Occupational Exposure to Artificial Optical Radiations: A Brief Review

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ABSTRACT
Many persons are occupationally exposed to artificial optical radiations. The objective of this study was to review descriptive or experimental studies assessing occupational exposure to artificial optical radiations. PRISMA methodology was followed to perform the review. Five articles were considered for full analysis. The selected articles were carried out in Italy and in UK. Four articles were carried out in hospitals and one in the entertainment industry. Given the actual legislative frame related to this issue in the EU countries, it was expected to gather more articles characterizing the exposure in different occupational groups. In general, the levels were above the exposure limits. Some potentially relevant studies were rejected due to language criteria. The relevance of this study could increase if more databases were included in search strategy.

KEYWORDS: non-ionising radiation; artificial optical radiation; occupational exposure

1. INTRODUCTION

Artificial optical radiation (AOR) exists in most workplaces and all workers are exposed. Optical radiation is a form of non-ionising radiation which is relatively easy to control. However, there is lack of awareness of workers for this potential risk. There are a number of applications of artificial optical radiation which require direct exposure of workers at levels that may exceed the exposure limit values (ELVs). The AOR sources of significant interest are some industrial process equipment (e.g., welding, paint drying ovens, melting of metal and glass, among others), entertainment industry and some medical applications (e.g., laser, neonatal phototherapy lamps, sterilization, surgical lights, etc.) (European Commission, 2011; Leccese, Salvadori, Casini, & Bertozzi, 2014). Such applications need detailed risk assessments to ensure that the exposure limit values are not exceeded. In fact, workers in a hospital environment may be exposed to different types of non-coherent AOR sources such as computer displays, ambient lighting, spotlight lamps for diagnosis, negatoscopes, operating theatre lighting, photodynamic and neonatal therapy sources, infrared ovens, germicidal UVR lamps of laminar flow cabinets, transilluminators, Wood lamps and sterilization UVR sources (Cavatorta et al., 2016). Minor attention has been paid to incoherent sources widely used in offices, e.g., lamps/luminaries, display screen equipment, copiers and scanners, and LED for lighting and signalling. The European Directive 2006/25/EC requires the employer to assess and, if necessary, measure and/or calculate the levels of exposure to optical radiation on the spectral range of wavelength from 180 to 3000 nm. In Portugal, the minimum requirements to protect workers against risks to health and safety that may result from exposure to the AOR are presented in Law no. 25/2010 (EU Directive 2006/25. The ELVs represent levels at which the International Commission On Non-Ionizing Radiation Protection (ICNIRP) considers that most of the working population can be repeatedly exposed without suffering any acute adverse health effects and without noticeable risk of long-term effects (Bonner, Khazova, O'Hagan, & Squire, 2012). Therefore, exceeding an exposure limit will not necessarily result in harmful health effects. In fact, the risk will increase as exposure levels increase above the ELV (Bonner, O’Hagan, & Khazova, 2012). The ELVs are not intended to avoid chronic skin effects: the incidence of these effects will be reduced by virtue of prevention of acute effects and reduction in lifelong exposure. The associated health effects, both beneficial and harmful, have been studied for decades (Necz & Bakos, 2014). Despite beneficial effects of UV radiation (generation of vitamin D), overexposure to it can cause and chronic skin and ocular diseases. There has been yet no systematic summary of the results of studies on the risks associated with occupational exposure to AOR. The aim of the present review is to summarise the literature on the assessment of the occupational exposure to AOR in different occupational groups.

2. MATERIALS AND METHODS

The systematic search was focused on the literature pertaining to the assessment of occupational exposure to AOR. The study was carried out according to the PRISMA statement (Moher, Liberati, Tetzlaff, & Altman, 2009). We searched the Scielo Citation Index, Medline and Web of Science Core Collection databases through the Web of Science research platform, from the year 2000 until 2016. The last search date was June 1, 2016. We used the terms “artificial optical radiation”, “laser” and “artificial UV” combined with “occupational exposure”, “disease”, “risk assessment”, “health”, “protection”, “safety” and “radiation workers”. After importing all results into EndNote Web (Thomson Reuters, USA), the articles were screened with respect to title, abstract and key words. The exclusion criteria were as follows: reviews or meta-analyses; duplicate printings; non English/Portuguese language; editorials, letters, patents, errata, meeting abstracts, and conference papers. Only peer-review articles reporting quantitative or qualitative assessment of AOR in occupational settings, written in English/Portuguese, were included.

3. RESULTS

The search strategy yielded a total of 288 citations before duplicates removal. After checking the duplicates, 201 papers were considered for screening. A total of 61 papers were deemed potentially relevant based on title and abstract. After application of the eligibility criteria while considering the full text, another 56 papers were excluded. A total of 5 studies were considered for the final analysis. Figure 1 displays the flowchart of the search strategy.

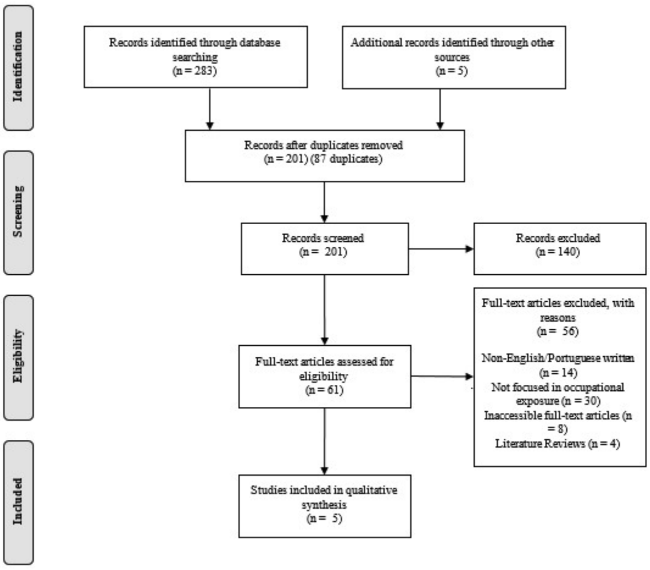

Figure 1 – Flow diagram of the articles screening process.

4. DISCUSSION

Leccese et al. (2014), describe in their article the exposure limit values concerning artificial optical radiation due to the main incoherent light sources found in offices. The assessment method used was radiometry (RD). The results were compared with the exposure limit values specified in the European legislation. From the analysis of the results the lighting sources typically present in workplaces under normal conditions of use, do not present a risk for workers' health. However, in the case of accidental exposure during work activities or exposure associated to maintenance tasks (short exposure distance), values higher than the limit levels have been observed (H_{eff} > ELVs in 2 sources; L_B > ELVs in 3 sources and E_{IR} > ELVs in 3 sources). Pinto et al. (2015) developed their study in neonatology departments of several hospitals. The exposure was determined by spectroradiometry (SRD). They found that, in general, phototherapy equipment has strong emission in the visible region, regarding the blue end, but some of them presents also emission in the UVA region. The study shows that the blue light exposure risk for workers can be very low or irrelevant only for that equipment based on traditionalfluorescent tubes, as well as for most of the assessed equipment based on LED or metal halide lamps. Cavatorta et al. (2016) surveyed medical lighting sources. In this sense a risk matrix for risk assessment was showed and detailed information about methodological aspects was described. The measurements were made by SRD. The authors of the study concluded that the emission of ambient lighting in the actual exposure conditions was always in accordance with the ELVs and the related risk was classifiable as not relevant. The risk related to the exposure to theatre operating lighting resulted not negligible through the application of the risk matrix. The assessment of laminar flow cabinets and closed transilluminators, revealed that if the UVR source is well contained within an enclosure with interlock, it presents low or even no risk of exposure. Differently, the emission from UVR lamps, open transilluminators or sources not provided with interlock, may represent a risk classifiable as high even in the actual working conditions of the surveyed hospitals, by the application of the risk matrix. Similar results were found by Coleman et al. (2010), who analysed sources of incoherent optical radiation in a hospital environment. The study analysed office lighting, operating theatre lighting, examination lamps, and sources for ultraviolet phototherapy and visible phototherapies, including photodynamic therapy and neonatal blue-light therapy. This study shows an interesting approach by classifying the sources into risk groups, making easier the risk management process. However, the authors enhance the need of further verification of this approach. Regarding objective measurements (made by SRD and RD), results shows that AOR > ELVs: examination lighting in 1 source; operating theatre in 5 sources; photobiology solar sim in 1 source; UVA phototherapy in 2 sources and UVB phototherapy in 3 sources. Finally, Bonner, et al. (2012) studied AOR exposure in the entertainment industry. Multiple illumination sources, continuously changing illumination conditions and people movement during performances, make the assessment of occupational exposure a very challenging process. This article provides a methodology for assessing AOR and presents two case studies of practical assessment in two entertainment venues. The authors concluded that the exposure of the performers in two assessed entertainment venues do not to present a risk of actinic, UVA or blue light hazards (in the actual functional conditions). The UVA and blue light hazard levels staring directly at some of the followspots may exceed exposure limits.

5. CONCLUSIONS

In general, the studies reviewed showed some types of AOR above the defined exposure limits, giving some measures to control the exposure as well as, in some cases, alternative approaches to classify the risk, that may require future validation. Few studies have investigated the occupational exposure to AOR in different occupational settings. Quality assessment of the selected studies should be provided in future versions of this review.

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