# EXPLORATORY ASSESSMENT OF THE ECONOMIC AND ROAD-SAFETY IMPLICATIONS OF SPHERICAL VERSUS ASPHERIC INTRAOCULAR LENSES IN OLDER DRIVERS

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## Introduction

Despite demonstrated reductions in spherical aberration and improvements in contrast sensitivity with aspheric intraocular lenses (IOLs),[1] spherical IOLs remain in use across several markets as a cost-effective alternative. The association between contrast sensitivity and driving performance[2], together with evidence linking spherical IOLs to prolonged reaction time while driving, suggests that further evaluation is warranted.

Objectives:

1. Evaluate the potential effect the aspheric IOLs may have on driving safety compared to spherical IOLs on pseudophakic patients.
2. Examine the potential impact the improvement in driving safety could have on societal economics in Australia.

[¥]Night-driving simulation for hazard identification in rural light with glare conditions at 55 mph. The difference between the aspherical IOL (TECNIS™ model Z9000) and spherical IOL (AcrySof® model SA60AT) was significant for the hazard (pedestrian) target identification (486 feet vs 441 feet; 0.5 second difference in reaction time delta = 45 feet, P = 0.0011).

## Methods

Previously reported simulated night-driving data for hazard identification and reaction time in two different groups of pseudophakic patients (implanted with either an aspheric IOL or spheric IOL) were utilized for this investigation:[3¥]

A structured literature review was conducted to extract commonly used formulas and variables within the motor vehicle safety industry. Four formulas were extracted from eleven publications, with two selected for analysis:

**Model One[4]:**

- Initial Time Headway (ITHW) – the time headway at the brake onset, primarily applies to a rear-end sudden braking event where the hazard is lead vehicle's brake onset
- The rear-end accident probability follows a generalized linear mixed model where car crash risk decreased by 68% with a 1-s increment in the ITHW.

**Model Two[5]:**

- Time-to-collision (TTC): time step *t* based on (1) when the speed of the subject vehicle is higher than that of the front vehicle
- Crash risk:

$$P(Crash) = \exp\left(-\frac{1}{c} \times TTC\right)$$

*c = calibration parameter, varies by the road condition; c=1 is used for Korean 3-lane highway*

Societal economics impact was then modelled using cataract prevalence and motor vehicle accident (MVA) data and weighted crash risk with IOL distribution in Australia. Model inputs were evaluated for temporal relevance and methodological rigor prior to quantification.

## Results

**Model One:**

Considering an ITHW difference of 0.5 second, the probability of crash with TECNIS IOL is 0.566 times $0.32^{0.5} \approx 0.566$ of spheric IOL, or a **43.4%** relative reduction in crash risk.

**Model Two:**

TTC inputs were 5.46 seconds for spheric IOLs and 6.02 seconds for aspheric IOLs. These corresponded to modelled crash probabilities of 0.0042 and 0.0024 respectively, suggesting a **42.9%** relative reduction in crash risk.

**Potential societal economics impact for 100% aspheric IOLs use in Australia**

**2.36%** (Δ Weighted Crash Risk (96.8%[6] vs. 100% aspheric)) X **AU\$88M** (MVA Expenditure ≥65 years[7]) X **398K** (AUS Cataract Prevalence ≥65 years[8]) / **4.38M** (AUS Population ≥65 years[9]) = **AU\$189K** (MVA cost-saving)

Calculated MVA expenditure attributable to patients post cataract surgery in Australians aged ≥65 years: AU$8 million.

**Earlier Hazard Detection**

**0.5s additional time for evasive action with aspheric IOLs[2]**

**Lower Crash Risk**

**2 models with consistent estimate of ~43% relative crash risk reduction**

**Economic Impact**

**Potential modeled societal savings of AU$189,000 under a 100% aspheric IOL scenario**

**Limitations**

The driving-simulation input reflects nighttime pedestrian hazard identification, whereas the published crash-risk models were developed for rear-end vehicle interactions. Model One's ITHW estimate should be interpreted as an analogous "available time buffer" rather than a direct pedestrian-hazard measure. While TTC is a more generalizable collision measure, Model Two's crash risk model includes a calibration parameter that may vary for Australian roads or pedestrian scenario. Therefore, the crash-risk and societal economic results represent potential modeled impacts based on surrogate driving-safety measures, not observed real-world crash or cost reductions in pseudophakic patients.

## Conclusion

Improved hazard detection associated with aspheric IOLs may translate into meaningful reductions in modeled motor vehicle crash risk. These findings suggest that optical design have implications for driving safety and potential societal economic burden, warranting further real-world evaluation.

**References**

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