

COST-UTILITY ANALYSIS OF TORIC AND MONOFOCAL INTRAOCULAR LENSES IN CATARACT SURGERY FOR ASTIGMATIC PATIENTS IN THE CZECH REPUBLIC

Authors: Lamblova K¹ and Dolezal T^{1,2}

¹Value Outcomes an IQVIA business, Prague, Czech Republic
²Department of Pharmacology, Faculty of Medicine, Masaryk University, Brno, Czech Republic



Background

The crystalline lens becomes opaque with aging, resulting in a deterioration of visual functions. Cataract surgery is the only treatment option, where the clouded crystalline lens is replaced with an artificial lens. Traditional monofocal intraocular lenses (IOLs) correct only one of the refractive error - they usually restore distance vision acuity but are unable to correct corneal astigmatism, unlike toric intraocular lenses. Additionally, toric IOLs have ability to improve patients’ freedom on spectacles.

Objectives

The objective of this study was to evaluate the cost-utility of toric IOL(s) compared with monofocal IOL(s) implantation during cataract surgery for corneal astigmatism in the Czech Republic. This analysis is one of the first evaluations of medical devices in the Czech Republic, as medical devices are currently not standardly subject to health economic evaluation here.

Methods

A lifetime Markov cohort model with a one-month cycle length was developed to project outcomes (Quality-Adjusted Life-Years, QALYs; spectacles use) and costs for astigmatic patients undergoing unilateral or bilateral cataract surgery from the health care payer’s perspective, which was either expanded to include the patient’s perspective or not. Model health states are defined by the need for spectacles for sharp vision after cataract surgery, the occurrence of possible (post)operative complications, and death. **Figure 1** illustrates the model scheme. The probability of spectacle (in)dependence associated with postoperative visual acuity and/or residual astigmatism, as well as toric IOL repositioning due to IOL rotation requiring re-intervention, was sourced from Holland et al.^{1,2} for unilateral cataract surgery and from Lane et al.^{2,3} for bilateral cataract surgery (**Table 1**). The types of spectacles prescribed for those requiring them were derived from Laurendeau C et al⁴ (**Table 2**). Other benefits and harms associated with the implantation of toric and monofocal IOL(s) during cataract surgery are similar according to Kessel et al.⁵ The mortality rate was sourced from Czech mortality tables⁶ and it was assumed that cataracts not affect common mortality rate. Spectacle replacement (every 3 years) was based on the statement of KOLs.⁷ Utilities and relevant disutilities were taken from published literature (Sullivan et al.⁸ & Luo et al.⁹, **Table 3**) and combined using an additive approach. It is assumed that the quality of life for patients after cataract surgery is equivalent to that of the general population due to the restoration of visual acuity; however, spectacle dependence and/or (post) operative complications can impair quality of life.

Figure 1. Model scheme

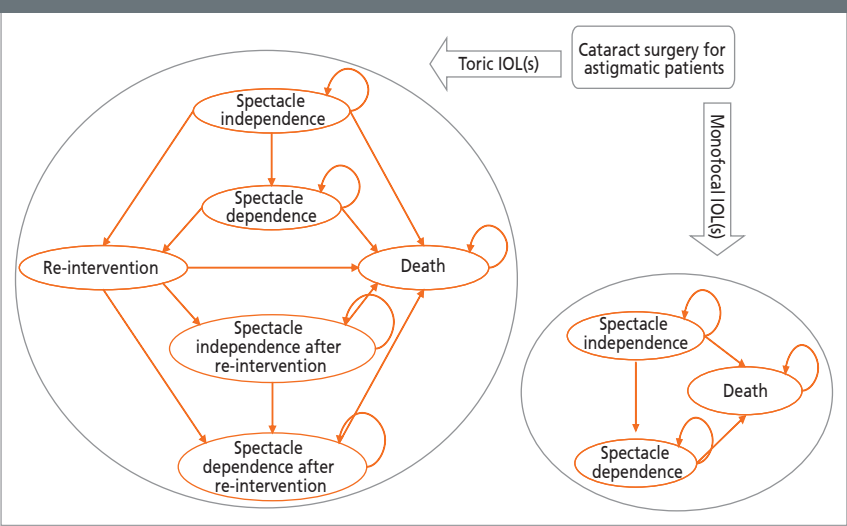


Table 1. Spectacles dependence^{1,2,3}

	Spectacles dependence after 6 months	
	Toric IOL	Monofocal IOL
Unilateral surgery	39.1% ^{1,2}	63.6% ^{1,2}
Bilateral surgery	2.6% ^{2,3}	48.9% ^{2,3}

Table 2. Type of spectacles⁴

	Bilateral/unilateral surgery	
	Toric IOL	Monofocal IOL
Reading	74.3%/60.9%*	30.0%/36.4%*
Distance	0.0%/0.0%*	0.0%/0.0%*
Reading & distance	0.0%/0.0%*	5.0%/4.5%*
Bifocal	17.1%/26.0%*	50.0%/45.4%*
Other (multifocal)	8.6%/13.1%*	15.0%/13.6%*

*assumption – utilization of particular type of spectacles based on distance spectacle independence after unilateral operation and distribution of types of spectacles after bilateral operation

Table 3. Utility of general population⁸ and disutility of spectacles’ wearing⁹ and toric IOL reposition⁹

		(Dis)utility
General population	age 60–69	0.774 ⁸
	age 70–79	0.723 ⁸
	age 80–89 & 90+*	0.657 ⁸
Toric IOL reposition ~ cataract**		–0.0271 ⁸
Spectacle dependence		–0.0200 ⁹

*assumption – utility of older people is not higher than younger people
**assumption – same as disutility of cataract based on not improvement of visual acuity associated with cataract due to reposition of toric IOL following the operation

Table 4. Costs on cataract surgery including monofocal IOL(s) implantation^{7,10,11,12}

		Total costs per surgery (€), unilateral surgery			Total costs per surgery (€), bilateral surgery		
		Payer	Patient	Sum	Payer	Patient	Sum
Cataract surgery	monofocal IOL(s)	692	44	736	1 320	87	1 408
	toric IOL(s)	726	431	1 157	1 387	862	2 249

Table 5. Costs on management of complications^{7,10,11}

	Total costs per intervention (€)		
	Payer	Patient	Sum
IOL repositioning	255	0	255

Table 6. Costs on spectacles and its maintenance^{7,12,Table 2}

		Total costs per spectacle (€), unilateral surgery			Total costs per spectacle (€), bilateral surgery		
		Payer	Patient	Sum	Payer	Patient	Sum
Spectacles after implantation	monofocal IOL(s)	0	189	189	0	195	195
	toric IOL(s)	0	173	173	0	159	159

Table 7. Costs on regular ophthalmologic care^{7,10,11}

	Total costs per year (€)		
	Payer	Patient	Sum
Regular ophthalmologic care	35	29	63

Table 8. CUA results for bilaterat cataract surgery

	Bilateral surgery		
	Toric IOLs	Monofocal IOLs	Difference
Total costs (€), health care payer’s perspective	1 496	1 661	–165
- cataract surgery including IOLs	1 387	1 320	66
- re-intervention due to IOL’ repositioning	1	0	1
- spectacles	0	0	0
- regular ophthalmologic care	108	340	–232
Total costs (€), health care payer’s & patients’ perspectives	2 642	2 784	-142
- cataract surgery including IOLs	2 249	1 408	841
- re-intervention due to IOL’ repositioning	1	0	1
- spectacles	196	757	–561
- regular ophthalmologic care	196	619	–423
QALY	7,2991	7,1660	0,1332
- utility of common population	7,3610	7,3610	0,0000
- disutility of re-intervention	–0,00001	0,00000	–0,00001
- disutility of spectacles	–0,0619	–0,1950	0,1332
ICER (€/QALY), health care payer’s perspective			Toric IOLs - dominant
ICER (€/QALY), health care payer’s & patients’ perspectives			Toric IOLs - dominant

Table 9. CUA results for unilaterat cataract surgery

	Unilateral surgery		
	Toric IOL	Monofocal IOL	Difference
Total costs (€), health care payer’s perspective	1 059	1 040	19
- cataract surgery including IOLs	726	692	34
- re-intervention due to IOL’ repositioning	1	0	1
- spectacles	0	0	0
- regular ophthalmologic care	332	348	–17
Total costs (€), health care payer’s & patients’ perspectives	2 417	2 122	294
- cataract surgery including IOLs	1 157	736	422
- re-intervention due to IOL’ repositioning	1	0	1
- spectacles	655	753	–98
- regular ophthalmologic care	604	634	–30
QALY	7,1708	7,1613	0,0095
- utility of common population	7,3610	7,3610	0,0000
- disutility of re-intervention	–0,00001	0,00000	–0,00001
- disutility of spectacles	–0,1902	–0,1997	0,0095
ICER (€/QALY), health care payer’s perspective			1 977
ICER (€/QALY), health care payer’s & patients’ perspectives			31 111

Results

Astigmatic patients require up to 2.7 fewer spectacles over their remaining lifetime after cataract surgery with the implantation of toric IOL(s) compared to monofocal IOL(s). Unilateral and bilateral toric IOL(s) implantation provides an additional 0.009 QALYs (7.171 vs. 7.161) and 0.113 QALYs (7.299 vs. 7.166), respectively, compared to monofocal IOL(s) implantation regardless of the perspective used, primarily due to increased spectacle independence, which enhances patients’ quality of life. Bilateral implantation of toric IOLs compared to monofocal IOLs results in total incremental cost savings of €165 from the health care payer’s perspective and only €142 when considering both perspectives, making it the dominant strategy (**Table 8**). Unilateral implantation of the compared lenses yields an incremental cost-effectiveness ratio of €1,977/QALY gained from the health care payer’s perspective and €31,111/QALY gained when both perspectives are combined, with additional costs of €19 and €294, respectively (**Table 9**). SA confirmed the robustness of the cost-effectiveness results for toric lenses.

References
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Conclusions

Toric lens(es) implantation is a cost-effective/dominant strategy for cataract surgery in astigmatic patients, protecting patients from spectacle dependence. The initial investment from health care payers and patients into implantation of toric lens(es) during unilateral and bilateral cataract surgery is partially or (nearly) fully offset by savings on spectacles, their maintenance, and associated regular ophthalmologic care.

Unlike bilateral cataract surgery, unilateral toric IOL cataract surgery is more expensive compared to standard monofocal IOL cataract surgery. This difference is driven exclusively by the greater spectacle dependence associated with unilateral cataract surgery.

To our knowledge, this is the first cost-utility analysis of toric IOL(s), and at the same time, it is one of the first cost-utility analyses of medical devices in the Czech Republic.