

Surgical lighting

A **surgical light** – also referred to as an operating light or surgical lighthouse – is to assist medical personnel during a surgical procedure by illuminating a local area or cavity of the patient. A combination of several surgical lights is often referred to as a “surgical light system”.

History

Technology development For lighting a surgical operation in the middle of 1850s, the room itself was built towards the south-east with windows in the ceiling to benefit from the natural sunlight as much as possible. The greatest problem with this was that the possibility to perform a procedure relied on the time of the day and weather conditions, but also the problem of the doctor, nurse or medical equipment easily blocking the illuminated area. A development of this was the use of mirrors on the four corners of the ceiling to reflect the sunlight towards the operating table but the problems were only slightly reduced.

Optical condenser in an indirect light was also tried to reduce the heating but without success. When the electric lights made their entrance into the operating room in the 1880s it also quickly showed problems. At this early stage of electricity the ability to control the light emitted was very low. The light created was still moving and diffuse with great heat radiation.

With the introduction of light-emitting diodes as light sources, the problem of heat radiation is removed, while energy requirement is reduced.

Terminology and measurements

- **Lux (lx)**

Unit for the amount of visible light measured by a luxmeter at a certain point.

- **Central illuminance (Ec)**

Illuminance (lx) at 1m distance from the light emitting surface in the light field centre.

- **Light field centre**

Point in the light field (lighted area) where illuminance reaches maximum lux intensity. It is the reference point for most measurements.

- **Depth of illumination**

The distance under the light emitting area where the illumination reaches 20% of the central illuminance

- **Shadow dilution**

The light's ability to minimise the effect of obstructions.

- **Light field diameter (D10)**

Diameter of light field around the light field centre, ending where the illuminance reaches 10% of Ec. The average of four different cross sections through the light field centre.

- **D50**

Diameter of light field around the light field centre, ending where the illuminance reaches 50% of Ec. The average of four different cross sections through the light field centre

Norms and requirements for surgical light

The International Electrotechnical Commission (IEC) has created the document *IEC 60601-2-41 – Particular requirements for the safety of surgical luminaries and luminaries for diagnosis, 2000* to establish norms and guidelines for the characteristics of a surgical and examination light to secure safety for the patient as well as lower the risk to a reasonable level when the light is used according to the user manual. Some of the standards for surgical lightheads are the following.

Homogenous light The light should offer a good illumination on a flat, narrow or deep surface in a cavity, despite obstacles such as surgeons' heads or hands.

Lux The central illuminance can not exceed 160 000 lux and should not be lower than 40 000 lux

Light field diameter The D50 should not exceed 50% of d10 diameter

Colour rendition For the purpose of distinguishing true tissue colour in a cavity, the colour rendering index (Ra) should be between 85 and 100.

Backup possibility In case of interruption of the power supply, the light should be restored within 5 seconds with at least 50% of the previous lux intensity, but not less than 40 000 lux. Within 40 seconds the light should be completely restored to the original amount of lux.

Announcement The IEC document also mentions what needs to be notified to the user. For example, should the voltage and power consumption be marked on or near the lampholder as well as on the lighthead. In the instructions for use the following info should be announced.

- Cleaning and decontamination of the surgical light
- Safety aspects of optical filter (purpose and warning to prevent removal)
- Central illuminance
- Light field diameter
- Depth of illumination
- Shadow dilution
- Correlated colour and colour rendering index
- Total irradiance
- Cleaning, disinfecting
- Handling of the lighthead in case of failure
- How the user should respect the national rules for hygiene and disinfecting

References

1. Extrait de la revue *Techniques Hospitalières* noo 400 Janvier/1979 "L'éclairage en salle d'opération" by M. Hainault p. 47
2. IEC International 60601 – Particular requirements for the safety of surgical luminaries and luminaries for diagnosis – Part 2-42.

Article Sources and Contributors

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