นิพนธ์ต้นฉบับ Original Article

การทบทวนวรรณกรรมอย่างเป็นระบบเรื่อง ชนิดและความชุกของการบาดเจ็บจากเลเซอร์จากการทำงานแต่ละอาชีพ

Types of laser injury by occupation and their prevalence: a systematic review

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บทคัดย่อ

การทบทวนวรรณกรรมอย่างเป็นระบบฉบับนี้ มีวัตถุประสงค์เพื่อศึกษาชนิดและความชุกของการบาดเจ็บจากเลเซอร์จากการทำงานในแต่ละอาชีพ โดยศึกษาจากงานวิจัยที่ได้รับการตีพิมพ์ในช่วงปี พ.ศ. 2553 จนถึงเดือนกรกฎาคม พ.ศ. 2562 จากแหล่งข้อมูลทั้งหมด 10 แหล่ง ได้แก่ ฐานข้อมูลบรรณานุกรม 7 แหล่ง (Ovid MEDLINE and In-Process, EMBASE, HMIC, PsycINFO, CINHAL Plus, NIOSHTIC และ PubMed MEDLINE) และเอกสารที่ไม่ได้พิมพ์เผยแพร่ 2 แหล่ง (UBIRA ETheses และ EThOS) รวมถึงรายการเอกสารอ้างอิงของการศึกษาที่ถูกคัดเข้าทั้งหมด จากนั้นประเมินคุณภาพตามชนิดการศึกษา และสกัดข้อมูลจากงานวิจัยที่มีคุณภาพระดับปานกลางขึ้นไปโดยใช้แบบฟอร์มที่ผู้วิจัยออกแบบเอง ข้อมูลที่ได้จากการสกัดจะถูกนำมาวิเคราะห์เชิงคุณภาพ จากการค้นหาได้ผลลัพธ์ทั้งหมด 2,056 ฉบับ และมี 29 ฉบับ ที่เข้าเกณฑ์คัดเข้าเพื่อนำมาวิเคราะห์ข้อมูล จากการวิเคราะห์แก่นสาระ (Thematic Analysis) สามารถแบ่งเป็น 5 กลุ่มอาชีพ ดังนี้ อาชีพเกี่ยวกับการแพทย์ (ร้อยละ 69.0) อาชีพเกี่ยวกับการบิน (ร้อยละ 17.2) อาชีพเกี่ยวกับสำนักงาน (ร้อยละ 6.9) อาชีพเกี่ยวกับงานบันเทิง (ร้อยละ 3.4) และอาชีพเกี่ยวกับการทหาร (ร้อยละ 3.4) ชนิดของสิ่งคุกคามที่มีการตีพิมพ์มากที่สุด คือ การสัมผัสฝุ่นละอองจากหัตถการเลเซอร์ ร้อยละ 85.0 ของงานวิจัยทางการแพทย์ (17 จาก 20 ฉบับ) และการบาดเจ็บที่ตา ร้อยละ 100 ของงานวิจัยทางการบิน (ทั้งหมด 5 ฉบับ) การศึกษานี้ไม่สามารถวิเคราะห์อภิมานเพื่อหาค่าความชุกได้เนื่องจากข้อมูลมีความหลากหลายสูง แต่สามารถระบุได้ว่าการติดเชื้อที่มีการศึกษามากทางการแพทย์ คือ การติดเชื้อเอชพีวีในอากาศ โดยมี 5 การศึกษาที่ระบุเกี่ยวกับเรื่องนี้ โดยส่วนใหญ่ระบุว่ามีโอกาสต่ำในการพบเชื้อเอชพีวีในอากาศหรืออุปกรณ์ป้องกัน และมีการศึกษาเพียงหนึ่งชิ้นระบุว่า พบความชุกการติดเชื้อเอชพีวีจากอากาศบริเวณเยื่อบุผิวทางเดินอาหารที่ร้อยละ 5.8 ของเจ้าหน้าที่ 156 คน ที่ทำงานสัมผัสควันจากเลเซอร์ในการรักษาหูดบริเวณอวัยวะสืบพันธุ์ของคนไข้ เทียบกับความชุก ร้อยละ 1.7 ของเจ้าหน้าที่ 115 คน ที่ไม่เคยมีประวัติสัมผัสสิ่งคุกคาม (p=0.12) จากข้อมูลทั่วไปทราบกันดีว่าการบาดเจ็บจากการทำงานด้วยเลเซอร์ที่พบมากที่สุด คือ ตาและผิวหนัง แต่การวิจัยนี้พบ

ว่าความแตกต่างของอาชีพก็อาจพบชนิดของการบาดเจ็บที่แตกต่างกัน โดยเฉพาะผลกระทบทางสุขภาพจากการสัมผัสควันจากเลเซอร์ในบุคลากรทางการแพทย์พบว่ามีการตีพิมพ์มากที่สุด อย่างไรก็ตามการใช้เลเซอร์ในการประกอบอาชีพมีแนวโน้มสูงขึ้นเรื่อย ๆ แต่การศึกษาเกี่ยวกับการบาดเจ็บในการทำงานเกี่ยวกับเลเซอร์ยังคงมีจำนวนน้อยมาก ดังนั้นจึงควรมีการศึกษาเพิ่มเติมในอนาคตเพื่อให้มีการพัฒนาองค์ความรู้ในด้านนี้มากขึ้น

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Abstract

This study explores the types of occupational laser injury and their prevalence in each occupation which occurred from 2010 to July 2019 by using a combination of search terms in 10 sources (seven from bibliographic databases-Ovid MEDLINE and In-Process, EMBASE, HMIC, PsycINFO, CINHAL Plus, NIOSHTIC, and PubMed MEDLINE, plus two from the grey literature-UBIRA ETheses and EThOS, and the last one from a reference list of all included studies). The final selected papers were assessed for quality by a different form of checklist depending on study type. At least average or above-average quality studies were extracted using a self-created data extraction form and were then analysed by deductive thematic analysis. From a total of 2,056 identified papers, 29 were retrieved for data extraction. Some 69.0% of the retrieved studies were accounted for by healthcare workers (HCWs), 17.2% by aviation, 6.9% by office work, 3.4% by entertainment, and 3.4% by the military. Type of laser injury was themed among each occupation. Laser-generated air contaminants (LGACs) were the main type of injury among healthcare workers, accounting for 85.0% of HCWs' studies (17 out of 20 papers), while ocular injury was the only published injury type in aviation (all 5 papers). In terms of prevalence, few studies were obtained, making it impossible to perform a meta-analysis. However, it could be concluded that the main concerned health effect of surgical smoke was human papillomavirus (HPV) transmission. There were five articles related to this topic, most showing a low risk of HPV contamination in the air and protective equipment. Only one paper mentioned that the prevalence of gastrointestinal mucosal HPV type was found among 5.8% of 156 employees who had been exposed to LGACs due to their involvement in the procedure of laser treatment of patients with genital warts, compared to 1.7% of 115 of those with no history of exposure to LGACs as a result of the procedure (p=0.12). Essentially, most laser incident reports were commonly known as ocular and skin injuries. Nonetheless, this result reveals that the highest number of studies was published in LGACs exposure among healthcare workers. Although there is a growing trend of laser use, the number of published papers related to this area was too small and could not meet all this study's research objectives. Therefore, further study in this area could help to develop more knowledge.

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Keywords
lasers, prevalence, laser injury, laser injury prevalence, occupational laser injury

Introduction

LASER is an acronym for "Light Amplification by Stimulated Emission of Radiation". It is a device that amplifies optical light and emits it as a laser beam. Recently, there has been a growing trend in the use of laser applications in industrial manufacturing, medical treatment, science technology, and other areas intimately bound up with global technological and economic development.[1] One worldwide laser market review showed that a more widespread demand for lasers is expected to the figure of around 15 billion US dollars in the future.[2]

The current study focuses on occupational laser injuries, defined as any injury resulting from exposure to laser hazards during work activity. In general, although similar equipment is used, different types of injury can occur depending on the nature of the work involved. However, despite these differences, the vast majority of laser-related injuries can be grouped into two overarching categories - beam or non-beam - and the overall health effects can be eye injuries, skin burns, fire, smoke inhalation (plumes). and accidents such as electric shock and explosion.[3-4] Beam hazards are damage caused by a laser beam-- not only the direct beam itself but also the reflection of a beam by a flat or a mirror-like surface.[5] Non-beam hazards are other hazards related to laser use besides the beam or its reflection.[6] The most common occupational injuries fall within the first category and result in eye injuries and skin injuries.[7] However, this data has not been updated for over 10 years. Moreover, there has been no attempt to summarise the more updated types of laser injury and analyse their prevalence in each occupation. Therefore, this is the first study attempt to diminish that knowledge gap.

Methodology

This qualitative systematic review study was conducted as a system and comprises a number of steps: search strategies, study selection, quality assessment, data extraction, and analysis. There was no funding or any conflict of interest in this project. Only one author conducted all the steps under supervision due to lack of resources. More information is given in the following sections.

Search strategies

Scoping searches were carried out using a number of databases: bibliographic databases, grey literature, and reference lists. This included seven from bibliographic databases, namely: Ovid MEDLINE and In-Process, EMBASE, HMIC, PsycINFO, CINHAL Plus, NIOSHTIC, and PubMed MEDLINE. The two sources from the grey literature were UBIRA ETheses and EThOS. The reference lists of all included studies were also followed. The terms used in the search were based on the study's research objective, namely to explore the type of laser injury by occupation and its prevalence by using the SPICE framework (Setting, Phenomena of interest, Comparison, Evaluation). The pilot search was conducted using search terms 1) and a) to e) with title or abstract filter.

1) Laser* AND occupation* or work or work-related AND injur* or accident* or burn* or occurrence* or exposure* or incident* or hazard* or health effect*. ti, ab

a) Laser* AND aircrew* or aviation or pilot* AND injur* or accident* or burn* or occurrence* or exposure* or incident* or hazard* or health effect*. ti, ab

b) Laser* AND worker* or employee* or engineer* or technician* or industrial AND injur* or accident* or burn* or occurrence* or exposure* or

incident* or hazard* or health effect*. ti, ab

c) Laser* AND nurse* or doctor* or assistant* or physician* or medical AND injur* or accident* or burn* or occurrence* or exposure* or incident* or hazard* or health effect*. ti, ab

d) Laser* AND military or soldier* or armed force* AND injur* or accident* or burn* or occurrence* or exposure* or incident* or hazard* or health effect*. ti, ab

e) Laser* AND science or student* or scientist* AND injur* or accident* or burn* or occurrence* or exposure* or incident* or hazard* or health effect*. ti, ab

Study selection

All articles obtained from the databases were imported to RefWorks ProQuest for management and screening. After deduplication, all the studies were screened by title and abstract following the inclusion criteria, namely:

Setting:	Any study about occupation or which was work-related. In undetermined cases, it was included for full-text screening.
Phenomena of Interest:	Laser injury or exposure by the worker.
Comparison:	None

Evaluation:

- The percentage of each occupation accounting for the total number of included studies.
- Type of laser injury by occupation.
- Prevalence of occupational laser injury.

Additional inclusion criteria were observational study, full-text available, and English language, while exclusion criteria were conference article/guideline, experimental study, and one case report.

Quality assessment

Quality assessment checklists were used depending on the study type. The CASP tool Appraisal Checklist was used to assess the quality of the systematic reviews and cohort studies[8-9], the CARE checklist was used to assess case reports, and the AXIS checklist was used to assess cross-sectional studies.[10-11] The overall checklists were considered to have three main sections: internal validity, result assessment, and applicability. Internal validity was the assessment of clear objectives, sample size justification, how a proper study design should be, etc. Result assessment was the complete described result. The applicability was the ability to apply for the local population and worthy benefits. The scales were shown in 5 choices: No, N/A, Yes, and if Yes then Poor, Fair, and Good will be scaled if applicable. Finally, the overall ranking of each paper was identified by the percentage of Good and Yes from the overall components. There were four quality levels of paper: excellent, good, average, and poor. Higher or equal to 80% of Good and Yes from overall components was identified as excellent quality, 60%-79% was identified as good quality, 50%-59% was identified as average quality, and lower than 50% was identified as poor quality.

Data extraction

At least average quality studies and above were retrieved for data extraction by a self-created extraction form consisting of 2 main parts: demographic characteristics and research interest details. The demographic characteristics were information about study ID, study type, setting, study population, and sample size. The research interest details were occupation, type of laser injury, prevalence, hazard sources, and knowledge of users.

Analysis

Deductive thematic analysis, a method for analysing qualitative data by coding and developing themes which are existing concepts or ideas[12], was applied because it is a highly flexible approach and can provide informative detail. This study was a mix of qualitative and quantitative data, various study types, and different settings, and therefore the use of thematic analysis was deemed to be an appropriate data analysis method. There were six-phase process for doing analysis: familiarisation with the data, coding, generating initial themes, reviewing themes, defining and naming themes, and writing up.

Results

Search results and inclusion/exclusion

The full selection process is outlined in a PRISMA flowchart (see Figure 1).

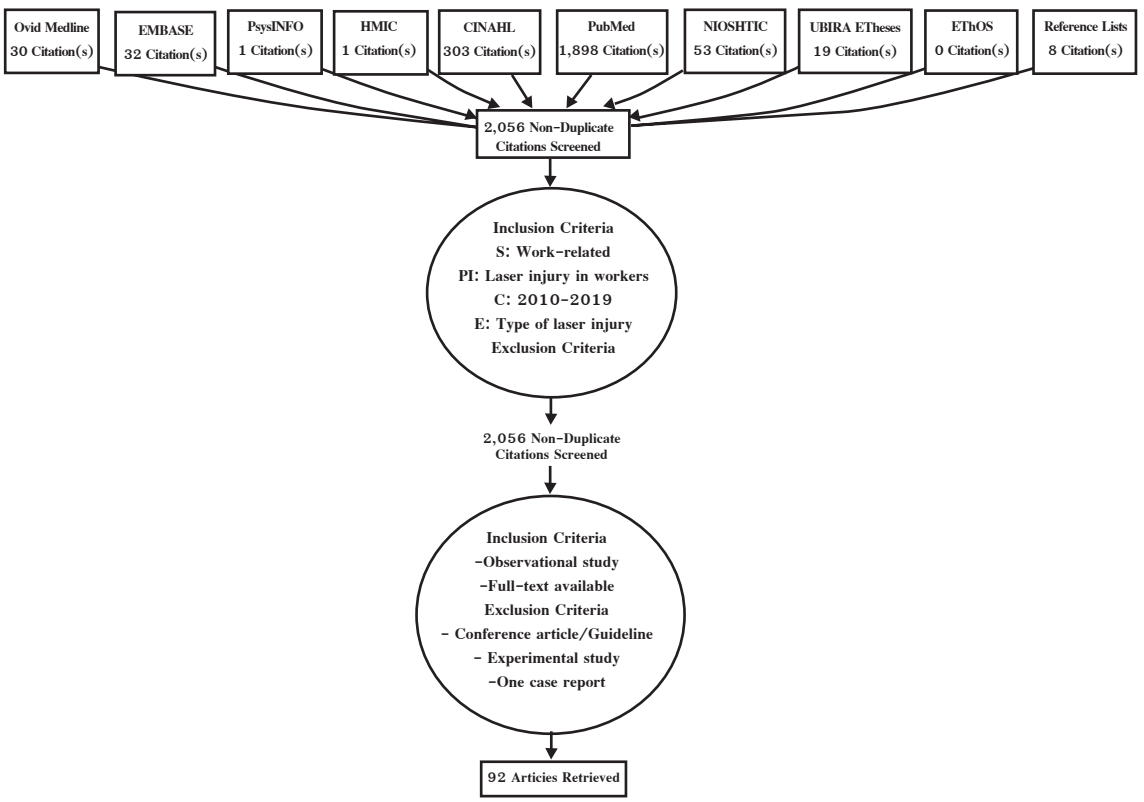

Figure 1: PRISMA flowchart of the selection process of records for inclusion/exclusion Quality assessment

Overall, the majority of studies were good quality (57.0% out of 35 papers). At least average quality studies or above were retrieved for data extraction, totalling 29 papers: 20 out of 24 papers in HCWs[13-32], 5 out of 5 papers in aviation[33-37], 2 out of 4 studies in office work[38-39], and one study each from entertainment and military.[40-41] As studies in healthcare workers, they were identified as excellent quality at 12.5% of the total 24 papers in HCWs, good at 62.5%, average at 8.3%, and poor qualities at 16.7%.

Study characteristics

The bulk of data was obtained in HCWs. Hence the study characteristics and the findings from

only healthcare workers are given in Table 1. The study populations were varied and depended on study type, which were medical personnel, medical treatment environment, and others. The single biggest study type was cross-sectional studies. A small number of studies were systematic reviews, literature reviews, cohort studies, and case reports. The detail of the settings differed and included laser hair removal (LHR) procedure, tattoo removal procedure, head and neck surgery, and CO_2 laser for genital wart treatment, among others.

After deductive thematic analysis, the data were grouped into five different occupations: healthcare workers (HCWs), aviation, office work, entertainment, and military. A total of 29 papers which were at least average quality studies or above were retrieved for data extraction. Some 69.0% of the retrieved studies were accounted for by HCWs, 17.2% by aviation, 6.9% by office work, 3.4% by entertainment, and 3.4% by the military. The type of laser injury was themed among each occupation. Laser-generated air contaminants (LGACs) was the main type of injury among HCWs, accounting for 85.0% (17 out of 20 papers for HCWs) while ocular injury was the only type of occupational laser injury interest in aviation (all 5 papers in aviation) as well as entertainment and military (only one paper each).[15-31,33-37,40-41] Printer-Emitted Engineered Nanoparticles (PEPs) were the main concern in office work (both 2 papers in office work).[38-39]

In terms of prevalence, few studies were obtained on which meta-analysis could not be performed. However, it could be concluded that the main health effect concern with surgical smoke was human papillomavirus (HPV) transmission. Five articles were related to this topic, most of them showing a low risk of HPV contamination in the air and protective equipment.[15,17,19,30] Only one paper mentioned that the prevalence of mucosal HPV type was found among 5.8% of 156 employees with experience of laser treatment of genital warts, compared to 1.7% of 115 of those with no experience (p=0.12).[16]

Discussion

Meanwhile, this study has attempted to systematically collect data from multiple sources, a procedure which could help to reduce selection bias and increase more accurate findings on the situation with laser accidents. At least average or above-average quality studies were analysed to filtrate a higher quality of data. The main limitation of this study is that the review conducted by only one reviewer due to a lack of resources. To our knowledge, it is the very first study attempts to summarise and update new types of laser injury and their prevalence in several themed occupations. Essentially, most of the laser incident reports were widely known as ocular and skin injuries.[7] This current study was able to reveal that LGACs exposure among HCWs was of high interest among published papers, while ocular injury was the only published injury type in aviation.[15-31,33-37] For the remaining occupations, the number of studies (around 1-2 studies) was insufficient, and therefore it should be borne in mind that the results might not be an accurate reflection of reality.[38-41]

In terms of prevalence, meta-analysis cannot be performed due to the high heterogenicity of information. The data for the risk of mucosal HPV type came from only one study.[16] Moreover, the other studies displayed a low risk of HPV contami-

nation in air and equipment.[15,17,19,30] Therefore, this study could assume that the risk of HPV transmission by surgical plume is quite low. Nevertheless, further research focusing on occupational HPV infection from surgical smoke to obtain richer data is required.

Conclusion

This study found that there were different interest types of occupational laser injury in each occupation. LGACs were the main focus among HCWs whereas ocular injury is still the main focus in aviation. Although there was worldwide laser use, the number of published articles in occupational laser injury still faces huge limitations. There was an insufficient number of papers to reveal even the type of laser injury in other occupations, except for HCWs and aviation. Moreover, this limitation meant that it was not possible to conduct a meta-analysis to obtain any prevalence. The overarching important conclusion to draw is that a large amount of further research focusing on various aspects of occupational laser injury is urgently needed.

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Table 1: Type of Laser Injury and the prevalence among healthcare workers(13,14,25-27).

ID	Type of study	Setting	Study population	Sample size	Outcome	Result			
						Type of injury	Prevalence	Sources	Knowledge of user
Alsulaiman, SM et al (2016)	Cross-sectional Study	International internet-based anonymous survey	Physicians in various specialties and optometrists	279 responders	Knowledge of users by answering 11 questions	Ocular Injury	N/A	Laser pointer	159 out of 194 users (82%) did not know the power of the pointer they use and 80% of them never checked laser power before using.
AlTaleb, RM et al (2019)	Cross-sectional Study	Private dermatology centers in Riyadh, Saudi Arabia	139 service providers	94 service providers	The level of adherence to optical safety guidelines during laser- assisted hair removal procedure	Ocular Injury	N/A	Laser hair removal procedures	Only 9.5% trained nurses from 94 different cosmetic hair-removal laser providers had acceptable adherence to optical safety guidelines during hair removal treatment.
Ball, K (2010)	Cross-sectional Study	Web-based survey	Perioperative nurses unidentified detail	777 nurses	Key indicators that are associated with compliance with smoke evacuation recommendations	LGACs	N/A	Any electrocautery and lasers	The specific key indicators influencing compliance include increased knowledge and training (P < 0.001 for mastectomy &hemorrhoidectomy, P = 0.03 for Certified Nurse, Operating Room certification and mastectomy, P = 0.006 for reading the AORN recommended practices).
Brace, MD et al (2014)	Cross-sectional Study	The Victoria General Hospital in Halifax, Nova Scotia, Canada	Air quality of the Otolaryngology-Head and Neck Surgery operations	146 air quality measurements	Changes in air quality during surgery	LGACs	N/A	Electrocautery, ultrasonic scalpels, and a variety of lasers in ENT surgery	N/A
Chuang, GS et al (2016)	Cross-sectional Study	The office building in Boston, Massachusetts	Air quality measurement of terminal hairs procedure from adult volunteers	1 air quality measurement of terminal hairs procedure from two adult volunteers	The chemical composition and quantify the ultrafine particle content of the plume generated during LHR	LGACs	N/A	Laser hair removal procedures	N/A

Table 1: Continued(28-31).

ID	Type of study	Setting	Study population	Sample size	Outcome	Result			
						Type of injury	Prevalence	Sources	Knowledge of user
Edwards, BE and Reiman, RE (2012)	Cross-sectional Study	Web-based survey	Current, active members of AORN	1,356 responders	The rates of compliance with generally recognized surgical smoke control measures	LGACs	N/A	Any electrocautery, electrosurgery, diathermy, ultrasonic scalpel, and laser procedures	≤ 14%-21% of AORN members using effective respirator.
Eshleman, EJ et al (2017)	Cross-sectional Study	The Massachusetts General Hospital Dermatology Laser & Cosmetic Center in Boston, MA	Airborne concentrations of particles in the waiting and procedure rooms of a dermatology office	12 Airborne concentrations of LHR procedure	Airborne concentrations of particles in a diameter size range of 10 nm to 1 μm in procedure rooms during laser hair removal procedures	LGACs	N/A	Laser hair removal procedures	N/A
Neumann, K et al (2017)	Cross-sectional Study	The Department of Gynecology and Obstetrics of the University of Lübeck, Germany	Air sampling in procedure rooms of routine cases of LEEPs	24 air sampling from HSIL patients	The investigation of detected contamination with high-risk HPV of surgical plume resulting from routine LEEPs	LGACs	4 out of 24 cases of detected high-risk HPV contamination resulting from routine LEEPs of HSIL of the cervix uteri.	LEEPs of HSIL of the cervix uteri	N/A
Steege, AL et al (2016)	Cross-sectional Study	The NIOSH Health and Safety Practices Survey of Healthcare Workers, an anonymous, multi-module, web-based survey	Members of professional practice organizations representing healthcare occupations which routinely use or come in contact with selected chemical agents including surgical smoke	4,533 respondents	Data from the survey of healthcare workers on precautionary practices for surgical smoke	LGACs	N/A	Laser surgery procedures	49% of 1,391 laser surgery respondents and 44% of 4,495 electrosurgery respondents said that they have never had training on the hazards of surgical smoke and another third were trained more than 12 months ago.

Table 1: Continued(15–17,32).

ID	Type of study	Setting	Study population	Sample size	Outcome	Result			
						Type of injury	Prevalence	Sources	Knowledge of user
Tremaine, AM and Avram, MM (2015)	Cross-sectional Study	The MAUDE electronic database on the FDA website	Reported adverse events between 1991 and December 2013	1,212 medical device reports (MDRs)	All reported device adverse events between 1991 and December 2013	Overall Injury	N/A	Any medical laser procedures	N/A
Ilmarinen, T et al (2012)	Cohort Study	The Department of Otorhinolaryngology, Head and Neck Surgery, Helsinki University Hospital	Samples from the treatment of laryngeal papillomas and genital warts	120 samples	The risk of HPV transmission from the patient to the protective surgical masks, gloves and oral mucosa of medical personnel during the treatment of laryngeal papillomas and genital warts	LGACs	All oral mucosa specimens (n= 50) and surgical mask samples (n= 20) obtained from the employees tested HPV negative whereas 14 out of 20 (70%) surgical gloves were positive.	Surgical treatment and carbon dioxide (CO2) laser treatment	N/A
Kofoed, K et al (2015)	Cohort Study	Departments of dermato-venerology and gynaecology in Denmark	Medical personnel employed at departments of gynaecology and dermato-venereology at Copenhagen University Hospital Gentofte and Bispebjerg, Odense University Hospital, Aarhus University Hospital, Copenhagen University Hospital Hvidovre, Herlev and Hilleroed	287 employees	Risk of human papillomavirus (HPV) transmission during laser vaporisation of genital warts or loop electrode excision procedure	LGACs	5.8% of 156 employees with experience of laser treatment of genital warts were found a mucosal HPV type as compared to 1.7% of 115 those with no experience (p = 0.12).	CO2-laser Evaporation of Genital Warts or Loop Electrode Excision Procedure of Cervical Dysplasia	N/A
Weyandt, GH et al (2011)	Cohort Study	The department of dermatology, venerology and allergology or in the department of obstetrics and gynecology	Patients with genital warts	10 samples	If treatment of genital warts with multilayer APC or CO2 laser ablation is associated with HPV contamination of the operation room	LGACs	All swabs obtained from glasses were negative for HPV DNA (n= 10). One swab pair obtained from nasolabial folds was positive for HPV type 38 DNA before and after treatment (n= 10).	HPV laser procedures	N/A

Table 1: Continued(18–21).

ID	Type of study	Setting	Study population	Sample size	Outcome	Result		
						Type of injury	Prevalence	Sources
Goon, PKC et al (2017)	Literature Review	PubMed Central	Available published evidence about live HPV or MCV transmission in smoke generated by laser or diathermy	N/A	Laser and diathermy smoke publications involving HPV and MCV	LGACs	N/A	Laser smoke diathermy smoke, plume(s) in gynecologica procedures
Lewin, JM et al (2011)	Literature Review	N/A	The literature on surgical smoke in dermatological procedures during the last 25 years	N/A	The literature on surgical smoke, its effects on those exposed, and measures that may be used to protect dermatologists and their staff	LGACs	N/A	Electrosurgic energy or las beams in dermatologic procedures
Manson, LT and Damrose,	Literature	N/A	Studies of surgical personnel with regard to risk of	5 studies	The literature assessing the infectivity of HPV in a laser	LGACs	No 1 and 2: No mentioned about HPV prevalence but patient-surgeon transmission is debatable. No 3: The authors found no evidence of an increased incidence of papilloma infection in these surgeons compared to the incidence in the general population. No 4: No mentioned about HPV prevalence but laser power density was sufficient to eliminate HPV infectivity. No 5: No HPV DNA was detected on the skin of surgeons or on the postfilter	HPV laser

Table 1: Continued(22–24).

ID	Type of study	Setting	Study population	Sample size	Outcome	Result			
						Type of injury	Prevalence	Sources	Knowledge of user
Pierce, JS et al (2011)[1]	Systematic Review	The U.S. National Library of Medicine database, Pubmed Database, and Reference List	Studies of laser plume-related occupational hazards for health care professionals	N/A	The published literature pertaining to the laser-induced plume chemical and physical composition, health effects, and methods of control	LGACs	N/A	Any laser surgical procedures	The frequency of smoke evacuator use was low, even lower use rates were observed for respiratory protection equipment (Edwards and Reiman).
Pierce, JS et al (2011)[2]	Systematic Review	PubMed, the Rockwell Laser Industries Laser Accident Database, and reference list	Articles relevant to beam and nonbeam medical laser hazards	≥ 500 articles	Studies of occupational hazards associated with medical laser applications	LGACs	N/A	Any medical laser procedures	Several authors have attributed the majority of laser-related accidents primarily to a lack of hazard recognition, disregard for laser safety procedures, and operator error, and have suggested that prevention strategies should focus mainly on education and training.
Rioux, M et al (2013)	Case Reports	N/A	N/A	2 cases	Case reports of two laser surgeons with HPV positive tonsillar cancer	LGACs	N/A	Laser ablation and later loop electrosurgical excision procedures (LEEP)	N/A