



# An update on immediate sequential bilateral cataract surgery

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## Purpose of review

The aim of this study was to present an overview of recent publications and opinions in the field of same-day bilateral cataract surgery.

## Recent findings

A Cochrane review was published comparing immediate sequential bilateral cataract surgery (ISBCS) and delayed sequential bilateral cataract surgery (DSBCS) with regard to safety outcomes, costs and cost-effectiveness. In addition, several large database studies provided more information on incidences of rare complications such as unilateral and bilateral endophthalmitis rates.

## Summary

Recently available evidence showed that ISBCS is an effective and cost-effective alternative to DSBCS. Nonetheless, additional (randomized) registry studies, randomized controlled trials and cost-effectiveness studies are needed to evaluate bilateral endophthalmitis rates, refractive outcomes and cost-effectiveness of ISBCS compared with DSBCS.

## Keywords

delayed sequential bilateral cataract surgery, immediate sequential bilateral cataract surgery, review

## INTRODUCTION

The 2019 world report on vision of the WHO indicated that at least 2.2 billion people are visually impaired [1]. Of these people, 1 billion suffer from a visual impairment that could have been prevented or has yet to be addressed. Cataract is among the main diseases causing this preventable blindness, with an estimated number of 65.2 million people in need of treatment [1]. To date, phacoemulsification cataract surgery with an IOL implantation is one of the most commonly performed types of surgery worldwide, with low complication rates (1.2%) and high success rates (93%) [2,3]. Moreover, it is considered one of the most cost-effective interventions in healthcare [1,4,5]. However, currently, an estimated 6.9 billion U.S. dollars are needed to cover the gap of costs for unaddressed cataract globally [1]. Meanwhile, the world is facing an ageing population, and the number of patients in need of cataract treatment is therefore assumed to increase as well [6]. Coinciding with this rising demand for care, an increase of healthcare expenditures is expected, which requires improvements in efficiency and logistics of the care that is provided.

## IMMEDIATE SEQUENTIAL BILATERAL CATARACT SURGERY

Although cataract surgery on one eye is effective in restoring functional vision, it is known that cataract surgery of the second eye leads to faster visual rehabilitation and further improvements in quality of life and patient satisfaction [7–10]. At present, most patients with bilateral cataracts undergo cataract surgery in both eyes on separate days, referred to as delayed sequential bilateral cataract surgery (DSBCS). In this procedure, a period of days, weeks

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**Curr Opin Ophthalmol** 2023, 34:21–26

DOI:10.1097/ICU.0000000000000907

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## KEY POINTS

- Recent evidence shows that ISBCS is an effective and cost-effective alternative to DSBCS provided that patients are selected carefully and safety guidelines are taken into account.
- Additional (randomised) registry studies, randomized controlled trials and cost-effectiveness studies are needed to evaluate bilateral endophthalmitis rates, refractive outcomes and cost-effectiveness of ISBCS versus DSBCS.
- The more efficient follow-up that is achieved in ISBCS can contribute to the reduction of the cataract surgery carbon footprint.

or even months is left between both surgeries. An alternative procedure involves operating on both eyes on the same day, but as two separate procedures, known as immediate sequential bilateral cataract surgery (ISBCS) [11]. Although ISBCS is increasingly performed in some countries [12,13], the procedure is not recommended in most national clinical practice guidelines due to concerns regarding complication risks [14,15]. Nonetheless, the ISBCS procedure gained more interest and has been adopted more rapidly during the COVID-19 pandemic due to advantages such as a reduction in the number of patient visits to the hospital [16–21].

Potential advantages of ISBCS include faster visual rehabilitation with no visual imbalance (anisometropia) between first eye surgery and second eye surgery, avoidance of additional day-care admission, less use of home care, a reduction in hospital visits and a reduction in costs [15]. Especially in the face of an ageing population and increasing global healthcare expenditures, this reduction in costs may have a substantial impact on a national and international level. To date, ISBCS is mainly performed in selected patients due to remaining concerns regarding safety and effectiveness of the procedure in comparison with DSBCS. These selected patients mainly include people who need cataract surgery under general anaesthesia, as the risk of receiving general anaesthesia twice is often higher than the potential risks of bilateral cataract surgery [13].

The main reasons for delaying second-eye surgery are the risk of bilateral complications such as a severe infection of the eye (endophthalmitis) and refractive surprise. In order to minimize risks when performing ISBCS, general principles have been developed [22]. Recommendations described in these guidelines include that relevant ocular or periocular diseases have to be managed, and that complete aseptic separation of first eye surgery and

second eye surgery is mandatory. This means that nothing that has been in physical contact with the first eye can be used during second eye surgery, instruments for the surgery of each eye have to go through complete and separate sterilization cycles, no cross-over of instruments, drugs or devices is allowed, different OVDs and different manufacturers or numerous surgical supplies should be used where reasonable and possible, separate sterile routines and operative field preparations should be performed for the first eye compared with the second eye, and the use of intracameral antibiotics at the end of surgery is strongly recommended. Furthermore, if a complication occurs in the first eye, this must be resolved before proceeding with the second eye and deferral of second eye surgery should be considered.

## ENDOPHTHALMITIS

The fear of endophthalmitis, most importantly a bilateral manifestation of the disease, has been identified as a predominant reason for not performing ISBCS [23–26]. Recently, a Cochrane review on immediate sequential bilateral cataract surgery for bilateral age-related cataracts has been published [27]. This review showed that there is likely no significant difference in endophthalmitis rates between ISBCS and DSBCS. However, because of the low incidence of bilateral endophthalmitis, none of the included studies was large enough to detect a bilateral case, and the amount and certainty of the evidence were graded low. In addition, the calculated risk of a bilateral event is very rare, with reported calculated rates of one in 70 million (using an incidence of 0.007%, assuming dependency between both eyes) [11] and one in two million (using an incidence of 0.07%, assuming no dependency between both eyes) [28]. In order to increase the level of certainty of the evidence regarding endophthalmitis rates, additional large non-randomized studies or (randomised) registry studies were found to be needed. Recently, three of such larger studies became available [28–30]. The study by Friling *et al.* [29] provides Swedish national data on endophthalmitis incidences for 1 457 172 cataract extractions, of which 92 238 were performed according to the ISBCS procedure. A significantly lower incidence of endophthalmitis was found for ISBCS compared with DSBCS, though it should be noted that independent risk factors for developing endophthalmitis were less frequent in the ISBCS group. Nonetheless, one case of bilateral endophthalmitis occurred in the ISBCS group compared with no bilateral cases in the DSBCS group. In contrast, the study by Lacy *et al.* [28] which included

**Table 1.** Reported endophthalmitis rates in immediate and delayed sequential bilateral cataract surgery in comparative studies

Endophthalmitis type	Study	Procedure	Incidence	P	Remarks
Unilateral	Herrinton <i>et al.</i> [38]	ISBCS	1/10 494 (0.009%)	0.6	Reported on patient level. Use of antibiotics from 2013 onwards, no information on differences between groups
		DSBCS	2/38 736 (0.005%)		
	Lacy <i>et al.</i> [28 <sup>■</sup> ]	ISBCS	98/165 609 (0.059%)	0.53	Reported on patient level. Diagnosis of endophthalmitis with supporting clinical findings.
		DSBCS	3004/5 408 030 (0.056%)		
	Friling <i>et al.</i> [29 <sup>■</sup> ]	ISBCS	12/92 238 (0.013%)	0.01	Reported on eye level. Parameters identified as independent risk factors for endophthalmitis were less frequent in ISBCS. Total number of endophthalmitis cases in ISBCS: 14. However, one patient had a bilateral infection (see below).
		DSBCS	408/1 364 934 (0.030%)		
	Malwankar <i>et al.</i> [30 <sup>■</sup> ]	ISBCS	1.74 per 1000	0.15	Reported on patient level. Total number of patients included: 4014 for ISBCS and 1 940 965 for DSBCS
		DSBCS	1.01 per 1000		
Bilateral	Lacy <i>et al.</i> [28 <sup>■</sup> ]	ISBCS	0 cases (0.000%)	NA	Four cases in ISBCS group were not supported by criteria/clinical findings
		DSBCS	7 cases (0.0001%)		
	Friling <i>et al.</i> [29 <sup>■</sup> ]	ISBCS	1 case	NA	Culture ISBCS case: coagulase-negative staphylococci resistant to prophylactic agents given perioperatively
		DSBCS	0 cases		
	Malwankar <i>et al.</i> [30 <sup>■</sup> ]	ISBCS	Seven cases	NA	From a total of 1976 patients diagnosed with endophthalmitis, laterality could not be determined from the ICD diagnosis.
		DSBCS	29 cases		

DSBCS, delayed sequential bilateral cataract surgery; ICD, international classification of diseases; ISBCS, immediate sequential bilateral cataract surgery; NA, not applicable.

165 609 ISBCS patients and 5 408 030 DSBCS patients, showed no significant difference in unilateral endophthalmitis rates between groups. In addition, they found no cases of bilateral endophthalmitis with clinical data supporting the diagnosis in the ISBCS group compared with seven cases in the DSBCS group. So, despite the time available for evaluation of first eye outcomes prior to second eye surgery, bilateral endophthalmitis occurred. Finally, the study of Malwankar *et al.* [30<sup>■</sup>] provided demographics and postoperative rates on endophthalmitis and cystoid macula oedema in 4014 ISBCS patients and 1 940 965 DSBCS patients. Again, no evidence was found for major differences in complications between the groups. Table 1 summarizes currently reported endophthalmitis rates in large database studies comparing ISBCS and DSBCS.

In general, endophthalmitis rates following cataract surgery have decreased over the years [31,32]. This is likely to be a result of the increase in the administration of intracameral antibiotics [33–35]. Currently reported rates range from 0 to 0.08% with the use of intracameral cefuroxime and from 0 to 0.053% with the use of moxifloxacin [36]. However, the other side of the coin is that the decrease in absolute endophthalmitis numbers combined with

the increase in the use of intracameral antibiotics potentially leaves us with predominantly drug-resistant strains. This is also shown in the bilateral endophthalmitis case described by Friling *et al.* [29<sup>■</sup>], as the pathogen involved was a methicillin-resistant and therefore cefuroxime-resistant coagulase-negative staphylococcus. Similarly, many of the other cases of endophthalmitis reported in that study involved bacteria that were resistant to the intracameral antibiotic cefuroxime, which is the antibiotic of first choice of many European countries. As an alternative, other antibiotics reported for prophylaxis include vancomycin and moxifloxacin [12]. Although these cover a broader spectrum of pathogens, there are increasing concerns of resistance for moxifloxacin and concerns regarding off-label use of these antibiotics [36–38]. In addition, vancomycin has been associated with haemorrhagic occlusive retinal vasculitis (HORV), which causes severe and permanent vision loss [36].

## REFRACTIVE SURPRISE

Nowadays, the level of success for cataract surgery is mostly determined by postoperative refractive outcomes. Currently accepted deviations from target

**Table 2.** Reported costs for immediate versus delayed sequential bilateral cataract surgery

Study	Design	Country	Costs ISBCS	Costs DSBCS	Total costs difference (ISBCS-DSBCS)
Leivo <i>et al.</i> [46]	Trial-based cost analysis	Finland	Healthcare costs € 2467 Patient costs € 815 Societal costs € 221 Total costs € 3503	Healthcare costs € 2936; Patient costs € 1589 Societal costs € 388 Total costs € 4913	- € 1410
Neel <i>et al.</i> [49]	Cost-minimization analysis	USA	Healthcare costs US\$3057 Patient costs US\$ 815 Societal costs US\$ 186 Total costs US\$ 4058	Healthcare costs US\$ 4099 Patient costs US\$ 1115 Societal costs US\$ 372 Total costs US\$ 5586	- US\$ 1528
Lundström <i>et al.</i> [47]	Model-based cost analysis	Sweden	Healthcare costs SEK 7929 Total costs SEK 7929	Healthcare costs SEK 9059 Total costs SEK 9059	- SEK 1130
O'Brien <i>et al.</i> [50]	Nonrandomized trial-based cost analysis	Canada	Healthcare costs CAN\$ 1059 Total costs CAN\$ 1059	Healthcare costs CAN\$ 1566 Total costs CAN\$ 1566	- CAN\$ 507
Rush <i>et al.</i> [51]	Nonrandomized trial based cost-analysis	USA	Healthcare costs US\$ 3123 Total costs US\$ 3123	Healthcare costs US\$ 4067 Total costs US\$ 4067	- US\$ 944
Malvankar-Mehta <i>et al.</i> [48]	Decision tree model	Canada	Healthcare costs CAN\$ 1334 Total costs CAN\$ 1334	Healthcare costs CAN\$ 2941 Total costs CAN\$ 2941	- CAN\$ 1607

CAN\$, Canadian Dollars; DSBCS, delayed sequential bilateral cataract surgery; ISBCS, immediate sequential bilateral cataract surgery; SEK, Swedish crowns; US\$, United States Dollars.

refraction lie within 1.0 and 0.5 D, and success rates of 93 and 72.7%, respectively, have been reported in a large European database study (the EUREQUO database) [3]. In addition, some studies set forth that in case of bilateral cataract surgery, the refractive outcomes of the first eye can be used to further optimize the prediction accuracy of the second eye [39–41]. On the contrary, a study by Jabbour *et al.* [42] showed no improvement in prediction accuracy for the second eye when using first eye outcomes, and most of the studies that do indicate a significant improvement are retrospective. Even though it is not certain to what extent this adjustment method is applied in current practice, the possibility of adjusting second eye IOL power based on first eye refractive outcomes is lost when performing ISBCS. Therefore, the risk of refractive surprise has been described as an important reason for not performing this procedure [15,26].

The Cochrane review on ISBCS found moderate (one randomized controlled trial) and low-certainty (three nonrandomized studies) evidence that there was no difference in the percentage of eyes that did not achieve refraction within 1.0D of target 1–3 months after surgery [27\*]. Furthermore, Owen *et al.* [43] recently published a retrospective cohort study on visual outcomes of ISBCS and DSBCS using population-based data from the American Academy of Ophthalmology Intelligent Research in Sight (IRIS) Registry. They found that ISBCS was associated with

slightly worse visual outcomes compared with DSBCS. However, the small statistical significant differences that were found may have been caused by a nonrandom surgery group assignment, the presence of confounding factors and a large sample size. In addition, no information on differences in relevant parameters (e.g. IOL calculation formulas or axial lengths) between groups were provided. Although it was suggested that refractive adjustments during the interval between first and second eye surgery may have accounted for better outcomes in DSBCS, no data were provided on whether these adjustments were performed or not and no sensitivity analyses were performed. Future randomized controlled trials such as the BICAT-NL trial [44] (ClinicalTrial.gov status: recruitment completed) can provide more insight in refractive outcomes of ISBCS compared with DSBCS.

### OTHER COMPLICATIONS

Apart from endophthalmitis and refractive surprise, the risk of other complications (both intraoperative and postoperative) was found to not be significantly different for ISBCS compared with DSBCS in the current Cochrane review [27\*]. However, the certainty of the evidence was graded very low, and a high heterogeneity was found in the definition of complications between studies. In general, ISBCS is only recommended if any intraoperative

complication in the first eye is resolved before continuing with the second eye and if patient safety and benefit are taken into account while deciding to proceed or not [22]. As for postoperative complications, the risk of some complications, such as retinal detachment and macular oedema, is likely to occur at a later postoperative stage than the time of 2 weeks usually left between first and second eye surgery in DSBCS.

## COSTS AND COST-EFFECTIVENESS

As the world faces a rising demand for cataract care and healthcare expenditures as a result of an ageing population, further improvements of efficiency in healthcare and a reduction of healthcare costs are inevitable. Apart from patient benefits, potential cost-savings related to ISBCS are an important advantage compared with DSBCS. For example, potential cost savings in ISBCS can be related to surgical costs, day-care admission costs, a reduction in the number of outpatient visits, a reduction of travel cost, less use of home care and informal care, and less productivity loss. Previous studies already showed that cataract of the first eye, as well as cataract surgery of the second eye are cost-effective [7,45]. Available studies that compare costs for ISBCS compared with DSBCS found lower costs in ISBCS [46–51] (Table 2). However, the Cochrane review showed there was a lack of cost-effectiveness studies on ISBCS versus DSBCS [27\*].

Future studies on cost-effectiveness (e.g. from a societal perspective) are needed to support implementation of ISBCS and to provide information in a standardised way that allows for comparison of cost-effectiveness on a range of subjects or diseases. However, a limitation of this standardized method is that results from one country are not directly interchangeable with healthcare systems in another country. Therefore, calculation of exact hospital costs savings require a customized approach and changes in reimbursement strategies should not be based solely on cost reductions reported in cost-effectiveness studies.

## CARBON FOOTPRINT WITH IMMEDIATE SEQUENTIAL BILATERAL CATARACT SURGERY

Another field for improvement of future cataract care involves its sustainability. The need for environment protection is high, as is reflected by the recent United Nations climate change conferences. Climate change is thought to be the biggest treat of the twenty-first century, and an estimated 250 000 additional deaths per year are expected by the WHO from 2030 until 2050 [52–54]. Therefore, there is a

clear need for cataract surgeons to critically evaluate the carbon footprint of cataract surgery. When performing ISBCS, the amount of waste is not likely to be reduced due to the need for separate sterilization requirements, and potential improvements in this regard are yet to be evaluated. However, a study by Morris *et al.* [55] showed that travel accounts for approximately 10% of CO<sub>2</sub> emissions in cataract surgery. Therefore, the more efficient follow-up that is achieved in ISBCS (e.g. reduced number of visits to the outpatient department, homecare combined for both eyes) can already contribute to the reduction of the cataract surgery carbon footprint.

## CONCLUSION

Recently available evidence shows that ISBCS is an effective and cost-effective alternative to DSBCS, provided that patients are selected carefully and safety guidelines are taken into account. Additional (randomized) registry studies can provide valuable information on (bilateral) endophthalmitis rates and complications. Furthermore, future randomized studies and cost-effectiveness studies are needed to provide information on noninferiority regarding refractive outcomes and cost-effectiveness of ISBCS compared with DSBCS.

## Acknowledgements

None.

## Financial support and sponsorship

None.

## Conflicts of interest

There are no conflicts of interest.

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Papers of particular interest, published within the annual period of review, have been highlighted as:

- of special interest
- of outstanding interest

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