International Journal of Technology Assessment in Health Care

www.cambridge.org/thc

Method

Cite this article: Hoelen T-CA, Nebel A-S, Paulus ATG, Evers SMAA, Willems PC, van Mastrigt GAPG (2026). Reference prices matter: impact on cost analyses in economic evaluations. *International Journal of Technology Assessment in Health Care*, **42**(1), e78, 1–8
https://doi.org/10.1017/S0266462326104103

Received: 20 April 2026 UTC
Revised: 09 June 2026 UTC
Accepted: 29 July 2026 UTC

Keywords:
reference prices; cost analysis; health technology assessment; economic guidelines; national costing guidelines

Corresponding author:
Thomáy-Claire Ayala Hoelen;
Email: thomay.hoelen@mumc.nl

© The Author(s), 2026. Published by Cambridge University Press. This is an Open Access article, distributed under the terms of the Creative Commons Attribution licence (http://creativecommons.org/licenses/by/4.0), which permits unrestricted re-use, distribution and reproduction, provided the original article is properly cited.

Reference prices matter: impact on cost analyses in economic evaluations

Thomáy-Claire A. Hoelen[1], Ann-Sophie Nebel[2], Agnes T.G. Paulus[3,4], Silvia M.A.A. Evers[3], Paul C. Willems[1] and Ghislaine A.P.G. van Mastrigt[3]

[1]Department of Orthopaedic Surgery, Care and Public Health Research Institute (CAPHRI), Maastricht University Medical Centre+, Netherlands; [2]Maastricht University, Faculty of Health Medicine and Life Sciences, Netherlands; [3]Department of Health Services Research, Care and Public Health Research Institute (CAPHRI), Maastricht University Faculty of Health Medicine and Life Sciences, Netherlands and [4]School of Health Professions Education (SHE), Maastricht University Faculty of Health Medicine and Life Sciences, Netherlands

Abstract

Objectives: Variability in methodology and pricing across country-specific health economic evaluation (EE) guidelines hampers cross-national transferability. Guideline updates can also impede generalizability within countries over time. This study empirically illustrates how changes in reference prices impact cost analysis within (partial) EEs, using the economic burden of adolescent idiopathic scoliosis (AIS) in the Netherlands and the United Kingdom (UK).

Methods: Country-specific databases were used to estimate costs to compare within- and cross-country EE guidelines. Reference prices from the Dutch (2014 and 2024) and UK (2021/2022 and 2022/2023) guidelines were considered, and resource usage was held constant. Costs were indexed (2022) and adjusted using Purchasing Power Parity. Societal cost per AIS patient, share attributions, and unit costs between EE guidelines were compared.

Results: Within-country comparisons indicated societal cost increases in the Netherlands (18 percent) and the UK (1 percent). Following a Dutch guideline update, twelve cost items changed by >10 percent, compared with four did in the UK update. UK societal costs were 69 percent higher than in the Netherlands. Ten cost items differed by >100 percent, with generally higher UK costs.

Conclusions: EEs cost analyses are substantially influenced by differences in reference prices across countries. National guideline updates can markedly affect the within-country comparability and generalizability of cost analyses over time. Increased transparency in methods used to derive reference prices is essential to improve transferability and interpretation of EE results. A standardized approach for estimating reference prices could reduce methodological variation, strengthen consistency across jurisdictions, and enhance comparability of international and longitudinal EEs.

Introduction

In times of high demand and limited resources, there is a need for more efficient allocation of existing resources in healthcare (1). The importance of health technology assessment (HTA) has risen since it provides a systematic approach to determining health conditions and interventions (2) and thereby may aid decision makers in efficient resource allocation (3). This is preferably performed utilizing a societal perspective, which entails considering all costs regardless of who incurred them (4;5). An example of a methodology applied in HTA is the cost-of-illness study (6), which aims to determine the economic burden associated with the disease or condition (7) and provides essential information that helps prioritize healthcare policies and interventions as well as aids in allocation of resources (8).

Being able to utilize economic evidence such as that from cost-of-illness studies in multiple contexts and healthcare settings further aids efficiency. However, there is great variation in the methodology and pricing structures described in country-specific EE guidelines. (9;10). More specifically, there is a lack of uniformity in reference prices, which are standardized average cost prices of cost units (11). This presents a challenge when comparing the economic burden between countries, making transferability more difficult. Additionally, updates of country-specific EE guidelines can further hamper the generalizability of study findings within countries over time. A prior study evaluated the impact of reference costs on valuation methods for unit cost calculation of general practitioner consultations (10). Mayer et al. concluded that the different approaches used to determine costs resulted in cross-study and cross-country cost variation that in turn reduced the reliability of EE data (10). Similarly, Essers et al. investigated the transferability of model-based EEs and found that overall structures of EEs may be transferable, although adaptations in the model inputs may be necessary (12).

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 17 Nov 2026 at 21:39:28, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/S0266462326104103

However, the impact of guideline reference price updates on cost analyses in health EEs has not been empirically quantified. To illustrate this gap, the economic burden associated with adolescent idiopathic scoliosis (AIS) was selected as an example. AIS refers to a complex spinal deformity that negatively impacts quality of life, results in productivity losses, and leads to recurring healthcare utilization, making it a relevant example for evaluating reference price influences on cost analyses. Assessing this empirical impact provides insight into how much reference prices depend on methodological choices and the reference year, as well as the limitations for comparability in findings over time and across multiple healthcare contexts. Furthermore, this can lead to collaborative optimization in the standardization of reference price derivation and prioritization of decisions on the management of diseases or conditions. Therefore, this study empirically illustrates how changes in reference prices affect cost analysis in EEs over time and across countries, using the economic burden associated with adolescent idiopathic scoliosis (AIS) in the Netherlands and the United Kingdom.

Methods

To empirically illustrate the impact of reference prices over time within and across countries, a cross-sectional study on the economic burden of AIS was used as an example. A quantitative research design was adopted, and the economic burden of AIS was considered from a societal perspective. The population prevalence of AIS is similar in both countries (2–3 percent) (13).

Context

The Netherlands and UK guidelines were selected as examples in this study since both countries have extensive expertise within HTA research and comprehensive national health EE guidelines. Additionally, recent updates of both guidelines make them relevant for demonstrating the impact of differences in reference prices over time. The Netherlands utilizes a costing manual incorporated within the Dutch health EE guideline for conducting EEs in healthcare (11). In the United Kingdom, the Personal Social Services Research Unit (PSSRU) developed a unit cost program providing annual cost estimates for health and social care services (14;15). Reference prices as reported in economic evaluation guidelines from the Netherlands (versions: 2014 (16) and 2024 (11)) and the United Kingdom (versions: 2021–2022 (14) and 2022–2023 (15)) were considered.

Economic burden of AIS

In 2022, a national, cross-sectional economic burden of AIS study was conducted using a bottom-up approach and societal perspective (17;18). The study was performed according to the Dutch guideline for EE (version: 2014) (16). Costs were assessed using the Institute for Medical Technology Assessment – Medical Consumption (19) (iMTA-MCQ) and Productivity Cost (20) (iMTA-PCQ) questionnaires. All costs were indexed for the year 2022 and presented in euros. In total, 229 participants with AIS completed the survey. The study used previously collected and anonymized data on resource usage during a period of 3 months as the basis for the current study on the impact of reference prices.

Data collection

The unit cost estimations were determined using a three-step approach: (i) identification, (ii) measurement, and (iii) valuation.

Identification

The cost items identified in the previously published societal burden of AIS study in 2022 (17) were considered in the current study. The identification of cost items was based on a societal perspective and included healthcare sector costs (e.g., visits to the general practitioner or medical specialist), patient and family costs (e.g., transport costs to the hospital), other sector costs (e.g., school days), and productivity losses consisting of costs associated with absenteeism, presenteeism, and unpaid voluntary work (21).

Measurement

Resource usage was fixed regardless of the guideline used for the analysis and was also based on resource usage (volumetric data) from the societal burden of AIS study previously conducted (17). The resource usage corresponded to a period of 3 months (quarterly).

Valuation

The valuation of costs was dependent on the country and guideline used. The unit costs per item were based on the calculation of multiplying the resource usage by the reference price. All reference prices for unit costs were indexed for the year 2022 and presented in euros. Adjustments for price conversion were considered based on the OANDA Currency Converter adjusted to May 2022 (OANDA, 2024). Furthermore, adjustments for Purchasing Power Parities (PPPs) were considered based on national PPPs provided by the OECD (22). PPPs are currency conversion rates based on gross domestic product that balance the purchasing power of different currencies by removing price level discrepancies between countries (22). The validity of PPP is influenced by factors such as the exchange rate and economic structures of countries and global openness (23). In line with the Dutch costing guidelines, PPP conversion took place after indexation (11).

In accordance with the Dutch guideline, the cost of informal care was estimated using the replacement cost method (16). According to the Dutch costing guideline, the preferred Friction Cost Method (FCM) was used to calculate productivity losses by multiplying total absenteeism time by the regular employee cost. The FCM assumes replacement after a friction period (± 19 weeks) (11). The cost of the medication was valued using the lowest cost price available in the data (24).

The cost estimation of the UK unit prices was carried out in accordance with the PSSRU unit cost program in 2022 (14) and was compared with the new guideline in 2023 (15). In addition, the National Health Service (NHS) reference cost schedule was used, which contains various service codes and specific cost information (25). Unit costs for each item that were most comparable to those in the Dutch guideline were selected. The estimated average friction period between 2010 and 2021 was 72.7 days (~10 weeks) for the United Kingdom (26). The national CPI was used (2.72 percent) (27), prices were converted by the currency rate of ~1.18 (28), and adjustments for PPPs were calculated using the factor 0.65 (22). In case no UK reference price could be found, the Dutch unit price was used as a proxy and subsequently converted into UK-equivalent values using currency conversion rates and PPP adjustments.

Reference price comparison

The difference in total societal costs per individual with AIS for a period of 3 months between guidelines and countries was considered. Subsequently, the cost share attributions for the various sectors, for example, healthcare, patient and family, other sector costs, and productivity, were compared. Finally, the unit costs per item were

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 17 Nov 2026 at 21:39:28, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/S0266462326104103

compared between the Netherlands and the United Kingdom, in order to determine the transferability of cost analyses. In addition, to investigate generalizability, the same calculations were performed for both guidelines per country. Differences were calculated using the formula: $\frac{New\,guideline - Old\,guideline}{Old\,guideline} * 100\%$.

Data analysis

The nonparametric bootstrapping method (1,000 replications) was performed for the cost calculations for each cost category (17;29). The continuous data were presented as mean and the categorical data as count. The significance level was set at p-value ≤0.05, and the data processing, calculations, and statistical analysis were conducted using R-software version 4.1.0 (package: summarytools, forcats, dplyr, tableone).

Ethics

Non-WMO approval was obtained for the original study from the Medical Ethical Testing Committee (METC) of the University Maastricht/academic hospital Maastricht (UM/MUMC+), as well as consent from the advisory board of the MUMC+ (METC 2022-3166). Informed consent was obtained from all participants before the start of the original study.

Results

Societal costs

To illustrate the practical implications of reference price differences, the total bootstrapped societal costs and individual sector costs associated with AIS over a 3-month period were calculated per country-specific guideline (Table 1). Differences between countries of more than 10 percent are presented in blue in Table 1. When using the Dutch 2014 guideline, the total bootstrapped societal costs per patient with AIS amounted to €1,562.70 (SD €270.95) per quarter, indexed for 2022. Updating the Dutch guideline (2014–2024), increased the bootstrapped quarterly societal costs by ~18 percent to €1,838.82 (SD €277.08), whereas updating the UK guidelines (2021/2022–2022/2023), increased costs by <1 percent from €3,082.89 (SD €361.72) to €3,102.34 (SD €362.87). Based on the most recent guidelines (NL: 2024 vs UK: 2022/2023), UK total societal cost estimates were ~69 percent higher than those for the Netherlands.

Cost share attribution

In both Dutch guidelines, productivity losses accounted for the largest share of total costs at 54 percent (guideline 2014) and 52 percent (guideline 2024), followed by healthcare sector costs at 40 percent (guideline 2014) and 38 percent (guideline 2024) (Supplementary Material, Table S1). The productivity losses and healthcare sector costs decreased slightly when adopting the updated guideline (2024). This was compensated by the 4 percent increase in other sector costs.

For the United Kingdom, this was reversed, with the healthcare sector costs accounting for the majority of the quarterly societal costs at 54 percent and 55 percent, respectively. This was followed by productivity losses at 44 percent (2021/2022 guideline) and 43 percent (2022/2023 guideline).

Unit costs

The variations in cost share attribution can be accounted for by changes in unit costs. An overview of the cost per unit item for the healthcare, patient and family, other sector costs, and productivity losses is provided in Table 2. Unit costs for all guideline versions and the difference in unit cost per item are presented.

Between the Dutch guideline updates (2014 vs. 2024), twelve cost items varied in price by more than 10 percent (Marked as blue in Table 2). Most notable increases in unit costs were seen for school days (65 percent), social work (60 percent), and homecare-household activities (34 percent). The most notable decreases in unit costs were seen for dietitian (59 percent), occupational therapist (40 percent), and the general practitioner (23 percent) consultations, as well as costs for transportation (24 percent). This is unlike the difference in unit costs between the UK guidelines, where only four cost items differed in price by more than 10 percent (marked as blue in Table 2). The general practitioner costs have increased most significantly by 31 percent, followed by dietitian costs, which have decreased by 19 percent.

When comparing the most recent UK guideline to the most recent Dutch guideline, there are ten items that differ more than 100 percent (Marked as blue in Table 2) in unit cost, with some items differing up to 581 percent. Most items have a higher unit cost in the UK guideline than the Dutch guideline.

Discussion

This study aimed to determine the impact of changes in reference prices on cost analyses in EEs over time and across countries, using AIS as an illustrative example. An increase of 18 percent in total societal costs per patient per quarter was noted for the Dutch 2024 guideline compared to the earlier version (2014). For the United Kingdom, the difference in total societal costs between guideline updates was merely 1 percent. This highlights the role of frequent guideline updates in shaping apparent cost differences, beyond methodological or definitional changes. When comparing the most recent guidelines between countries, UK costs were ~69 percent higher than those in the Netherlands despite identical resource use and indexation for the same year. These findings demonstrate that total cost estimates are strongly influenced by the selection of guideline reference prices, and that cost analyses are highly sensitive to changes in reference prices even when controlling for PPP index year and resource usage for a specific condition.

For example, it is surprising that the reference price for general practitioner consultations in the updated Dutch guideline has decreased despite higher demand and tighter resources in healthcare. According to the Dutch guideline (2014), the reference price for a general practitioner consultation, indexed for 2022, was €40.33. This was based on the total expenditure of 2013, the insured population of that same year, and the number of consultations per person. However, in the updated Dutch guideline, the reference price was significantly reduced to €30.87, including registration fees. The difference may be due to changes in calculation methodology utilized since it was based on total expenditure in 2021 and the number of consultations in 2021 (11). This example illustrates how differences in total societal costs could be attributed to variation in unit costs. These differences may arise depending on the definition used for a specific cost item or the methodology used to determine the reference price used to calculate the unit cost (10). Thus, reference prices are not merely reflections of market prices or system expenditure, but are constructed estimates dependent on methodological assumptions, including cost components, allocation methods, and valuation perspectives (10).

Beyond the impact on societal costs, variations in reference prices also affected the distribution of costs across sectors. With regard to cost share attribution, productivity losses accounted for

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 17 Nov 2026 at 21:39:28, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/S0266462326104103

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 17 Nov 2026 at 21:39:28, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/S0266462326104103

Table 1. Quarterly societal costs per individual with adolescent idiopathic scoliosis indexed for 2022

	Resource usage			Unit costs										
	3 months			Dutch 2014		Dutch 2024		Δ	UK 2022[a]		UK 2023[a]		Δ	Δ Dutch 2024 vs. UK 2023
Category	Min	Max	Mean (SD)	Mean	SD	Mean	SD	%	Mean	SD	Mean	SD	%	%
Healthcare sector costs														
General Practitioner	0	20	1.29 (2.70)	€ 52.10	(108.80)	€ 39.87	(83.33)	−23	€ 98.44	(205.70)	€ 128.50	(268.60)	31	222
Social Worker	0	4	0.11 (0.52)	€ 8.80	(41.01)	€ 14.11	(65.58)	60	€ 10.32	(47.98)	€ 10.65	(49.51)	3	−25
Physical therapist	0	50	5.51 (7.08)	€ 222.30	(285.60)	€ 214.40	(275.50)	−4	€ 430.40	(552.90)	€ 409.00	(525.50)	−5	91
Occupational therapist	0	7	0.08 (0.65)	€ 3.20	(26.04)	€ 1.91	(15.71)	−40	€ 7.31	(60.01)	€ 7.40	(60.75)	1	287
Speech therapist	0	4	0.03 (0.29)	€ 1.02	(10.56)	€ 1.14	(11.79)	12	€ 2.17	(22.48)	€ 2.06	(21.36)	−5	81
Dietitian	0	3	0.08 (0.38)	€ 5.00[b]	(22.60)	€ 2.06	(9.30)	−59	€ 15.49	(70.00)	€ 12.51	(56.55)	−19	507
Homeopath/acupuncturist	0	6	0.13 (0.66)	€ 7.10	(36.44)	€ 7.13	(36.44)	0	€ 48.53	(248.00)	€ 48.53	(248.00)	0	581
Psychologist/psychiatrist	0	12	0.70 (2.05)	€ 74.90	(220.20)	€ 84.59	(248.60)	13	€ 85.75	(252.00)	€ 79.68	(234.20)	−7	−6
Occupational physician	0	2	0.10 (0.38)	€ 10.20	(38.43)	€ 10.19	(38.43)	0	€ 27.44	(103.60)	€ 25.43	(95.95)	−7	150
Inpatient care (overnight hospital stay)	0	13	0.15 (1.14)	€ 88.90	(663.60)	€ 82.04	(612.80)	−8	€ 209.10	(1,562.00)	€ 209.10	(1,562.00)	0	155
Day treatment	0	5	0.14 (0.51)	€ 46.80	(171.80)	€ 46.53	(170.70)	−1	€ 39.75	(145.80)	€ 41.46	(152.10)	4	−11
Outpatient care (<24 hours)	0	10	0.67 (1.31)	€ 74.60	(145.80)	€ 80.56	(157.30)	8	€ 490.30	(957.70)	€ 510.10	(996.30)	4	533
Emergency care	0	1	0.02 (0.15)	€ 7.30	(47.69)	€ 5.97	(38.89)	−18	€ 6.88	(44.77)	€ 6.88	(44.77)	0	15
Ambulance	0	0	0	€ 0.00		€ 0.00			€ 0.00		€ 0.00			
Medication prescription costs	0	10	1.30 (1.87)	€ 231.80	(1,345.79)	€ 231.28	(1,345.28)	0	€ 353.85	(2,130.98)	€ 353.85	(2,130.98)	0	53
Home care – household activities	0	13	0.20 (1.49)	€ 4.80	(36.27)	€ 6.37	(48.63)	33	€ 6.37	(48.63)	€ 6.37	(48.63)	0	0
Home care – personal care at home	0	0	0	€ 0.00		€ 0.00			€ 0.00		€ 0.00			
Home care – nursing at home	0	0	0	€ 0.00		€ 0.00			€ 0.00		€ 0.00			
Total healthcare sector costs				€849.05	(121.72)	€838.44	(119.77)	−1	€1,845,27	(235.96)	€1,864.72	(237.68)	1	122
Patient and family costs														
Transportation costs	0	50	7.67 (8.48)	€ 9.80	(10.69)	€ 9.10	(9.96)	−7	€ 15.74	(20.00)	€ 15.74	(20.00)	0	73
Parking costs per visit at hospital	0	11	0.87 (1.66)	€ 3.20	(6.11)	€ 3.39	(6.52)	6	€ 6.36	(12.21)	€ 6.36	(12.21)	0	88
Medication OTC costs	0	2	0.50 (0.66)	€ 1.20	(5.89)	€ 1.22	(5.89)	2	€ 1.46	(5.85)	€ 1.46	(5.85)	0	20
Total patient and family costs				€ 14.20	(1.16)	€ 13.71	(1.11)	−3	€ 23.53	(2.25)	€ 23.53	(2.25)	0	72

(*Continued*)

Table 1. (*Continued*)

	Resource usage			Unit costs										
	3 months			Dutch 2014		Dutch 2024		Δ	UK 2022[a]		UK 2023[a]		Δ	Δ Dutch 2024 vs. UK 2023
Category	Min	Max	Mean (SD)	Mean	SD	Mean	SD	%	Mean	SD	Mean	SD	%	%
Other sector costs														
School days	0	30	2.50 (6.17)	€ 115.60	(283.96)	€ 190.35	(468.11)	65	€ 42.14	(103.64)	€ 42.14	(103.64)	0	−78
Total other costs				€ 30.20	(10.50)	€ 49.82	(17.31)	65	€ 11.03	(3.83)	€ 11.03	(3.83)	0	−78
Productivity costs														
Absenteeism	0	366	5.81 (39.0)	€ 639.60	(3,797.76)	€ 597.00	(3,538.00)	−7	€ 357.00	(1,914.00)	€ 357.00	(1,914.00)	0	−40
Presenteeism	0	18	0.76 (1.90)	€ 97.04	(241.56)	€ 91.10	(227.00)	−6	€ 91.10	(227.00)	€ 91.10	(227.00)	0	0
Productivity loss unpaid work	0	180	7.97 (23.8)	€ 409.00	(1,221.74)	€ 450.00	(1,343.00)	10	€ 1,022.00	(3,054.00)	€ 1,022.00	(3,054.00)	0	127
Total productivity costs				€ 944.40	(248.64)	€ 936.86	(236.10)	−1	€ 1,203.06	(223.90)	€1,203.06	(223.90)	0	28
Total societal costs				€ 1,562.70	(270.95)	€ 1,838.82	(277.08)	18	€ 3,082.89	(361.72)	€3,102.34	(362.87)	1	69

SD, standard deviation; OTC, over the counter drug.
[a]Currency rate of 1.17776 (15 May 2022), PPP calculated using the factor 0.651.
[b]Unit cost not reported in guideline (estimate used).

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 17 Nov 2026 at 21:39:28, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/S0266462326104103

Table 2. Overview of reference prices indexed for 2022

Category	Unit guideline	Reference price[a] (€), Mean (SD)			Reference price[a] (€), Mean (SD)			Dutch 2024 vs. UK 2023 (%)
		Dutch 2014[b]	Dutch 2024	Δ (%)	UK 2022[c]	UK 2023[c]	Δ (%)	
Healthcare sector costs								
General Practitioner	Consult	€ 40.33	€ 30.87	−23	€ 76.21	€ 99.51	31	222
Social Worker	Consult	€ 79.43	€ 127.00	60	€ 92.92	€ 95.88	3	−25
Physical therapist	Consult	€ 40.33	€ 38.89	−4	€ 78.05	€ 74.18	−5	91
Occupational therapist	Consult	€ 40.33	€ 24.32	−40	€ 92.92	€ 94.07	1	287
Speech therapist	Consult	€ 36.66	€ 40.93	12	€ 78.05	€ 74.18	−5	81
Dietitian[d]	Consult	€ 60.00	€ 24.70	−59	€ 185.84	€ 150.15	−19	508
Homeopath/acupuncturist	Consult	€ 55.00	€ 55.00	0	€ 374.35	€ 374.35	0	581
Psychologist/psychiatrist	Consult	€ 107.20	€ 121.00	13	€ 122.66	€ 113.98	−7	−6
Occupational physician	Consult	€ 100.00	€ 99.00	−1	€ 269.46	€ 249.66	−7	152
Inpatient care (overnight hospital stay)	Days	€ 581.67	€ 537.00	−8	€ 1,368.80	€ 1,368.80	0	155
Day treatment	Consult	€ 337.20	€ 335.00	−1	€ 286.19	€ 298.51	4	−11
Informal care	Consult	€ 17.10	€ 18.80	10	€ 42.75	€ 42.75	0	127
Outpatient care (<24 hours)	Consult	€ 111.20	€ 120.00	8	€ 730.34	€ 759.85	4	533
Emergency care	Consult	€ 316.50	€ 258.00	−18	€ 297.02	€ 297.02	0	15
Ambulance	Ride	€ 629.20	€ 528.00	−16	€ 682.01	€ 754.42	11	43
Medication prescription costs	Number	Variable	Variable		Variable	Variable		
Home care – household activities	Hours	€ 24.44	€ 32.76	34	€ 32.76[e]	€ 32.76[e]	0	0
Home care – personal care at home	Hours	€ 61.10	€ 57.58	−6	€ 42.75	€ 48.85	14	−15
Home care – nursing at home	Hours	€ 89.20	€ 75.00	−16	€ 75.00[e]	€ 75.00[e]	0	0
Patient and family costs								
Transportation costs	Trip	€ 3.25	€ 2.47	−24	€ 10.15	€ 10.15	0	311
Parking costs per visit at hospital	Trip	€ 3.67	€ 3.92	7	€ 7.34	€ 7.34	0	87
Medication OTC costs	Number	Variable	Variable		Variable	Variable		
Other sector costs								
School days	Days	€ 46.03	€ 75.88	65	€ 16.80	€ 16.80	0	−78
Productivity costs								
Absenteeism and presenteeism	Hours	€ 42.46	€ 39.88	−6	€ 39.88[e]	€ 39.88[e]	0	0
Productivity loss unpaid work	Hours	€ 17.11	€ 18.80	10	€ 42.75	€ 42.75	0	127

[a]All prices are indexed for the year 2022.
[b]CPI calculated using the factor 1.222, PPP calculated using the factor 0.726.
[c]Currency rate of 1.17776 (15 May 2022), PPP calculated using the factor 0.651.
[d]Reference price of this item was not reported in guidelines; therefore, a price estimate was used.
[e]Utilization of Dutch reference prices according to the 2024 guideline.

the greatest share of societal costs in the Netherlands, whereas in the United Kingdom the majority of the societal costs could be attributed to the healthcare sector. There was notable variation in unit costs for the country-specific guideline updates in the Netherlands, with differences up to 65 percent in unit cost, whereas the UK guidelines showed less variation, with differences up to 31 percent. The variation was also reflected when comparing country-specific cost items between the Netherlands and United Kingdom, with differences up to 580 percent.

The difference between the Netherlands and United Kingdom may be due to the application of guideline-specific unit costs while controlling resource utilization rather than aggregating spending at the system level. Additionally, variation in methodological construction of reference prices, including variation in the incorporation of components such as labor costs, overhead attribution, and service costing approaches used in unit valuations may have resulted in higher total costs for the United Kingdom (30;31). Although PPP adjustments aid monetary comparability between

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 17 Nov 2026 at 21:39:28, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/S0266462326104103

jurisdictions, they do not eliminate methodological differences in the derivation of reference prices (32;33;34).

Furthermore, differences may occur because of variation in the adopted perspective of the EE. The lack of standardized reference prices for cost items such as absenteeism can be attributed to the United Kingdom's adopted EE perspective, which lies between a healthcare and a full societal perspective (35). For categories without a standardized UK reference price, Dutch reference prices were substituted and converted using PPP. The need for proxy estimates highlights a practical challenge encountered when conducting multinational economic evaluations and may have introduced bias. Additionally, this variation in the preferred perspective reduces transferability and increases the potential for error due to estimations or substitutions for missing reference prices.

These findings have broader implications for national and international health economic research and policymaking. Within-country guideline updates primarily affect the generalizability of cost analyses over time as identical resource utilization can lead to substantially different cost estimates following updates in reference prices. In contrast, cross-country differences in reference prices primarily affect the transferability of cost analyses, posing a major challenge for multinational collaborations seeking to align cost outcomes. These discrepancies limit the utility of EEs for informing multinational decision making, reimbursement strategies, or cross-border health initiatives. Thus, the findings in this study emphasize the need for standardization and harmonization of the methodology for determining unit cost estimates and reference prices at the national and international level (10;33;34). The current study provides empirical support for initiatives such as the PECUNIA project, which aims to enhance international comparability through harmonized methods for developing reference unit costs (33;34). By illustrating how variations in the construction of reference prices impact cost analyses, the present findings reinforce the importance of such harmonization efforts. Similarly, Hjemlgren et al. compared health EE guidelines from various countries and concluded that more explicit insight into the monetary valuation of resources is needed for harmonization with respect to reference prices (36).

While standardization and harmonization of reference price methodologies may improve the comparability of cost analysis, they do not solely account for the variation in HTA outcomes across countries. Differences in HTA frameworks, willingness-to-pay thresholds, health outcome valuation and decision making criteria may arise depending on how HTA jurisdictions conceptualize and value health gains (37;38;39). Consequently, standardization and harmonization of reference price methodologies serve as a complementary step toward improving transferability of EEs.

The variation in cost share attribution may also impact prevention and intervention strategies that target specific sectors. Strategies aimed at reducing healthcare sector costs may not be as impactful in the Netherlands compared to the United Kingdom, considering the main cost share attribution in the Netherlands is centered around productivity sector losses. These are essential aspects to consider when implementing cross-national prevention or intervention strategies, for example, the context of cross-border healthcare collaborations.

This study demonstrates the impact of reference prices on cost analyses in EEs and thereby raises awareness of the resulting implications. By acknowledging the challenges, discussions can be started, and solutions can be found. To understand the impact reference prices have on cost analyses, factors such as resource usage were controlled. However, it should be noted that resource usage may change depending on the context of the study.

A limitation of this study is the error in unit cost valuation. There are several variables that contribute to increased margins of error in reference prices. First, reference price definitions varied between guidelines, and hence the reference price that was most representative was selected. Second, in case reference prices were not available, an estimation had to be made, as was the case for the reference price of a dietitian consultation for the Dutch guideline (version 2014). These increases in error further illustrate the need for standardization of definitions and availability of similar reference prices for items across countries. Finally, the lack of UK reference prices for productivity losses required the use of Dutch proxy estimates, which may have resulted in a biased presentation of the true costs. However, it also demonstrates a practical challenge in EEs across multiple nations, where a lack of comprehensive guideline coverage requires the adoption of proxy estimates.

Conclusions

Changes in reference prices substantially impact cost analyses within and across countries. The sensitivity of cost analyses reduces the transferability of cost analysis findings between countries. Furthermore, reference price changes due to country-specific guideline updates hamper the generalizability of longitudinal studies' findings within countries. Greater transparency, standardization, and international harmonization of reference price methodologies are needed to improve comparability, transferability, and usefulness of EEs.

Supplementary material. The supplementary material for this article can be found at http://doi.org/10.1017/S0266462326104103.

Author contribution. The authors made the following contributions. Conceptualization: T.C.A.H. and A.N. Material preparation: T.C.A.H., and A.N. Data curation: T.C.A.H. and A.N. Formal analysis: T.C.A.H. and A.N. Writing – original draft preparation: T.C.A.H. Writing – review and editing: T.C.A.H. and A.N. Final approval: T.C.A.H. and A.N.

Authorship confirmation. All authors certify that they meet the ICMJE criteria for authorship.

Funding statement. The authors received no financial support for this research. Open access funding provided by Maastricht University Medical Centre.

Competing interests. The authors declare none.

References

1. **Goeree R**, **He J**, **O'Reilly D**, et al. Transferability of health technology assessments and economic evaluations: A systematic review of approaches for assessment and application. *ClinicoEconomics and Outcomes Research*. 2011;**3**:89–104. https://doi.org/10.2147/CEOR.S14404.
2. **Mitton C**, **Seixas BV**, **Peacock S**, **Burgess M**, **Bryan S**. Health technology assessment as part of a broader process for priority setting and resource allocation. *Appl Health Econ Health Policy*. 2019;**17**(5):573–576. https://doi.org/10.1007/s40258-019-00488-1.
3. **Drost RM**, **van der Putten IM**, **Ruwaard D**, **Evers SM**, **Paulus AT**. Conceptualizations of the societal perspective within economic evaluations: A systematic review. *Int J Technol Assess Health Care*. 2017;**33**(2):251–260. https://doi.org/10.1017/S0266462317000526.
4. **Kim DD**, **Silver MC**, **Kunst N**, et al. Perspective and costing in cost-effectiveness analysis, 1974–2018. *PharmacoEconomics*. 2020;**38**(10):1135–1145. https://doi.org/10.1007/s40273-020-00942-2.

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 17 Nov 2026 at 21:39:28, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/S0266462326104103

5. **Avşar TS**, **Yang X**, **Lorgelly P**. How is the societal perspective defined in health technology assessment? Guidelines from around the globe. *PharmacoEconomics*. 2023;**41**(2):123–138. https://doi.org/10.1007/s40273-022-01221-y.
6. **Wiethoff I**, **Evers SM**, **Michels M**, **Hiligsmann M**. An introduction to health technology assessment and health economic evaluation: An online self-learning course. *Neth Hear J*. 2023;**31**(6):219–225. https://doi.org/10.1007/s12471-023-01777-0.
7. **Larg A**, **Moss JR**. Cost-of-illness studies. *PharmacoEconomics*. 2011;**29**(8):653–671. https://doi.org/10.2165/11588380-000000000-00000
8. **Jo C**. Cost-of-illness studies: Concepts, scopes, and methods. *Clin Mol Hepatol*. 2014;**20**(4):327–337. https://doi.org/10.3350/cmh.2014.20.4.327.
9. **Goeree R**, **Burke N**, **O'Reilly D**, et al. Transferability of economic evaluations: Approaches and factors to consider when using results from one geographic area for another. *Curr Med Res Opin*. 2007;**23**(4):671–682. https://doi.org/10.1185/030079906X167327.
10. **Mayer S**, **Fischer C**, **Zechmeister-Koss I**, **Ostermann H**, **Simon J**. Are unit costs the same? A case study comparing different valuation methods for unit cost calculation of general practitioner consultations. *Value Health*. 2020;**23**(9):1142–1148. https://doi.org/10.1016/j.jval.2020.06.001.
11. **Hakkaart - van Roijen L**, **Peeters S**, **Kanters T**, et al.. 2024 Kostenhandleiding voor economische evaluaties in de gezondheidszorg: Methodologie en Referentieprijzen Diemen; 2024. https://www.zorginstituutnederland.nl/documenten/2024/01/16/richtlijn-voor-het-uitvoeren-van-economische-evaluaties-in-degezondheidszorg
12. **Essers BA**, **Seferina SC**, **Tjan-Heijnen VC**, et al. Transferability of model-based economic evaluations: The case of trastuzumab for the adjuvant treatment of HER2-positive early breast cancer in the Netherlands. *Value Health*. 2010;**13**(4):375–380. https://doi.org/10.1111/j.1524-4733.2009.00683.x.
13. **Negrini S**, **Donzelli S**, **Aulisa AG**, et al. 2016 SOSORT guidelines: Orthopaedic and rehabilitation treatment of idiopathic scoliosis during growth. *Scoliosis and Spinal Disorders*. 2018;**13**:1–48. https://doi.org/10.1186/s13013-017-0145-8
14. **Jones K**, **Weatherly H.**, **Birch S**, et al. *Unit costs of health and social care 2022 manual. Technical report*. Kent, UK: Personal Social Services Research Unit (University of Kent) & Centre for Health Economics (University of York); 2023.
15. **Jones KC**, **Weatherly H**, **Birch S**, et al. *Unit costs of health and social care 2023 manual. Technical report*. Kent, UK: Personal Social Services Research Unit (University of Kent) & Centre for Health Economics (University of York); 2024.
16. **Hakkaart-van Roijen L**, **Van der Linden N**, **Bouwmans C**, **Kanters T**, **Tan SS**. Kostenhandleiding: Methodologie van kostenonderzoek en referentieprijzen voor economische evaluaties in de gezondheidszorg In opdracht van Zorginstituut Nederland Geactualiseerde versie. 2015.
17. **Hoelen T-CA**, **Evers SM**, **Arts JJ**, **Willems PC**, **van Mastrigt GA**. The societal burden associated with adolescent idiopathic scoliosis: A cross-sectional burden-of-disease study. *BMC Public Health*. 2024;**24**(1):3065. https://doi.org/10.1186/s12889-024-20423-x.
18. **Hoelen T-CA**, **Willems PC**, **Arts JJ**, **van Mastrigt G**, **Evers S**. The economic and societal burden associated with adolescent idiopathic scoliosis: A burden-of-disease study protocol. *North American Spine Society Journal (NASSJ)*. 2023;**14**:100231. https://doi.org/10.1016/j.xnsj.2023.100231.
19. **Bouwmans C**, **Hakkaart-van Roijen L**, **Koopmanschap M**, et al. IMTA Productivity Cost Questionnaire (IPCQ). *Value Health*. 2014;**17**(7):A550. https://doi.org/10.1016/j.jval.2014.08.1791.
20. **Bouwmans C**, **Krol M**, **Severens H**, et al. The iMTA productivity cost questionnaire: A standardized instrument for measuring and valuing health-related productivity losses. *Value Health*. 2015;**18**(6):753–758. https://doi.org/10.1016/j.jval.2015.05.009.
21. **Drummond MF**, **Sculpher MJ**, **Claxton K**, **Stoddart GL**, **Torrance GW**. *Methods for the economic evaluation of health care programmes*. 4th ed. Oxford, UK: Oxford University Press. 2015.
22. **OECD**. Purchasing Power Parities (PPP) (indicator). 2024. Available from: https://data.oecd.org/conversion/purchasing-power-parities-ppp.html.
23. **Nagayasu J**. Causal and frequency analyses of purchasing power parity. *J Int Financ Mark Inst Money*. 2021;**71**:101287. https://doi.org/10.1016/j.intfin.2021.101287.
24. **Zorginstituut Nederland. Medicijnkosten**. Medicijnkosten nl. 2022. Available from: https://www.medicijnkosten.nl/.
25. **NHS**. 2021/22 National Cost Collection Data Publication England. 2023. Available from: https://www.england.nhs.uk/publication/2021-22-national-cost-collection-data-publication/.
26. **Hanly P**, **Ortega M**, **Pearce A**, et al. Estimating global friction periods for economic evaluation: A case study of selected OECD member countries. *PharmacoEconomics*. 2023;**41**(9):1093–1101. https://doi.org/10.1007/s40273-023-01261-y.
27. **Statistics OfN**. Methodological development to public service productivity: healthcare. 2020. Available from: https://www.ons.gov.uk/.
28. **OANDA**. Currency Converter: OANDA. 2024 Available from: https://www.oanda.com/currency-converter/en/?from=USD&to=EUR&amount=1.
29. **van den Boom N**, **van den Hurk A**, **Kalmet P**, **Poeze M**, **Evers S**. Economic evaluations in fracture research an introduction with examples of foot fractures. *Injury*. 2022;**53**(3):815–820.
30. **Amies-Cull B**, **Luengo-Fernandez R**, **Scarborough P**, **Wolstenholme J**. NHS reference costs: A history and cautionary note. *Heal Econ Rev*. 2023;**13**(1):54. https://doi.org/10.1186/s13561-023-00469-0.
31. **Mokri H**, **Kvamme I**, **de Vries L**, **Versteegh M**, **van Baal P**. Future medical and non-medical costs and their impact on the cost-effectiveness of life-prolonging interventions: A comparison of five European countries. *Eur J Health Econ*. 2023;**24**(5):701–715. https://doi.org/10.1007/s10198-022-01501-6.
32. **Fischer C**, **Mayer S**, **Perić N**, **Simon J**. Harmonization issues in unit costing of service use for multi-country, multi-sectoral health economic evaluations: A scoping review. *Heal Econ Rev*. 2022;**12**(1):42. https://doi.org/10.1186/s13561-022-00390-y.
33. **Mayer S**, **Berger M**, **Perić N**, et al. The development of a new approach for the harmonized multi-sectoral and multi-country cost valuation of services: The PECUNIA reference unit cost (RUC) templates. *Appl Health Econ Health Policy*. 2024;**22**(6):783–796. https://doi.org/10.1007/s40258-024-00905-0.
34. **Pokhilenko I**, **Kast T**, **Janssen L**, et al. International comparability of reference unit costs of education services: When harmonizing methodology is not enough (PECUNIA project). *Expert Rev Pharmacoecon Outcomes Res*. 2023;**23**(1):135–141. https://doi.org/10.1080/14737167.2023.2152331.
35. **Sittimart M**, **Rattanavipapong W**, **Mirelman AJ**, et al. An overview of the perspectives used in health economic evaluations. *Cost effectiveness and resource allocation*. 2024;**22**(1):41. https://doi.org/10.1186/s12962-024-00552-1.
36. **Hjelmgren J**, **Berggren F**, **Andersson F**. Health economic guidelines—Similarities, differences and some implications. *Value Health*. 2001;**4**(3):225–250. https://doi.org/10.1046/j.1524-4733.2001.43040.x.
37. **Vemer P**, **Rutten-van Mölken MP**. Largely ignored: The impact of the threshold value for a QALY on the importance of a transferability factor. *Eur J Health Econ*. 2011;**12**(5):397–404. https://doi.org/10.1007/s10198-010-0253-3.
38. **Weise A**, **Buechter RB**, **Pieper D**, **Mathes T**. Assessing transferability in systematic reviews of health economic evaluations–a review of methodological guidance. *BMC Med Res Methodol*. 2022;**22**(1):52. https://doi.org/10.1186/s12874-022-01536-6.
39. **Ahmadnezhad E**, **Kheirandish M**, **Akbari-Sari A**, **Rashidian A**. Systematic review of tools and approaches for evaluating the transferability of health technology assessments across different jurisdictions. *Int J Health Policy Manag*. 2024;**13**:8218. https://doi.org/10.34172/ijhpm.8218.

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 17 Nov 2026 at 21:39:28, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/S0266462326104103