SYNOPSIS

KEY POINT SUMMARY

OBJECTIVES

The objective of this study was to evaluate the lighting of workstations designed for radio diagnostic reporting and to gather information pertaining to the visual interaction between worker and device with the intent to prevent risks to the health of the radiologists.

Lighting Assessment of Ergonomic Workstation for Radio Diagnostic Reporting

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Key Concepts/Context

Diagnostic imaging involves traditional radiology, computerized tomography (CT), and magnetic resonance imaging (MRI). Each of these procedures involves assessment, planning, execution, reporting, and verifying results. Present-day technology involves the processing of images by computer software. Reporting involves viewing these images on diagnostic monitors. While the authors contend that there is abundant literature on radiology software and the relation between device settings and visual performance, there is little information available on the ergonomic features of image display devices. The design of these devices and the workstation is crucial to the health of radiologists, as are other environmental aspects such as temperature, humidity, air quality, ventilation, light, and noise.

According to the authors, adequate lighting (both in the reporting room and on the device settings) is the most important factor relevant to the work performance and health of a radiologist. This study assessed the lighting of two radio diagnostic reporting workstations in a hospital in Tuscany, Italy. They installed a patented LED backlight system, or LBS, in one of the workstations and made objective and subjective assessments of its potential benefits. Results indicated that participating radiologists found the LBS helped in reducing visual fatigue.

Methods

Two different types of diagnostic reporting rooms were evaluated in this study: an adjustable ergonomic reporting workstation and a nonadjustable reporting workstation. These rooms were included in the study – x-ray, CT, and MRI radio diagnostic rooms. The x-ray and CT rooms had adjustable workstations, while the

DESIGN IMPLICATIONS

Although the authors recommend more studies to examine correlation between visual fatigue and the use of LBS, they still recommend installing LBS in radiological workstations.

MRI room had a nonadjustable workstation. The lighting conditions of the three workstations and the x-ray and MRI rooms were assessed.

- X-ray diagnostic room – adjustable workstation: Located in the center of the entrance to the radiology department, this room did not have its own ceiling and all of its lighting was natural (from ceiling skylights). Therefore, all assessments were carried out during the availability of daylight. Three lighting scenarios were examined: all workstation lights were switched off; workstation lights were on at a 100% intensity; and workstation lights were set to 50% intensity. There were three measurement surfaces – a horizontal plane 20 cm from the ground, a plane at the work top – 80 cm from the ground, and a plane corresponding to the monitors 110 cm from the ground.
- MRI radio diagnostic room – nonadjustable workstation: This room did not have any natural lighting. Since there was no dedicated lighting available for this workstation, an LED backlight system or LBS (Italian patent number 0001423820, Leccese et al., 2016) was installed and evaluated as well. A total of seven lighting scenarios were examined – first with general lighting on and LBS off, five scenarios with general lighting off and LBS on (at different locations, light beams at different angles, and different luminous intensities), and the seventh scenario with both general lighting and LBS off (some light was provided from the internal window that looked into the MRI device room). There were four measurement surfaces: a horizontal plane 20 cm from the ground, a plane at the work top 80 cm from the ground, a plane corresponding to the monitors 110 cm from the ground, and the last horizontal plane was above the workstation, 140 cm from the ground.

Illuminance and luminance for all scenarios in both workstations were carried out using a dataloggerDelta Ohm model HD2101.1 and a universal photometer Hagner model S4 both provided by the Lighting and Acoustics Laboratory, University of Pisa.

In addition to the above objective measurements, an 18-item questionnaire was administered to obtain user perspective on the LBS in the nonadjustable workstation. Apart from the demographic questions, the questionnaire had two parts: the first part asked for responses on work habits and the second pertained to the use of the LBS. The participants in this survey were radiologists who worked in the MRI room. The LBS was installed in this room for one month. The participants had the ability to adjust the height, direction, and intensity of the LBS. A total of 16 radiologists participated in the survey.

Findings

X-ray diagnostic room – adjustable workstation:

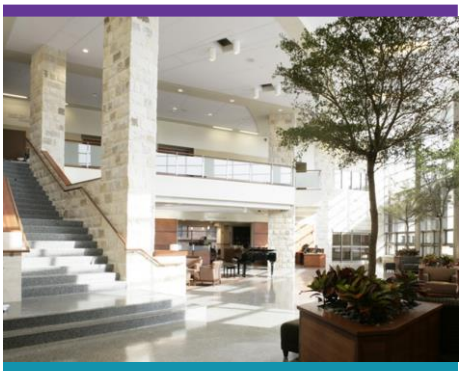
- The average illuminance at the plane 20 cm off the ground was calculated to be much lower than the recommended value provided in the guidelines of the American Association of Physicists in Medicine (AAPM, 2205) and EN 12464-1, 2011. The average illuminance at the worktop and monitor planes were much higher than recommended by the AAPM (2005) for scenarios 2 and 3 (lighting intensity at 100% and 50%, respectively).
- The luminance ratio for scenario 1, where lights were all off, was not enough for the visual task of reading the PC monitor and just enough for reading the diagnostic monitor. The luminance ratio for scenario 2 with the light intensity at 100% was not satisfactory for either visual task. Scenario 2 where lighting intensity was set at 50% met the requirements of the AAPM.

MRI radio diagnostic room – nonadjustable workstation:

- The average illuminance for scenario 1 exceeded the recommended illuminance by seven times – a scenario that would contribute to glare and make it difficult to see displayed images. Scenario 7, where artificial lighting was kept off, had very low levels of illuminance. For scenarios 2-6, LBS was installed and kept on and the general lighting was kept off. When the LBS was perpendicular to the wall panel and its luminous intensity was at 100% (scenario 2) and 50% (scenario 3), the average illuminance did not comply with EN 12464-1, 2011, but met the requirements of AAPM, 2005.
- The luminance ratio for all five scenarios with LBS on were consistent with the values required for reading on the diagnostic monitors, but not for reading on the PC monitor.

Survey findings:

- Work habits: Participants responded that they worked for four to six hours a day. Their work sessions ranged from 20 minutes to three hours. Of the 16 participants, 10 complained of visual fatigue while reporting, 62% of these said they took breaks from their reporting to give their eyes rest, 25% said they turned on a desk lamp to increase the light intensity, and 13% said they decreased the viewing distance (which resulted in incorrect postures). Participants indicated their preference for adjustable diffused light.
- Response to LBS: 63% of participants found LBS to be very useful and 25% found it to be quite useful. 87% responded that reporting was easier with



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LBS. Daily visual fatigue was reported reduced by 75% of respondents and 50% responded that weekly visual fatigue had reduced.

- LBS configuration: 70% of the participants preferred placing LBS similar to scenario 2 – the light source behind the diagnostic monitors, 55 cm above desktop, the light beam directly perpendicular to the wall panel, and set to 100% intensity. 25% of the participants wanted the LBS placed similar to scenario 3 – the light source behind the diagnostic monitor, 65 cm above the worktop, the light beam directly perpendicular to the wall panel, and set to 50% intensity. And 5% of the participants wanted the LBS placed similar to scenario 5 – the light source above the diagnostic monitor, 65 cm from the worktop, the light beam angled 30° down and intensity set to 100%

Limitations

Authors do not identify limitations to their study. However, they do indicate the necessity for further studies to examine correlation between visual fatigue and LBS. Although the authors mention they assessed three radio reporting rooms, their methods and findings focus on only two rooms.