[d] (%)	Guselkumab (%)	Yisaipu (%)	Standard of care (%)
PASI 75–89	9.2	21.6	9.1	22.9	13.1	16.8	25.1	5.3
PASI 90–99	46.0	50.7	43.6	41.8	49.0	40.5	23.2	1.5
PASI 100[e]	41.3	11.1	43.8	16.1	31.7	30.5	2.9	0.0

NMA network meta-analysis, *PASI* Psoriasis Area Severity Index, *RCTs* randomized controlled trials

[a]PASI response rate (PASI < 50) represents the corresponding percentage reduction (50%) in the PASI score from the baseline. For each intervention, the proportion of patients achieving PASI response rate is reported

[b]Efficacy data for all interventions except guselkumab was obtained from a published mixed-treatment comparison conducted with RCTs involving Chinese patients with moderate-to-severe plaque psoriasis [35]. For guselkumab, efficacy inputs were obtained by updating the NMA published by Pan et al. [36] in January 2022. Study details are reported in Supplementary Appendix A

[c]PASI response rate for the secukinumab arm was assumed to be a weighted average of the response rate for patients receiving secukinumab 150 mg and those receiving 300 mg in the ratio of 32.3% and 67.7%, respectively. This ratio was based on a real-world study of patients with psoriasis treated with secukinumab in China. Study details are reported in Supplementary Appendix B

[d]For ixekizumab, efficacy data was only available for week 12. For weeks 4, 8 and 16, efficacy inputs were calculated using week 12 response rates for ixekizumab and secukinumab arms

[e]PASI 100 data for all interventions was only available for week 12. For week 4 and week 8, PASI 100 inputs were set to 0.0%. For week 16, data was based on treatment-specific weighted average scores for PASI 90–99 and PASI 100 responses at week 12

for the treatment of moderate-to-severe plaque psoriasis (Table 2). Bayesian NMA method was used to combine evidence from the identified randomized controlled trials (RCTs). Details of the NMA methods and results are reported in the Supplementary Appendix A. For secukinumab, PASI response rate was assumed to be a weighted average of the response rate for patients receiving secukinumab 150 mg and those receiving 300 mg in the ratio of 32.3% and 67.7%, respectively. This ratio was derived from a real-world study evaluating the efficacy and safety of secukinumab treatment in Chinese patients with psoriasis. Study details are reported in the Supplementary Appendix B.

Dropout Rate Inputs

The dropout rate for the secukinumab arm was assumed to be a weighted average of the rate for secukinumab 150 mg (12.6%) and 300 mg (9.7%) arms in the ratio of 32.3% and 67.7%, respectively, based on data from a long-term phase 3 trial of secukinumab (ERASURE). For year 1, a dropout rate of 10.6% was estimated for the secukinumab arm [19]. For all other interventions, the year 1 dropout rate was assumed to be equivalent to that of the secukinumab arm. Beyond 1 year, a constant annual dropout rate of 20.0% was applied for all interventions representing a long-term adherence pattern to biologics based on published literature [37].

Adverse Events Inputs

Serious adverse events considered for analysis included non-melanoma skin cancer (NMSC), other malignancies, and severe infections (Table 3). Severe infections included sepsis, tuberculosis, pneumonia, skin and soft tissue infections, bone and joint infections, and urinary tract infections.

Mortality Inputs

The general annual mortality rates per 100,000 individuals were considered in the model, derived from the China Population and Employment Statistical Yearbook 2021 (Supplementary Table 5) [41].

Utility Inputs

Given the absence of preference-based health state utility estimates for Chinese patients with psoriasis, utility weights classified by PASI scores were derived using the Dermatology Life Quality Index (DLQI) data from a clinical trial of secukinumab evaluating patients with moderate-to-severe psoriasis in China (CAIN457A2318) [18]. An ordinal logistic regression method was implemented to map DLQI data to EQ-5D-3L-based utility estimates using the Chinese EQ-5D value set (Table 4) [42, 43]. Disutilities associated with methotrexate and cyclosporine, and the proportion of patients using each therapy are available in Table 4.

Cost and Resource Use Inputs

The model considered direct medical costs (without co-pay) which included drug acquisition costs, medical support costs (physician visits and monitoring), and adverse event costs (inpatient episode). All cost inputs were inflated to 2022 using the Chinese consumer price index (Table 5). The resource use pattern for interventions represented in the model is available in Supplementary Table 6.

Base-Case Analysis

The base-case analysis assessed the cost-effectiveness of secukinumab compared with other biologics from the Chinese healthcare system perspective. The primary effectiveness outcome was quality-adjusted life years (QALYs). The incremental cost-effectiveness ratio (ICER) was calculated and a treatment with higher QALYs at lower costs against a comparator was considered "dominant."

The base-case analysis was conducted over a lifetime horizon to comprehensively evaluate all relevant costs and health effects for this chronic condition. An annual discount rate of 5% was applied to both costs and outcomes [52]. A willingness-to-pay (WTP) threshold for China was considered to be three times the gross domestic product per capita in 2022 and set at ¥257,094/QALY [53].

Table 3 Rate of serious adverse events

Serious adverse events	Secukinumab[a] (%)	Adalimumab[b] (%)	Infliximab[b] (%)	Ustekinumab[b] (%)	Ixekizumab[c] (%)	Guselkumab[c] (%)	Yisaipu[b] (%)
Non-melanoma skin cancer	0.4	0.7	0.4	0.6	0.3	0.6	3.5
Other malignancies	0.4	0.6	7.7	0.6	0.5	0.6	0.0
Severe infections	1.0	5.2	5.5	1.0	0.1	0.6	5.1

[a]Secukinumab data was obtained from a pooled analysis of phase 3 trials data [19]. Adverse event rate for the secukinumab arm was assumed to be a weighted average of the rate for patients receiving secukinumab 150 mg and those receiving 300 mg in the ratio of 32.3% and 67.7%, respectively. This ratio was based on a real-world study of patients with psoriasis treated with secukinumab in China. Study details are reported in Supplementary Appendix B
[b]Adalimumab, infliximab, Yisaipu, and ustekinumab data were obtained from approved product label and Dixon et al. [38]
[c]Ixekizumab and guselkumab data were obtained from Armstrong et al. [39] and Blauvelt et al. [40], respectively

Sensitivity Analyses

One-way sensitivity analysis and probabilistic sensitivity analysis (PSA) were performed to assess the robustness of the study findings. In the one-way sensitivity analysis, the model input parameters such as PASI response, drop-out rate, adverse events, utility inputs, discount rate, and costs were varied to identify sensitive parameters with the greatest effect on the model results. A list of the parameters and their ranges is provided in the Supplementary Table 7.

In the PSA, the uncertainty around the results was determined by running the model 10,000 times with a certain distribution of each input parameter (response rate, dropout rate, costs, and utility weights). The analysis results were presented using cost-effectiveness acceptability curves estimated using the net monetary benefit (NMB) statistic for a range of WTP thresholds for each treatment. Scenario analyses were performed using different proportions for patients receiving secukinumab 150 mg and 300 mg (44.3% vs 55.7%, 59.5% vs 40.5%, and 70.6% vs 29.4%, respectively) based on real-world studies conducted in China. Details are provided in Supplementary Table 8. Another scenario analysis was conducted using alternative prices for adalimumab and infliximab based on the average retail price weighted according to their market share in China (Supplementary Table 9).

Compliance with Ethics Guidelines

This article is based on mathematical modeling with inputs informed primarily by previously conducted studies and does not contain any new studies with human participants or animals performed by any of the authors.

RESULTS

Base-Case Results

Among patients with moderate-to-severe plaque psoriasis, secukinumab generated the highest

Table 4 Utility weights and disutilities

Utility weights[a]	
PASI score	**EQ-5D utility weight**
PASI < 50	0.651
PASI 50–74	0.755
PASI 75–89	0.880
PASI 90–99	0.937
PASI 100	0.967
PASI ≥ 75	0.934
Disutilities associated with standard of care[b]	
Treatment	**Disutility**
Methotrexate	0.971
Cyclosporine	0.912

DLQI Dermatology Life Quality Index, *EQ-5D* EuroQol-5 Dimension, *PASI* Psoriasis Area Severity Index
[a]EQ-5D utility weights classified by PASI scores were calculated by mapping DLQI data from a phase 3 trial (CAIN457A2318) [18, 42] using the Chinese EQ-5D value set [43]
[b]Disutilities associated with standard of care were obtained from Diamantopoulos et al. [44]

QALYs (12.334) at a lifetime cost of ¥231,477. The iv administered infliximab achieved the second highest QALYs (12.330) followed by ixekizumab, guselkumab, adalimumab, ustekinumab, and Yisaipu. The total costs and QALYs for all the interventions are presented in Table 6.

With the highest number of QALYs at lower costs, secukinumab dominated all other biologics except ixekizumab in this population. Although patients receiving ixekizumab incurred marginally lower costs (¥228,320) than those receiving secukinumab, they gained fewer QALYs (12.284). Therefore, secukinumab was a cost-effective option compared with ixekizumab at a WTP threshold of ¥257,094 per QALY gained (Table 6).

Table 5 Cost inputs

Variable	**Cost**	**Source**
Cost for biologic treatments (per dose)		
Secukinumab 150 mg	¥870	Yaozhi website [45]
Secukinumab 300 mg	¥1479	Yaozhi website [45]
Adalimumab 40 mg	¥1290	Yaozhi website [45]
Infliximab 100 mg[a]	¥2007	Yaozhi website [45]
Ustekinumab 45 mg	¥4318	Yaozhi website [45]
Ixekizumab 80 mg	¥1218	Yaozhi website [45]
Guselkumab 100 mg	¥4571	Yaozhi website [45]
Yisaipu 50 mg	¥316	Yaozhi website [45]
Cost for non-biologic treatments (per day)		
Systemic treatments	¥15	Claims-based analysis[b]
Topical treatments	¥4	Claims-based analysis[b]
Medical support costs (per visit or assessment)		
Pre-treatment assessment	¥505	Claims-based analysis[b]
Monitoring	¥220	Claims-based analysis[b]
Regular physician visit	¥27	Claims-based analysis[b]
Skin cancer screening	¥134	Claims-based analysis[b]
Physician visit for iv administration[a]	¥8	Claims-based analysis[b]
Adverse event costs (per inpatient episode)		
Psoriasis	¥10,258	Claims-based analysis[b]
Sepsis	¥35,003	Zhu et al. [46]
Lymphoma	¥52,327	Jin et al. [47] and Chen et al. [48]
Melanoma	¥52,327	Jin et al. [47] and Chen et al. [48]
Non-melanoma skin cancer	¥52,327	Jin et al. [47] and Chen et al. [48]

Table 5 continued

Variable	Cost	Source
Tuberculosis	¥13,460	Du et al. [49] and Xie et al. [50]
Pneumonia	¥14,234	Claims-based analysis[b]
Skin and soft tissue infection	¥11,722	Lu et al. [51]
Bone and joint infection	¥11,722	Lu et al. [51]
Urinary tract infection	¥11,722	Lu et al. [51]
Costs for standard of care (per visit or assessment)		
Regular physician visit	¥27	Claims-based analysis[b]
Monitoring lab work: methotrexate	¥133	Claims-based analysis[b]
Monitoring lab work: cyclosporine	¥133	Claims-based analysis[b]
Liver biopsy during methotrexate treatment	¥181	Claims-based analysis[b]
UVB phototherapy	¥597	Claims-based analysis[b]

iv intravenous, *UVB* ultraviolet B

[a]Average weight of patient receiving infliximab iv infusion was assumed to be 60 kg. Administration cost applicable for infliximab only

[b]Cost inputs were derived using data from the China Health Insurance Research Association (CHIRA) medical insurance claims database. Study details are reported in Supplementary Appendix C

Sensitivity Analyses

In the one-way sensitivity analysis, the PASI response at 16 weeks and year 2+ dropout rates were found to be the most sensitive parameters affecting the model results for all treatment comparisons. The detailed results are shown using the tornado diagrams in Supplementary Fig. 4. The PSA results demonstrated that secukinumab was likely to provide the highest NMB in 76% of the simulations (Supplementary Table 10). Furthermore, the cost-effectiveness acceptability curve demonstrated that secukinumab had the highest probability of being cost-effective compared to other biologics at a WTP of ¥85,000 and above per QALY gained (Fig. 2).

Table 6 Costs, QALYs, and ICER values for patients with moderate-to-severe plaque psoriasis

Treatment	Total costs	QALYs	ICER (secukinumab versus comparator)
Secukinumab	¥231,477	12.334	–
Adalimumab	¥284,034	12.120	Dominates
Infliximab	¥369,555	12.330	Dominates
Ustekinumab	¥233,666	12.098	Dominates
Ixekizumab	¥228,320	12.284	¥62,323/QALY
Guselkumab	¥272,709	12.202	Dominates
Yisaipu	¥254,220	11.750	Dominates

ICER incremental cost-effectiveness ratio, *QALYs* quality-adjusted life years

In the scenario analyses with higher proportion of patients receiving secukinumab 150 mg versus 300 mg, secukinumab was the most cost-effective treatment compared with all other biologics except infliximab. Patients receiving infliximab gained slightly higher QALYs but at higher costs than those receiving secukinumab in all three scenarios. This resulted in an ICER of ¥23,933,817/QALY (proportion of patients receiving secukinumab 150 mg, 44.3%), ¥7,659,166/QALY (proportion of patients receiving secukinumab 150 mg, 59.5%), and ¥5,095,731/QALY (proportion of patients receiving secukinumab 150 mg, 70.6%), respectively, for infliximab compared with secukinumab. Thus, infliximab was not a cost-effective option compared with secukinumab at a WTP threshold of ¥257,094 per QALY gained. Similar to base-case analysis, secukinumab also dominated adalimumab and infliximab in the scenario analyses conducted using the alterative drug prices for adalimumab and infliximab, respectively. The results for

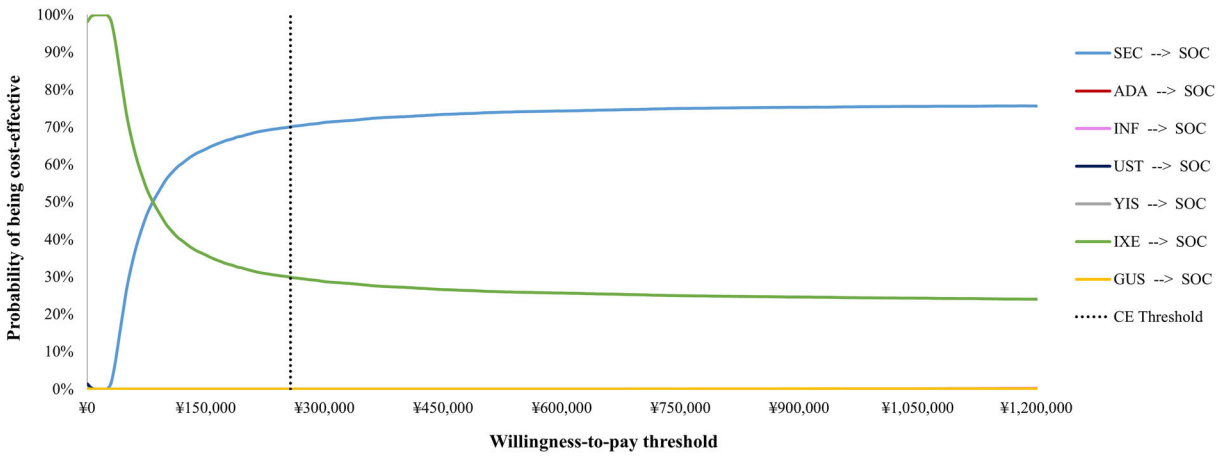

Fig. 2 Probability of cost-effectiveness for biologics at different willingness-to-pay thresholds. *ADA* adalimumab, *CE* cost-effectiveness, *GUS* guselkumab, *INF* infliximab, *IXE* ixekizumab, *SEC* secukinumab, *SoC* standard of care, *UST* ustekinumab, *YIS* Yisaipu

scenario analyses are presented in Supplementary Table 11.

DISCUSSION

The present study assessed the cost-effectiveness of secukinumab compared with other commonly used biologics for moderate-to-severe plaque psoriasis in China from the healthcare system perspective. To our knowledge, this is the first comprehensive economic evaluation comparing the costs and benefits (QALYs) associated with secukinumab versus other commonly used biologics in Chinese settings.

We found that secukinumab was a cost-effective treatment option compared with adalimumab, infliximab, ustekinumab, ixekizumab, guselkumab, and Yisaipu among patients with moderate-to-severe psoriasis over a lifetime horizon. The results of base-case analysis were most sensitive to changes in the PASI response at 16 weeks and year 2+ dropout rates for all treatment comparisons. The alternative scenario analyses also provided results similar to base-case analysis confirming the cost-effectiveness of secukinumab.

Our study results were aligned with similar evaluations conducted in other countries where secukinumab was a cost-effective option compared with adalimumab, etanercept, infliximab, and ustekinumab [24–29]. From the Japanese healthcare system perspective, secukinumab 300 mg dominated infliximab and ustekinumab, providing the highest QALYs at a lower cost in psoriasis treatment over a 5-year time horizon. The ICER for secukinumab compared with adalimumab was slightly higher than a WTP threshold of JP¥8,000,000 per QALY gained [24]. In the Italian National Health System (NHS) settings, secukinumab 300 mg was a cost-effective option against ustekinumab (dominant), adalimumab, etanercept, infliximab, and standard of care for the treatment of plaque psoriasis for over 10 years [25]. Similar findings were reported in a Canadian study evaluating the cost-effectiveness of secukinumab versus other biologics for plaque psoriasis over a 10-year time horizon. In this study, etanercept was strongly dominated, whereas adalimumab, ustekinumab, and secukinumab 150 mg were weakly dominated by secukinumab 300 mg. The ICER for infliximab versus secukinumab 300 mg was very high ($1,039,403 per QALY gained) [26]. In Germany, secukinumab 300 mg as the first-line treatment of moderate-to-severe psoriasis was the most cost-effective option that demonstrated the lowest cost per PASI 90 responder over 16 weeks as well as 52 weeks compared with adalimumab, etanercept, infliximab, and ustekinumab [27].

In contrast to our study findings, two studies reported modest cost savings and QALY gain with ixekizumab versus secukinumab in the treatment of moderate-to-severe psoriasis [30, 31]. In the UK, the cost-effectiveness of sequential biologics containing first-line ixekizumab versus first-line secukinumab (followed by ustekinumab, infliximab, and best supportive care) was assessed in patients with moderate-to-severe plaque psoriasis. Treatment with ixekizumab was associated with a marginal gain of 0.03 QALYs and cost savings of £898 compared with secukinumab over a lifetime horizon [30]. Similar results were obtained in another study evaluating ixekizumab versus secukinumab for moderate-to-severe plaque psoriasis in the Spanish NHS setting. Ixekizumab provided an additional 0.04 QALYs and potential savings of €1951 compared with secukinumab over a lifetime horizon [31]. One limitation of these analyses was exclusion of costs associated with serious adverse events requiring hospitalization [30, 31]. In the cost per responder analysis evaluating the guselkumab for the treatment of moderate-to-severe psoriasis in Germany, guselkumab had a lower cost per PASI 90 responder compared with adalimumab, apremilast, etanercept, infliximab, ixekizumab, secukinumab, tildrakizumab, and ustekinumab over a 1-year time horizon [32].

In China, one real-world study estimated the cost and effectiveness of adalimumab and secukinumab treatment for moderate-to-severe plaque psoriasis over 12 weeks. The cost per PASI 75 responder in the adalimumab group (¥17,581) was lower than that in the secukinumab group (¥46,332). This difference was attributed to the higher drug price of secukinumab (¥2998) than adalimumab (¥1290) during year 2019–2020 when only adalimumab was included in the national reimbursement drug list (NRDL) [33]. This study considered only the drug acquisition costs over 12 weeks, whereas in our analysis, different medical costs were accounted for the total cost estimation. In addition, our analysis used QALYs, the most preferred outcome measure for economic evaluation.

Various factors contributed to the strength of this analysis. Based on approved product label and common clinical practice in China, the current evaluation considered the weight-based dosing for secukinumab. In the absence of head-to-head RCTs, the comparative clinical efficacy data for different biologics were derived from an NMA, conducted using the Bayesian technique. Inclusion of costs for drug acquisition, medical support, and adverse events in the current analysis indicated the true economic burden of psoriasis on the Chinese healthcare system. To better reflect the preference of Chinese patients, the DLQI data was used to derive the EQ-5D-based utility estimates. A lifetime horizon was considered to account for the chronic course of the disease. Finally, the robustness of the model results was confirmed using both one-way and probabilistic sensitivity analyses.

Nonetheless, this model-based analysis has certain limitations. The model used short-term efficacy data to project lifetime efficacy, derived from the NMA which was restricted to week 16 because of crossover of treatment arms beyond week 12 or week 16. The other limitation was treatment sequencing, as the present analysis was restricted to first-line biologic treatment only. In clinical practice, patients who do not respond to first-line biologic can switch to another biologic agent. However, efficacy inputs for treatment sequencing are not readily available in the literature. Thus, results may be sensitive to assumptions about the choice and efficacy of subsequent treatments. Drug costs were estimated using the published list prices; therefore, this analysis did not include any confidential discounts. Dropout rates from the secukinumab trials were used to calculate the QALYs for all other biologics. Finally, indirect costs were not considered as the analysis was performed from a healthcare system perspective.

CONCLUSIONS

This cost-effectiveness analysis demonstrated that secukinumab is the most cost-effective treatment option compared with other commonly used biologics (adalimumab, infliximab, ustekinumab, ixekizumab, guselkumab, and

Yisaipu) for moderate-to-severe plaque psoriasis in China over a lifetime horizon.

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Data Availability. All data generated or analyzed during this study are included in this published article or as supplementary information files.

Declarations

Conflict of Interest. Jinsui Zhang, Zemin Xia, Min Hu and Wen Chen declare that they have no conflicts of interest. Wanjie Guo, Xiaoxiao Ren and Fang Liu are employees of Novartis Pharmaceuticals, Beijing, China. Gargi Ratnaparkhi, Amit Pagada and Subhashini Subramanian are employees of Novartis Healthcare Pvt. Ltd., Hyderabad, India.

Ethical Approval. This article is based on mathematical modeling with inputs informed primarily by previously conducted studies and does not contain any new studies with human participants or animals performed by any of the authors.

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