Advisory report

**(Attn. sector management ORC Erasmus MC CL,
Sophia Childrens hospital
and ARBO service Erasmus MC)**

Preventing Complaints from OR Lighting with the FL-41 Filter

Name: Marije Kruisselbrink, 21M

December 2023

Preface

This research was conducted as a final project for the Operations Assistant course at Erasmus MC. To develop a recommendation, both a literature review and a field study were undertaken. The literature review was jointly authored with two fellow students from the course. The field study was conducted at Erasmus MC and Sophia's Children's Hospital, involving two surveys and a pilot study on the use of FL-41 glasses in the operating room. The findings from these studies, along with the recommendations and conclusions, are presented in this report.

I would like to invite you to review this research and advisory report. Through this study, I have concluded that colleagues experiencing discomfort due to operating room lighting may find relief. A minor investment in an FL-41 filter (or an MC-41 filter) could significantly alleviate their symptoms. This, in turn, could reduce the incidence of illness among these workers.

Thank you for considering the findings of this research.

December 2023, Gouda

Contents

Introduction

The motivation for this research and advisory report stems from my own experience with discomfort caused by the operating room lighting.

"Over the past two years working in the OR, my migraine attacks have significantly increased. This ranged from daily experiences of visual auras in the OR to classic migraine attacks, leading to frequent absences. Following a colleague's suggestion, I started wearing a migraine filter over my glasses. This is an FL-41 filter, whose pink/orange lenses block the blue light from the surgical lamps. The filtering of blue light provides a much calmer visual experience. As a result, I have had far fewer episodes of auras and have not had to call in sick due to classic migraine attacks."

In an operating room, good lighting is essential to properly visualize the surgical area. Operating assistants are exposed to this lighting daily and may experience discomfort as a result. It is crucial to minimize the negative effects of operating room lighting. The literature review identified several potential solutions, and I chose to further investigate the FL-41 filter as a possible remedy. This advisory report aims to demonstrate why the FL-41 filter should be introduced for operating assistants who suffer from the effects of operating room (OR) lighting.

Since I wear the FL-41 filter myself, I have found it to be an effective and affordable solution that has alleviated my symptoms. I am keen to share this with my colleagues. If more colleagues benefit, it could lead to reduced absenteeism and, consequently, lower costs.

Through the field study, it emerged that indeed, more colleagues experience complaints due to the OR lighting. I then organized a pilot in the OR, where colleagues could test the FL-41 filter. The glasses and clips with the FL-41 were provided by OLVS Optical Solutions in Rijswijk, in collaboration with Multilens from Sweden.

Current & desired situation

Current situation

Throughout the day, operating assistants experience varying degrees of discomfort from the operating room (OR) lighting.
They suffer from migraines, headaches, eye strain and general fatigue due to the light and the reflection of the light and its reflection of gauzes and instruments. Seeing flickering lights has also been reported several times. The literature review revealed that little research has been done on OR lighting. To my knowledge, no field studies have been conducted in operating rooms.

Desired situation

The ideal scenario would be for operating assistance to experience fewer to no complaints from the lighting in the operating rooms. Alongside reducing the intensity of the lights, the hospital should provide the FL-41 filter to colleagues who suffer from lighting-related complaints. The FL-41 filter has been shown to reduce complaints, thereby reducing sick leave and cutting costs. This represents progress for both the colleagues and the hospital.

Literature review CAT

The literature review, including a meta-analysis, indicated that 25% of the 5000 surgeons reported experiencing eye fatigue as a work-related health risk, partly due to OR lighting and ergonomics (Curlin 2020). The meta-analysis did not differentiate between OR lighting and ergonomics. The intense light from OR lamps can cause eye fatigue due to shadowing effects from a focused beam but also because of the difference in luminance ratio.

Bright light can cause glare and overexposure. Glare can temporarily blind someone when OR light reflects off a shiny instrument and then into the eyes, leading to strong pupil constriction. As a result, when the reflection moves away, the person can be temporarily blinded. Excessive light can also reduce color distinction because OR lamps do not emit perfect broad-spectrum light but rather light of a specific color. This makes colors less distinguishable.

Pupil Reflex and Luminance Ratio
In the OR, two bright lamps illuminate the wound during surgery. This makes the patient more illuminated than the rest of the environment.
Tests show that the patient area could be up to 15x brighter than the surrounding environment. This contrast is known in the literature as Luminance ratio, and the recommendation of the IESNA (Illuminating Engineering Society of North America) is to have a maximum ratio of 3:1 for the surgical area and its immediate surroundings, and 5:1 for the surgical area and the instrument table.

Lots of ambient light lowers this contrast. Extra ambient light generally increases brightness in the OR, making the bright lamps less contrasting. Daylight also has a positive effect in the OR, providing diffuse, non-flickering ambient light. Additional ambient light, specifically daylight, enhances visual performance.

As an operating assistant, you need to watch the surgical area along with the surgeon, but also keep the instrument table organized. This causes the pupils to narrow through the pupillary light reflex when looking at the surgical area, while they must dilate again when looking at the surroundings. Lots of light makes you see sharper. The pupil constricts faster than it relaxes afterward. As a result, relatively less light reaches the retina when looking at the instrument table, making it harder to distinguish fine instruments, for example, in ENT surgeries.

However, bright light in a surgical area has advantages too. With narrowed pupils, the surgeon sees more sharply. When operating in-depth, less light reaches these areas, making bright lamps beneficial for deep surgery. Bright lamps can cause glare on new instruments, leading to reduced visibility and complaints because the glare also causes pupil constriction.

Background on FL-41 glasses

The FL-41 filter is comfortable, and many users report relief from migraines. The FL-41 filter also reduces symptoms often experienced by those with visual stress. It has a proven positive effect on benign Blepharospasm (BEB), both in terms of light sensitivity and blink frequency.

The FL-41 filter, characterized by its pink/orange tint, primarily absorbs blue and green light. The greatest absorption is at the boundary between blue and green.
Many people find the filter comfortable and many report relief from migraines.

Field Research

Survey

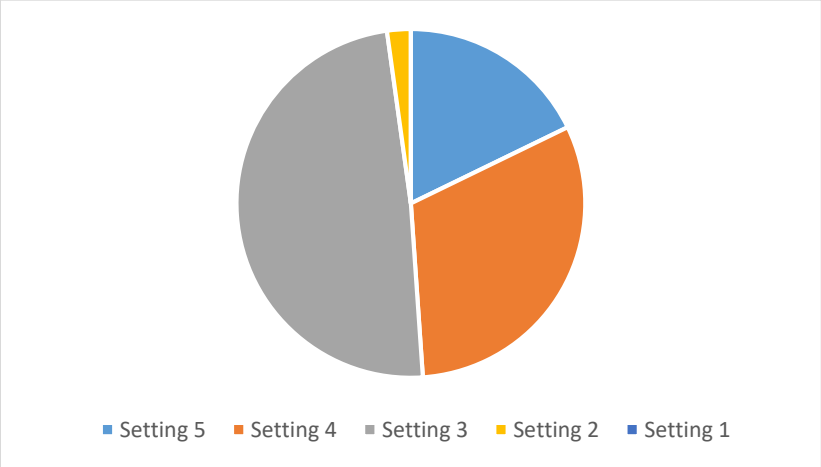
The initial survey was distributed to 248 operating assistants at the EMC surgical complex and Sophia Children's Hospital and consisted of 11 questions.
These questions were about the intensity of OR lighting and the complaints that OR lighting can cause.
91 operating assistants responded to the survey, yielding a response rate of 36.7%. Of these respondents, 27.5% expressed interest in participating in the OR pilot study.

Survey Results:
The first question was a general question aimed at identifying the specific unit within the OR complex where the operating assistant works. The subsequent three questions addressed the intensity of the OR lighting, followed by questions regarding any discomfort experienced due to the lighting.

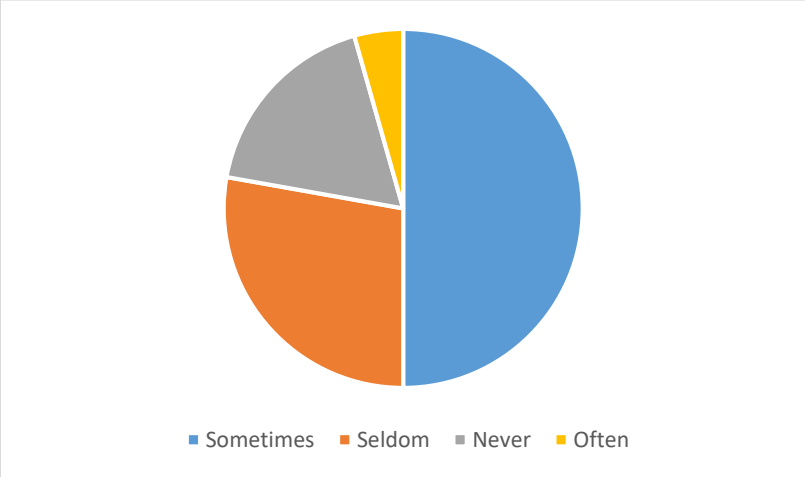
Results related to lighting intensity:

What is the most common setting for the OR lights to be set to during surgery?

Setting 3 48,9%, setting 4, 31,1%, setting 5 17,8, setting 2 2,2 % and setting 1 is not used.



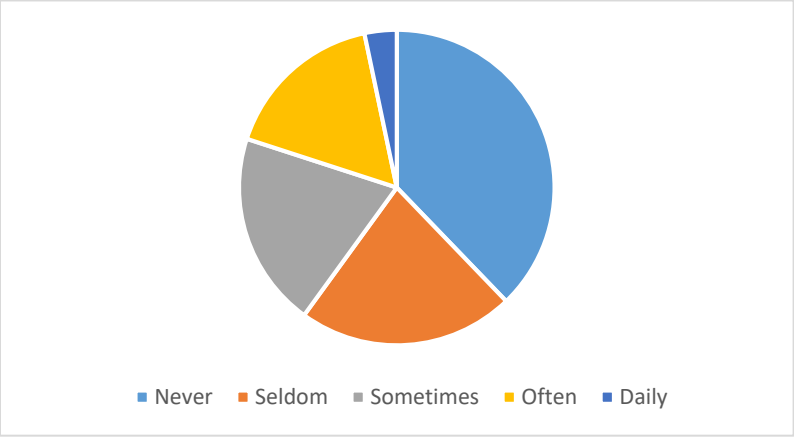
Does the operator ever ask to turn up the lights?



The advice from the supplier of the lamps is that the intensity of the lamps should be on setting 2 or 3 for good visibility. It was found that for almost 48.9% of the respondents, the lamps were set at position 3, with 31.1% % at position 5, the highest intensity.

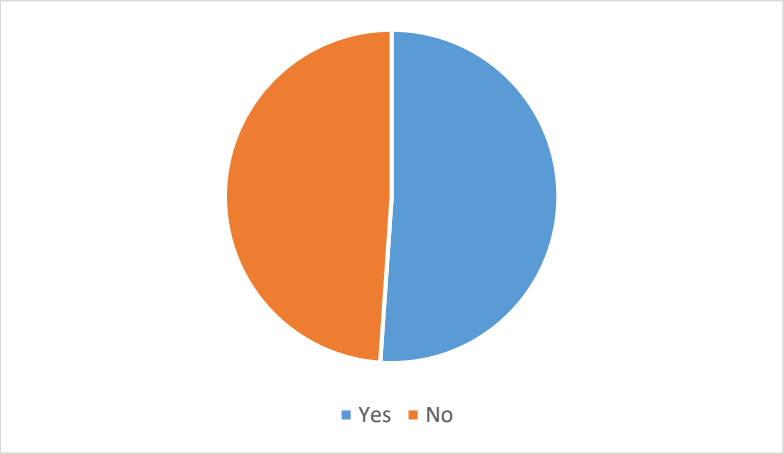
50% of the respondents indicated that the operator sometimes indicated that the lamps should be set higher in intensity. With 27.8% of the respondents, this rarely needed to, 17.8% of the respondents never had to set the lighting settings higher and 4.4% of the respondents were often asked to set the lamps higher.

How often do you turn down the OR lighting yourself because you think it is set too bright?

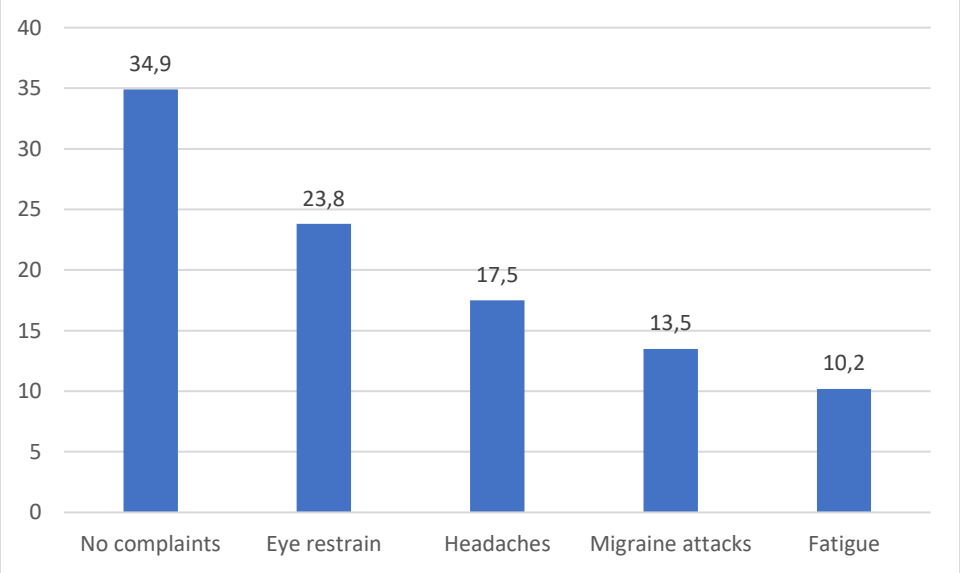


37.8% of the respondents never set the lighting higher, 22.2% rarely turn up the intensity, 20% sometimes, 16.7% often and 3.3% of the respondents do so daily.
Results related to discomfort caused by lighting:

Do you ever experience physical complaints due to the OR lighting?



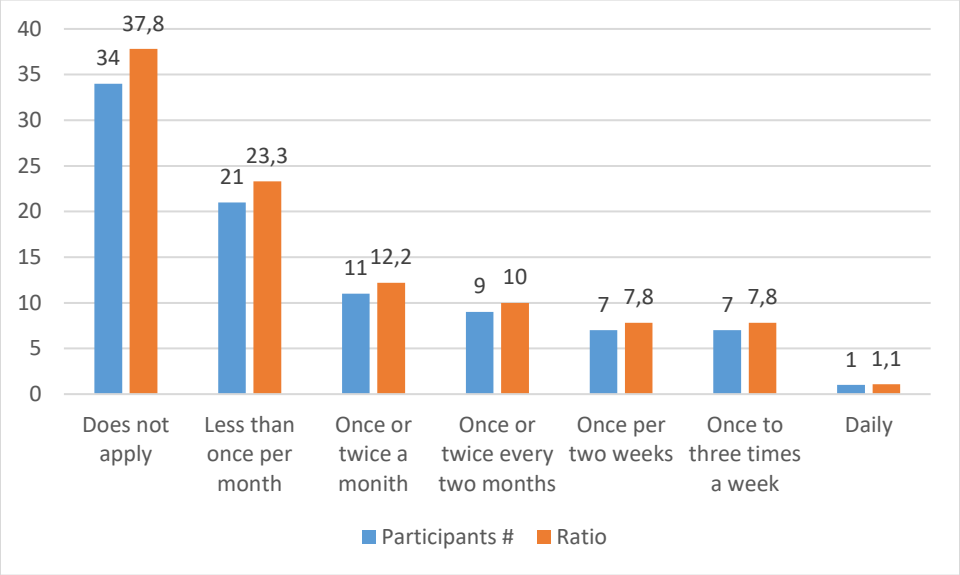
Which complaints do you experience?



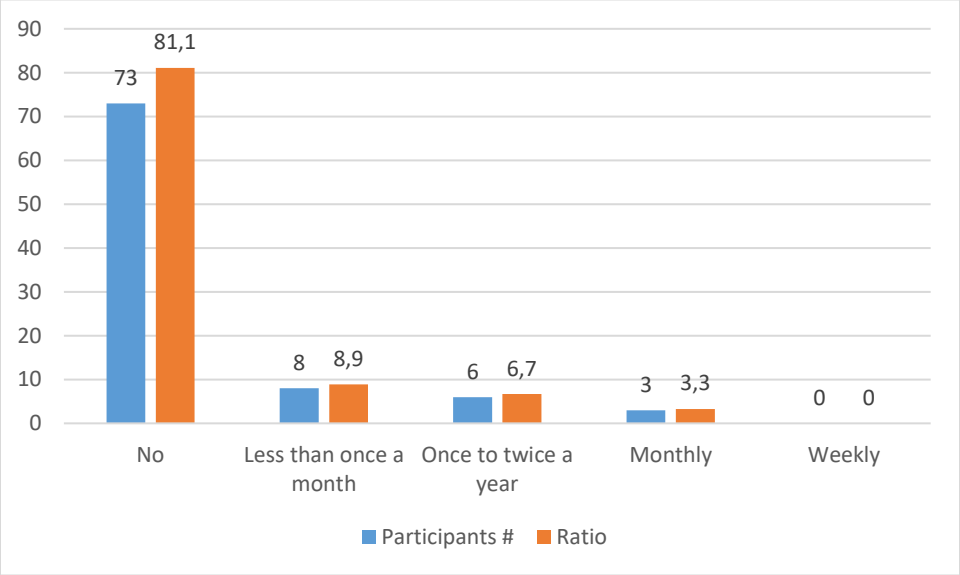
When asked whether or not complaints are experienced, 51.1% of the respondents indicated they experience complaints.

When this question is asked again with types of complaints, 65.1% experience complaints compared to 34.9% of respondents who do not experience complaints from OR lighting.
23.8% experience eye restrain, 17.5% headaches, 13.5% experience migraine attacks and 10.2% experience fatigue.

To what extent do these complaints hinder your work?



Do you ever call in sick because of these symptoms?



The various complaints impede work to a greater or lesser extent. 18.9% of the respondents even have had to call in sick at least once due to complaints caused by the OR lighting. 12.2% more often than twice a year because of complaints from the OR lighting.

Of the 91 respondents, 56 were familiar with the FL-41 filter because two colleagues in the ORC already wear these glasses. Out of the 91 respondents, 26 expressed their willingness to participate in the pilot study that involves wearing the FL-41 filter in the OR.

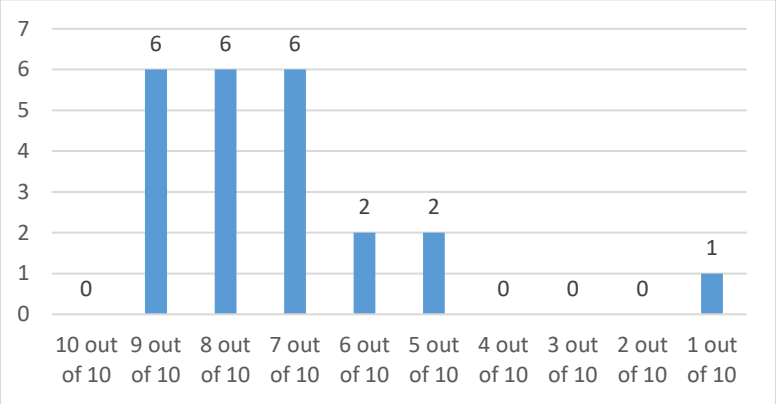
Pilot in the OR

Participants in this pilot were able to test the filter for an average of 5 days, after which they could share their findings by filling out a short survey.

Survey following the pilot in the OR

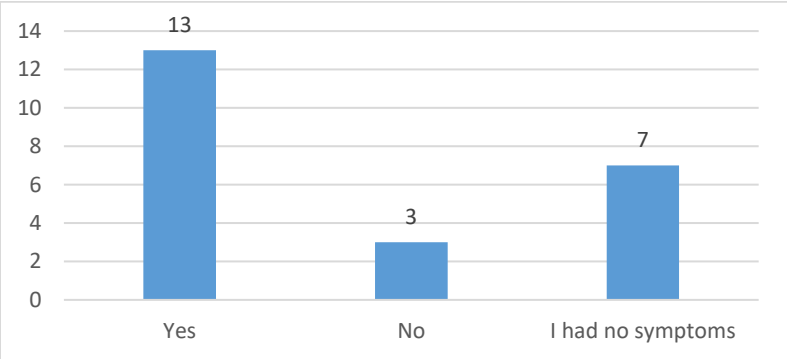
Of the 26 participants in the pilot, 23 shared their findings in this brief survey.

How did you experience wearing the FL-41 filter glasses/clip?



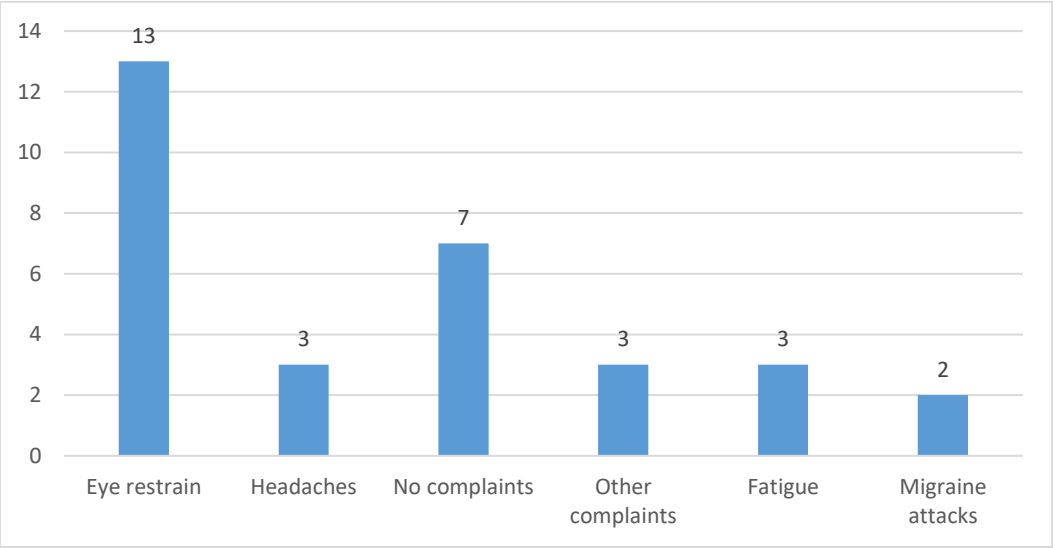
18 Participants rated the glasses/clip a 7 or higher, with 6 participants giving a score of 9 out of 10, and another 6 rating it an 8.

Have your symptoms been reduced by wearing the FL-41 glasses/clip?



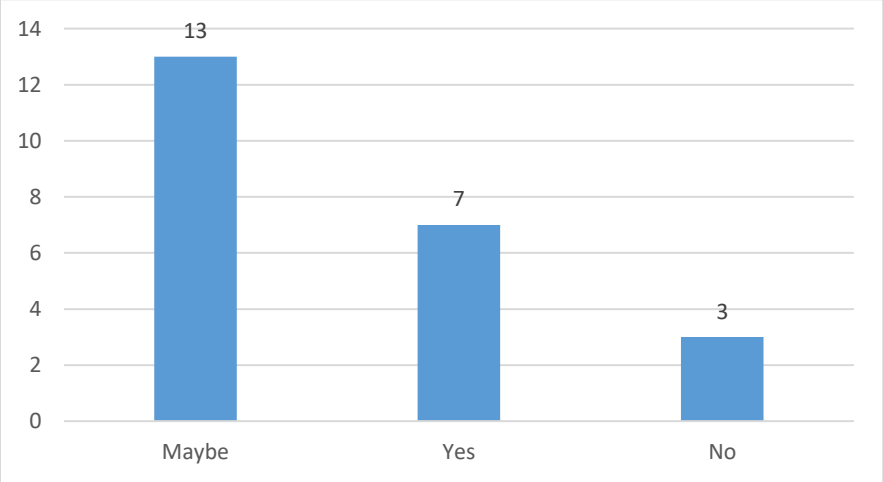
Of these participants, 13 (or 56.5%) reported experiencing symptoms before the pilot, and they noted a reduction in their complaints. However, 3 participants experienced no improvement, and 7 reported no prior complaints."

Which complaints are reduced thanks to wearing the FL-41 glasses/clip?



For all complaints included in this study, the complaints decreased to varying degrees.

After this pilot, would you like to purchase FL41 glasses/clip yourself?



As a result of their experience during the pilot, 7 participants are certain they want to purchase the FL-41 glasses/filter, while 13 are still considering it. 3 Participants have decided against acquiring the glasses/filter. This indicates that even those who did not experience pre-existing complaints found the glasses/filter to be beneficial.

During the pilot, participants encountered various other findings while wearing the glasses/clip with the FL-41 filter, which they shared in the survey:

- 1 Participant perceived the color difference as unpleasant.
- Only one size of glasses was available for the pilot, which some found too large. This was experienced as a disadvantage. However, they did note less eye fatigue at the end of the day by wearing the glasses. Others experienced discomfort due to the weight of oversized glasses.
- The clip was perceived as heavy, leading to a preference for the glasses over the clip. Possibly the clip can be made lighter for increased comfort.
- Participants would like to see the filter incorporated into OR splash goggles.
- The glasses/clips caused a darker field of vision, making it challenging to place very small 8-0 needles on the needle holder.
- Participants without prior complaints reported less eye fatigue at the end of the day.
- Some participants had to get used to wearing the glasses.
- Two participants also tested the FL-41 filter for computer work and reported a positive experience.

Additionally, respondents from both the surveys and the pilot appreciated the focus on the brightness of OR lighting and its potential to cause discomfort.

Advice/recommendations

Now that there is increased awareness about the brightness of the surgical lighting, a standard setting for the lights should be considered, such as setting 3 instead of 5. The lights can always be turned up when desired during surgery. Alternatively, the surgeon can use a headlamp if more light is needed in the surgical area.

As the literature review has shown, daylight in the OR should also be considered. Daylight is available at the center location, but this is not the case at Sophia Children's Hospital. This should be taken into consideration in the new building plans for Sophia. By allowing daylight to enter into operating rooms ambient light increases, which reduces the lighting ratio compared to the OR lights.

If these measures are taken but complaints persist, or if they cannot be implemented and complaints continue, a solution must be found to reduce the discomfort and absenteeism. As indicated, the FL-41 filter has been shown to offer relief.

Field research indicates that many colleagues experience various complaints due to OR lighting. The pilot demonstrated that these complaints could be reduced or prevented by wearing glasses with the FL-41 filter or using a clip with the filter over regular glasses.

This report shows that the surveys and the pilot provide a serious reason to accommodate colleagues who experience relief from the FL-41 filter by reimbursing them for the purchase of the FL-41 filter.

- The clip with FL-41 filter is available from **€ 138,-**.

- Glasses with FL-41 filter start at **€ 151,-**.

Type: Nelli glasses

Fit-over glasses were not included in the pilot, but are also available.

- Fit-over glasses with FL-41 are available starting at **€ 144,-**.

Biocover

The options mentioned above come in various sizes and strengths (dark, medium, light) and can be ordered online at for instance https://www.ergowerken.nl. However, visiting a reputable optician, especially for prescription FL-41 filter lenses, is recommended. The optician can then contact OLVS.

Dark

Medium

Light

Colleagues who experience fewer or no symptoms during daily activities will be more productive and less likely to call in sick. Lower absenteeism will ensure an improvement in the overall well-being of the colleagues. Less absenteeism also means fewer ORC closures, significantly reducing costs.

The costs of reimbursing the FL-41 filter in any form are relatively minor compared to these benefits.

Conclusion

The field research revealed that more colleagues were indeed experiencing complaints due to the lighting in the OR. The subsequent pilot study in which colleagues tested the FL-41 filter, highlighted the need for a solution to prevent or alleviate these lighting-related issues. The FL-41 filter can certainly be a good solution for some staff members and should therefore be facilitated by EMC.

Acknowledgments

The glasses and clips with the FL-41 were facilitated by OLVS Optical Solutions in Rijswijk, in collaboration with Multilens from Sweden. Without their support, the OR pilot study would not have been possible, for which my heartfelt thanks.
Also, I sincerely thank all the colleagues who filled out the surveys and tested the glasses/clip in the OR. This research could not have been conducted without their participation.

Literature list

- Albilali, A., & Dilli, E. (2018). Photophobia: When Light Hurts, a Review. Current neurology and neuroscience reports, 18(9), 62. https://doi.org/10.1007/s11910-018-0864-0
- Alhusuny, A., Cook, M., Khalil, A., Thomas, L., & Johnston, V. (2021). Characteristics of headaches among surgeons and associated factors: A cross-sectional study. The surgeon : journal of the Royal Colleges of Surgeons of Edinburgh and Ireland, 19(5), e79–e87. https://doi.org/10.1016/j.surge.2020.07.012
- Alhusuny, A., Cook, M., Khalil, A., Hill, A., & Johnston, V. (2022). The relationship between visual impairments and activity of the neck/shoulder muscles among surgeons During simulated surgical tasks. Surgical endoscopy, 36(7), 5326–5338. https://doi.org/10.1007/s00464-021-08913-0
- Alhusuny, A., Cook, M., Khalil, A., & Johnston, V. (2021). Visual symptoms, Neck/shoulder problems and associated factors among surgeons performing Minimally Invasive Surgeries (MIS): A comprehensive survey. *International archives of occupational and environmental health*, *94*(5), 959–979. https://doi.org/10.1007/s00420-020- 01642-2
- Alhusuny, A., Cook, M., Khalil, A., Xie, Y., & Johnston, V. (2020). Neck/shoulder problems and visual disturbances among surgeons: a scoping review. Journal of Surgical Research, 247, 413-428.
- Artemenko, A. R., Filatova, E., Vorobyeva, Y. D., Do, T. P., Ashina, M., & Danilov, A. B. (2022). Migraine and light: A narrative review. Headache, 62(1), 4–10. https://doi.org/10.1111/head.14250
- Cougnard-Gregoire, A., Merle, B. M. J., Aslam, T., Seddon, J. M., Aknin, I., Klaver, C. C. W., Garhöfer, G., Layana, A. G., Minnella, A. M., Silva, R., & Delcourt, C. (2023). Blue Light Exposure: Ocular Hazards and Prevention-A Narrative Review. *Ophthalmology and therapy*, *12*(2), 755–788. https://doi.org/10.1007/s40123-023-00675-3
- Curlin, J., & Herman, C. K. (2020). Current State of Surgical Lighting. Surgery journal (New York, N.Y.), 6(2), e87–e97. https://doi.org/10.1055/s-0040-1710529
- Digre, K. B., & Brennan, K. C. (2012). Shedding light on photophobia. Journal of neuro-ophthalmology: the official journal of the North American Neuro-Ophthalmology Society, 32(1), 68–81. https://doi.org/10.1097/WNO.0b013e3182474548
- Glick, D. R., Abariga, S. A., Thomas, I., Shipper, A. G., Gunia, B. C., Grandner, M. A., ... & Wickwire, E. M. (2023). Economic impact of insufficient and disturbed sleep in the

workplace. *Pharmacoeconomics*, 1-15.

- Golvani, J., Roos, L. & Henricson, M. Operating room nurses' experiences of limited access to daylight in the workplace – a qualitative interview study. BMC Nurs 20, 227 (2021). https://doi.org/10.1186/s12912-021-00751-8
- Hemphälä, H., Johansson, G., Odenrick, P., Åkerman, K., & Larsson, P. A. (2009). Lighting recommendations in operating theatres. In The 17th World Congress on Ergonomics. IEA.
- Hemphälä, H., Osterhaus, W., Larsson, P. A., Borell, J., & Nylén, P. (2020). Towards better lighting recommendations for open surgery. Lighting Research & Technology, 52(7), 856-882.
- Hislop, J., Hensman, C., Isaksson, M., Tirosh, O., & McCormick, J. (2020). Self-reported prevalence of injury and discomfort experienced by surgeons performing traditional and robot-assisted laparoscopic surgery: a meta-analysis demonstrating the value of RALS for surgeons. Surgical endoscopy, 34(11), 4741–4753. https://doi.org/10.1007/s00464-020-07810-2
- Janosik, E., & Kułagowska, E. (2007). Ocena warunków oświetlenia w salach operacyjnych oraz ich wpływu na odczucia personelu pielegniarskiego [Evaluation of lighting conditions in operating rooms and their influence on feelings perceived by the nursing staff]. Medycyna pracy, 58(5), 403–410.
- Knoop M, Stefani O, Bueno B, et al. Daylight: What makes the difference? Lighting Research & Technology. 2020;52(3):423-442. doi:10.1177/1477153519869758
- Lembo, M., Cannatà, V., Militello, A., Ritrovato, M., Zaffina, S., Derrico, P., & Borra, M. (2015). Illuminazione artificiale e luce blu in sala operatoria: quali rischi per il chirurgo? [Artificial lighting and blue light in the operating room: what risks for the surgeon?]. La Medicina del lavoro, 106(5), 342–350.
- Maquet PowerLED 2 brochure . (2021). Opgehaald van gentinge: https://www.getinge.com/dam/hospital/documents/english/brochure_maquet_powerled_ii-en-non_us_canada.pdf
- *maquet-sergical-lights-ultimate-guide.* (2021). Opgehaald van gentinge: https://www.getinge.com/dam/hospital/documents/english/brochure_maquet_powerled_ii-en-non_us_canada.pdf
- Maquet PowerLED 2 chirurgisch licht . Opgehaald van Getinge: https://www.getinge.com/int/products/maquet-powerled-2/
- Nguyen, E., Inger, H., Jordan, C., & Rogers, D. (2021). Ocular Causes for Headache.

Seminars in pediatric neurology, 40, 100925. https://doi.org/10.1016/j.spen.2021.100925

- Ouyang, X., Yang, J., Hong, Z., Wu, Y., Xie, Y., & Wang, G. (2020). Mechanisms of blue light-induced eye hazard and protective measures: a review. Biomedicine & pharmacotherapy = Biomedecine & pharmacotherapie, 130, 110577. https://doi.org/10.1016/j.biopha.2020.110577
- Olvs. (z.d.). *Comfort Filters - Multilens*. OLVS. https://slechtzienden.nl/producten/163/comfort-filters
- Peyrat, P., Breysse, J., & Chambard, C. (2021). Fatigue visuelle et éclairage opératoire. *Inter bloc*, *40*(1), 35–38. https://doi.org/10.1016/j.bloc.2021.01.008
- Shugaba, A., Lambert, J. E., Bampouras, T. M., Nuttall, H. E., Gaffney, C. J., & Subar, D. A. (2022). Should All Minimal Access Surgery Be Robot-Assisted? A Systematic Review into the Musculoskeletal and Cognitive Demands of Laparoscopic and Robot-Assisted Laparoscopic Surgery. Journal of gastrointestinal surgery : official journal of the Society for Surgery of the Alimentary Tract, 26(7), 1520–1530. https://doi.org/10.1007/s11605-022-05319-8
- Tatsumoto, M., Suzuki, E., Nagata, M., Suzuki, K., & Hirata, K. (2022). Prophylactic Treatment for Patients with Migraine Using Blue Cut for Night Glass. Internal medicine (Tokyo, Japan), 10.2169/internalmedicine.0132-22. Advance online publication. https://doi.org/10.2169/internalmedicine.0132-22
- Thoss, F., Ballosek, S., Bartsch, B., & Thoss, F. (2018). Subjective and Electroretinographic Dynamics of Light Adaptation in the Human Visual System. *Vision*, *2*(1), 10. https://doi.org/10.3390/vision2010010
- Vagge, A., Ferro Desideri, L., Del Noce, C., Di Mola, I., Sindaco, D., & Traverso, C. E. (2021). Blue light filtering ophthalmic lenses: A systematic review. Seminars in ophthalmology, 36(7), 541–548. https://doi.org/10.1080/08820538.2021.1900283