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Respiratory symptoms associated with electrocautery smoke: a systematic literature review

Abstract

The smoke produced by the use of electro cauterization is formed by gaseous chemical compounds (gaseous phase) and by particle components (particulate phase) that can trigger harmful, local or systemic, reversible or irreversible effects in people who use this equipment. These chemicals can trigger genetic mutations and cancer in the human body. In addition to mutation and cancer, particles in the smoke of electro-cauterization can be inhaled and retained in the respiratory tract of workers, causing various respiratory signs and symptoms, including foreign body sensation in the throat, pharyngeal burning, nausea, and nasal congestion. It can also cause headache and eye irritation. Objective: To identify studies related to the presence of respiratory symptoms in health professionals related to the use of electrocautery. Methodology: A bibliographic search was carried out in the databases and indexes: Pubmed, Science Direct, Scopus, Proquest, Scielo, Schoolar Google. Original articles published between 2015-2020 were selected. For the extraction and synthesis of the content of the articles included, an Excel sheet was designed with the following variables: authors, title, year of publication, country and scientific journal; study objective, materials and methods, population and sampling, reported results. Results: A total of 121 articles were retrieved, of these 94 were excluded from the subsequent analysis due to the lack of appropriate data, the remaining 27 full-text studies met the inclusion and exclusion criteria set out in the study, which were included in the review. It was possible to establish that there are risks when inhaling electrocautery smoke that can trigger chronic respiratory pathologies such as lung cancer.

Keywords: health personnel, smoke, electrosurgery, lung diseases

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Introduction

The electrocautery is a medical device that consists of generating electric current, which has as its main objective the production of heat. This is achieved because it is based on high frequency technology, that is why with the determined voltage and a high frequency they can perform hemostasis in small blood vessels or even coagulate and cut tissues, and thus provide good results. Electrocautery can achieve temperatures above 200 ° C, which is why they can be used in different specialties and have various functions, for example, by placing it just a few millimeters above the tissue, it can achieve disseminated coagulation.[1]

The smoke produced by the use of electro cauterization is formed by gaseous chemical compounds (gaseous phase) and by particle components (particulate phase) that can trigger harmful, local or systemic, reversible or irreversible effects in people who use this equipment. Regarding the chemical composition, it may contain polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), carbon monoxide (CO), among others. These chemicals can trigger genetic mutations and cancer in the human body. In addition to mutation and cancer, particles in the electro-cautery smoke can be inhaled and retained in the respiratory tract of workers, causing various respiratory signs and symptoms, including foreign body sensation in the throat, pharyngeal burning, nausea, and nasal congestion. It can also cause headache and eye irritation.[2]

Markowska M et al.,[3] carried out a qualitative analysis of the surgical smoke produced during burn operations in February of this year, as a result of which they assure that the safety of the surgical team must be an important aspect of treatment planning in all rooms. where electrocoagulation is used. So far, there have been no studies focusing on the risks posed by surgical smoke released during resection of burned tissue. The available literature focused exclusively on healthy tissue surgeries. The study revealed the presence of complex hydrocarbon derivatives that also appear in surgical smoke, which is formed by cutting healthy tissue. Their presence has not been fully described in the available literature so far. In their research they reveal the importance of generating studies aimed at determining the percentage value of organic and inorganic compounds, as well as the solid particles that make up surgical smoke, in order to correctly design protective masks.

Exposure to inhalation of toxic substances through the use of electrocautery in surgical procedures, may be the cause of respiratory symptoms in surgical instrumentation since the smoke particles generated by this medical equipment are highly irritating due to their chemical composition, it is changing based on multiple variables: type of cauterized tissue, energy applied, device used, duration of the intervention, patient's immune status, treated disease, among others. In vitro studies warn that electrocautery smoke could have a mutagenic effect on the respiratory epithelium. To this must be added that the chemical agents resulting from the pyrolysis of the tissues have an unpleasant odor, which, added to its composition, can potentially cause discomfort and various respiratory symptoms such as pharyngeal burning, cough and irritation.[4]

The function of the surgical mask used in operating rooms must be taken into account since these are used as a physical barrier to protect employees against risks such as splashes of large blood droplets or body fluids, but according to the Security Administration and Occupational Health (OSHA) of the United States are not designed or certified to prevent the inhalation of small airborne contaminants, for this reason OSHA recommends the use of masks

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and respirators certified by the National Institute for Health and Safety Occupational (NIOSH)[5] taking into account that the electrosurgical unit is a biomedical equipment implemented in recent decades, which decreases a high percentage of surgical time, which in turn is used in 70% of procedures, exposing the team surgical to the smoke generated from it.

Every day people die due to work accidents or work-related illnesses, with more than 2.78 million people according to the International Labor Organization (ILO) and that 374 million work-related injuries occur annually. fatal, resulting in more than 4 days of absenteeism. The cost of this daily adversity is enormous and the economic burden of poor safety and health practices is estimated at 3.94 percent of the global Gross Domestic Product each year.[6] Annually, 12.2 million people, mostly from developing countries, die at working age from non-communicable diseases,[7] for this reason it has been decided to carry out this study in order to provide a solution to workers who are exposed to some occupational risks which are not only going to cause a high socioeconomic cost but also to deteriorate the quality of life of the worker.

The foregoing motivates the need to carry out this research with the aim of identifying studies related to the presence of respiratory symptoms in health professionals related to the use of electrocautery.

Research methodology

Systematic search of the literature using the Scoping Review methodology. A bibliographic search was carried out in the databases and indexes: Pubmed, Science Direct, Scopus, Proquest, Scielo, Schoolar Google. Original articles published between 2015-2020 were selected with the intention of exploring the scientific production generated in the most recent years on the subject, written in English and Spanish, after reviewing the title and abstract, the full text was retrieved (See diagram selection of review articles). For the extraction and synthesis of the content of the articles included, an Excel sheet was designed with the following variables: authors, title, year of publication, country and scientific journal; study objective, materials and methods, population and sampling, reported results. The quality of the data collected was verified by two members of the research team through meetings of agreement and consensus between them. Considering the ethical requirements for documentary research, copyright is protected, appropriately citing the document.

The terms of the Medical Subject Headings [MeSH] were used. In particular, the following combination was performed: "Health Personnel" AND "Smoke" AND "Electrosurgery" AND "Lung Diseases", in each of the databases and indexes selected in the study.

Results

A total of 121 articles were retrieved, of these 94 were excluded from the subsequent analysis due to the lack of appropriate data, the remaining 27 full-text studies met the inclusion and exclusion criteria set out in the study, which were included in the review (Figure 1).

The included studies are numbered in Graph 1, published between 2015 and 2020, mainly in South America, Latin America, and Europe. There were 8 studies related to the components of surgical smoke and respiratory symptoms and / or pathologies (Graph 2) of which three were systematic review studies, one qualitative study, one descriptive study, one literature review study, and two did not report the type of study.

In 2018 Aponte Jara et al.,[8] carried out a systematic review in the country of PERU, in the personnel of the operating room, where they reported that surgical smoke produces health effects due to exposure in the personnel of the surgical center, such as changes in the nasal mucosa, respiratory symptoms, headache, nausea, vertigo, presence of the HPV virus in the nasal mucosa, being a factor of help the prolonged time of surgeries, inadequate evacuation system and use of masks without facial seal. Increasing the risk of cancer and other respiratory pathologies as mentioned in the study carried out by Markowska et al.,[3] in this year which analyzed volatile, non-polar organic compounds that are released during the excision of burned tissue using an electric knife (mono- and bipolar).

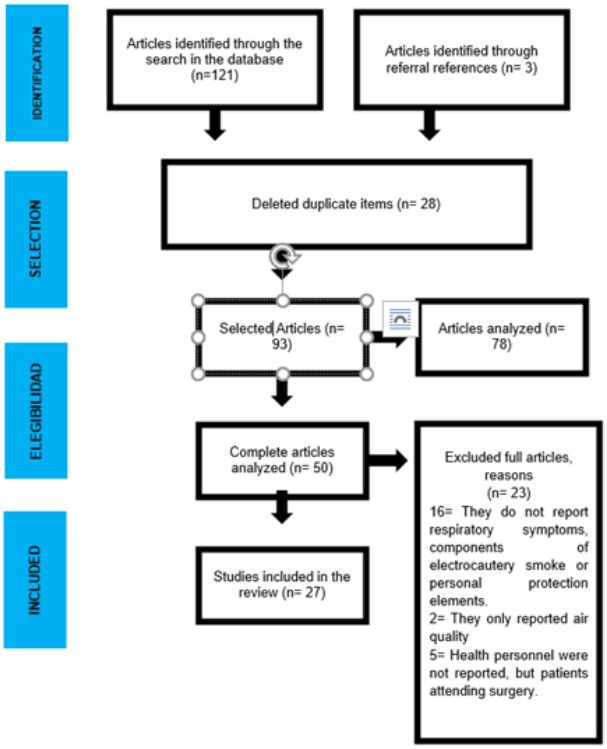
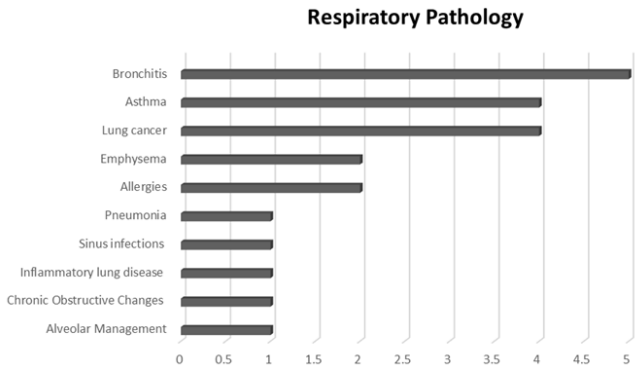
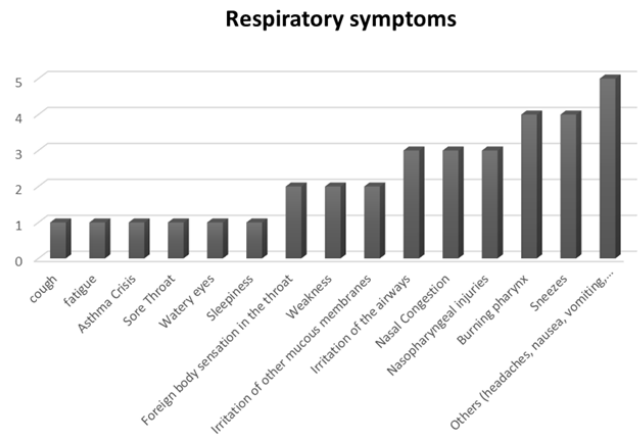


Figure 1 Review items selection diagram.



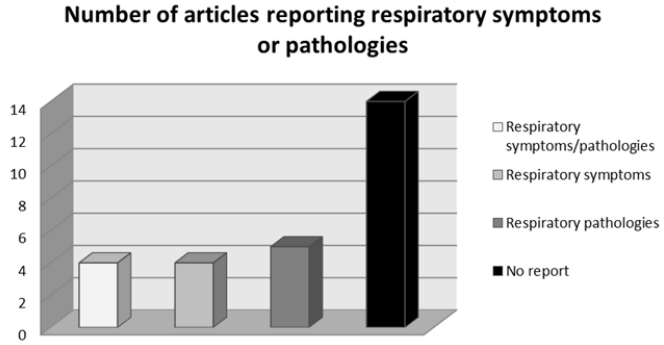
Graph 1 Respiratory Pathology.

Of the 27 studies included in this review, there were nineteen studies that did not report the time of exposure to electrocautery smoke, thirteen did not report the use of personal protection elements, fourteen reported the use of N95 or surgical mask, eight reported the time of exposure to surgical smoke and only three studies reported the relationship between the time of exposure and the use of personal protection elements.



Graph 2 Respiratory symptoms.

Regarding the results associated with the time of exposure to electrocautery smoke and the use of personal protection elements (Graph 3) Vieira et al.,[9] in 2017 they carried out a field, exploratory and cross-sectional study with a quantitative approach in the intraoperative team of a surgical center in the north of Paraná, Brazil, where they resulted in an average exposure to electrocautery smoke during surgical procedures of 3.6 minutes, and the use of a surgical mask occurred in 1990. % of the workers, but no worker belonging to the intraoperative team, used some type of respiratory mask, such as N95.



Graph 3 Number of articles reporting respiratory symptoms or pathologies.

In 2015 Lindsey et al.,[10] carried out a systematic review where they reported that most surgical masks only filter particles of approximately 0.5 mm in size; However, most of the particles of the feathers are ultrafine and much smaller, on the other hand, in 2019, when conducting a review study, Yi Liu et al.,[11] determined that to avoid injury from smoke inhalation surgical, respiratory protection such as a basic surgical mask, high filtration mask, or an N95 respirator should be worn.

Navarro et al.,[12] in 2016, carried out a study with the aim of demonstrating that exposure to smoke as a result of electrocoagulation, causes changes in the nasal mucosa in doctors in training at a public hospital in Mexico, where they obtained as a result that the longest exposure time to said smoke occurs in the specialties of the neurosurgery and general surgery services, which had an exposure time of approximately 16 and 22 minutes, generating changes in the nasal mucosa. In contrast, Atar et al.,[13] in 2017 in the country of Turkey, carried out an experimental study with 16 healthy adult Wistar albino rats which were exposed to smoke for 60 min / day for 4 weeks, showing an increase in inflammation of the fabric due to irritation from smoke.

For many years, there has been an interest in determining and defining exactly what danger is posed by surgical smoke, from determining the risks of inhaling surgical smoke, as well as establishing the potential cumulative hazards. a specific link between exposure to surgical smoke and the adverse health effects of perioperative personnel. There are no mandatory regulations for Colombia and the world stating that surgical smoke must be evacuated, but the standards of professional organizations clearly indicate that there is a potential danger if personnel continuously inhale substances present in surgical smoke.

There is increasing evidence to suggest that particles of approximately 5 µm or more are deposited on the walls of the nose, pharynx, trachea, and bronchi, while those less than 2 microns are deposited on the bronchioles and alveoli.[1] The chemical load of cautery of one gram of tissue is comparable to that derived from six cigarettes. Viral DNA has been isolated from HIV and HPV, and both Staphylococcus and Neisseria were cultured from surgical smoke.[2] Thus, different studies have managed to show that standard surgical masks do not offer protection; while portable evacuation devices are the best risk reduction measure.

It is considerable that health institutions contemplate different mechanisms to eliminate a controllable danger such as smoke, which can help to minimize health costs and improve the health of surgical personnel. In addition, these efforts allow controlling this environmental risk in the workplace.

During open surgery procedures, there are a number of ways for operating room personnel to avoid surgical smoke, such as moving or moving away from large columns of smoke, thereby preventing inhalation. Higher quality or double masked filter masks can be used. It is recommended to use suction devices such as simple smoke evacuation near the electrocautery blade (2-3 cm) when smoke occurs; If placed too far, only 50% of the smoke will be evacuated from an evacuation system which should be very efficient, as well as a suction device that does not interfere with intraoperative activities or maneuvers, with a source of vacuum and filtering. enough to make the environment a safe area for the surgical team.

Conclusion

Despite the few studies found, exposure to electrocautery smoke has been shown to cause respiratory symptoms that can be detrimental to health personnel. The risks of inhaling electrocautery smoke can trigger chronic respiratory diseases such as lung cancer. Strategies for the prevention of occupational disease must be generated, such as the adequate use of personal protection elements and the implementation of smoke evacuation systems.

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Conflicts of interest

There are no financial conflicts of interest.

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