

Cost-Utility Analysis of Early Vitrectomy vs Intravitreal Biopsy and Injection for Endophthalmitis

Journal of VitreoRetinal Diseases

2025, Vol. 9(6) 766–769

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DOI: 10.1177/24741264251364008

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Abstract

Purpose: To perform a cost-utility analysis comparing primary pars plana vitrectomy (PPV) within 24 hours with primary nonsurgical vitreous tap (or tap and inject [T&I]) for the management of endophthalmitis. **Methods:** Retrospective cost-utility analysis using decision tree modeling. The Victorian Endophthalmitis Registry was used to model outcome probabilities and costs from a third-party payer perspective. Australian Medicare data were used to calculate costs in a hospital-based setting (Australian dollars [A\$]). Cost utility was based on preserved visual acuity and cost per quality-adjusted life year (QALY). **Results:** The authors identified 206 eyes treated between January 1, 2011, and January 1, 2021; 36 eyes received PPV, and 170 eyes received T&I. Seventeen eyes in the T&I group required delayed PPV. Mean incident ages were 76.29 years (53% female) in the PPV group and 74.28 years (55% female) in the T&I group. Imputed costs were A\$1,523 and A\$310 for PPV and T&I, with additional per-night admission costs of A\$1,177. The mean presenting vs discharge logMAR of endophthalmitis was 2.24 vs 1.25 for the PPV group and 1.88 vs 1.03 for the T&I group. The mean durations of admission were 4.33 nights (PPV) and 4.04 nights (T&I). Total calculated costs per admission were A\$6,929.41 and A\$5,065.08 for PPV and T&I, respectively. Estimated lifetime QALYs gained were 2.23 (PPV) and 2.45 (T&I). The final costs derived per QALY were A\$3,107 (PPV) and A\$2,067 (T&I). **Conclusions:** PPV and T&I are both cost-effective per gained QALY, though the latter provided superior cost utility. A prospective randomized trial is indicated as the 2 groups differed at baseline, with eyes receiving vitrectomy having worse presenting visual acuity and prognosis.

Keywords

endophthalmitis, small-gauge vitrectomy, vitreoretinal surgery

Introduction

Endophthalmitis is a vision-threatening condition caused by infection and inflammation of the inner coats of the eye, with an approximate incidence of 1 in 3000.^{1,2} Acute presentation of endophthalmitis may be treated surgically by pars plana vitrectomy (PPV) or more commonly in the outpatient setting, by vitreous biopsy and injection of intravitreal antibiotics (tap and inject [T&I]). Left untreated, endophthalmitis can progress to blindness, panophthalmitis requiring enucleation and evisceration of a painful globe, and even death. As the indications for intraocular injections and other procedures broaden, so too do the likely incidence and cost burden of treating endophthalmitis with vision loss sequelae, despite improvements to procedural sterility and antibiotic prophylaxis.³ The landmark Endophthalmitis Vitrectomy Study (EVS) has recommended guidelines for surgical PPV vs nonsurgical management of endophthalmitis based on

level of presenting visual acuity (VA). However, in this study, a cost-utility analysis was not performed between the 2 treatment groups. Since the study's publication, advances in smaller-gauge transconjunctival vitrectomy has allowed for safer, more comprehensive vitreous clearance with reduced surgical morbidity.⁴ PPV has become a preferred treatment for cases of endogenous

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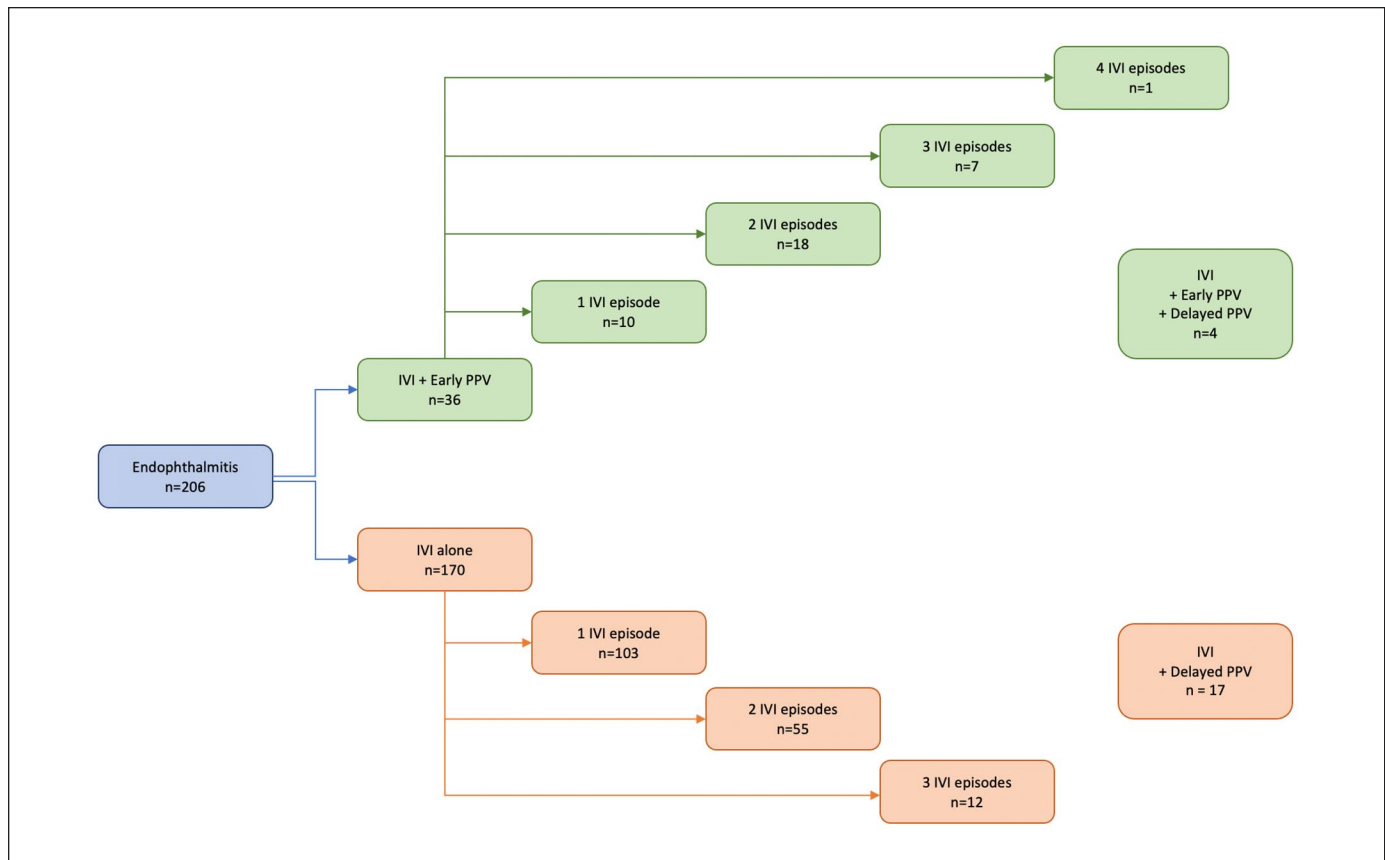


Figure 1. Decision analysis flow diagram. Abbreviations: IVI, vitreous biopsy and injection of intravitreal antibiotics; PPV, primary pars plana vitrectomy.

endophthalmitis, fungal endophthalmitis, or endophthalmitis with a high bacterial virulence.⁵ Here, we present the first cost-utility analysis of in-hospital treatment of endophthalmitis, comparing early primary PPV vs primary nonsurgical T&I alone in a Victorian tertiary hospital setting.

Methods

Using patient data from the Victorian Endophthalmitis Registry between January 1, 2011, and January 1, 2021, we performed a retrospective cost-utility analysis using decision tree modeling to demonstrate outcome probabilities and cost from a third-party payer perspective (Figure 1). The registry includes cases of endogenous, posttrauma, and postsurgical endophthalmitis. The study was completed using the Victorian Endophthalmitis Registry at The Royal Victorian Eye and Ear Hospital, in accordance with tenets of the Declaration of Helsinki. This study was assessed by the institutional Human Research Ethics Committee and was deemed not to require separate ethics approval. Informed consent was not required owing to the retrospective, non-patient identifying data processing. Early vitrectomy was defined as primary PPV within 24 hours of acute endophthalmitis presentation. Published Australian Medicare and Diagnosis Related Group data were used to calculate costs in a hospital-based setting (Australian

dollars [A\$]).⁶ Total modeled costs included initial costs for early PPV, T&I, anesthesia, and additional overnight facility bed costs. The total cost was calculated using Medicare Benefits Schedule item numbers plus per night stay costs derived from Diagnosis Related Groups. The Medicare Benefits Schedule codes used to calculate costs of the procedures in this study were 42725 for PPV, 42738 for T&I, and 20145 for initiation of anesthesia. The average calculated cost per night of admission was calculated using a Royal Victorian Eye and Ear Hospital shared-room rate with the Diagnosis Related Group codes C03A and C14A applied for PPV and T&I, respectively. As the Diagnosis Related Group cost weighting differed between surgical ward and non-ward beds (A\$1476 vs A\$878), an average of these 2 was used to find a per-night cost. Life expectancy data for Australia were derived from the World Bank data repository.⁷ VA cutoff values (in logMAR equivalents) to determine low VA (hand motions, counting fingers, and light perception levels) were derived from published peer-reviewed research.^{8,9} The Czoski-Murray utility formula was used to convert VA level to utility values, with a 3% annual discount rate applied to costs and remaining lifetime quality-adjusted life year (QALY) gains in both groups.¹⁰ Cost utility was calculated based on the preserved visual utility, remaining life expectancy, and cost per QALY gained, with a cost-effective threshold of A\$50,000 per QALY.

Table 1. Demographics of the Early Pars Plana Vitrectomy Group.

Characteristic	Value
Total eyes	36
Female sex (%)	52.7
Mean age (y)	76.3
Mean presenting visual acuity (logMAR)	2.24
Mean final visual acuity (logMAR)	1.24
Mean number of intravitreal injections	1.97

Table 2. Demographics of the Vitreous Tap and Intravitreal Antibiotic Group.

Characteristic	Value
Total eyes	170
Female sex (%)	55.3
Mean age (y)	74.28
Mean presenting visual acuity (logMAR)	1.88
Mean final visual acuity (logMAR)	1.03
Mean number of intravitreal injections	1.46

Table 3. Utility Value Calculation for Pars Plana Vitrectomy Group.^a

	LogMAR	Snellen Decimal	Utility Value
Presenting VA	2.24	0.0058	0.113
Discharge VA	1.25	0.056	0.476
Utility value gained			0.363

Abbreviation: VA, visual acuity.

^aMean age, 76.29 years; life expectancy (World Bank), 82.9 years; Δ, 6.61.**Table 4.** Utility Value Calculation for Vitreous Tap and Intravitreal Antibiotic Group.^a

	LogMAR	Snellen Decimal	Utility Value
Presenting VA	1.88	0.013	0.243
Discharge VA	1.03	0.094	0.555
Utility value gained			0.315

Abbreviation: VA, visual acuity.

^aMean age, 74.28 years; life expectancy (World Bank), 82.9 years; Δ, 8.62.

Results

We identified 206 eyes consecutively for 10 years between January 1, 2011, and January 1, 2021. Thirty-six eyes received PPV, and 170 eyes received primary T&I only (Tables 1 and 2). Seventeen patients (10%) from the T&I group required delayed vitrectomy due to clinical deterioration. Mean incident ages were 76.29 years (53% female) in the PPV group and 74.28 years (55% female) in the T&I group. An average Australian sex-combined life expectancy of 82.9 years was derived from the World Bank data repository. The mean presenting logMAR VA of patients with endophthalmitis was 2.24 for the PPV group and 1.88 for the T&I group (Tables 3 and 4). Mean VA at

discharge was 1.25 logMAR for the PPV group and 1.03 logMAR for the T&I group. The mean duration of admission was 4.33 nights and 4.04 nights for the PPV and T&I groups, respectively. The total imputed procedural costs were A\$1,523 and A\$310 for the PPV and T&I groups, respectively, with additional per-night admission costs of A\$1,177. The total calculated costs of admission based on procedural and average night hospital stay were A\$6,929.41 and A\$5,065.08 for PPV and T&I, respectively. The estimated lifetime QALYs gained were 2.23 and 2.45 in the PPV and T&I groups, respectively. The cost derived per QALY for PPV in the hospital setting was A\$3,107, compared to A\$2,067 in the T&I-only group, and A\$2,130 accounting for eyes in the T&I group that progressed to delayed vitrectomy.

Conclusions

Opinions vary among ophthalmologists on the role of early vitrectomy to treat acute endophthalmitis. Current management guidelines are informed by findings from the EVS, which found that differences in final VA were not statistically significant between early vitrectomy and intravitreal antibiotic treatment groups with a presenting VA level of hand motions or greater. Although a direct cost-utility comparison between these 2 groups was not performed in the EVS, ancillary studies have estimated that the implementation of EVS guidelines in the United States would save approximately US\$7.6 million in US Medicare charges annually.^{11,12} At present, there is a paucity of evidence supporting early vitrectomy outside the setting of poor presenting VA, endogenous etiology, or high bacterial virulence. Several decades on from the EVS, it is unclear whether these indications should broaden, accounting for the increased safety and accessibility of small-gauge vitrectomy. It is also unclear whether healthcare cost-saving now favors shorter admission and faster VA recovery over the marginal procedural costs of primary vitrectomy to treat acute endophthalmitis.

In this cost-utility analysis, both groups differed at baseline as patients receiving PPV were likely to have worse average presenting VA (logMAR 2.24 vs 1.88). The overall improvement in average VA during admission was larger in the PPV group (logMAR 0.99 vs 0.85), allowing for differences in group size. This suggests a greater magnitude of benefit despite greater severity of disease in the PPV group. Furthermore, owing to the retrospective nature of this study, no subgroup analysis nor randomization was performed for endogenous and posttraumatic endophthalmitis etiologies between the PPV and T&I groups. These etiologies are widely regarded to have a poorer presenting VA and prognosis and would typically have received vitrectomy surgery. This may therefore have led to an overestimation of hospital admission costs in the PPV group. In contrast to the EVS, coexisting retinal pathologies such as age-related macular degeneration, diabetic macular edema, and retinal vein occlusion were not excluded, as a reflection of the overall low incidence of this condition and the real-world association of endophthalmitis following intravitreal treatment for these conditions.

The Czoski-Murray formula was preferred over that of Sharma for the calculation of cost utility, due to its greater

sensitivity to Snellen decimal differences in the poorer ranges of acuity that are typical in endophthalmitis.^{10,13} Although both cost-utility formulas assume a best-eye VA scenario, acute endophthalmitis is an unforeseen complication and is therefore assumed to be indiscriminate between better- or worse-seeing eyes. These considerations allowed for a QALYs-gained calculation factoring in small sample sizes and an advanced average age of patients (76.29 years for PPV and 74.28 years for T&I) compared to their average life expectancy (82.9 years). A combined average life expectancy value (male and female) was derived from World Bank data as sex was well-balanced between groups. As the average age of patients in the PPV group was older and not controlled for due to sample size, the actual QALYs gained may be underestimated in the PPV group compared to the T&I group based on average remaining life expectancy, which would derive a higher cost per QALY for this analysis.

Although the cost per QALY was greater for the PPV group than T&I group (A\$3,107 vs A\$2,067), both interventions were found to be cost-effective at a threshold of A\$50,000 per QALY. Due to the retrospective nature of this study and the low incidence of endophthalmitis, this cost-utility analysis did not control for the severity of presentation or etiology of endophthalmitis. It is possible that patients presenting with worse VA remaining in the T&I group would have contributed to a significantly greater duration of admission, which would have greater cost implications given the overnight Diagnosis Related Group expenses of surgical beds (A\$1,177 per night). Furthermore, as this study only compared VA at presentation with discharge, it is possible that significant improvements toward final VA for the PPV group were observed further downstream at follow-up owing to the early, complete clearance of pathogens and proinflammatory mediators within the vitreous, which reduces retinal damage from chronic, prolonged inflammation.¹⁴

In this report, we model the cost utility of early vitrectomy compared with intravitreal biopsy and antibiotics based on practices at a tertiary eye hospital in Australia, as well as the costs to the healthcare system overall. Primary PPV for the treatment of endophthalmitis did not demonstrate favorable cost utility compared with T&I in the hospital setting, though both interventions are cost-effective per gained QALY. Presenting VA is a confounder, as severity of presentation influences the decision to proceed to surgical management. A prospective randomized trial is needed to study whether indications for early vitrectomy in acute endophthalmitis should be broadened to achieve better vision and cost outcomes.

Ethical Approval

The study was completed using the Victorian Endophthalmitis Registry at The Royal Victorian Eye and Ear Hospital in accordance with tenets of the Declaration of Helsinki. The Victorian Endophthalmitis Registry is an encrypted online database with robust Human Research Ethics Committee (HREC) approval. This study was assessed by the HREC and deemed not to require separate ethics approval application.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of the article.

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References

1. Bhoomibunchoo C, Ratanapakorn T, Sinawat S, Sanguansak T, Moontawee K, Yospaiboon Y. Infectious endophthalmitis: review of 420 cases. *Clin Ophthalmol*. 2013;7:247-252.
2. Merani R, Hunyor AP. Endophthalmitis following intravitreal anti-vascular endothelial growth factor (VEGF) injection: a comprehensive review. *Int J Retina Vitreous*. 2015;1(1):9.
3. Hurley A, Allen P, Dawkins R, Atkins-Brown W. Endophthalmitis: relationship of precipitating event and microbiology. *Clin Experiment Ophthalmol*. 2018;46:128-128.
4. Ho IV, Fernandez-Sanz G, Levasseur S, et al. Early pars plana vitrectomy for treatment of acute infective endophthalmitis. *Asia Pac J Ophthalmol (Phila)*. 2019;8(1):3-7.
5. Clarke B, Williamson TH, Gini G, Gupta B. Management of bacterial postoperative endophthalmitis and the role of vitrectomy. *Surv Ophthalmol*. 2018;63(5):677-693.
6. Medicare Statistics. Medicare [Internet]. Canberra, ACT: Medicare Australia. 2022. Updated August 12, 2022. Accessed June 3, 2021. www.hcfa.gov/stats
7. World Bank Life Expectancy Data [Internet]. The World Bank. 2020. Updated 2020. Accessed, 2023. <https://data.worldbank.org/indicator/SP.DYN.LE00.IN?locations=AU>
8. Lange C, Feltgen N, Junker B, Schulze-Bonsel K, Bach M. Resolving the clinical acuity categories “hand motion” and “counting fingers” using the Freiburg Visual Acuity Test (FrACT). *Graefes Arch Clin Exp Ophthalmol*. 2009;247(1):137-142.
9. Schulze-Bonsel K, Feltgen N, Burau H, Hansen L, Bach M. Visual acuities “hand motion” and “counting fingers” can be quantified with the Freiburg visual acuity test. *Invest Ophthalmol Vis Sci*. 2006;47(3):1236-1240.
10. Czoski-Murray C, Carlton J, Brazier J, Young T, Papo NL, Kang HK. Valuing Condition-Specific Health States Using Simulation Contact Lenses. *Value Health*. 2009;12(5):793-799.
11. Wisniewski SR, Hammer ME, Grizzard WS, et al. An investigation of the hospital charges related to the treatment of endophthalmitis in the Endophthalmitis Vitrectomy Study. *Ophthalmology*. 1997;104(5):739-745.
12. Sulkes DJ, Scott IU, Flynn HW, Feuer WJ. Evaluating outpatient versus inpatient costs in endophthalmitis management. *Retina*. 2002;22(6):747-751.
13. Brown GC, Sharma S, Brown MM, Kistler J. Utility values and age-related macular degeneration. *JAMA Ophthalmol*. 2000;118(1):47.
14. Vallejo-Garcia JL, Asencio-Duran M, Pastora-Salvador N, Vinciguerra P, Romano MR. Role of inflammation in endophthalmitis. *Mediators Inflamm*. 2012;2012:1-6.