Evaluating Slit Lamp Performance in Diagnosing Anterior Uveitis: A Simulated Model Approach – Are all slit-lamps the same? And, does it matter?

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Introduction

Anterior uveitis is the most common form of intra-ocular inflammation in childen and young people (CYP) (1). The Standardisation of Uveitis Nomenclature (SUN) working group reccomennds using 1x1mm 'Bright' light beam for early diagnosis (2). The slit lamp lamp with less illumination could make it harder to detect low grade anterior uveitis, particularly relevant in CYP, as often are completely asymptomatic and delays in diagnosis could result in profound vision impairment.(3) This study sets to investigate if all slit lamps in a tertiary eye centre emit similar amount of light, and its effect on diagnosis of uveitis using simulated cell chambers.

Methodology

A total of 43 slit lamps were assessed for light emissions, reference numbers, and service dates. Lux measurements were conducted using a photometer at six standardised settings—full brightness head-on , 45° angle, and 1×1 mm aperture at 45°—both with and without room lighting (Fig.1).

Simulated anterior chambers were created with floating particles in a suspended solution resembling inflammatory cells, with six solutions (0 to 4+) matched to chamber depth, according to the SUN criteria via a haemocytometer. (Fig.2, 3)

Observers independently recorded cell count & SUN grading at maximum brightness (1x1mm beam, 16X magnification) while blinding and randomisation were ensured, utilising both the brightest and dimmest slit lamps. (Fig. 4)
Data was recorded independently by two masked examiners. Analysis evaluated slit lamps' efficacy in visualising anterior chamber cells.



Figure 1 : Meauring Lux with Photometer

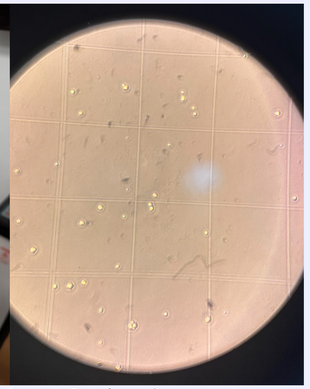


Figure 2: Particles under Hemocytometer 4+

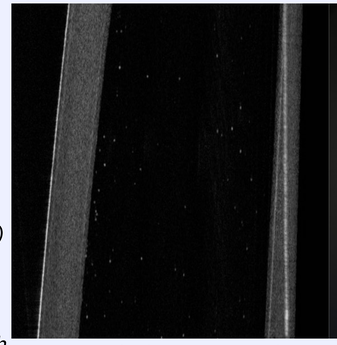


Figure 3: Optical Coherence Tomography of 4+

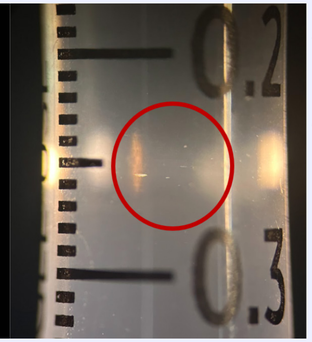


Figure 4: View of "cells" of Low grade

References
1. American Academy of Ophthalmology [Internet]. 2021 [cited 2025 Feb 24]. Pediatric Anterior Uveitis. Available from: https://www.aao.org/education/disease-review/pediatric-anterior-uveitis
2. Jabs DA, Nussenblatt RB, Rosenbaum JT, SUN Working Group. Standardization of uveitis nomenclature. Am J Ophthalmol. 2005;140(3):509-516. doi:10.1016/j.ajo.2005.03.057
3. https://www.rcophth.ac.uk/resources-listing/guidelines-for-screening-for-uveitis-in-juvenile-idiopathic-arthritis-jia/

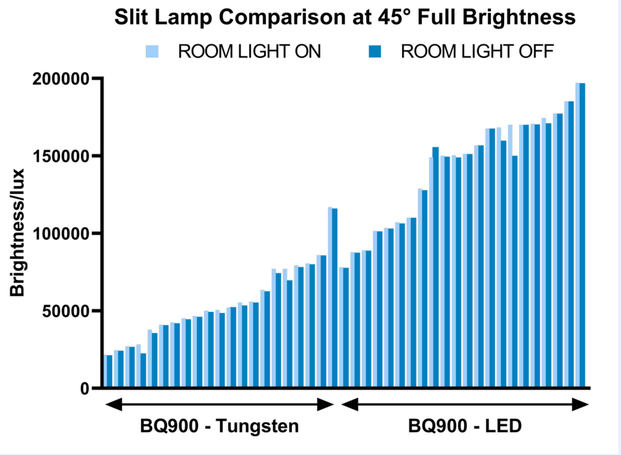


Figure 5: Slit Lamp Comparison at full brightness. Comparing Room light On vs Off.

Results: Simulated Anterior Chamber

Participants included 13 examiners (Ophthalmologists, Optometrists, 1 student) individually assessed 6 solution grades using both LED and Tungsten, representing the brightest and dimmest slit lamps. (Fig.7)
LED lighting significantly improved detection of subtle inflammation:

- *Grade 0.5+: LED = 2.25 cells vs Tungsten = 0.83 (p = 0.0002)*
- *Grade 1+: LED = 5.85 vs Tungsten = 4.15 (p = 0.029)*

At higher SUN grades (2+ to 4+), although LED lamps appeared brighter, consistently enabling more particles being detected, the differences were not statistically significant— likely due to:

1. *Limited sample size (n = 13), reducing statistical power*
2. *The clinically overt nature of high-grade inflammation, which is easily visible under most lighting conditions*

These results emphasise the value of brighter, more consistent LED lighting particularly for detecting early, low-grade uveitis, where clinical judgement is more reliant on optimal illumination

Discussion

This study confirms that not all slit lamps are the same. Lux output varied widely between units, particularly among older Tungsten BQ900 models, with up to a 7-fold difference in brightness at full power. Under diagnostic conditions (1×1 mm, 45°, light off), LED lamps were brighter (1275 vs. 793 lux) and more consistent (CV: 8% vs. 16%), supporting more reliable clinical performance. Variability may also be influenced by lamp age, bulb degradation or lack of calibration, underscoring the need for regular maintanence protocols.
In simulated testing, the findings suggest brighter lighting slit lamp are more reliable and consistent in detecting low-grade anterior uveitis, with more reliable clinical judgement at optimal illumination.

Results: Slit Lamp Comparisons

A total of 21 Tungsten and 22 LED slit lamps evaluated.

Light intensity Comparison at 45° Full Brightness (Fig.5)

Full Brightness testing to assess baseline performance data of hardware variability:

- *Tungsten BQ900 lux range: 24,500 – 116,900lux (SD: 23,970 lux)*
- *LED BQ900 lux range: 78,100 – 197,000lux (SD: 35,689 lux)*

Coefficient of Variation (CV): LED (24.99%) vs. Tungsten (43.5%) = LED more consistent

Light intensity comparisons at 45°, 1×1 mm (Fig.6)

Slit Lamp Type	Light On Lux (Range)	Light Off Lux (Range)	Mean Lux Difference (± SD)
Tungsten BQ900	1011 (290–2240)	793 (240–2070)	218.1 ± 124.9
LED BQ900	1413 (700–2570)	1275 (540–2440)	138.2 ± 101.8

Figure 6: Slit lamp comparison at 45°, 1×1 mm

CV: LED (8%) vs Tungsten (16%) = LED more consistent, and Cohen's d =4.15, indicating a large and clinically meaningful brightness difference.
LED slit lamps produced significantly higher and more consistent lux levels under diagnostic conditions (light off, 1x1mm, 45°). This improved brightness in the LED slit lamp enhance visualisation of anterior chamber, particuarly in simulated low SUN grade uveitis.

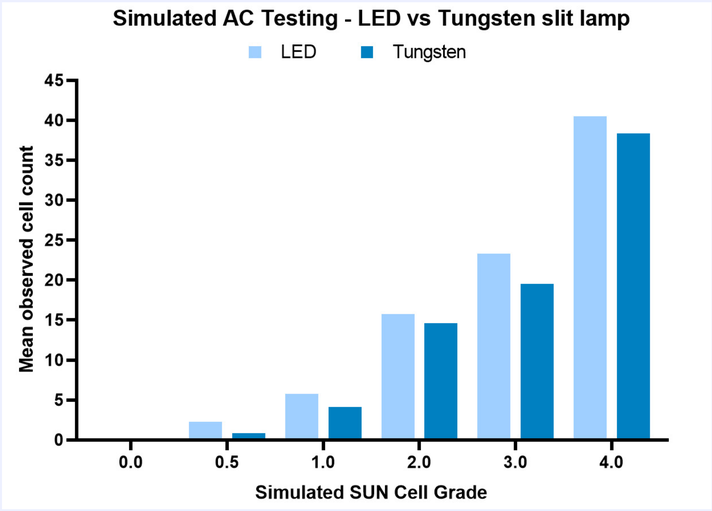


Figure 7: Simulated Anterior Chamber Testing

Conclusion

This study demonstrates that slit lamp variability can significantly affect the detection of anterior uveitis, particularly in low grade uveitis. LED slit lamps provided higher and more consistent light output compared to Tungsten models, which was associated with improved identification of low-grade inflammation in a simulated setting. These findings underscore the importance of equipment standardisation and support the adoption of LED slit lamps to enhance diagnostic accuracy and reduce the risk of missed or delayed treatment in clinical practice.