WHITE PAPER

Progressive illumination can have a positive effect on surgical performance

Reducing visual fatigue in the OR

Reducing contrast between the surgical site and surrounding areas improves comfort and visual performance. The most effective surgical lighting will provide a gradual transition between the illuminated area and the operating room lighting to reduce eye strain.

Visual fatigue affects work performance

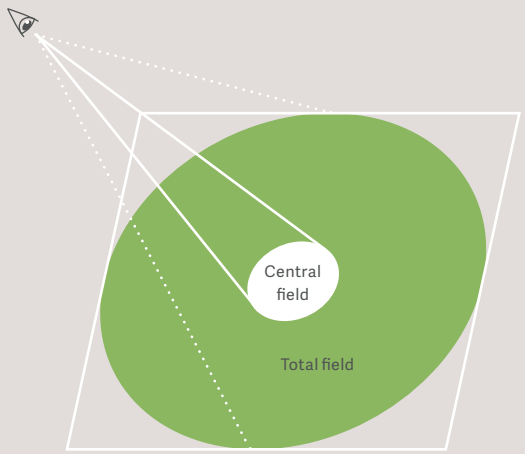
Poor visual conditions can have dire consequences in the OR

A correlation exists between reduced visual fatigue and diagnostic accuracy (Krupinski, 2009), performance (Kato) and safety (Patterson). These visual problems can place surgeons and their patients at risk (Hemphälä, 2009).

Studies assessing the impact of visual acuity on work performance date back to the first half of the 20 century (Simonson, 1948) and across industries. Lighting plays an important role in reducing visual and corresponding physical fatigue. While all industries are looking for ways to reduce fatigue to improve productivity, the risks of visual fatigue in the surgical suite carry additional weight.
When confronted with poor visual conditions, human beings demonstrate an unconscious tendency towards strained posture. We can see a classic example of this behavior all around us in the forward lean and rounded shoulders of laptop and mobile phone users. Visual strain can cause up to three times as much musculoskeletal strain (Hemphälä, 2009), causing overall bodily fatigue which is correlated with increased errors [Kato, Barker, Patterson].

High-contrast lighting can contribute to fatigue-related errors

Therefore, it is important for hospitals to choose an OR light which can reduce strain, minimize fatigue, and improve surgical outcomes. For decades, it's been known that very high contrast in the workplace has been shown to inhibit task performance (Stone, 1980). This is particularly significant in a surgical setting.
Understandably, illumination must be bright and focused at the surgical site. Modern surgical lights provide a light field of approximately 20 cm in diameter, with illumination of up to 160,000 lux – brighter than a sunny day at the beach. The ambient lighting in the room rarely exceeds 1,000 lux. The contrast between the brightly illuminated light patch and the surrounding area is too dramatic, resulting in discomfort and eye strain. Studies have shown that one-third of surgeons suffer from visual fatigue, leading to poor posture and physical strain that can compromise the surgeon's performance (Hemphälä, 2009).



Reducing the contrast between the light field and the adjacent surfaces

Nearly half a century ago, contrast ratios were developed to ensure optimum visual comfort (Déribéré, 1968). The NUTEK study of the 1990s went one step further, and identified clear ratios for illumination of adjacent and distant surfaces (NUTEK, 1994).

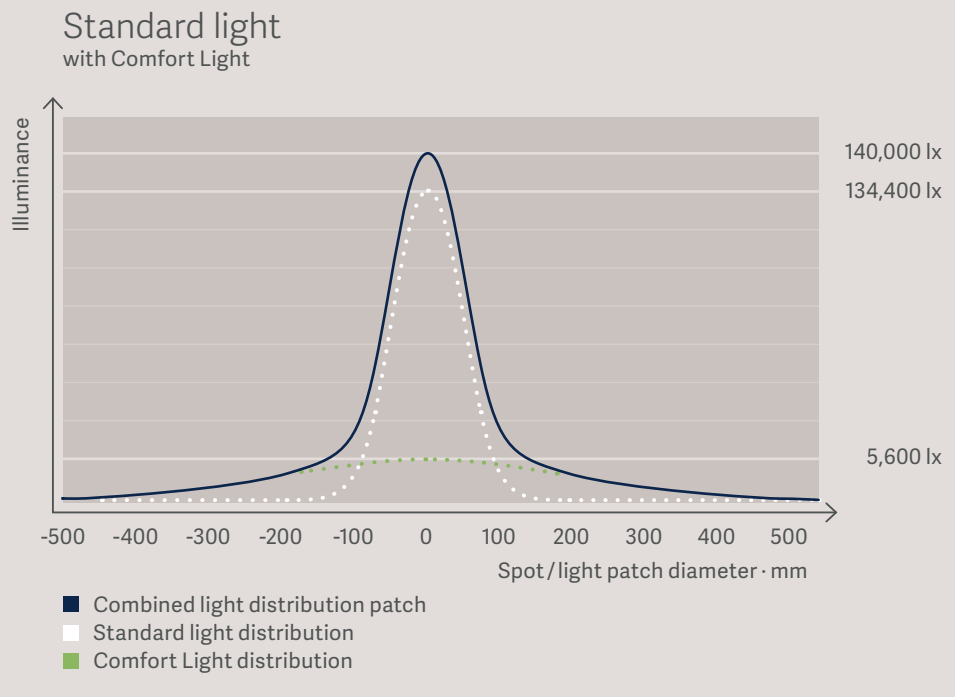
Based on the NUTEK research, the illumination of surfaces in the surgeon's peripheral field of view (80 to 120 cm diameter) should not exceed a ratio of 3:1 (NUTEK, 1994).

Surgery-specific studies have agreed with the NUTEK results: more uniform illumination of the operating table can have a positive effect on reducing strain (Hemphälä, 2009).

Identifying visual preferences for contrast ratios

In 2013, a study was conducted to identify the visual preferences of 50 participants to determine the best contrast ratios.

Six illumination scenarios were presented. In each test, the main surgical light was controlled independently to maintain high quality illumination on the surgical site. Varying amounts of additional light were added to create different levels of contrast in the light patch periphery.
These six timed tests required participants to perform a series of actions, followed by a questionnaire about their visual experience. When peripheral illumination increased, participants noted a decrease in the sensation of glare, along with an improvement in overall visual comfort and visual acuity in the surrounding area. However, the benefits decreased when the peripheral illumination was too great. Based on the study conducted in 2013, Getinge chose to integrate the Comfort Light option in the Maquet PowerLED II Surgical Light. Its illumination profile is proven to minimize visual fatigue.

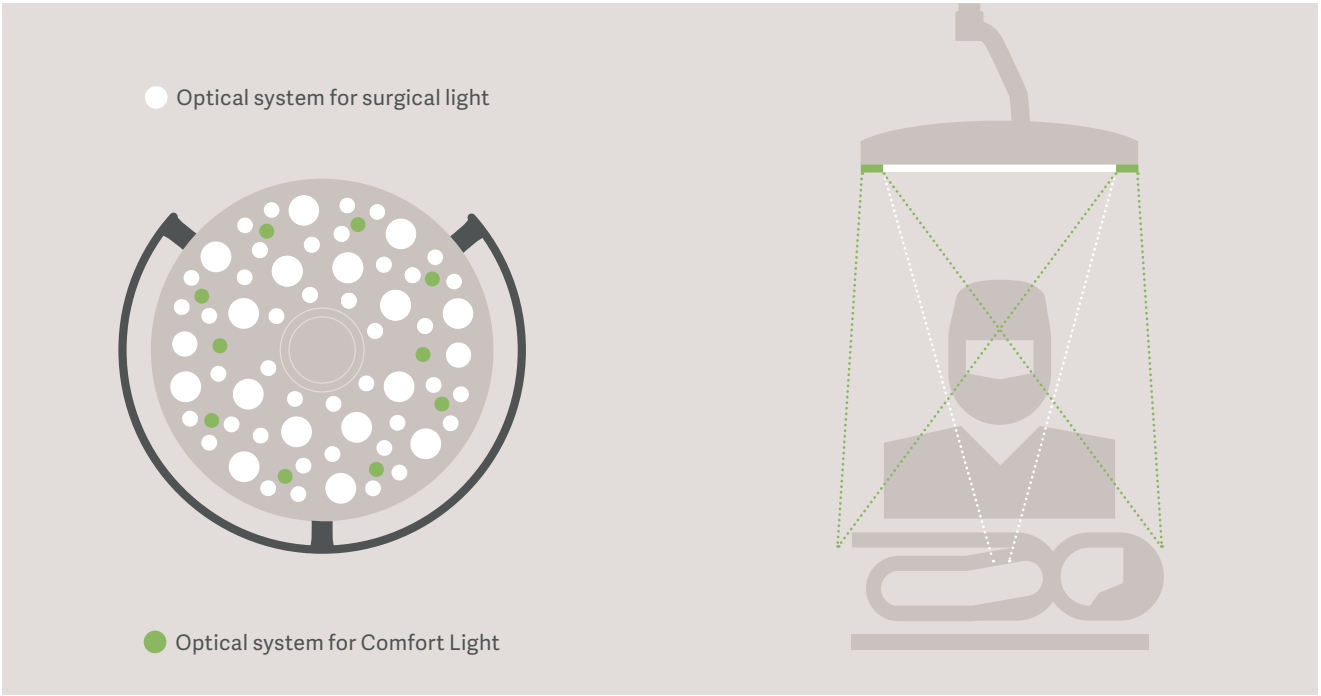


Transitional lighting improves comfort and visual acuity

Based on the questionnaires, nearly 80% of participants subjectively preferred the gradual transition of an intermediate light source to moderate the contrast.

Effective integration of transitional lighting

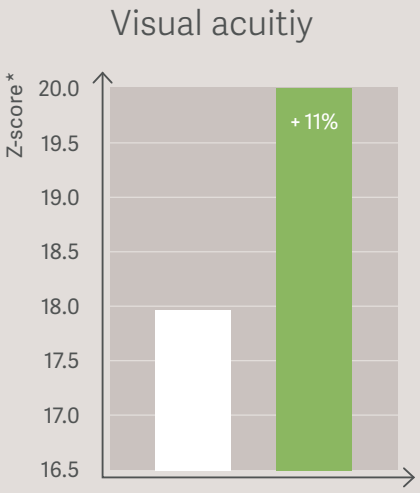
The nature of surgical lighting is that the primary light patch and the transitional lighting must always be concentric. To achieve this goal, the transitional light must be mounted within the same light head, encompassing a broader area surrounding a shared central axis.
The addition of a transitional light will require additional power. In an effort to deliver the best illumination with the least heat, between 4 and 6% of nominal illumination is recommended. The transitional light should also be able to be turned off as needed to meet individual user preferences.

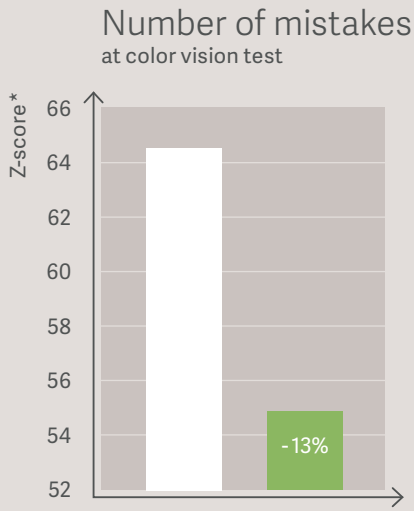


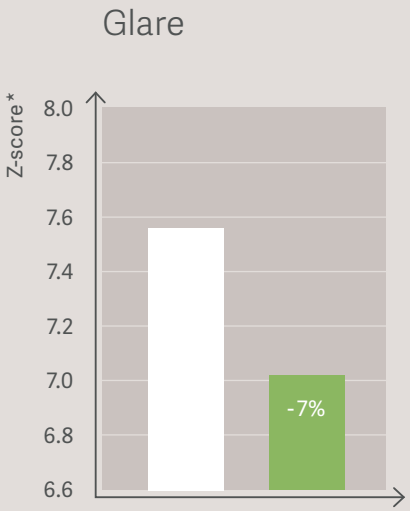
Maquet PowerLED II with Comfort Light – reducing visual fatigue to minimize errors

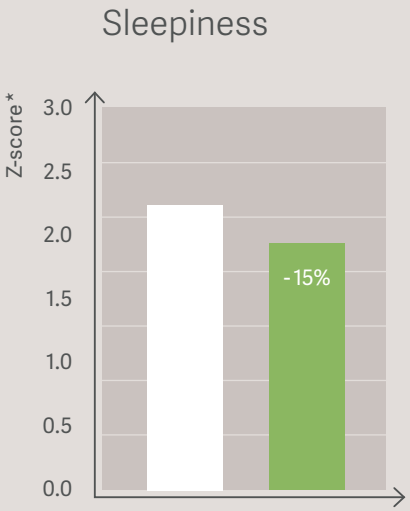
Thanks to the Comfort Light feature, Maquet PowerLED II improves visual performance, reduces the sensation of glare and increases the feeling of wakefulness leading to a better working environment for the surgical staff.

We can see from the figures that transitional lighting reduces the sensation of glare by 7%, and the feeling of sleepiness by 15%. However, the transitional lighting also improved their visual performance. Indeed, participants saw an 11% improvement in visual acuity with the addition of transitional lighting, and a corresponding 13% reduction in errors on a color vision test. The latter is of particular importance, as color plays a significant role in tissue discrimination during surgery.









Surgical light alone
Surgical light with Comfort Light

* A Z-score is frequently used in statistics and is a good way to eliminate inter-individual deviations, as it serves to consider a participant's result according to his/her average result over all of the scenarios tested. The formula is as follows: Z-score = (value – average value)/standard deviation.

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