



António Machado Coelho

Perioperative Nurses` competency level and adherence to guidelines related to surgical smoke safety:

A descriptive literature review

Helsinki Metropolia University of Applied Sciences

Batchelor of Nursing (AMK)

Thesis

October 2021

Author	António Machado Coelho
Title	Perioperative Nurses` competency level and adherence to guidelines related to surgical smoke safety: a descriptive literature review
Number of Pages	25 pages + 2 appendices
Date	29.10.2021
Degree	Degree Program in Nursing
Degree Programme	Degree Program in Nursing
Instructors	Anna Partanen, Senior Lecturer
<p>Nowadays, technological devices are widely used in surgeries (lasers, electrocauteries, ultrasonic scalpels, radiofrequency devices and power tools). These tools bring many advantages to the procedures, but on the other hand they produce surgical smoke leaving OR personnel exposed to its hazards. Surgical smoke (also known as plume, diathermy plume, cautery smoke, bioaerosols) is released into air, by using those devices, leading the tissue to reach its boiling point due to cutting and coagulating of target tissue. The plume is composed of 95% of water and 5% of cellular debris that contains toxic components such as benzene, bioaerosols, formaldehyde, cyanide, and biologic matter such as bacteria, viruses, blood, and tissue particles. There is evidence of the presence of some known carcinogens in the smoke, as well as potentially hazardous biological matter (such as HPV virus). Various symptoms including eye irritation, oral cavity irritation and headache, are suggested to be connected to the exposure of surgical smoke.</p> <p>This thesis is a literature review with a purpose to describe nurses` competency level related to surgical smoke and their adherence to the guidelines concerning surgical smoke safety. Nursing competency is viewed as a vital element of nursing care and its core abilities include knowledge, attitudes, skills, values, and abilities. Guidelines of safety related to surgical smoke advice for a total smoke evacuation, revision and development of policies and procedures, training for OR staff and quality performance improvements.</p> <p>The articles used in this literature review were selected from the databases CINAHL and Medline with different search terms and limitations. 9 studies were included based on the results (2 being from a performed manual search). According to the analysis of the studies selected to this thesis, the results indicate that there is generally demand for improved nurses` knowledge level related to surgical smoke, especially when it comes to measures to improve safety. The guidelines need to be clear in order to improve adherence and there is an important need for training to improve the safety in the work environment.</p>	
Keywords	Surgical smoke; Perioperative nursing; Nursing competency; Health and safety

Tekijä	António Machado Coelho
Otsikko	Perioperatiivisten sairaanhoitajien kirurgiseen savuun ja siihen liittyviin ohjeistuksiin liittyvä kompetenssi ja sitoutuminen: Kuvaileva kirjallisuuskatsaus
Sivumäärä	25 sivua + 2 liitettä
Aika	29.19.2021
Tutkinto	Sairaanhoitaja, AMK
Tutkinto-ohjelma	Hoitotyö
Ohjaajat	Anna Partanen, Lehtori
<p>Kirurgisissa toimenpiteissä käytetään nykyään paljon sähköistä leikkausteknologiaa kuten laser- ultraääni- ja sähköleikkausveitsiä. Vaikka sähkökirurgisten instrumenttien käytössä on monia etuja, ne myös tuottavat leikkaussaliin kirurgista savua, jolle leikkaussalin henkilöstö altistuu. Kirurginen savu on koostumukseltaan 95 % vettä ja 5 % vaurioituneista soluista vapautuvia kemiallisia yhdisteitä kuten bentseeniä, bioaerosoleja, formaldehydiä, syanidia sekä biologisia partikkeleja kuten kudoshiukkasia, bakteereja ja viruksia. Kirurgisen savun on todettu sisältävän tunnettuja karsinogeenisiä sekä esimerkiksi papilloomaviruksia. Kirurgiselle savulle altistuminen on yhdistetty erilaisiin oireisiin kuten silmien ja suuontelon ärsyyntymiseen sekä päänsärkyyn.</p> <p>Tämä opinnäytetyö on kirjallisuuskatsaus, jonka tarkoitus on kuvailla sairaanhoitajien kirurgiseen savuun sekä siihen liittyviin ohjeistuksiin liittyvää kompetenssia ja sitoutumista. Sairaanhoitajien kompetenssia tarkastellaan keskeisenä hoitotyön elementtinä ja sen ydinalueita ovat tieto, asenteet, kyvyt ja arvot. Kirurgiseen savuun liittyvät ohjeistukset neuvovat täydelliseen savunpoistoon, käytänteiden kehittämiseen, tarkistuksiin sekä hoitohenkilöstön kouluttamiseen.</p> <p>Kirjallisuuskatsauksessa käytetyt artikkelit valittiin CINAHL- ja Medline-tietokannoista erilaisin hakusanoin ja rajauksin. Hakutuloksien perusteella katsaukseen sisällytettiin yhdeksän tutkimusta. Kirjallisuudelle tehdyn analyysin perusteella sairaanhoitajien kirurgiseen savuun liittyvää tietotasoa on yleisesti ottaen syytä parantaa erityisesti turvallisuustoimenpiteisiin liittyen. Ohjeistuksien tulisi olla selkeitä, jotta niihin sitoutuminen paranee. Kirurgiseen savuun liittyvän työturvallisuuden parantamiseksi leikkaussalihenkilöstön kouluttamiselle on tarvetta.</p>	
Avainsanat	Kirurginen savu; Perioperatiivinen hoitotyö; Hoitotyön kompetenssi; Työturvallisuus

Content

1	Introduction	1
2	Abbreviations	2
3	Key words	2
3.1	Surgical Smoke	2
3.2	Perioperative Nursing	2
3.3	Nursing competency	3
3.4	Health and safety	3
4	Background	4
4.1	Surgical smoke in operating room	4
4.2	The components of surgical smoke	4
4.3	Effects of surgical smoke	5
4.4	Health and safety guidelines related to surgical smoke in Perioperative settings	6
4.4.1	Measures for a smoke-free working environment	7
5	Purpose, aims and study questions	8
6	Methodology and methods	8
6.1	Database Search	9
6.2	Data Selection	10
6.3	Data Analysis	12
7	Findings	14
7.1	Overview of the studies selected.	14
7.2	Nursing Competency	15
7.2.1	Knowledge related to surgical smoke	15
7.2.2	Attitudes related to surgical smoke	16
7.3	Adherence to guidelines related to surgical smoke	17
7.3.1	Factors preventing safety	17
8	Discussion of the findings	19
8.1	Knowledge as an important core ability of nursing competency	19
8.2	Adherence to guidelines	20
9	Ethical considerations and validity of the study	21

10	Conclusions and recommendations	22
	References	23

Appendixes

Appendix 1. Literature search from different databases.

Appendix 2. Articles used in the review.

1 Introduction

Surgeries are carried out nowadays with a large variety of technology such as electro-cauteries, lasers, and ultrasonic scalpels (Benson, S. et al., 2019 pp: 991). These tools allow increased efficiency and reduced complications to the patients. On the other hand, their usage has raised concerns due to surgical smoke they produce in the operating rooms (Saito et al., 2019 pp: 2). Surgical smoke is released into air by the use of those devices when the tissue reaches its boiling point, due to cutting and coagulating of target tissue. There is a variety of terminology related to surgical smoke, including plume, diathermy plume, cautery smoke and bioaerosols (Ulmer, B., 2008 pp: 721). Studies related to consistency of surgical smoke have been made (Weston, R. et al., 2009 pp: 1152). However, the content as well as amount of the smoke may vary in different types of procedures and target tissues (Barrett, Garber, 2003 pp: 979). There is evidence of presence of some known carcinogens in the smoke (Weston et al., 2009 pp: 1154), as well as potentially hazardous biological matter (such as HPV virus). Research and increased knowledge related to the potential health effects of exposure to surgical smoke is necessary. Various symptoms including headaches, eye irritation and oral cavity irritation etc. are suggested to be connected to exposure of surgical smoke in some relatively recent studies (Saito et al., 2019 pp: 2; Asdornwised et al., 2018 pp: 33).

Protecting operating room personnel from the smoke hazards is essential. Understanding the importance of guidelines and preventative measures play an important role for a better outcome. Measures such as smoke evacuation, the use of PPE (personal protective equipment) and staff education are pointed out as key steps in OR safety (Asdornwised et al., 2018 pp: 37-38). When examining the guidelines for smoke safety by the Association of Perioperative Reregistered Nurses (AORN) the importance of having a smoke-free working environment has been pointed out. Guidelines provide guidance and help to establish a safe working environment for both personnel and patients (Fencl, J., 2017 pp: 490).

This work is a descriptive literature review to this topic with the purpose to describe nurses' competency and adherence for implementing practices addressing the surgical smoke safety. This work intended to assess what knowledge and attitudes the nurses possessed in relation to the topic, through the analysis of evidence-based studies from journals with a high impact factor; and to understand how much perioperative nurses adhere to the recommendations for a safe environment. The aim of this work is to pro-

duce knowledge related to nurses' competency and adherence for implementing practices addressing the surgical smoke safety and can be used in healthcare in perioperative settings to ensure the quality of health and safety for the perioperative personnel and patients.

2 Abbreviations

OR (operating room); LEV (Local exhaust ventilation); ESU (electrosurgical units); PPE (Personal protective equipment); ANA (American Nurses Association); HPV (human papillomavirus); HIV (Human Immunodeficiency Virus); AORN (Association of Perioperative registered nurses).

3 Key words

3.1 Surgical Smoke

Surgical smoke is released into air by the use of those devices when the tissue reaches its boiling point, due to cutting and coagulating of target tissue. There is a variety of terminology related to surgical smoke, including plume, diathermy plume, cautery smoke and bioaerosols (Ulmer, B., 2008 pp: 721). It is listed as a workplace hazard and a potential cause of health issues for everyone in OR (Ball, 2010 pp: e2) and it can lead to incidence of a wide range of negative effects and worsening of acute or chronic conditions (Arli, 2020 pp: 489). Different particle sizes are generated by different tools, target tissues and exposure to the plume can be similar to passive tobacco smoking (İlçe et al., 2017).

3.2 Perioperative Nursing

Perioperative nursing initially was referred as "operating room nursing". Considering the variety of tasks that are included in the process (such as care provided before and after surgery) the terminology perioperative nursing was adopted. Perioperative phase begins upon the transmission of information to the patient of their need to surgery. It includes the preparations needed (preoperative), the actual surgical procedure (intraoperative) and the recovery until their release from care (postoperative) (Goodman et al., 2014 pp: 1-7). Therefore, perioperative nursing refers to specialized nursing care provided throughout the different phases of the surgical procedure (Spry, 2009 pp: 3). For the elaboration of this thesis and considering that surgical smoke is originated during surgical

procedures, the intraoperative phase personnel competencies are the ones discussed in this review.

3.3 Nursing competency

Although nursing competency is viewed as a vital element of nursing and the care provided (Karami et al., 2017 pp:1-2), its surrounding concepts aren't yet fully developed. Multiple research studies have, with the help of literature and international guidelines and standards, helped to set definitions of the concept of competency (Fukada, 2018 pp: 1). There are important core abilities that fulfill the nurse's role: skills, knowledge, attitudes, values, and abilities (Karami et al., 2017 pp: 1-2) and by being competent, nurses possess the capacity to provide professional, safe, and effective care to the patient. Competency was defined by the Japanese Nurses Association as "the ability to perform clinical nursing care that is based on the nurse's ethical thinking and accurate nursing skills and that is provided to meet the needs of the cared." (Fukada, 2018 pp:1-2).

3.4 Health and safety

It is a fact, that many sides effects can originate from surgical smoke, so it is essential to provide a safe environment (FencI, J, 2017 pp: 489). Health and safety at work, sometimes known as occupational health and safety, consists of risk management and promotion of safety (Australian Government, 2021). Management should identify the causes of injury and illness, the depth of harm and outcomes and to take action to eliminate the hazards from workplace (Health and safety Executive, 2021), ensure the proper functioning of equipment, promote safe working methods, provide training and supervising, and monitor health of their workers (Australian Government, 2021). On the other hand, nurses must continue to seek for information to promote their care delivery ability and promote safety in workplace (FencI, J, 2017 pp: 490). Benefits of health and safety include improvement in productivity and reduction of the onset of injury and illness (Australian Government, 2021).

4 Background

4.1 Surgical smoke in operating room

“It is important to recognize that exposure to surgical smoke can be harmful to anyone who is in the procedure room, including the patient.” (Fencel, J., 2017 pp: 489)

Nowadays, electrosurgery is widely used in most operating rooms (in over 80% of the surgeries performed) (İlçe et al., 2017; Meeuwsen et al., 2019 pp: 248). It includes surgeries carried out with a wide variety of technological devices such as lasers, electrocauteries, ultrasonic scalpels (Benson, S. et al., 2019 pp: 991), radiofrequency devices and power tools (Asdornwised, 2018 pp: 33). The usage of these devices allows a rapid achievement in hemostasis while dissecting the tissue but also highlights the importance surgeons understanding and mastering different appropriate settings and work principles related to the functioning of the instruments (Meeuwsen et al., 2019 pp: 248). By doing so, it allows a better implementation of changes to ensure the safety of operating rooms (Osman, 2016 pp: 15).

In one hand, these devices bring significant advantages to the surgeries (e.g., efficiency and reduced complications to the patients). On the other hand, their usage produces surgical smoke (Saito et al., 2019 pp: 2) leaving especially doctors and nurses exposed to its hazards and causing them health problems. (Ball, 2010 pp: e2) Researchers have, for several decades, identified the presence of biological matter and chemical components in the surgical smoke (Lindsey et al., 2015 pp: 429). But while the serious hazards have been highlighted, this issue has not been granted the attention it requires, to protect the work environment and the operating room personnel (Ball, 2010 pp: e1).

4.2 The components of surgical smoke

Surgical smoke is composed of 95% of water and 5% of cellular debris (Okoshi et al., 2014). Multiple research studies have shown the presence (in those 5%) of toxic components such as benzene, bioaerosols, formaldehyde, cyanide (Goodman et al., 2014 pp: 333) (Gao et al., 2016 pp: 609), bacteria, viruses, blood, and tissue particles. There has been documented the presence up to 150 toxic chemicals in the composition of the surgical smoke (Okoshi et al., 2014), and that the higher the temperature reached during the procedures, the more toxic the surgical smoke becomes (Lindsey et al., 2015 pp: 434). The amount and composition of the surgical smoke is conditioned by the tools

utilized, the type of procedure performed, the target tissue and by the presence of viruses and bacteria (Okoshi et al., 2014). The particles in the smoke's composition can cause harm when inhaled (Lindsey et al., 2015 pp: 429) and the smallest ones tend to travel the most: depositing in the alveolar region causing aggravation of conditions or the possibility of leading to new infections (Tan & Russell, 2017 pp: 34).

Chemical	Exposure considerations
Aldehydes acetaldehyde, formaldehyde, acrylamide	<ul style="list-style-type: none"> • Potential carcinogen • Respiratory tract irritant
Benzene	<ul style="list-style-type: none"> • Potential carcinogen • Eye, nose and eye irritator • Can cause headaches, nausea, dizziness.
Xylene	<ul style="list-style-type: none"> • Respiratory irritant, skin irritant • Eye damage can occur.
Toluene	<ul style="list-style-type: none"> • Exposure can cause headaches, nausea, and dizziness.
Furfural	<ul style="list-style-type: none"> • Eye and respiratory tract irritant

(Lindsey et al., 2015 pp: 435; Okoshi et al., 2014);

Table 1. List of some examples of surgical smoke components and exposure risks

4.3 Effects of surgical smoke

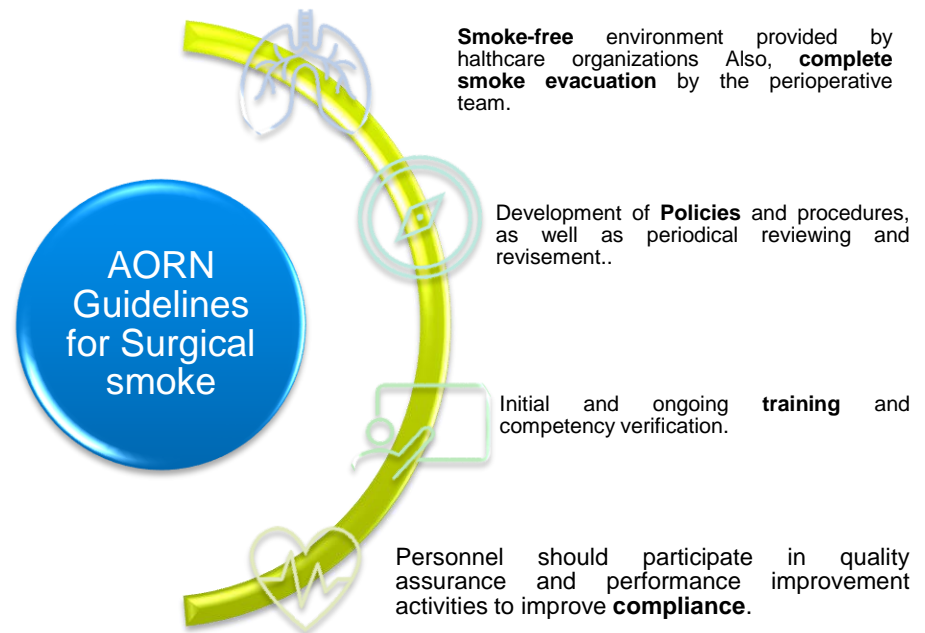
Surgical smoke has many side effects. In recent studies by İlçe et al. (2017); Asdorniwised et al. (2018); and Ünver et al. (2016), headaches were the most common negative effect for perioperative nurses, followed by sore throat as the second. Other negative effects included nausea/dizziness/vomiting, watery eyes/eye irritation, weak-

ness; coughing/sneezing, chronic bronchitis, asthma, vertigo, nervous agitation, abdominal pain, and bad odor (İlçe et al., 2017; Asdorniwised pp: 700-701 et al., 2018; Ünver et al., 2016 pp: 38;). There has been linked the transmission to perioperative personnel, of infectious diseases through the plume (for example HPV, HIV, tuberculosis, Hepatitis B and C). But in recent studies, for example one from Turkey where doctors and nurses were interviewed, İlçe et al. (2017) stated that none of the participants had been diagnosed with HIV, hepatitis B, C or cancer (İlçe et al., 2017).

Asdorniwised et al. (2018) stated in their study, that although the presence of symptoms was high in nurses (eg. Headaches were present in 79% of the participants, sore throat in 74% of the participants), the overall severity was considered as low. Coughing and sneezing were pointed out as the highest in severity level (Asdorniwised et al., 2018 pp: 38). Besides serious hazards that are entangled with surgical smoke, it also creates vision obstruction and unpleasant smell in the operating room (Liu et al., 2019 pp: 2789). When it comes to rplume exposure, it has been compared to the effects of passive smoking (İlçe at al., 2017), and the daily amount of smoke produced in the OR equivalent to 27-30 cigarettes. (Okoshi et al., 2014) The long-term effects of this exposure have yet to be proven (İlçe at al., 2017).

4.4 Health and safety guidelines related to surgical smoke in Perioperative settings

Understanding perioperative nurses' adherence with guidelines for surgical smoke safety is one of this thesis research questions, but it is first of all vital to explore what the guidelines are in relation to the surgical smoke issue. According to the law, healthcare organizations (employers) are obliged to provide a safe working environment from healthcare professionals, free from identifiable causes of harm (Fencl, J., 2017 pp: 492). Therefore, there are multiple recommendations when handling the surgical plumes that are described below based on the guidelines for smoke safety by AORN's (Association of perioperative registered nurses). The goal for their guidelines was to provide guidance and help establish a safe working environment for all personnel and patients (Fencl, J., 2017 pp: 490).



(Fencel, J., 2017 pp: 490)

Figure 1. Key takeaway factors from AORN guidelines for surgical smoke safety

4.4.1 Measures for a smoke-free working environment

“...the decision to use or not use a smoke evacuator should not be made by any one practitioner or be based on personal preference. If the procedure generates surgical smoke, the surgical team should use smoke evacuation techniques.” (Fencel, J., 2017 pp: 492).

Using smoke evacuation systems in addition to room ventilation as the first line of defense against surgical smoke exposure: central or portable smoke evacuation systems (for large amounts of smoke), local exhaust ventilation (LEV) (wall suction through an inline filter (for smaller amounts of smoke) and the use of laparoscopic filtration systems when applicable. Use of respiratory protection (such as the respirator N-95) is pointed out as second line in hazard prevention and assuring OR safety. Other PPEs include gloves, eye wear and long sleeve (Fencel, J., 2017 pp: 492; Goodman et al., 2014 pp: 334; Spruce & Braswell, 2012 pp: 382). It's in great important to notice that the literature states that regular surgical masks and regular room ventilating systems are insufficient in handling the plume. Surgical masks are not able to filter the smallest particles produced (Arlin, S. 2020 pp: 489). To fully managing the surgical smoke problem in ORs, complete smoke evacuation is the only solution (Ball, 2010 pp: e2).

5 Purpose, aims and study questions

The purpose of this thesis was to describe what is the nurses' competency level related to surgical smoke and their adherence to the guidelines concerning surgical smoke safety. The aim of this work was to produce knowledge related to nurses' competency and adherence to the surgical smoke safety that could be utilized in developing safe practices in perioperative settings to produce new knowledge.

Study questions:

1. What is the competency of nurses related to level surgical smoke?
2. What is the nurse's adherence to the guidelines related to surgical smoke safety?

6 Methodology and methods

The methodological approach in this thesis is qualitative and the method used in this thesis is a descriptive literature review, aiming to identify, analyze, assess, and interpret knowledge on the topic (Coughlan & Cronin, 2021 pp: 10). Literature review is an objective summary of the findings made in previous studies from a selected topic (Cronin, P. et al., 2008 pp: 38). That summary should identify the new knowledge, as well as gaps in the current literature (Coughlan & Cronin, 2021 pp: 2).

It is an important tool that seeks answers from literature and not an essay, meaning studies can't be selected to portrait a particular view (Coughlan & Cronin, 2021 pp:1-2). Important principles for literature review are transparency, clear search strategy as well as accurate referencing and use of terminology throughout the work (Parahoo, K., 2014 pp: 123; Cronin, P. et al., 2008 pp: 38). Steps for undertaking a descriptive literature review include identifying a topic area; define/refine question/aim; develop a search strategy; search literature; appraise of the quality of the included literature; analyze the findings and develop themes; write the review; consider implications for research and practice (Coughlan & Cronin, 2021 pp: 10).

A descriptive literature review provides a critical discussion, that usually deals with a wide range of problems, providing insight of the topic, highlighting inconsistencies and similarities in the current literature (Coughlan & Cronin, 2021 pp:2; Moule & Goodman,

2009 pp:139). Because the attempt is to provide a comprehensive and up-to-date understanding of the research related to the topic, systematic methods like clear inclusion and exclusion criteria and elaboration of conclusions and recommendations were adopted in the descriptive literature review model (Parahoo, K., 2014 pp:125; Moule & Goodman, 2009 pp:139).

6.1 Database Search

The process of research through databases started in January 2021, using the following databases: CINAHL and MEDLINE. The initial searches were set to include studies published less than 5 years ago, but due to short number of results that could answer my studies question, the filter range was elongated to 10 years. Inclusion and exclusion criteria were set as boundaries in the search of studies in the databases. The following table (table 2) describes the inclusion and exclusion criteria in detail.

Inclusion criteria	Exclusion criteria
<ul style="list-style-type: none"> • With full text available, • Written in English, • Containing an abstract, • Published preferably less than 10 years ago, • Nursing related studies, • The articles with content most suitable to answer the study questions 	<ul style="list-style-type: none"> • Other language than English , • Not containing an abstract or list of references, • Published more than 10 years ago, • The content did not answer the study questions, • Being a literature review, • Duplicate literature, • Not referring to nursing, • Literature with limited content access

Table 2. Exclusion and inclusion criteria

Searching terms included “surgical Smoke” and different combinations such as: “Surgical smoke” AND perioperative nurses; “Surgical smoke” AND prevention; “Surgical plume”; “Surgical smoke” and awareness; “Surgical smoke” AND evacuation; “Electro-surgical smoke”; “Surgical smoke” AND guidelines; Nurs* AND “Surgical smoke” Or “Plume”. The database search was conducted applying a systematic approach, meaning that there

was a clear and organized search process including keywords, the databases and strategies used (like limitations applied) and alternative searching methods (Coughlan & Cronin, 2021 pp: 3).

6.2 Data Selection

When selecting the articles, the inclusion and exclusion criteria described in the table 2 were applied, keeping in mind that the studies were required to answer my research question. After the searches with keywords the total number of articles were 226, from those studies were selected by the title 121, by the abstract 72 were selected and lastly after whole text evaluated and elimination of the duplicates 9 articles were chosen for this work.

Databases	CINAHL	Medline	Manual	Total
Number of Hits	162	62	2	226
Included Based on title	92	29	2	123
Included Based on abstract	54	17	2	73
Included Based on Full text	7	0	2	9

Table 3. Database search

When selecting the studies used on this thesis and to the quality of the chosen articles, JUFO was checked. JUFO is a forum by Finnish scientific community with the objective of providing support to ensure quality assessment of academic research (JUFO, 2021).

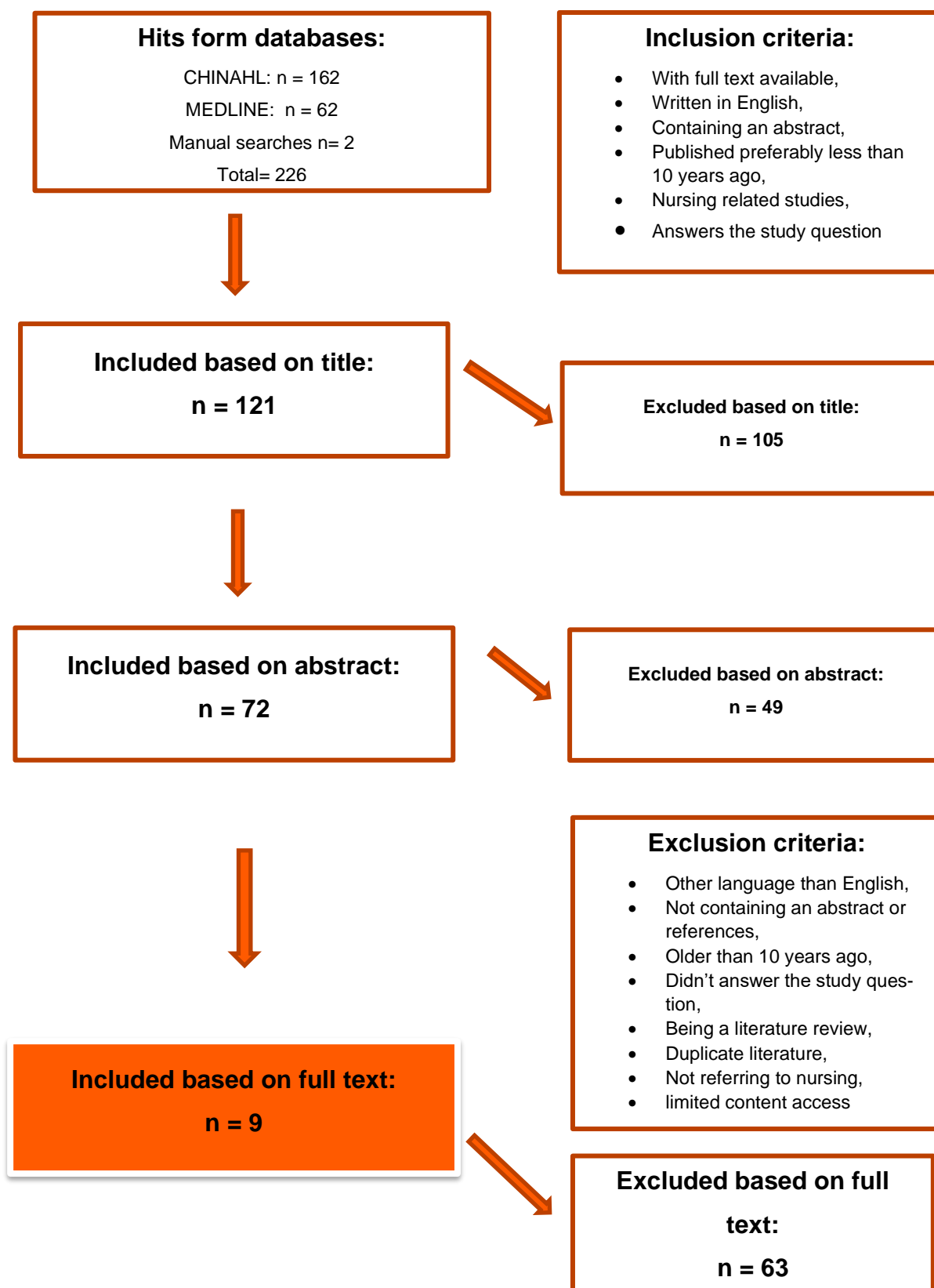


Figure 2. Data selection process

6.3 Data Analysis

According to Elo and Kyngäs, “content analysis is a research method for making replicable and valid inferences from data to their context, with the purpose of providing knowledge, new insights, a representation of facts and a practical guide to action” (Elo and Kyngäs, 2008 pp: 108). In data analysis, it is important to look at the quality of the literature, identify strengths and limitations and understand the outcomes of study (Coughlan & Cronin, 2021 pp: 4). Two different approaches can be applied when performing content analysis: Inductive or deductive. Inductive is applied when there is lack of previous knowledge or when the existing knowledge is fragmented, moving from specific to general allowing particular segments to be included in larger statements. Deductive content analysis is applied when the purpose revolves around testing a theory based on previous knowledge. It is based on earlier theory and develops from general to specific (Elo and Kyngäs, 2008 pp: 111). In this work the findings made in previous research were analyzed inductively to make conclusions of the current understanding of the topic and to answer the research questions. Organizing themes to present the studies is the most effective way once the search and selection of studies have been completed. Even if there isn't a set rule for the quantity of themes used, the number should be considered sufficient to allow a deep discussion (Coughlan & Cronin, 2021 pp: 77).

Original text	Meaning unit	Sub-category	Generic Category	Main Category
<i>“Ninety-two-point six percent of all the nurses reported that they know the meaning of surgical smoke”</i>	Almost all nurses understood the meaning of surgical smoke.	Knowledge of the definition	Knowledge related to surgical smoke	Nursing Competency related to surgical smoke
<i>“...while 55.6% were aware of the negative effects of it.”</i>	Almost 50% was not aware of the surgical smoke hazards.	Knowledge of the hazards	Knowledge related to surgical smoke	Nursing Competency related to surgical smoke

<p><i>“In addition, it was found that 83.9% of the participants did not participate in any training programs on surgical smoke safety.”</i></p>	<p>Significant percentage of the participants did not have training related to surgical smoke</p>	<p>Education and training</p>	<p>Knowledge related to surgical smoke</p>	<p>Nursing Competency related to surgical smoke</p>
<p><i>“The data showed that the most commonly used equipment to control surgical smoke in the OR was wall suction without an inline filter and that this was generally used only during surgery.”</i></p>	<p>No proper smoke ventilation.</p>	<p>Smoke evacuation</p>	<p>Factors preventing safety</p>	<p>Adherence to guidelines related to surgical smoke</p>
<p><i>“63 % of the participants stated that surgical protocol had not been made, 37 % reported that they had no information about protocols to protect them from the adverse effects of surgical smoke.”</i></p>	<p>Lack of awareness surgical smoke protocols.</p>	<p>Knowledge of the guidelines</p>	<p>Factors preventing safety</p>	<p>Adherence to guidelines related to surgical smoke</p>

Table 4. Example of data analysis method

7 Findings

7.1 Overview of the studies selected.

The aim of this literature review was to produce knowledge of the nurses' competency and adherence for implementing practices for surgical smoke safety. This section presents the findings from the chosen articles answering the research question. The literature used in this review is summarized in a table in Appendix 2. A total of 9 articles were included in this thesis, 1 of the selected studies were qualitative and 8 were quantitative. Methods utilized were questionnaires, surveys, and descriptive statistical analyses from countries like Turkey, United States of America, Canada, Thailand and New Zealand. As an outcome of analysis the findings were categorized accordingly: two (2) main categories ("Nursing competency related to surgical smoke" and "Adherence to guidelines related to surgical smoke"), three (3) generic categories ("Knowledge related to surgical smoke", "Attitudes related to surgical smoke", "Factors preventing safety") and six (6) sub-categories ("Knowledge of the definition", "Knowledge of the hazards", "Education and Training", "Lack of Smoke evacuation", "lack of use of PPE" and "lack of knowledge of the guidelines").

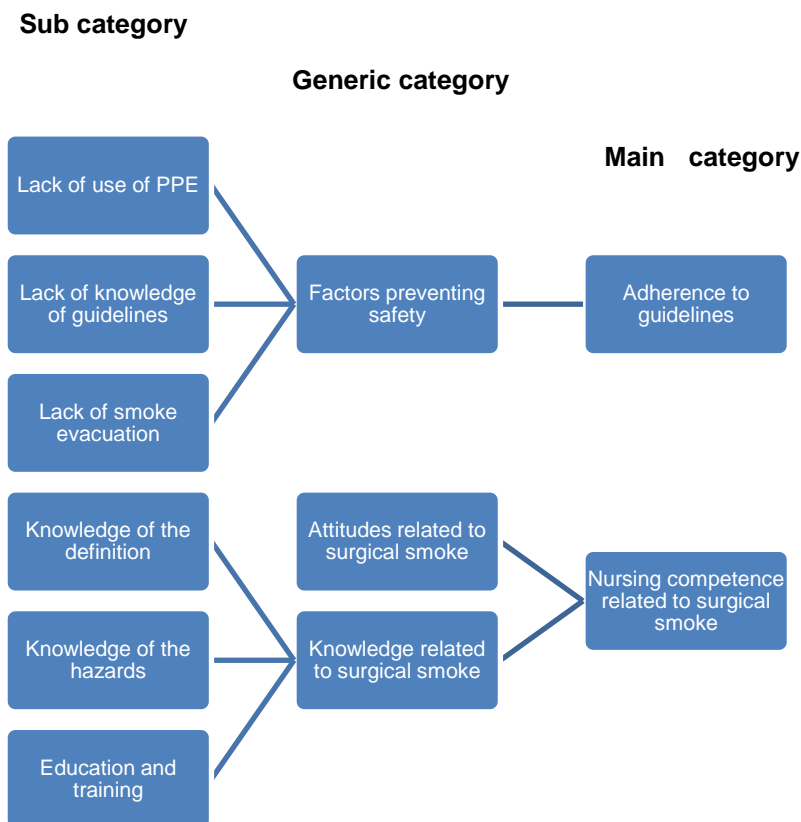


Figure 3. Organization of the categories utilized in the result section

7.2 Nursing Competency

7.2.1 Knowledge related to surgical smoke

“Knowledge of the definition”

This section aimed to obtain from the selected articles the results that relate to nurses' level of knowledge of what surgical smoke means. In a study conducted by Arli (2020), the knowledge related to surgical smoke of the OR staff members working in a state hospital in the eastern part of Turkey, was identified through a questionnaire. Majority (66.1 %) of the participants volunteering to the study were surgical nurses. In the questionnaire surgical nurses' correct answer rate revealed a somewhat medium level of knowledge. The questionnaire showed some common misconceptions for example related to the sufficiency of a surgical mask during aerosol-generating procedures (Arli, 2020 pp: 491-494). Another study in Turkey by Ünver et al. (2016) revealed, that over 90% of the participating OR nurses were familiar with the concept of surgical smoke (Ünver et al., 2016 pp: 698-699).

“Knowledge of the hazards”

The objective of this section was to obtain from the selected articles the results that relate to nurses' understanding of various hazards and risks related to surgical smoke. In a study by Ünver et al. (2016), 54 perioperative nurses working in two big Turkish university hospitals, responded to a survey aiming to determine the status of exposure to surgical smoke. Only 55,6 % of the participants reported to know the negative effects of the plume (Ünver et al., 2016 pp: 698-699). However, higher percentages of knowledge have been reported in other studies. In a study in New Zealand by Rodrigues (2018), only 16 % of the participants did not know the hazards present in the plume (Rodrigues, 2018 pp: 21). Osman (2015) revealed in another study from New Zealand, 75 % awareness of the surgical smoke originated health issues. Among the participants there was complete understanding of the insufficiency of the (regular) masks protection regarding exposure to the plume (Osman, 2015 pp: 16). Similarly in a study by Asdornwised (2018), In Thailand, a clear majority of the nurses (92%) knew about the hazards. Media (28.8%), department heads/operating room nurses (14.1%) and colleagues (34%) were the main reported sources of information for the responding nurses (Asdornwised et al., 2018 pp: 36).

“Education and Training”

The results that relate to the level of education and training provided to nurses regarding surgical smoke were obtained in this section. Starting with the study by Steege et al. (2017) a clear majority of the 4533 respondents of the survey of National Institute for Occupational Safety and Health (in the United States) had not received any training during the last 12 months and most of them had never been trained on the hazards of surgical smoke (Steege et al., 2017 pp: 16). 70 % of Asdornwised et al. (2018) study's participants answered with “sometimes, rarely and never” to the question regarding training against the plume's hazards. 76,1 % reported having professional equipment demonstrations “sometimes, rarely and never” (Asdornwised et al., 2018 pp: 36). Similarly, the previously mentioned studies in Turkey revealed shortage in the nurses' education related to surgical smoke: 20,4 % of the participants in Ünver's study had taken education about surgical smoke. (Ünver et al., 2016 pp: 698-699). Even 83.9 % of the participants in Arli's study had not partaken in any training related to the topic (Arli, 2020 pp: 491-494).

7.2.2 Attitudes related to surgical smoke

The last section related to nursing competence aimed to obtain from the selected articles the results that relate to nurses' attitudes considering surgical smoke. Vast majority of the participants in Osman's study (2016) had concerns related to the exposure to surgical smoke and expressed desire in using smoke evacuation devices. Only 2,5 % stated no concerns related to the exposure and had no desire in wanting some form of evacuation tool (Osman, 2016 pp: 16). In Ünver's et al. (2016) study almost half of the participants gave suggestions related to the surgical smoke problem. Of those suggestions, 64 % expressed a desire for additional smoke evacuation devices, 20 % wanted to have education in the matter and 16 % better air conditions in OR (Ünver et al., 2016 pp: 700). İlçe et al. (2017) have found a difference between doctors' and nurses' levels in using protective measures. Nurses reportedly used more protection methods like PPE than doctors (İlçe et al., 2017).

7.3 Adherence to guidelines related to surgical smoke

7.3.1 Factors preventing safety

“Lack of smoke evacuation”

In this section the results that relate to the lack of use of smoke evacuation in ORs were collected. The surgical smoke control practices in North America were monitored repetitiously in 2007 and 2010. The Local exhaust ventilation usage increased slightly between these years. On the other hand, the use of smoke evacuators (a more effective control measure) changed very little. Ultimately wall suction remained the primary LEV method for most of the procedures generating surgical smoke (Edwards & Reiman, 2012 pp: 339-348). Steege et al. (2017), have described in a large, survey-based study the surgical smoke exposure control precautions in the U.S. Less than half of the respondents reported that local evacuation ventilation (LEV) was always used during laser surgery. Much lower percentage reported LEV being always used during electrosurgeries. (Steege et al., 2017 pp: 4-6).

Ünver (2016) reported that the participants working in two big Turkish hospitals´ reported that the operating rooms did not have devices for smoke evacuation, and aspiration catheters were used instead. Only 1.2 % of the nurses reported the existence of smoke evacuation systems (Ünver et al., 2016). According to a questionnaire made to nurses working in secondary and tertiary hospitals in Thailand by Asdornwised et al. (2018), the most commonly used smoke evacuation equipment was a wall suction without an inline filter. None of the participating nurses reported the usage of central evacuation systems in OR. 63.7 % and 54.7 % answered never using portable smoke evacuation devices and laparoscopic filtration systems respectively (Asdornwised et al., 201 pp: 37-38). According to Rodrigues (2020) During a wide diversity of surgical procedures, the usage of smoke evacuation devices remains low. For example, during total hip replacement surgery, most participants reported that smoke evacuations were never (Ball, 2010 pp: e10). Overall, 53 % of the participants were noncompliant with smoke evacuation procedures (Rodrigues, 2020 pp: 21).

In multiple studies, reasons for noncompliance with smoke evacuation procedures were reported. The participating nurses stated that low adherence was due to: smoke evacuation not being part of regular protocols, exposure to the plume being minimal, LEV not being provided by the employer, some nurses not knowing what LEV was used for, the procedures being internal to the patient, nurses not having control over the decision,

surgeon's resistance to apply smoke evacuation, high cost of the devices, bulkiness of the instruments and not being easy to maneuver, the excessive noise produced during the usage of the devices, and the lack of clear regulation (Steege et al., 2017 pp: 6; Edwards & Reiman, 2012 pp: 341-342; Osman, 2016 pp: 15).

“Lack of use of PPE”

Another section related to factors preventing safety aimed to extract from the selected articles the results that relate to nurses' lack of use of PPE in ORs. According to Asdornwised et al. (2018) a considerable percentage of the nurses participating to the survey reported to rarely or never use high filtration masks (over 50 %), and 25 % answered that always used. In terms of protective eye wear only 29 % stated to use them always (Asdornwised et al., 2018). In the study by Steege et al. (2017), the participants reported never wearing a respirator N-95 or other high filtration respirators. Instead, it was used surgical masks (in over 90 % of the participants). Reasons stated in the study for not using respirators included: not being part of the protocol, not easily available in OR, not being provided by employer and not being used due to minimal exposure to surgical smoke (Steege et al., 2017 pp: 6). In İlçe 's study (2017) 91% of the respondents stated to wear surgical masks, around 47 % to wear eye protection, 40 % gowns and 8,9 % high filtration masks (İlçe et al., 2017).

“Lack of knowledge of the guidelines”

In this section the objective was to collect from the selected articles the results that relate to nurses' lack of knowledge of surgical smoke guidelines and recommendations. Steege's study (2017) reported a significant percentage (4 out of 10) of the over 4500 survey respondents reported to not be aware of their employers' procedures addressing the hazards of surgical smoke. A minority of them possessed the knowledge of such procedures at their workplace (less than one third). Most of the participants were unaware if any exposure monitoring had taken place in last 12 months (Steege, 2017 pp: 5). 63 % of the participants in İlçe 's study (2017) affirmed that no surgical protocol had been made and 37 % referred that they had no information about protocols to protect them from the hazards of surgical smoke (İlçe et al., 2017). 60 % answered sometimes, rarely or never, in Asdornwised study (2018), when asked about using perioperative standards and recommendations when handling smoke in OR. (Asdornwised et al., 2018) Similarly, in Rodrigues' study (2018) 41 % were unaware of safety considerations and 53 % were of local smoke evacuation policies even if 47% worked for more than 5 years in OR.

(Rodrigues, 2018 pp: 21). In Osman's study, even 97,5 % being unaware of their hospital's policies on surgical smoke evacuation (Osman, 2016 pp: 15).

8 Discussion of the findings

If 40 years ago the existence of the plume in ORs was considered as a regular part of surgical procedures, the current state of research and literature has proven the hazardous content of the smoke. According to guidelines, the smoke must be fully evacuated, the OR personnel should receive education and training, and guidelines must be created and implemented (Fencl, 2017 pp: 489). Following these principles, this thesis' purpose revolved around the description of nurses' competency related to the plume as well as the adherence for smoke safety. It is important to discuss these results, compare them to the guidelines and literature and point out the lack of information and practices.

8.1 Knowledge as an important core ability of nursing competency

According to literature the core abilities that fulfill the nurse's role are skills, knowledge, attitudes, values, and abilities and by being competent, nurses possess the capacity to provide professional, safe, and effective care to the patient (Karami et al., 2017). The selected literature did not fully provide sufficiently information to evaluate the nursing competency in light of all these core abilities. Not many of the selected studies gave an insight related to the knowledge of the definition of surgical smoke. Ünver's study (2016) however states that over 90% possessed the knowledge of the definition. (Ünver et al., 2016). In other studies, it was found that the majority of the participants had knowledge related to the hazards (Asdornwised et al., 2018 pp: 36). This allows a conclusion to be drawn: the concept of surgical smoke is known by the majority of the participating nurses in the variety of studies used in this thesis.

As a clear result, nurses in a majority, never had any training in matters related to surgical smoke. Asdornwised et al. (2018) states that majority reported not having equipment demonstrations by a professional. (Asdornwised et al., 2018 pp: 36). The findings are in conflict with the recommendations provided by guidelines for surgical smoke safety. According to AORN guidelines, it is vital to educate nurses and by doing so increase nurses' empowerment (best tool provided through training and verification of competencies). Training should discuss matters such as the definition of surgical smoke, what devices originate the plume, what the hazards are to everyone in the OR, what smoke evacuation devices are available and what supplies are used, teach correct set ups, and use

of different machines and how to properly dispose of evacuation device's supplies (Fencl, 2017 pp: 492)

Nurses' attitudes related to surgical smoke is not a very investigated topic in the studies analyzed for this thesis. Nevertheless, it is possible to verify within the studies some statements regarding it. For example, according to Ünver's study (2016), nurses gave suggestions like wanting to have smoke evacuation equipment in their OR. In general majority had concerns related to the exposure, but there still was a small number of nurses that were not concerned with the effects of the plume and also expressed no desire in the improvement of ORs' air conditions or need for smoke evacuation devices (Ünver et al., 2016 pp: 700). Even if the majority of nurses appears to have progressive attitudes for surgical smoke safety, there still is space for improvement for example related to safety measures against surgical smoke

8.2 Adherence to guidelines

It was evident in the light of the chosen studies, that there is no proper smoke evacuation in many of the ORs where the nurses related to the selected studies work. This information goes against the recommendations. According to them smoke evacuation techniques should be used in procedures generating smoke. Also, the guideline states that "using a smoke evacuation system in addition to room ventilation is the first line of defense against surgical smoke exposure." (Fencl, 20 pp: 492). In most studies was found that the usage of smoke evacuation systems was generally very low. Ünver's results even state that there wasn't any devices for surgical smoke evacuation (Ünver et al., 2016). This allows for opening of important conversation, if the guidelines clearly advise for total smoke evacuation, why aren't the recommendations applied in practice?

The use of PPE, as mentioned previously, demonstrates higher usage rates in nurses when compared to doctors. In general, the usage of these protective items is elevated, but on the other hand the usage of respirators is quite low. Steege et al., reported that nurses in their study never wearing respirators, instead just using surgical masks (Steege et al., 2017 pp: 6). Guidelines and research have shown that these surgical masks do not provide effective protection against small particles of the plume. It was evident that a large percentage of nurses were not aware of their hospital guidelines or the existence of such. In İlçe's study, for example 63 % of the participants affirmed that no surgical smoke protocol had been made (İlçe et al., 2017). According to AORN's guidelines, well defined policies ensure responsibility in providing the best care for patients (Fencl, J., 2017 pp: 492) and must address full smoke evacuation, the selection of devices and

supplies, positioning of the smoke capturing devices, recommended PPE, requirements for training, and procedures for reporting health hazards. (Fencl, J., 2017 pp: 492) Revision in guidelines can be achieved with the help of questionnaires, audit tools, observation, and focus groups. (Osman, 2016 pp: 15)

9 Ethical considerations and validity of the study

Ethics can be defined as “norms for conduct that distinguish between acceptable and unacceptable behavior” (Resnik, 2011). Issues with ethics appear in different stages of the research process (Moule & Goodman, 2009). There are several ethical considerations related to every research process. According to Parahoo, ethical principles can be described as the right to not harm, right of privacy and full disclosure and autonomy (Parahoo, 2006 pp.102-103).

Because this work is a literature review it does not contain ethical considerations related to direct researcher-participant contacts. However, the steps in the process related to data selection, objective evaluation of the relevancy of sources, proper acknowledging, and exact quoting of the authors as well as objective analyzing of the selected literature include ethical considerations which are connected to the validity of this work. Credibility of this review may be affected by the inexperience of the author when it comes to write an extensive literature review. Limited Finnish language skills of the author were set as the decision factor in not using Finnish databases. By doing so, an important opportunity to check more sources and achieving an understanding of Finnish the healthcare and safety in practice was not obtainable.

Roberts P et al. define reliability and validity as “ways of demonstrating and communicating the rigor of research processes and the trustworthiness of research findings” (Roberts, P. et al., 2006 pp: 41). In this work the reliability involves inclusion criteria applied to the selection of the articles which are used as sources of information. Also, the variety in terminology related to the topic has to be carefully considered to avoid un-intentional exclusion of relevant literature in the database searching process. As mentioned earlier, neutral approach and elimination of personal biases are vital for the reliability of this work.

10 Conclusions and recommendations

The studies analyzed in this literature describe the situation related to surgical smoke in several countries and continents (for example Thailand, New Zealand, and Turkey). Geographical factors were not an inclusion or exclusion criteria when selecting the literature. It is reasonable to assume, that there is a variety of differences in the health care systems in the countries where the studies chosen to this review have been made. It is necessary to remember, that the findings and conclusions represented in this work are made in the light of the chosen literature and should not be generalized or applied too straightforwardly.

To summarize the analyzed literature, it is clear that nurses are not fully competent to handle the risks of surgical smoke. According to Kay Ball (2010), the investigated key indicators that predict increased compliance with smoke evacuation recommendations are: increased knowledge and training, positive perceptions of the recommendations, ease in understanding and implementing the recommendations, large facility size, larger number of surgical specialties offered, greater interconnectedness and strong leadership support. (Ball, 2020, pp: 9-20). To increase the adherence to guidelines, it is important to apply recommendations, like the AORN guidelines for smoke safety. The guidelines state the need for education and training for OR personnel, the importance of creating a smoke-free environment (including usage of PPE and proper devices for total evacuation of smoke) and creating policies and revising them (Fencil, J., 2017 pp: 490).

References

Arli, S. (2020). Knowledge of the Operating Room Team Members about Surgical Smoke Safety, *International Journal of Caring Sciences*, Volume 13, Issue 1, 489-496

Asdornwised, U., Pipatkulchai, D., Damnin, Suwat, Chinswangwatanakul, V., Boonsripi-tayanon and M., Tonklai, S. (2018). Recommended practices for the management of surgical smoke and bio-aerosols for perioperative nurses, *Journal of Perioperative Nursing* 31 (1), 33-41

Australian Government (2021). Work health and safety, <https://business.gov.au/Risk-management/Health-and-safety/Work-health-and-safety> Last accessed 21 October 2021

Ball, K. (2010). Compliance With Surgical Smoke Evacuation Guidelines: Implications for Practice, *AORN Journal*, Vol 92, No 2, 142-149

Ball, K. (2010). Surgical Smoke Evacuation Guidelines: Compliance Among Perioperative Nurses, *AORN Journal*, Vol 92, No2, e1-e23

Barret, W. and Garber, S. (2003). Surgical smoke – a review of the literature: Is this just a lot of hot air?, *Surgical Endoscopy*

Benson, S., Maskrey, J., Nembhard, M., Unice, K., Shirley, M. and Panko, J. (2019). Evaluation of Personal Exposure to Surgical Smoke Generated from Electrocautery Instruments: A Pilot Study, *Annals of Work Exposures and Health* 63 (9)

Coughlan, M. and Cronin, P. (2021). *Doing a Literature review in nursing, health and social care*, Sage Publications, 3rd edition

Cronin, P. Ryan, F., Coughlan, M. (2008). Undertaking a literature review: a step-by-step approach, *British Journal of Nursing* 17 (1)

Edwards, B. and Reiman, R. (2012). Comparison of Current and Past Surgical Smoke Control Practices, *AORN Journal*, Vol 95 No 3, 337-350

Elo, S. and Kyngäs, H. (2008). The qualitative content analysis process, *Journal of Advanced Nursing* 62 (1)

Fencl, J. (2017). Guideline Implementation: Surgical Smoke Safety, *AORN Journal*, 105(5), 488-497

Fukada, M. (2018). Nursing Competency: Definition, Structure and Development, *Yonago Acta Medica* No.61, 1–7

Gao, S., Koehler, R., Yermakov, M., and Grinshpun, S. (2016) Performance of Face-piece Respirators and Surgical Masks Against Surgical Smoke: Simulated Workplace Protection Factor Study, *Annals of Occupational Hygiene*, 2016, Vol. 60 No. 5, 608–618

Goodman, T. and Spry. C., *Essentials of Perioperative Nursing*, Jones & Bartlett Learning, Fifth edition

Health and Safety Executive (2021). Managing risks and risk assessment at work, <https://www.hse.gov.uk/simple-health-safety/risk/index.htm> Last accessed 21 October 2021

İlçe, A., Soysal, G. and Yavuz, M. (2017). The examination of problems experienced by nurses and doctors associated with exposure to surgical smoke and the necessary precautions, *Journal of Clinical Nursing*, 26 (11-12), 1555-1561

Jufo, Publication Forum, <https://www.julkaisufoorumi.fi/en> last accessed on 29.10.2021

Lindsey, C., Hutchinson, M. and Mellor, G. (2015). The Nature and Hazards of Diathermy Plumes: A Review, *AORN Journal* 101, 428-442

Meeuwsen, F., Guédon, A., Klein, J., Van Der Elst, M., Dankelman, J. and Dobbelsteen, J. (2019). Electrosurgery: short-circuit between education and practice, *Minimally Invasive Therapy & Allied Technologies*, Vol. 28, No. 4, 247-253

Moule, P. and Goodman, M. (2009). *Nursing research: An introduction*, Sage Publications, 1st edition

Okoshi, K., Kobayashi, K., Kinoshita, K., Tomizawa, Y., Hasegawa, S. and Sakai, Y. (2014) . Health risks associated with exposure to surgical smoke for surgeons and operation room personnel, *Surgery Today*

Osman, J. (2016). Clinical Surgical Smoke Danger: Time for Consistent Policy and Practice, *The Dissector* Vol. 43, No 4, 14-20

Parahoo, K. (2014). *Nursing research, principles process and issues*, 3rd edition, Hampshire, UK: Palgrave Macmillan

Resnik, D.B. (2011). What is Ethics in Research & Why is it Important?, National Institute of Environmental Health Science. <http://www.niehs.nih.gov/research/resources/bioethics/whatis/> Last accessed 27 March 2021

Roberts, P. and Priest, H., (2006), Reliability and validity in research, *Nursing standard* 20 (44)

Rodrigues, A. (2018). Electrosurgical Smoke Evacuation Quality Improvement Project, *The dissector* Vol. 46, No. 2, 20-24

Saito, A., Margatho, A., Bieniek, A., Stanganelli, C. and Ribeiro, R. (2019). Signs and symptoms related to inhalation of surgical smoke in the nursing team, *Escola Anna Nery* 23 (3)

Spruce, L., Braswell, M. (2012). Implementing AORN Recommended Practices for Electrosurgery, *AORN Journal*, Volume 95, No. 3, 373-390

Spry, C. (2009). *Essentials of Perioperative Nursing*, Jones and Bartlett publishers, 4th edition

Steege, A., Boiano, J. and Sweeney, M. (2017). Secondhand Smoke in the Operating Room? Precautionary Practices Lacking for Surgical Smoke, *Am J Ind Med*, 59(11), 1020–1031

Ulmer, B. (2008). The Hazards of Surgical Smoke, *AORN Journal* 87 (4)

Ünver, S., Topcu, S. and Findik, U. (2016). Surgical Smoke, Me and My Circle, *International Journal of Caring Sciences* Volume 9, Issue 2, 697-703

Weston, R., Stephenson, R., Kutarski, P and Parr, N. (2009) Chemical Composition of Gases Surgeons Are Exposed to During Endoscopic Urological Resections, *Urology* 74 (5)

Literature search from different databases

Database	Keywords (Serch terms)	Limitations	Hits	Included based on title	Included based on abstract	Included based on whole text/Whole article included
CINAHL	"Surgical smoke"	Full text articles, abstract available, published 2010-2021	44	27	17	7
CINAHL	"Surgical smoke" AND "perioperative nurses"	Full text articles, abstract available, published 2010-2021	10	7	4	0
CINAHL	"Surgical smoke" AND prevention	Full text articles, abstract available, published 2010-2021	30	19	10	0
CINAHL	"Surgical plume"	Full text articles, abstract available, published 2010-2021	38	22	12	0
CINAHL	"Surgical smoke" AND awareness	Full text articles, abstract available, published 2010-2021	1	1	1	0
CINAHL	"Surgical smoke" AND evacuation	Full text articles, abstract available, published 2010-2021	23	8	5	0
CINAHL	"Electrosurgical Smoke"	Full text articles, abstract available, published 2010-2021	5	3	2	0
CINAHL	"Surgical Smoke" AND guidelines	Full text articles, abstract available, published 2010-2021	9	5	3	0

MEDLINE	"Surgical Smoke"	Full text articles, abstract available, published 2010-2021	18	13	8	0
MEDLINE	Nurs* AND "surgical smoke" or "plume"	Full text articles, abstract available, published 2010-2021	44	14	8	0
MEDLINE	"Electrosurgical Smoke"	Full text articles, abstract available, published 2010-2021	2	1	1	0
Manual search			2	2	1	2
			Total 226	Total 121	Total 72	Total 9

Articles used in this review

	Author, date and Country	Title or aim/purpose of the study	Methods and participants	Main results
1.	Arlı, S., 2020, Turkey (International Journal of Caring Sciences Volume 13, Issue 1, 489-496) Database – CINAHL	Title – “Knowledge of the Operating Room Team Members about Surgical Smoke Safety” Aim - to identify the knowledge of the operating room team members about surgical smoke safety.	Quantitative Questionnaire Participants: n= 62 (composed of surgeons, anesthetists, surgical technicians, anesthesia technicians, and surgical nurses)	Majority of the participants were aware of the harmful components of surgical smoke.
2.	Arzu İlçe, A., Yuzden, G. and Yavuz, M., 2017, Turkey (Journal of Clinical Nursing)	Title – “The examination of problems experienced by nurses and doctors associated with exposure to surgical smoke and the necessary precautions” Aim – Investigate problems experienced by nurses and doctors as the result of exposure to surgical smoke.	Quantitative Descriptive statistical analyses Participants: n= 81 nurses and doctors (55.6% were nurses)	Main negative effects were headaches, watery eyes, coughs, burning throat, bad odors in hair, nausea.
3.		Title – “Recommended practices for the management of surgical smoke	Quantitative	Majority of the participants were aware of

	Asdornwised, U., Pipat-kulchai, D., Damnin, Suwat, Chinswang-watanakul, V., Boonsripi-tayanon and M., Tonklai,, 2018, Thailand (Journal of Perioperative Nursing Volume 31 Number 1) Database – CINAHL	and bio-aerosols for perioperative nurses in Thailand” Aim – Assessment of recommended practices to prevent exposure to surgical smoke and bio-aerosols by perioperative nurses.	Survey Participants: n= 377 nurses	the harmful components of surgical smoke. Health problems present such as headaches, sore throat, eye irritation, nausea/dizziness, chronic bronchitis, and asthma.
4.	Ball, K., 2010, U.S.A. (AORN Journal, Vol 92 No 2)	Title – “Surgical Smoke Evacuation Guidelines: Compliance Among Perioperative Nurses” Aim – Evaluate indicators of compliance related to surgical smoke evacuation.	Quantitative Survey Participants: N= 777 nurses	Investigated key indicators that predict increased compliance with smoke evacuation recommendations are: increased knowledge and training, positive perceptions of the recommendations, ease in understanding and implementing the recommendations, large facility size, larger number of surgical specialties offered, greater interconnect-edness and strong leadership support.

5.	Edwards, B. and Reiman, R., 2012, Us and Canada (AORN Journal Vol 95 No. 3 pp: 337-350)	<p>Title – “Comparison of Current and Past Surgical Smoke Control Practices”</p> <p>Aim – To compare results of the survey from 2007 with results from 2010.</p>	<p>Quantitative Survey</p> <p>Participants: n= 1356 nurses, nurses assistants</p>	<p>Main obstacles to compliance included surgeons’ resistance or refusal to allow LEV use, cost, bulkiness or noise produced.</p>
6.	Osman, J., 2016, New Zealand (The Dissector)	<p>Title – “Surgical Smoke Danger: Time for Consistent Policy and Practice”</p> <p>Aim – Understand staff awareness level to the issue and policies</p>	<p>Quantitative Survey</p> <p>Participants: n= 40 nurses</p>	<p>97.5 % of the participants were unaware of the policies; and were concerned with the negative effects.</p>
7.	Rodrigues, A., 2018, New Zealand (The dissector Vol. 46, No. 2) Database – CINAHL	<p>Title: “Electrosurgical Smoke Evacuation Quality Improvement Project”</p> <p>Aim – To measure staff compliance with local policy and recommended Practices for Electrosurgery</p>	<p>Qualitative Survey questionnaire</p> <p>Participants: n=32 nurses</p>	<p>53% of the nurses were unaware of the local electrosurgical smoke evacuation policy; 53% were non-compliant with smoke evacuation while 16% were unaware of the adverse effects of surgical smoke.</p>

8.	Steege, A., Boiano, J. and Sweenie, M., 2017, USA (American Journal of Industrial Medicine, 59 (11), 1020-1031)	<p>Title – “Secondhand smoke in the operating room? Precautionary practices lacking for surgical smoke”</p> <p>Aim – To describe surgical smoke exposure control precautions used during laser and electrosurgical procedures</p>	<p>Quantitative Survey</p> <p>Participants: n= 4533 (Around 56% were nurses)</p>	Smoke evacuation devices not used very much.
9.	Ünver, S., Topcu, S. and Findik, U. et al., 2016, Turkey (International Journal of Caring Sciences Volume 9, Issue 2, Page 697) Database – CINAHL	<p>Title – “Surgical Smoke, Me and My Circle”</p> <p>Aim – determine the status of the exposure to the surgical smoke, the negative effects of it and the responses taken from family members.</p>	<p>Qualitative Descriptive study</p> <p>Participants: n=54 nurses</p>	92.6% aware of the meaning of surgical smoke but only 55.6% aware of the negative effects. Most negative effect was throat infection and the most common was headaches.

Appendix 2

5 (4)