

**HUMAN PAPILOMA VIRUS AND BIOAEROSOLS IN ELECTROCAUTERY SMOKE:
INTEGRATIVE REVIEW**

PAPILOMA VÍRUS HUMANO E BIOAEROSSÓIS NA FUMAÇA DO ELETROCAUTÉRIO: REVISÃO
INTEGRATIVA

PAPILOMA VIRUS HUMANO Y BIOAEROSOLES EN HUMO DE ELECTROCAUTERIO: REVISIÓN
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ABSTRACT

Objective: to analyze the scientific evidence available in the literature on the presence of bioaerosols in the smoke generated during cauterizations in patients with Human Papilloma Virus. **Method:** integrative review of the literature. The descriptors were searched in the databases: National Library of Medicine National Institutes of Health (PubMed), Cumulative Index to Nursing and Allied Health Literature (CINAHL) and Latin American and Caribbean Literature in Health Sciences (LILACS). The descriptors were combined in different ways ensuring a broad search. The final sample comprised seven primary articles. **Results:** the analyzed articles demonstrated the existence of viruses such as Human Papilloma Virus and bacteria such as coagulase-negative *Staphylococcus*, *Neisseria* and *Corynebacterium* in the smoke generated by the cauterization of warts in patients with Human Papilloma Virus. **Conclusion:** the evidence points to a biological risk related to electrocautery smoke; however, research with higher levels of scientific evidence is necessary for the evaluation of potential contamination of workers.

Descriptors: *Papillomaviridae*; Cautery; Smoke; Sexually Transmitted Diseases; Containment of Biohazards.

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RESUMO

Objetivo: analisar as evidências científicas disponíveis na literatura sobre a presença de bioaerossóis na fumaça gerada durante cauterizações realizadas em pacientes com Papiloma Vírus Humano. **Método:** revisão integrativa da literatura. Os descritores foram pesquisados nas bases de dados: *National Library of Medicine National Institutes of Health* (PubMed), *Cumulative Index to Nursing and Allied Health Literature* (CINAHL) e Literatura Latino-Americana e do Caribe em Ciências da Saúde (LILACS). Os descritores foram combinados de diferentes formas garantindo uma ampla busca. A amostra final compreendeu sete artigos primários. **Resultados:** Os artigos analisados demonstraram a existência de vírus como o Papiloma Vírus Humano e bactérias como o *Staphylococcus* de coagulase negativa, *Neisseria* e *Corynebacterium* na fumaça gerada pela cauterização de verrugas em pacientes com Papiloma Vírus Humano. **Conclusão:** As evidências apontam o risco biológico contido na fumaça da cauterização, porém é necessário pesquisas com maiores níveis de evidência científica para a avaliação do potencial de contaminação do trabalhador.

Descritores: *Papillomaviridae*; Cauterização; Fumaça; Doença Sexualmente Transmissível; Exposição a Agentes Biológicos.

RESUMEN

Objetivo: analizar las evidencias científicas disponibles en la literatura sobre la presencia de bioaerosoles en el humo generado durante cauterizaciones realizadas en pacientes con Papiloma Virus Humano. **Método:** revisión integrativa de la literatura. Los descriptores fueron aplicados en las bases de datos: *National Library of Medicine National Institutes of Health* (PubMed), *Cumulative Index to Nursing and Allied Health Literature* (CINAHL) y Literatura Latino-Americana y del Caribe en Ciencias de la Salud (LILACS). Los descriptores fueron combinados de diferentes formas garantizando una amplia búsqueda. La muestra final comprendió siete artículos primarios. **Resultados:** Los artículos analizados demostraron la existencia de virus como el Papiloma Virus Humano y bacterias como el *Staphylococcus* de coagulase negativa, *Neisseria* y *Corynebacterium* en el humo generado por la cauterización de verrugas en pacientes con Papiloma Virus Humano. **Conclusión:** Las evidencias apuntan que hay riesgo biológico en el humo de cauterización, sin embargo son necesarias investigaciones con mayores niveles de evidencia científica para la evaluación del potencial de contaminación de trabajador.

Descriptorios: *Papillomaviridae*; Cauterización; Humo; Enfermedades de Transmisión Sexual; Contención de Riesgos Biológicos.

INTRODUCTION

The number of people with Sexually Transmitted Infections (STIs) has had a steady increase in recent years. Despite multiple and intense prevention campaigns, a considerable portion of the sexually active population is vulnerable to these infections. To illustrate, approximately 600 million people worldwide are infected with Human Papilloma Virus (HPV), considered one of the most common STIs⁽¹⁾.

It is estimated that 54.6% of Brazilians aged 16 to 25 years have been infected with HPV. This disease represents a

serious public health problem, with serotypes 16 and 18 classified as having a high risk for malignant lesions, which are responsible for almost all cases of cervical cancer⁽²⁾.

The HPV incubation period may vary from two to eight months, and may take up to 20 years for the first manifestations to appear⁽³⁾. Contamination by this virus can also be prevented by vaccination. However, to date, no method has proved fully effective for the treatment of all individuals with the virus neither capable of eradicating HPV⁽⁴⁾.

To aid in the control of venereal warts caused by HPV, methods of chemical and surgical cauterization of the lesions as

well as immunity stimulators are used as treatment methods. These treatments aim to reduce, remove or destroy lesions caused by HPV⁽³⁾. Among the surgical options, electrocautery is a technique that has the advantage of removing the warts at once⁽⁵⁾.

When electrocautery is used at low temperatures, tissue vaporization occurs, and bioaerosols are formed. The latter may contain particles such as cell or blood fragments, bacteria and viruses such as *mycobacterium tuberculosis*, Human Immunodeficiency Virus (HIV), Hepatitis B (HBV), Hepatitis C (HCV) and HPV⁽⁶⁾. The generation of these particles exposes the workers to the biological risk of contamination by these microorganisms⁽⁷⁾.

A study carried out in Norway showed that after exposure to the electrocautery smoke produced during cauterizations of HPV-caused anogenital venereal warts, a surgeon presented a diagnosis of laryngeal papillomatosis. Biopsy found that the HPV types found were specific to the anogenital region, suggesting that the laryngeal papillomatosis may have been acquired by inhaling the electrocautery⁽⁸⁾ and HPV-contaminated smoke.

There is, therefore, an important need to understand how health workers who participate in procedures of electrocautery of warts caused by HPV are exposed to biological risks related to the inhalation of surgical smoke. Moreover, it is relevant to know what bioaerosols are present in this smoke, so that actions can be taken to prevent damages and the possible development of diseases by these health professionals.

The following research question was investigated: Which bioaerosols are found in the smoke generated by electrocautery of warts in HPV-infected patients? To answer this question, the present study aimed to analyze the scientific evidence available in the literature on the presence of bioaerosols in the smoke generated during cauterizations performed in patients with HPV.

METHODS

This is an integrative review of the literature with the following steps:

elaboration of the research protocol listing the purpose of the study, research question, choice of databases and method of data collection. After that, primary studies were sought in the literature, and then data were extracted, the primary studies included in the review were evaluated, and the results obtained were interpreted and presented⁽⁹⁾.

The search for primary studies was carried out in the following databases: National Library of Medicine National Institutes of Health (PubMed), Cumulative Index to Nursing and Allied Health Literature (CINAHL) and Latin American and Caribbean Literature in Health Sciences (LILACS) according to the criteria and manuals of each database.

The research question was formulated based on an adaptation of the PICO (Patient, Intervention, Comparison, Outcome) model, where "P" corresponded to patients with HPV; "I" corresponded to cauterization of warts; "C" was not needed because the objective of this study did not include comparisons; and "O" was the presence of bioaerosols in surgical smoke. This model allowed the identification of the key words for the search of relevant primary studies in each database⁽¹⁰⁾.

In the LILACS database, controlled DeCS - Health Sciences Descriptors used were: patients; sexually transmitted diseases; and *papillomaviridae*. And the non-controlled descriptors were: Sexually Transmitted Disease; venereal diseases; HPV. The controlled descriptors selected by the Medical Subject Headings (MeSH Database) were: *patients, sexually transmitted, diseases, papillomaviridae, cautery, electrocoagulation, warts, electrosurgery, bacteria, aerosol, fungi* and *viroses*. The controlled descriptors used in the CINAHL Heading comprised the descriptors above mentioned plus *smoke surgical*. As non-controlled descriptors, the following were used in these two bases: *venereal diseases, STD, papillomaviridae, Human Papiloma Virus, electrocautery, electrical cautery, endocavitary fulguration, galvanocautery, surgical diathermy, verrucas, laser plume, and virus*. In the MeSH Database, *smoke surgical* was included as non-controlled descriptor. The terms were crossed in order to provide a wide

search in the selected databases, using the Booleans AND and OR.

The inclusion criteria were: studies that addressed the presence of microorganisms in the electrocautery smoke, researches developed with humans and published in Portuguese, English and Spanish. The exclusion criteria established were opinion studies, commentaries, theses, dissertations and laboratory studies, because they were gray literature. The justification for not determining a time interval in the search of articles is due to the importance, relevance and little exploration of the theme of this study.

The level of scientific evidence of the selected articles was as follows: level 1 – studies with methodological design of meta-analyses or systematic reviews; level 2 – randomized controlled clinical trials; level 3 – non-randomized clinical trials; level 4 – cohort and case-control studies; level 5 – systematic reviews of descriptive and qualitative studies; level

6 – descriptive or qualitative studies; and level 7 – expert opinion⁽¹¹⁾.

The selection of the studies was carried out from May to June, 2016, by three independent reviewers, who selected the studies respecting the inclusion and exclusion criteria and the research question. In cases of doubt and disagreement, the three reviewers made a simultaneous reading and those considered ineligible by at least two of the reviewers were excluded.

In the first analysis of the articles collected (n = 6,115), 11 were selected after reading the title and abstract. The excluded articles were duplicates that did not meet the research question and eligibility criteria established in this study. After reading the 11 articles in full length, three were excluded because they were studies carried out in laboratory and with animals and one because it was a literature review. The final sample of this study comprised seven articles, as presented in Figure 1.

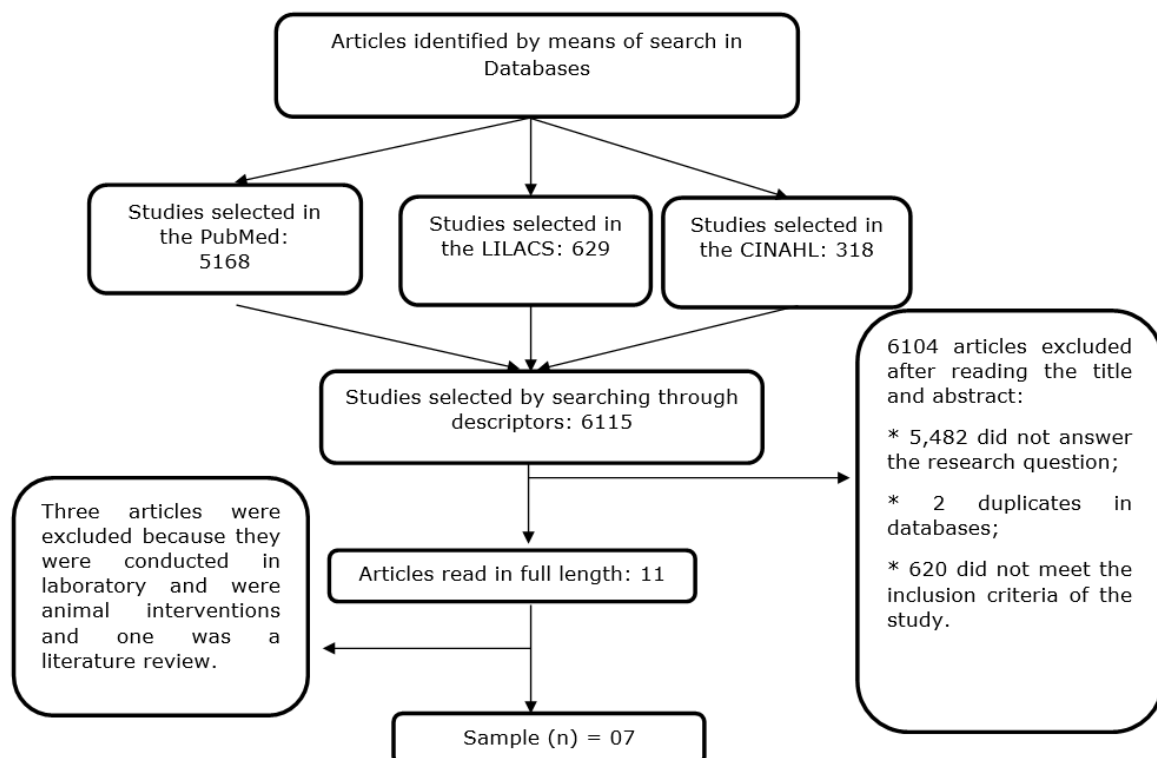


Figure 1: Flowchart of identification, selection and inclusion of studies in the integrative literature review, Londrina (PR), 2016.

RESULTS

After analyzing the articles included in this literature review (Table 1), five (62.5%) were published in the 1990s and three (37.5%) were published between the years 2006 and 2012. That indicates a gap of research related to the topic.

This topic is of interest of many areas that use electrocautery, because among the authors of the studies there were several specialties such as: general surgery, infectious-contagious diseases, otorhinolaryngology, gynecology and obstetrics, urology, dermatology and pathology.

Table 1: Identification of selected articles according to year of publication, country of study, database, authors, type of study, level of scientific evidence, objective, strategy used and main results, Londrina (PR), 2016.

Year/Country/ Data base	Authors/Type of study/ Level of scientific evidence	Objective	Strategy	Main results
1990 Canada PubMed	Ferenczy; Bergeron; Richart ⁽¹²⁾ Descriptive study Level of evidence: 6	To explore, with the aid of molecular hybridization techniques, whether the laser treatment of HPV-containing genital infections is associated with the dispersion of viral DNA.	Samples were collected from 110 patients with Dacron swabs, five pre-filter samples, four vacuum tubes containing surgical smoke, and nasopharynx, eyelid and ear samples from the surgeon before and after the procedure.	HPV viral DNA was found in the collection filters. However, none of the cell samples obtained from the surgeon after each of the nine laser treatment sessions tested positive for HPV DNA.
1991 Norway PubMed	Hallmo; Naess ⁽⁸⁾ /Case study Level of evidence: 6	To present a case of laryngeal papillomatosis where infection associated with laser surgery seems likely.	Biopsy of the patient's larynx lesions was performed by DNA hybridization test <i>in situ</i> .	HPV is considered to be an agent potentially transmissible from patient to surgeon through plumes of smoke produced by laser.
1994 USA PubMed	Anil Sood; Mostafavi; Stoerker; Stone ⁽¹³⁾ Descriptive study Level of evidence: 6	To determine the prevalence of HPV in the surgical plume of electrosurgery excision procedures of patients with positive cervical intraepithelial neoplasia.	Surgical smoke was collected through a filter. Samples were analyzed by the Polymerase Chain Reaction (PCR) method (n = 49).	HPV DNA was found in 37% of the filters.
1995	Gloster; Roenigk ⁽¹⁴⁾	To define the risks for surgeons in acquiring	Physicians performing the treatment of warts	There was no significant difference between the incidence of warts in

USA PubMed	Control case Level of evidence: 4	warts from CO ₂ laser plumes.	using laser were interviewed and the results were compared with population-based control groups (n = 4,200).	surgeons performing the CO ₂ laser procedure and the general population.
1998 USA PubMed	Capizzi; Clay; Battey ⁽¹⁵⁾ Cohort study Level of evidence: 4	To analyze the potential bacterial and viral exposure present in the operating room as a result of the CO ₂ laser smoke plumes	High Efficient Particulate Air (HEPA) filters were used in a smoke evacuator and in the environment during the face region procedure (n = 13).	Presence of coagulase-negative <i>Staphylococcus</i> , <i>Neisseria</i> , and <i>Corynebacterium</i> in CO ₂ laser plumes was found.
2006 The Netherlands PubMed	Alp; Bleichrodt; Hansson; Voss A ⁽¹⁶⁾ Descriptive study Level of evidence: 6	To evaluate the composition of surgical smoke and the potential risk of infection in surgical procedures	Different procedures that used electrocautery were evaluated.	Surgical smoke produced with or without a heating process contained bioaerosols with viable and non-viable cellular material.
2012 Finland PubMed	Ilmarinen; Auvinen; Hiltunen-Back; Ranki; Aaltonen; Pitkaranta ⁽¹⁷⁾ Descriptive study Level of evidence: 6	To determine the risk of transmission of HPV from patients to the oral mucosa of the medical staff from masks and gloves during treatment of laryngeal papillomas and genital warts.	Oral mucosa samples were collected from patients and workers exposed to pre and post-procedure surgical smoke. Samples were also collected from the surgical masks and gloves (n = 120).	HPV can contaminate protective equipment such as gloves and masks when not properly applied and disposed.

DISCUSSION

It is known that the smoke produced by electrocautery has a mixture of diversified chemical substances of organic, inorganic and biological pollutants. Among the biological pollutants are a number of particles such as bacteria, as for example *Mycobacterium tuberculosis* or viruses such as HIV, HBV, HCV and HPV⁽⁶⁾. Information that surgical smoke contains toxic gases and vapors such as cyanide and formaldehyde, as well as contaminating bacteria and viruses, has

been widely reported in the scientific literature^(7,18).

Chronic exposure to smoke produced by cauterization is an important risk for the worker health. However, it is difficult to assess the harmful effect of surgical gases, as well as the toxicology of the composition of surgical smoke and its potential danger⁽¹⁹⁾. Transmission of HPV DNA from contaminated persons to health care providers is unlikely to occur when protective measures such as gloves and masks are properly used⁽¹⁷⁾ and when smoke extraction equipment is used in areas where cauterization is performed⁽¹²⁾.

However, the reality found in the work areas is that workers only wear surgical

masks, and this item alone is not adequate when the worker is exposed to surgical smoke⁽²⁰⁾, and when facilities do not present smoke evacuators, or aspirations for this function as indicated by the Association of Perioperative Registered Nurses (AORN)⁽²¹⁾.

For decades, it has been documented that the use of a smoke extraction devices or filters positioned close to electrocautery or endoscope valves promotes additional safety for the healthcare team and patients⁽¹⁶⁾. Concerning the use of smoke evacuators in the collection of debris produced by smoke generators, the debate on their effectiveness remains⁽²²⁾. Health workers in the environment using electrocautery are at potential exposure to air contaminants⁽²²⁾.

The potential for contamination depends on the size and distribution of the particles generated, which in turn involves numerous factors such as type of treatment to be used, amount of smoke emission, surgical technique and operated organ. The generated particles may vary in size from 0.1 to 2.0 μ m⁽²²⁾.

Ordinary surgical masks do not provide adequate protection against electrocautery smoke. These masks protect the workers on average for two hours of exposure and have a filtering capacity of about 99% for particles larger than 1 μ , and this protection may vary according to the seal and its fit on the face⁽²³⁾.

The AORN⁽²¹⁾ recognizes that exposure to surgical smoke and bioaerosols poses a danger to patients and practitioners, and the Occupational Safety and Health Administration (OSHA) estimates that half a million workers are exposed to surgical laser smoke each year in the United States of America.

Analyzing the studies included in this review and knowing the pathogens present in the smoke produced by cauterization, the biological risk that the smoke represents to the health of the exposed workers is a recognized fact. The present review identified a gap in the knowledge about cauterization of warts of patients with HPV: there is no strong evidence that microorganisms contaminate workers who make use of this equipment.

Experimental research is needed to identify the potential contamination and incidence of occupational diseases related to the use of electrocautery, so as to create protocols for the appropriate use of personal and collective protective equipment in order to minimize the risk of contamination.

Information and continuing education programs are also important to alert health workers and managers about the risks of exposure to biological agents by those who are exposed to cautery smoke.

The recommendation is that operating rooms have exhaustion and ventilation for the renewal of the air in the surgical environment, with filtering of microorganisms and toxic gases such as anesthetics⁽²⁴⁾ associated with air renewal. There is also a recommendation by several associations for the use of a local exhaust device to filter surgical smoke⁽²⁵⁻²⁸⁾.

Despite the wide and extensive search of primary studies, this integrative review has limitations. The limitations are mainly related to the level of evidence of the researches inserted in this review, since they did not present methods that could determine the cause and effect factors on the contamination of workers by pathogens in the smoke of the cauterization of warts in patients with HPV.

CONCLUSION

In this review, the presence of bioaerosols such as HPV, coagulase-negative *Staphylococcus*, *Neisseria* and *Corynebacterium* was found in electrocautery smoke, but it was not clear whether the presence of these microorganisms causes diseases in workers exposed to the electrocautery smoke from HPV warts.

In clinical practice, this study corroborates the need for the health students and health teams to use vacuum cleaners and surgical smoke exhaust fans in the operating rooms and use the N-95 mask during cauterization of warts in patients with HPV. It is necessary to develop researches with experimental methods to determine the viability of the described microorganisms.

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