Do the daily tariffs of hospital stay in the guidelines for economic evaluation reflect the actual costs of hospitalisation in the Netherlands?

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Abstract

BACKGROUND

The Dutch guidelines for economic evaluation recommend cost-utility analysis for performing an economic evaluation. For the cost-analysis of this evaluation, the use of standard tariffs is recommended by the Dutch guideline for costing studies, when performing micro-costing studies is too time-consuming. However, the standard daily tariff for a hospital stay is only based on an unpublished micro-costing study performed on the neurology-, paediatric- and surgery unit(1). The standard daily tariff appears to be an overestimation of the price reflecting all hospital units. In addition, the uncertainty around this tariff is not mentioned in the guideline. Therefore, it is not known which extent of uncertainty has to be taken into account when using the standard daily tariff. This study aims to convert the Dutch standard daily tariff to the estimated actual costs of hospitalization. A method for estimating the actual daily tariff and its uncertainty will be researched. Thereafter, the impact of the deviation from the actual price on cost-utility analysis will be determined. In this way, the usability of the Dutch standard daily tariff will be researched.

METHODS

A method for estimating the actual Dutch standard daily tariff based on the more accurate UK tariffs was developed. The deviation in inpatient day price of the three units relative to all hospital units was calculated and used as a correction factor in order to calculate the actual Dutch tariff. Also, the uncertainty of this modified tariff was determined by using the deviation of the bounds of the 95% CI from the average price of the UK tariffs. The impact on the incremental cost-utility ratio (ICUR) of the modified standard tariff was researched by incorporating this new tariff in a Dutch cost-utility study, using the Dutch standard daily tariffs. In addition, a sensitivity analysis was performed by using the bounds of the 95% CI in the cost-utility analysis and researching the outcomes on the ICUR.

RESULTS

A comparison between the UK average costs of all hospital units and the UK neurology-, paediatric- and surgery unit showed a deviation of +34,06%. After adjustment of the Dutch standard tariff for an inpatient day with this deviation, the tariff changed from €476 to €355 (95% CI: €275-€615). This modified tariff for an inpatient day increases the ICUR of minimally invasive pancreatectomy from -€23,722 to €4,980 per QALY (sensitivity analysis: €24.054 - -€56.617 per QALY).

CONCLUSION

Altogether, the Dutch standard tariff for an inpatient day should be used with caution in cost-utility analysis. Based on the UK standard tariffs for a hospital stay, the three hospital units used for calculating the Dutch standard daily tariffs seems to lead to a too high estimate of the costs. In addition, the deviation of the standard tariff from the actual costs proved to have a substantial impact on the ICUR outcomes. The change of

the ICUR can lead to a different position towards the willingness-to-pay (WTP) threshold and therefore can result in different policy decisions. Also, the sensitivity analysis showed a high variation in price across different hospital units. For this reason, the uncertainty based on the UK data is relevant to take into account when using the reference price.

Introduction

In order to balance the supply and demand for healthcare in countries, economic evaluations are performed. Healthcare interventions are compared in economic evaluations on both costs and clinical effects. In the Netherlands, cost-utility analysis (CUA) is recommended in guidelines as a type of economic evaluation. Within the cost-utility analysis, clinical effects are expressed as quality-adjusted life years (QALYs) and costs as monetary units. QALYs are an aggregate of time spent in a healthy state and the associated quality of life (QoL)(2).

Furthermore, costs are obtained by performing costing studies, for which bottom-up micro-costing is the gold standard. However, micro-costing studies can be time-consuming and performing the most-precise method is not always necessary when the concerned cost component is not a major part of the total costs(3). For this reason, standard tariffs can be used for some components of the cost-analysis. The Dutch guideline for costing studies provide these standard tariffs for when it is not possible or needed to perform a micro-costing study, with the aim to gain comparability and quality of the economic evaluation in the Netherlands(1).

For hospitalisation, the use of a standard daily tariff is advised. However, differences in indications or healthcare resource use are not included in this tariff. Furthermore, guideline research showed the price is only based on the neurology-, paediatric- and surgery unit(4). The choice for these units has only based on the availability of a, not published yet, micro-costing study performed on these three units(5). However, there is not known whether the costs of these units are representative of the costs of all hospital units. The standard daily tariff might be an overestimation of the actual price of hospitalisation.

Previous studies have shown the impact of different hospital costing methods on economic evaluation. In these studies, different methods in cost-analysis eventually lead to changed cost-effectiveness and for this reason, in possible different policy decisions(6). The impact of an insufficient estimate of the standard daily tariff of hospital stay is not known. Therefore, this study aims to convert the Dutch standard daily tariff to the estimated actual costs of hospitalisation. A method for estimating the actual daily tariff and its uncertainty will be researched. Thereafter, the impact of the deviation from the actual price on cost-utility analysis will be determined. In this way, the usability of the Dutch standard daily tariff will be researched.

Methods

METHOD FOR ESTIMATING THE ACTUAL DUTCH DAILY TARIFF

The actual Dutch standard daily tariff was approximated by using the UK tariffs for inpatient days. Since the original costing data for specific healthcare related groups (HRG) is available for the UK(7), it was possible to compare the average price of an inpatient day with the price on the neurology-, paediatric- and surgery unit. The deviation in inpatient day price of the three units relative to all units was used to convert the Dutch reference price to an average overall price. In this way, the actual Dutch daily tariff was estimated.

In order to calculate the UK average prices, the excel file 'National schedule of reference costs 2017-2018' was used in Excel 2007(8). The prices in tabs 'Elective Inpatients Excess Bed Days' and 'Non-Elective Inpatients Excess Bed Days' were used because this UK costing data does provide a price for an inpatient day and the total utilization of this service shown per HRG.

The average UK price of all hospital units was calculated by determining the proportion between the total bed days of elective inpatients excess bed days and non-elective inpatients excess bed days and multiplying these ratios with the average unit costs for both types of excess bed days. After that, both outcomes were summed up and, in this way, the weighted average UK price of all hospital units was determined. For the calculation of the average price of the three hospital units, the HRGs concerning neurology and paediatrics were included, since surgery interventions do not have specific HRGs codes. Also, surgery interventions are incorporated into the neurology- and paediatric HRGs. The average price for these HRGs was calculated by summing up the total cost of elective inpatients excess bed days and non-elective inpatients excess bed days per unit and dividing this outcome with the sum of the total activity of both types of excess bed days per unit. The mean of the two obtained average prices for an inpatient day per unit was calculated, and the outcome was the average price of the three hospital units. This method was chosen since the Dutch standard daily tariff was also obtained by calculating the mean of the average prices for an inpatient day per unit(4).

IMPACT OF ADJUSTMENT OF THE STANDARD DAILY TARIFF

After the Dutch standard daily tariff was converted to an average price for all hospital units with the deviation factor, the impact of the adjusted price on the incremental cost-utility ratio (ICUR) of a cost-utility analysis was researched. The adjusted daily tariff was incorporated in the cost-utility analysis of following Dutch study: *'Costs and quality of life in a randomized trial comparing minimally invasive and open distal pancreatectomy (LEOPARD trial)'* (2019)(9). The study used the Dutch standard daily tariffs for inpatient days in order to value the duration of hospital stay. The ICUR of minimally invasive pancreatectomy compared with open distal pancreatectomy was re-estimated using the modified reference price. This obtained ICUR was compared to the original ICUR in the study.

The formula in figure 1 was used in order to re-calculate the ICUR. In this calculation, the QALYs remained constant while the costs varied after the adjustment of the hospital costs. The total costs of both interventions were re-calculated by dividing the admission costs (shown in table 4) by the correction factor. Subsequently, the impact of the adjusted standard daily tariff on the base case ICUR was researched. Re-calculations of costs and the ICUR were performed in Excel 2007.

$$ICUR = \frac{costs\ laparoscopic\ distal - costs\ open\ distal}{QALYs\ laparoscopic\ distal - QALYs\ open\ distal}$$

Figure 1 formula for calculating the ICUR

SENSITIVITY ANALYSIS

A 95% confidence interval was calculated for the UK inpatient daily tariff and the re-estimated Dutch daily tariff. Since the adjusted Dutch inpatient daily tariff was based on the UK daily tariff, the same deviation from the mean of the low and high 95% CI of the UK price was used for the Dutch price. After the 95%, CI for the Dutch daily tariff was determined, a sensitivity analysis was performed to research the low and high 95% CI impact on the ICUR. For the lower bound, the adjusted inpatient costs were divided by the deviation factor from the mean, while for the upper bound, the costs were multiplied by the deviation factor. After that, the lower and upper outcome of the total costs were filled in the ICUR formula (figure 1), while the QALYs remained the same, and both effects on the ICUR were researched.

Results

METHOD FOR ESTIMATING THE ACTUAL DUTCH DAILY TARIFF

Average UK daily tariff for inpatient days

Table 1 shows the calculation conducted for determining the average UK price for an inpatient day. After the proportion of the total activity from the elective and non-elective hospital stays was taken into account, the average price of £345,76 was found.

Table 1 calculation of the UK average price for an inpatient daily tariff

Description	Total activity	Unit cost (weighted average HRGs)	Proportion (elective/non-elective)	Costs ($Ratio \times unit\ cost$)
Elective Inpatients Excess Bed Days	373.428	£431,11	0,0896	£38,63
Non- Elective Inpatients Excess Bed Days	3.794.287	£337,36	0,9104	£307,13
Average price inpatient day ($Cost\ elective + cost\ non - elective$)				£345,76

Average UK daily tariff for the neurology-, paediatric- and surgery unit

After including the interventions on the neurology-, paediatric- and surgery unit, the total costs and excess bed days were determined. Table 2 shows these data and the calculation conducted for the UK daily tariff for the neurology-, paediatric- and surgery unit. An average daily tariff of £463,64 was found for these hospital units.

Table 2 calculation of the UK inpatient daily tariff for the neurology-, paediatric- and surgery unit

	Total costs (elective)	Total costs (non-elective)	Excess bed days (elective)	Excess bed days (non-elective)	Average price per unit
Neurology	£14.685.982	£132.331.079	36.312	410.874	£329
Paediatric	£18.384.009	£74.835.977	27.358	128.395	£598,51
Average $\frac{\Sigma Total\ costs}{\Sigma \text{Excess bed days}}$					£463,64

Estimating the actual Dutch daily tariff for inpatient days

After determining the UK daily tariff for all units and the neurology-, paediatric- and surgery unit, the deviation in inpatient day price of the three units relative to all units was calculated. A deviation of +34,09% was found. For this reason, a correction factor of 1,3409 was used to convert the Dutch reference price (€476,00) to an average overall price. In this way, the actual Dutch daily tariff was estimated at €354,98. The calculations conducted can be found in table 3.

Table 3 calculation of the actual Dutch inpatient daily tariff

	UK daily tariff	Dutch daily tariff
Neurology-, paediatric- and surgery unit	£463,64	€476,00
All hospital units	£345,76	€354,98
Correction factor $Daily\ tariff\ 3\ units / Daily\ tariff\ all\ units$	1,3409	1,3409

IMPACT OF ADJUSTMENT OF THE STANDARD DAILY TARIFF

The cost-utility analysis of the study *'Costs and quality of life in a randomized trial comparing minimally invasive and open distal pancreatectomy (LEOPARD trial)'* (2019) (9) is shown in table 4. The study estimates QALYs generated for laparoscopic distal pancreatectomy at 0,81 and open distal pancreatectomy at 0,792. The total costs for laparoscopic distal pancreatectomy are €14.204 per patient and for open distal pancreatectomy €14.631 per patient. Eventually, the calculation conducted for the ICUR in this study resulted in -€23.722 per QALY.

Table 4 costs and incremental cost utility ratio (ICUR) of minimally invasive pancreatectomy (costs in euro 2016)

Resource		Unit	Laparoscopic distal pancreatectomy (*n* = 43) Mean units	Costs	Open distal pancreatectomy (*n* = 56) Mean units	Costs	Difference in costs
Surgery		Procedure	1,0	5.081	1,0	4.043	1.038
Admission				6.517		8.549	(2.032)
	Surgical ward	Days	11,4	5.950	12,1	6.806	(857)
	ICU	Days	1,7	567	4,0	1.743	(1.175)
After discharge				841		600	239
	Outpatient clinic	Visit	4,7	628	3,6	489	139
	Emergency room	Visit	0,8	213	0,4	112	101
Imaging		Procedure	3,5	647	3,2	500	147
Reinterventions		Procedure	1,4	1.118	1,3	938	181
Total costs				14.204		14.631	90
QALYs			0,81			0,792	
ICUR per QALY					(23.722)		

The ICUR of minimally invasive pancreatectomy compared with open distal pancreatectomy was re-estimated using the modified Dutch daily tariff. The hospital costs in the cost-utility analysis were adjusted by dividing the admission costs in table 4 with the correction factor 1,3409. The outcomes of this conducted calculation are shown in table 5. After modifying the Dutch daily tariff, the total costs for laparoscopic distal pancreatectomy are estimated at €12.547 per patient and for open distal pancreatectomy €12.457 per patient. Since the QALYs remain constant, the ICUR is determined at €4.980 per QALY.

Table 5 costs and incremental cost utility ratio (ICUR) of minimally invasive pancreatectomy after adjustment of the daily tariff (costs in euro 2016)

Resource		Unit	Laparoscopic distal pancreatectomy (*n* = 43) Mean units	Costs	Open distal pancreatectomy (*n* = 56) Mean units	Costs	Difference in costs
Surgery		Procedure	1,0	5.081	1,0	4.043	1.038
Admission				6.517		8.549	(2.032)
	Surgical ward	Days	11,4	4.437	12,1	5.076	(857)
	ICU	Days	1,7	423	4,0	1.300	(1.175)
After discharge				841		600	239
	Outpatient clinic	Visit	4,7	628	3,6	489	139
	Emergency room	Visit	0,8	213	0,4	112	101
Imaging		Procedure	3,5	647	3,2	500	147
Reinterventions		Procedure	1,4	1.118	1,3	938	181
Total costs				12.547		12.457	90
QALYs			0,81			0,792	
ICUR per QALY					4.980		

Therefore, the conversion of the Dutch reference price to an average overall price in the cost-utility analysis leads to an increase in the ICUR from -€23,722 to €4,980 per QALY.

SENSITIVITY ANALYSIS

A 95% confidence interval was calculated for the UK inpatient daily tariff and the re-estimated Dutch daily tariff, which CI was based on the UK interval. Table 6 shows the calculation of the 95% CI for both tariffs. The 95% CI of the UK tariff was calculated at £345,76 (£267,42 - £598,74) and the Dutch tariff at €354,98 (€274,55 - €614,71).

Table 6 95% confidence interval of the UK inpatient daily tariff and the re-estimated Dutch daily tariff

	Lower bound	Average price (μ)	Upper bound
UK	£267,42	£345,76	£598,74
Netherlands	€274,55	€354,98	€614,71
Deviation (%) from μ	29,29%		73,17%

First of all, the low 95% CI impact on the ICUR was calculated. The hospital costs in the cost-utility analysis were adjusted to the lower bound by dividing the admission costs in table 5 with the correction factor 1,2929 (table 6). Table 7 shows the outcomes of adjusting to the lower bound of the 95% CI in the cost-utility analysis. After modifying the admission costs, the total costs for laparoscopic distal pancreatectomy are estimated at €11.446 per patient and for open distal pancreatectomy €11.013 per patient. Since the QALYs remain constant, the ICUR is determined at €24.054 per QALY.

Table 7 sensitivity analysis of the low 95% CI impact on the ICUR (costs in euro 2016)

Resource		Unit	Laparoscopic distal pancreatectomy (*n* = 43) Mean units	Costs	Open distal pancreatectomy (*n* = 56) Mean units	Costs	Difference in costs
Surgery		Procedure	1,0	5.081	1,0	4.043	1.038
Admission				6.517		8.549	(2.032)
	Surgical ward	Days	11,4	3.432	12,1	3.926	(857)
	ICU	Days	1,7	327	4,0	1.005	(1.175)
After discharge				841		600	239
	Outpatient clinic	Visit	4,7	628	3,6	489	139
	Emergency room	Visit	0,8	213	0,4	112	101
Imaging		Procedure	3,5	647	3,2	500	147
Reinterventions		Procedure	1,4	1.118	1,3	938	181
Total costs				11.446		11.013	433
QALYs			0,81			0,792	
ICUR per QALY					24.054		

Thereafter, the high 95% CI impact on the ICUR was researched. The admission costs in table 5 were multiplied with the correction factor 1,7317 (table 6) in order to obtain the higher bound in the cost-utility analysis. The outcomes of adjusting to the higher bound of the 95% CI are shown in table 8. The total costs for laparoscopic distal pancreatectomy are estimated at €16.103 per patient and for open distal pancreatectomy €17.122 per patient. The ICUR is determined at -€56.617 per QALY.

Table 8 sensitivity analysis of the high 95% CI impact on the ICUR (costs in euro 2016)

Resource		Unit	Laparoscopic distal pancreatectomy (*n* = 43) Mean units	Costs	Open distal pancreatectomy (*n* = 56) Mean units	Costs	Difference in costs
Surgery		Procedure	1,0	5.081	1,0	4.043	1.038
Admission				6.517		8.549	(2.032)
	Surgical ward	Days	11,4	7.684	12,1	8.789	(857)
	ICU	Days	1,7	732	4,0	2.251	(1.175)
After discharge				841		600	239
	Outpatient clinic	Visit	4,7	628	3,6	489	139
	Emergency room	Visit	0,8	213	0,4	112	101
Imaging		Procedure	3,5	647	3,2	500	147
Reinterventions		Procedure	1,4	1.118	1,3	938	181
Total costs				16.103		17.122	(1.019)
QALYs			0,81			0,792	
ICUR per QALY					(56.617)		

In summary, the use of the Dutch average price for all hospital units in the cost-utility analysis leads to an increase in the ICUR from -€23,722 to €4,980 per QALY with a sensitivity of €24.054- -€56.617 per QALY.

Discussion

This aim of this study was to research the usability of the Dutch standard daily tariff by estimating the actual Dutch tariff for an inpatient day. A method for a better estimate and its uncertainty was researched. Also, the impact of the re-estimated price and the uncertainty on cost-utility analysis was determined.

METHOD FOR ESTIMATING THE ACTUAL DUTCH DAILY TARIFF

The calculated deviation between the UK average price of an inpatient day of all hospital units and the price on the neurology-, paediatric- and surgery unit was +34,09%. With this deviation, the Dutch daily tariff for all hospital units was obtained at €354,98.

A limitation of this estimation method is the different price structure of the UK and Dutch tariffs for an inpatient day. For the Dutch tariffs, medication and diagnostics are excluded from the tariff(4). While for the UK tariffs, these components are included in the tariff, except for highly expensive medicines and diagnostics(7). The medicines and diagnostics might explain the costs differences between different HRGs partly. For this reason, it is possible that the found deviation is an overestimation. However, also in the Dutch guideline for costing analysis, high differences between different units can be observed. For instance, the difference between the neurology unit (€395) and the paediatric unit (€627)(10).

On the other hand, the unpublished micro-costing study where the Dutch standard tariff is based on can also lead to a limitation for the estimation method. For the calculation of the average UK price for the neurology-, paediatric- and surgery unit, the costs for surgery within the neurology-, paediatric unit was used. Since it was not possible to research how the Dutch study included the surgery costs, this can lead to a deviation in the calculated average price for all hospital units from the actual price.

IMPACT OF ADJUSTMENT OF THE STANDARD DAILY TARIFF

The modified Dutch daily tariff for all hospital units increases the ICUR of minimally invasive pancreatectomy from -€23,722 to €4,980 per QALY. For this reason, a difference in ICUR of €28.702 per QALY was observed. Such a high impact can influence the position of the ICUR according to the willingness-to-pay threshold. Eventually, this can lead to non-reimbursement of cost-effective healthcare and the availability for the patient.

However, the perspective of the used study was a hospital healthcare perspective(9). Using this perspective, is a possible limitation for determining the effect because healthcare decisions in the Netherlands are based on cost-utility analysis studies with a societal perspective(7). For this reason, further research is needed in order to determine the impact and the consequences of the modified Dutch daily tariff.

SENSITIVITY ANALYSIS

The 95% confidence interval for the modified Dutch daily tariff (€354,98) was calculated at €275-€615, based on the UK 95% confidence interval. Thereafter, the effect of the

upper and lower bound on the ICUR was obtained: €24.054 - -€56.617 per QALY. The high variation in price across different hospital units leads to a wide-ranging effect on the ICUR. Therefore, when the Dutch daily tariff is used in cost-utility analysis, using a wide range is recommended.

Conclusion

Altogether, the Dutch standard tariff for an inpatient day should be used with caution in cost-utility analysis. This is due to the high deviation between the average price of an inpatient day of all hospital units and the price on the neurology-, paediatric- and surgery unit and in addition, the impact of this deviation on cost-utility analysis. Estimating the actual tariff based on the UK standard tariffs seems to be a promising method. However, further research is needed to assess to what extent the price structure of the Dutch and UK standard tariff correspond. Also, insight into the unpublished micro-costing is needed to explain the Dutch price structure and to calculate the confidence interval based on the original costing data. In this way, a more precise estimation can be established and therefore, a high under- or overestimation of the ICUR can be prevented. This is important because the change of the ICUR can lead to a different position towards the willingness-to-pay (WTP) threshold and therefore can result in different policy decisions. At last, the sensitivity analysis showed a high variation in price across different hospital units. For this reason, the uncertainty based on the UK data is relevant to take into account when using the reference price

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