Control of airborne particles in surgical procedures during the Covid-19 pandemic: scoping review

Controle de partículas aéreas nos procedimentos cirúrgicos durante a pandemia da Covid-19: revisão de escopo

Control de partículas aéreas en los procedimientos quirúrgicos durante la pandemia de Covid-19: revisión de alcance

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ABSTRACT

Objective: To map the technical and managerial strategies for the management and reduction of airborne particles production in surgical procedures settings during the Covid-19 pandemic. Method: Scoping review, according to the Joanna Briggs Institute methodology, based on documents indexed in MEDLINE, VHL, CINAHL, Cochrane, Embase, Scopus, Web of Science, and gray literature, published in Portuguese, English, or Spanish. All studies from indexed scientific journals and recommendations published by international agencies or academic associations from 2019 to January 2022 were considered. Findings were summarized and analyzed using descriptive statistics and narrative synthesis. Results: Twenty-two studies were selected, 19 of which were published in English, two in Spanish, one in Portuguese, with a predominance of literature reviews. Findings were categorized into recommendations for the environment, the team, and the surgical technique. Conclusion: The review mapped the technical and managerial strategies for the management and reduction of the airborne particles production in surgical procedures settings. They involve from the use of personal protective equipment, training, anesthetic modality, airway manipulation, to the execution of the surgical technique.

DESCRIPTORS
Surgicenters; Aerosols; Infection Control; Coronavirus Infections; Severe Acute Respiratory Syndrome.
INTRODUCTION

Severe acute respiratory syndrome caused by coronavirus 2 (SARS-CoV-2), better known as COVID-19, represents one of the greatest challenges for global public health (1). Since its identification in December 2019 in the Chinese province of Wuhan, COVID-19 was responsible for thousands of deaths in several countries (2). As the disease progresses, on March 11, 2020, the World Health Organization (WHO) declared COVID-19 a pandemic and emerging disease (3). However, the knowledge under construction about the pathogenicity of the virus and its ability to mutate has required rapid responses from health systems, grounded on decision-making based on the best scientific evidence (4).

SARS-CoV-2 is a respiratory virus that initially settles in the upper respiratory tract and can be transmitted by airborne particles such as droplets and aerosols. Droplets are macro-particles that reach up to one meter away after being expelled, while aerosols are microparticles that remain suspended in the environment for a long period and can be transported through the air, increasing the transmission potential (5). Given this scenario and the need to protect health teams and patients, precautionary measures were required and have been constantly reassessed (6–7). More specifically, in the operating room environment, elective surgeries were initially suspended until a more favorable epidemiological scenario was reached (8). These measures were necessary due to the high risk of exposure that the procedures performed in the operating room pose to the healthcare team and patients regarding SARS-CoV-2 infection (9).

Among the procedures with the greatest potential to produce aerosol, intubation/extubation, manual airway ventilation, the use of electrocautery and high-speed drills stand out (10). Recent studies have been conducted to estimate the concentration of dispersed particles during surgical procedures, aiming at increasing the understanding of the possible risks of exposure to SARS-CoV-2 during surgeries (8–11). Researchers quantified the average concentration of particles using an optical meter during endonasal surgeries. They found that close to the surgeon there was an increase in the average concentration of 2,445 particles/cubic feet during the use of the drill and 1,825 particles/cubic feet during the use of a microdebrider (11). Although associated with a surgical modality, these data reinforce the need to adopt measures that are known to be effective for protection and prevention of infection, such as the correct use of personal protective equipment (PPE) (11–12). It should be noted that, besides the use of PPE, studies indicate measures related to controlling the amount of inoculum in the environment, as well as environmental conditions such as temperature and humidity, which can change the viability time of aerosolized viral particles (11–14).

Despite the advancement of knowledge on the prevention and control of COVID-19, the literature still lacks evidence and mapping of comprehensive recommendations related to measures to control the production of airborne particles in surgical procedures settings. Therefore, a scoping review is warranted, to map the technical and managerial strategies for the management and reduction of the production of airborne particles in surgical procedures settings during the Covid-19 pandemic. A preliminary search was performed in PROSPERO, MEDLINE, Cochrane Database of Systematic Reviews and JBI Evidence Synthesis and no reviews with this approach, completed or in progress, were identified.

Given what has been said, the study aims at mapping the technical and managerial strategies for the management and reduction of the production of airborne particles in surgical procedures settings during the Covid-19 pandemic.

METHOD

DESIGN OF STUDY

This is a scoping review, guided by the JBI review methodology (15). This methodology allows mapping concepts, clarifying areas of knowledge and possible gaps. To conduct the study, five steps were followed: identification of the research question; survey of relevant studies, considering the scope and coverage of the review; selection of studies, according to predefined criteria; data mapping; and presentation of results. The recommendations of the Prisma Extension for Scoping Reviews (Primas-ScR) checklist were also considered (16).

The review was registered on the platform Open Science Framework, with identification DOI 10.17605/OSF.IO/4AW57.

GUIDING QUESTION, SEARCH, AND INCLUSION CRITERIA

The study guiding question was: what are the technical and managerial strategies for the management and reduction of the production of airborne particles in surgical procedures settings during the Covid-19 pandemic?

The studies included in this scoping review were selected using the PCC (Population, Concept and Context) mnemonic strategy, as follows: population (P), patients aged 18 years or older; concept (C), technical and managerial strategies used to manage and reduce the spread of airborne particles in surgical procedures settings; context (C), operating room during the Covid-19 pandemic. Technical strategies are understood as the set of assistance procedures, adjusted to control the production of airborne particles. Management strategies, on the other hand, refer to a set of actions involving planning and evaluation aimed to control the production of airborne particles.

For the review, documents were included, such as scientific articles, theses, dissertations, books, protocols, and recommendations on technical and managerial strategies used for the management and reduction of the spread of airborne particles in surgical procedures settings for patients over 18 years of age. Moreover, documents should have been published from 2019, year of first notification of the disease, in English, Portuguese and Spanish.

Letters to the editor, abstracts in events annals, research protocols, and documents in the field of dentistry were excluded.

To search and identify the documents/studies, the following electronic sources were used: Medical Literature Analysis and Retrieval System Online (MEDLINE) via PubMed, Virtual Health Library (VHL), Cumulative Index to Nursing and Allied Health Literature (CINAHL), Cochrane Library, Embase, Scopus, and Web of Science. Access to the full texts was made through the Portal of Periodicals of the Coordination for the Improvement of Higher Education Personnel (CAPES), with use of proxy from the Universidade Federal de Juiz de Fora.
(UFJF). As a search strategy for studies/documents, the structuring presented in Chart 1 was used.

The searches took place on July 16, 2021, with a new search being established, in all bases and sources, on January 23, 2022.

DATA SELECTION, ANALYSIS AND TREATMENT

Following the databases and sources search, the documents were selected based on the research question. The results obtained were exported to the reference manager Rayyan®, developed by Qatar Computing Research Institute (QCRI). The manager allowed the removal of duplicate documents, the independent selection and screening of documents by two reviewers. Therefore, the first phase was the reading of titles and abstracts, independently and blindly, by the two reviewers. Disagreements were resolved by discussion between the two reviewers and, when necessary, the participation of a third reviewer. For documents meeting the inclusion criteria, the second phase was carried out, involving the reading of the documents in their entirety, seeking information about technical and managerial strategies for the management and reduction of the production of airborne particles in surgical procedures environments during the Covid-19 pandemic. Disagreements were resolved with the participation of a third researcher.

Chart 1 – Search strategy for document retrieval – Juiz de Fora, MG, Brazil, 2022.

| Source of information | Search Strategies |
|-----------------------|-------------------|
| MEDLINE via PubMed | ((("Aerosols"[Mesh]) OR Aerosol*: OR "Particulate Matter"[Mesh] OR (Particulate Matter) OR (Ultrafine Fibers) OR (Airborne Particulate Matter OR (Particulate Matter, Airborne) OR (Air Pollutants, Particulate) OR (Particulate Air Pollutants) OR (Ambient Particulate Matter OR (Particulate Matter, Ambient) OR (Ultrafine Particulate Matter) OR (Particulate Matter, Ultrafine) OR (Ultrafine Particles) OR (Particles, Ultrafine)) AND ((("COVID-19" [Supplementary Concept] OR (COVID-19) OR (2019 novel coronavirus disease) OR (COVID19) OR (COVID-19 pandemic) OR (SARS-CoV-2 infection) OR (COVID-19 virus disease) OR (2019 novel coronavirus infection) OR (2019-nCoV infection) OR (coronavirus disease 2019) OR (coronavirus disease-19) OR (2019-nCoV diseases) OR (COVID-19 virus epidemic) OR (2019 novel coronavirus outbreak) OR (2019-nCoV outbreak) OR (2019 novel coronavirus Pneumonia) OR (2019-20 China Pneumonia Outbreak) OR (2019-20 Wuhan coronavirus Outbreak) OR (2019-nCoV Acute Respiratory Disease) OR (2019-nCoV Epidemic) OR (2019-nCoV Outbreak) OR (2019-nCoV Pneumonia) OR (2019-new coronavirus Epidemic) OR (2019-new coronavirus disease) OR (2019-nCoV Infection) OR (2019 novel coronavirus Pneumonia) OR (Novel Coronavirus Pneumonia) OR (Wuhan coronavirus Epidemic) OR (Wuhan coronavirus Infection) OR (Wuhan coronavirus Outbreak) OR (Wuhan coronavirus Pandemic) OR (Wuhan coronavirus Pneumonia) OR (Wuhan Seafood Market Pneumonia) OR (New Coronavirus) OR (Novel Coronavirus) OR (Coronavirus disease) OR (2019-nCoV) OR (Ncov 2019) OR (2019-ncov) OR (Covid 19) OR (Covid19) OR (2019-Covid) OR (Sars 2) OR (Sars 2019) OR (Sars CoV 2) OR (Sars CoV-2) OR (2019-nCoV) OR (2019-nCoV) OR (Severe Acute Respiratory Infections) OR (Severe Acute Respiratory Infection) OR (Coronavirus 2) OR (Acute respiratory disease) OR (Sars virus) OR (Wuhan market virus) OR (Virus mercado Wuhan) OR (Wuhan Coronavirus) OR (Coronavirus de Wuhan) OR (Coronavirus*) OR ("Coronavirus Infections"[Mesh]) OR (Coronavirus Infections) OR (Coronavirus Infection) OR (Infection, Coronavirus) OR (Infections, Coronavirus) OR (Middle East Respiratory Syndrome) OR (MERS) OR (Middle East Respiratory Syndrome) OR ("Betacoronavirus"[Mesh]) OR (Betacoronaviruses) OR (Tylokyticeris bat coronavirus HKU4) OR (Pipistrellus bat coronavirus HKUS) OR (Human coronavirus HKU1) OR (HCoV-HKU1) OR (Roussetus bat coronavirus HKU9) OR ("Middle East Respiratory Syndrome Coronavirus"[Mesh]) OR (Middle East Respiratory Syndrome Coronavirus) OR (MERS-CoV) OR (MERS Virus) OR (MERS Viruses) OR (Virus, MERS) OR (Viruses, MERS) OR (Middle East respiratory syndrome-related coronavirus) OR (Middle East respiratory syndrome-related coronavirus) OR (Hospitals*[Mesh]) OR (Hospital) OR ("Cross Infection"[Mesh]) OR (Infection, Cross) OR ("Cross Infections"[Mesh]) OR (Infections, Cross) OR (Healthcare Associated Infections) OR (Healthcare Associated Infection) OR (Infection, Healthcare Associated) OR (Infections, Healthcare Associated) OR (Health Care Associated Infections) OR (Infections, Hospital) OR (Infection, Hospital) OR (Infection, Nosocomial) OR (Nosocomial Infection) OR (Hospital Infections) AND (Surgicenters) OR (Surgical Procedures, Operative) OR (Surgical Instruments) OR (General Surgery) OR (surgey department, hospital) OR (Surgical Service, Hospital)) |
| BVS | (((mh:aerosols)) OR (particulate matter) OR (airborne particulate matter) OR (ultrafine particulate matter)) AND (and covid-19) OR (2019 novel coronavirus disease) OR (sars-cov-2 infection) OR (2019-ncov infection) OR (2019-nccov disease) OR (2019 novel coronavirus pandemic) AND (mh:hospitals)) OR (healthcare associated infection) OR (infections, hospital) OR (nosocomial infection)) AND (mh:surgicenters)) OR (Surgical Procedures, Operative) OR (Surgical Instruments) OR (surgery department, hospital) OR (Surgical Service, Hospital) |
| CINHAL | airborne transmission or airborne precautions OR droplet precautions AND aerosol transmission of infectious disease and covid-19 or coronavirus or 2019-nccov AND hospital acquired infections AND health professionals AND Surgicenters AND Surgical Procedures, Operative AND Surgical Service, Hospital |
| Cochrane | (Aerosol*[ti,ab,kw OR (Particulate Matter*[ti,ab,kw AND (covid19)*ti,ab,kw OR (Coronavirus infections)*ti,ab,kw AND (Surgicenters)*ti,ab,kw) |
| Embase | (aerosol*[ti,ab,kw OR (particulate matter)*ti,ab,kw OR (airborne)*ti,ab,kw OR "airborne transmission"*ti,ab,kw) OR "coronavirus disease 2019"*ti,ab,kw OR "acute respiratory tract disease"*ti,ab,kw OR "severe acute respiratory syndrome coronavirus 2"*ti,ab,kw OR (sars cov 2)*ti,ab,kw AND "clinical isolate wuhan/hu-1/2019"*ti,ab,kw) OR (coronavirus infection)*ti,ab,kw AND surgery)*ti,ab,kw |
| Scopus | (TITLE-ABS-KEY (aerosol) OR ALL (particulate AND material) AND TITLE-ABS-KEY (particulate AND material, AND airborne) OR TITLE-ABS-KEY (ultrafine particles) AND TITLE-ABS-KEY (coronavirus) OR TITLE-ABS-KEY (2019-nCoV AND (airborne transmission disease) OR TITLE-ABS-KEY (coronavirus AND disease) OR TITLE-ABS-KEY (2019-nCoV AND disease) OR TITLE-ABS-KEY (2019 novel coronavirus AND epidemic) OR TITLE-ABS-KEY (2019-nCoV AND acute AND respiratory AND disease) AND ALL (hospital) AND TITLE-ABS-KEY (surgery) OR TITLE-ABS-KEY (surgeicenters)) |
| Web of Science | Aerosol (Topic) AND COVID-19 (Keyword Plus®) OR 2019 novel coronavirus disease (Keyword Plus®) OR SARS-CoV-2 infection (Keyword Plus®) AND Hospital (Keyword Plus®) OR Surgical Procedures, Operative (Keyword Plus®) OR Surgical Service, Hospital (Keyword Plus®) |

To identify other relevant studies/documents in the gray literature, the following sources were searched: Google Scholar (first five pages); Brazil – Portal of Theses and Dissertations for CAPES; Search system of the National Health Surveillance Agency (Anvisa); United States of America (USA) – Search engine American College of Surgeons (ACS); search system for Centers for Disease Control and Prevention (CDC); European continent -System for Information on Gray Literature in Europe (OpenGrey); UK – British Library ETHOS; Sweden and other Scandinavian countries – Academic Archive Online (DWA) and Australia and New Zealand – National Library of Australia (Trave). For the search in the gray literature, combinations of the keywords “Surgical Procedures”; “COVID-19” and “aerosol” were used.
Control of airborne particles in surgical procedures during the Covid-19 pandemic: scoping review

The information from the documents selected for analysis was independently extracted by two reviewers, using spreadsheets from Microsoft Excel®. A third reviewer participated in the validation of the information and in the discussion to establish consensus among the authors, when required. The mapping of information was established based on the JBI instrument to characterize the productions(13). For data extraction, a chart was created that included authorship, year of publication, language and country of origin, type of study and objectives, surgical procedure and technical/managerial strategies for the management and reduction of the spread of airborne particles in surgical procedures settings.

Subsequently, data were categorized into recommendations, according to the technical and managerial strategies for the management and reduction of airborne particles in the surgical environment.

Based on the categorized data, a narrative presentation of the information was performed.

RESULTS

The search in the investigation bases retrieved 6,521 potentially relevant documents/studies. A total of 1,032 duplicate documents were excluded. A total of 5,489 publications were analyzed by title and abstract, and 5,302 documents/studies were excluded because they did not meet the inclusion criteria. Thus, 187 documents/studies were fully evaluated for eligibility. At the end, 22 documents/studies(12,17–37) were included to compose the final review sample (Figure 1).

Of the 22 documents/studies included, 19 were published in English(12,17–29,32–35,37), two in Spanish(30–31) and one in Portuguese(36). As for the origin, nine were produced in the American continent(17,19,21,27–28,30,35–37), seven in the Asian continent(18,23–26,32), five on the European or Eurasian continent(12,22,31,33–34) and one in Oceania(20). Among the studies, 14 were reviews(12,17–19,22,25–26,28–34), four were expert consensus statements(20–21,24–27), three were protocol recommendations(35–37), and one was related to the development of a technique for aerosol reduction(31). The characterization of the articles included is shown in Chart 2 and that of the gray literature publications is shown in Chart 3.

The information in the documents/studies included evidenced three themes with technical and managerial recommendations to reduce the production of airborne particles in surgical procedures settings during the Covid-19 pandemic: recommendations for the environment; recommendations for the team; and recommendations for the surgical technique/procedure (Chart 4).

DISCUSSION

The studies included in this review were mostly literature reviews(12,17–19,22,25–26,28–34), produced mainly by authors from the Asian continent(18,23–26,32). Rapid reviews prevailed, focusing on compiling recommendations from experts and international bodies aiming at minimizing perioperative aerosol production. These reviews, produced mostly in 2020, are consistent with the initial situation of the pandemic that requires speed in the establishment of protocol behaviors and recommendations for health services. Regarding the Asian continent, it is inferred that this predominance is related to the search for recommendations in the first continent to notify and initiate measures to contain the spread of Covid-19 in surgical centers(34).

As for surgical procedures, the highest frequency in the guidelines was focused on videolaparoscopic surgery(12,17–19,21,27–32). It is a minimally invasive surgical approach that uses high-resolution cameras and appropriate instruments inserted through trocars in small incisions(12,19). This technique allows a closed approach to the surgical site; however, there is high chance of particles scattering along with the smoke from electrical or ultrasonic equipment(32).

Regardless of the surgical technique, scientific societies and world health agencies initially recommended postponing elective surgeries, except in regions with a favorable epidemiological situation(38–39). However, with the sedimentation of knowledge about the disease and the mass vaccination of the world population, even if in a heterogeneous way, the surgeries that were once postponed are being resumed(34). Therefore, even for vaccinated patients, screening and complementary tests prior to surgeries are important(35,36–37). These behaviors increase safety for patients and the healthcare team(34).

Therefore, investigations(40–42) first recommend patients screening, with anamnesis aimed at identifying signs and symptoms of Covid-19. In addition, they also recommend carrying out molecular or immunological diagnostic tests and, when not available in a timely manner, considering the patient as a possible carrier of Covid-19(41–42). A study(33) also recommends chest computed tomography as an additional possibility for patient screening.

Regarding the recommendations for the operating room settings, there is an indication of an exclusive operating room

Figure 1 – PRISMA-ScR flowchart for the selection of publications(36) - Juiz de Fora, MG, Brazil, 2022.

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Regarding the recommendations for the operating room settings, there is an indication of an exclusive operating room
and post-anesthetic recovery room for patients suspected or diagnosed with Covid-19\(^{(43-44)}\). It is also important to establish a circulation flow and equip operating rooms with a ventilation and filtration system, to favor the safe elimination of smoke, gases, and aerosols\(^{(25,43)}\). Authors\(^{(12,22)}\) highlight the importance of operating rooms equipped with high-efficiency filters, which guarantee about 25 filtrations per hour and with a negative pressure of at least −4.7 Pa in relation to the antechamber. If these resources cannot be used, the maintenance of a stable pressure should be encouraged. Therefore, it is recommended to turn off the air conditioning equipment during aerosol generating procedures\(^{(22)}\). Care with filtration and pressure shall be maintained during the process of operating rooms final cleaning\(^{(21)}\).

The multidisciplinary surgical team shall undergo specific training on flows, disposal of contaminating materials, biological risk, with emphasis on protection through the use of PPE\(^{(25,43)}\). The use of PPE such as respiratory protection masks for droplets and aerosols, caps, glasses, face shield, gloves, gown, and waterproof footwear is essential to preserve the teams’ health\(^{(17-20)}\).

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**Chart 2** – Characterization of the articles included in the review – Juiz de Fora, MG, Brazil, 2022.

| Articles | Author/year/language/country | Base/journal | Design/objective | Procedure |
|----------|------------------------------|--------------|-----------------|-----------|
| A.1\(^{(37)}\) | Chadi AS, et al. 2020/English/Canada | PUBMED/Ann Surg | Narrative review/To review the risks of viral transmission during laparoscopy. | Laparoscopy |
| A.2\(^{(38)}\) | Shabbir A, et al. 2020/English/Singapore | PUBMED/Surg Endosc | Literature review/To compile recommendations reviewed by international societies. | Laparoscopy/general surgery |
| A.3\(^{(39)}\) | Veziant J, et al. 2020/English/US | PUBMED/J Chir Visc | Literature review/to analyze contamination in laparoscopy. | Laparoscopy |
| A.4\(^{(40)}\) | Iorns JF, et al. 2021/English/Australia and New Zealand | PUBMED/Med J Aust | Expert consensus/to reduce aerosol generation in cardiothoracic surgery. | Cardiothoracic |
| A.5\(^{(41)}\) | Pandey AS, et al. 2020/English/US | PUBMED/J. NeuroInterven, Surg. | Expert consensus statement/to reduce aerosol generation in neurosurgery. | Neurosurgery |
| A.6\(^{(42)}\) | Rodulesco T, et al. 2020/English/France | PUBMED/Eur Arch. Otorhinolaryngol | Systematic review/to summarize recommendations for sinus and skull surgery. | Sinus and skull surgery |
| A.7\(^{(43)}\) | Das A, et al. 2020/English/India | PUBMED/Eur Arch. Otorhinolaryngol | Applied research/to develop methods to minimize aerosolization in surgery. | ENT surgery |
| A.8\(^{(44)}\) | Nedunchezhian AS, et al. 2020/English/India | PUBMED/J Neurosoci Rural Pract | Expert statement/to establish perioperative management during this pandemic. | Neurosurgery |
| A.9\(^{(45)}\) | Boghdady ME, et al. 2021/English/Ireland | PUBMED/Surgeon | Systematic review/to review the technique of laparoscopy during COVID-19. | Laparoscopy |
| A.10\(^{(46)}\) | Sharma A, et al. 2020/English/India | PUBMED/Indian J Otolaryngol Head Neck Surg. | Literature review/to evaluate robotic surgery during the Covid-19 pandemic. | Robotic surgery |
| A.11\(^{(47)}\) | Mitr M, et al. 2020/English/India | Web of Science/J Res Med Dent Sci | Literature review/perioperative analysis in anesthesia and airway management. | General surgery |
| A.12\(^{(48)}\) | Wright JD, et al. 2020/English/US | Scopus/Semin Perinatol | Expert consensus/To guide technique in gynecological surgery. | Gynecological laparoscopy |
| A.13\(^{(49)}\) | Balakrishnan K, et al. 2020/English/US | CINAHL/Otolaryngol Head Neck Surg | Literature review/to describe airway approach during the pandemic. | Head and neck surgery |
| A.14\(^{(50)}\) | Gupta N, et al. 2020/English/India | CINAHL/Int J Surg. | Literature review/to review the risk of spreading COVID-19 in laparoscopy. | Laparoscopy |
| A.15\(^{(51)}\) | Cabrera LF, et al. 2020/Spanish/Colombia | VHL/See colomb cir. | Narrative review/to evaluate the effect of aerosols during laparoscopy. | Laparoscopy |
| A.16\(^{(52)}\) | Gracia M, et al. 2020/Spanish/Spain | VHL/ Clin Invest Ginecol Obstet | Literature review/to establish recommendations for laparoscopic surgery. | Laparoscopy |
| A.17\(^{(53)}\) | Amrutha K, et al. 2020/English/India | Embase/Ind J Car Dis Wom | Literature review/to review recommendations on gynecological procedures. | Laparoscopy |
| A.18\(^{(54)}\) | Ozoner B, et al. 2020/English/Turkey | PUBMED/World Neurosurg | Literature review/to establish guidelines in neurosurgery. | Neurosurgery |
| A.19\(^{(55)}\) | Antunes D, et al. 2021/English/UK | PUBMED/Surgeon | Systematic review/to assess whether surgical smoke increases the risk of Covid-19 infection. | Open and laparoscopic surgery |

**Chart 3** – Characterization of publications retrieved by searching the gray literature – Juiz de Fora, MG, Brazil, 2022.

| Production | Title | Production type/Source | Year/Language/Country |
|-----------|-------|------------------------|-----------------------|
| P1\(^{(20)}\) | Joint Statement: Roadmap for Resuming Elective Surgery after COVID-19 Pandemic | Recommendations /ACS | 2020/English/US |
| P2\(^{(21)}\) | Guidelines for the prevention and control of infections by the new coronavirus (SARS-CoV-2) in surgical procedures | Recommendations /Anvisa | 2021/Portuguese/Brazil |
| P3\(^{(22)}\) | Interim Infection Prevention and Control Recommendations for Healthcare Personnel During the Coronavirus Disease 2019 (COVID-19) Pandemic | Recommendations /CDC | 2020/English/US |
The PPE guidelines shall also clarify about donning and doffing, hand hygiene before and after equipment removal, which equipment shall be discarded or reused, as well as the orderly flow for this process\(^{17–18,43}\).

A study highlights the importance of carrying out briefings among team members to assign roles, discuss surgery, identify aerosol-generating procedures, and review recommendations\(^{20}\).

As for the recommendations on surgical procedures, these range from the selection of the anesthetic modality, the adequate manipulation of the airways, to the execution of the surgical technique\(^{12,20–21,30}\). In the context of the Covid-19 pandemic, the main objective is to reduce the production and dispersion of air particles as much as possible, opting for procedures that do not produce aerosols, gases or fumes\(^{20,45}\). Whenever possible, anesthesia through locoregional blocks should be used, considering that general anesthesia requires manipulation of the pathways, with ventilation maneuvers, tracheal intubation and, consequently, aerosol production\(^{17–18}\). However, when tracheal intubation is necessary, it shall be performed by an experienced professional, in the shortest possible time and with a limited number of people present\(^{20,26}\). Research recommends that other team professionals only enter the operating room after an average interval of 10 minutes, which guarantees at least four cycles of ambient air filtration\(^{18,22}\).
With regard to the surgical modality, i.e., minimally invasive or open surgery, there are no clear recommendations in the literature on which technique produces fewer airborne particles. The included literature identifies thoracic, neurosurgical, otorhinolaryngological, maxillofacial, and laparoscopic surgeries as procedures related to the high production of air particles. Among them, research has reported a greater risk related to laparoscopy, due to gas leakage from the pneumoperitoneum, which can contain high concentrations of suspended virus. In this regard, the safe management of pneumoperitoneum is recommended, with low pressures of carbon dioxide and the use of a suction and frequent filtration system to avoid the accumulation of surgical smoke (plume) in the abdominal cavity.

Another recommendation identified in the studies concerns the size and number of surgical incisions, with the risk of producing surgical smoke being proportional to the size and number of incisions. In addition, all energy-generating equipment, such as electrocautery or ultrasonics, shall be set to low power to reduce the production of aerosolized particulate matter.

For surgical completion, the authors recommend the use of tubes only if strictly necessary and the synthesis with absorbable threads or any closure device that reduces gases leakage through the surgical wound.

The literature still lacks further studies to determine if there is a direct relationship between the transmission of Covid-19 and surgical smoke. Thus, it is up to government health agencies, responsible for guidelines, to monitor the production of evidence syntheses, adjusting or modifying the recommendations, when necessary.

This investigation has as limitations the inclusion of studies in only three languages and the time frame. The former limitation is related to the technical capacity of the team and the lack of reliable resources for the translation of studies into other languages. As for the latter limitation, despite being linked to Covid-19, a recently emerging disease, it may have been a limiting factor for the mapping of recommendations in other pandemic contexts.

It is believed that the results of the present investigation will be able to provide a set of actions for settings of surgical procedures performed during the COVID-19 pandemic and in other epidemic scenarios.

CONCLUSION

The mapping of strategies for managing the production of airborne particles in surgical rooms during the Covid-19 pandemic identified technical and managerial recommendations regarding the operating room environment, the multiprofessional team, and the surgical procedures themselves.

Technical strategies are mainly related to wearing complete attire, recommending regional anesthesia when possible, avoiding manual bag and mask ventilation, prioritizing rapid sequence intubation, minimizing the length and number of surgical incisions, to reduce electrosurgery, to use ultrasonic dissection, installation of tubes and, in video surgeries, to use techniques that reduce the accumulation or extravasation of gas or surgical smoke. Management strategies are related to training the multidisciplinary team, controlling the movement of people, providing equipment and supplies that are strictly necessary for the procedures and using rooms with a ventilation system and negative pressure.

The results presented are intended to support safe clinical practice and collaborate with new research on airborne particle control strategies in surgical procedure settings. However, the results of this review are provisional and may change as scientific discoveries about Covid-19 advance. Thus, new studies are recommended that include research with a high level of evidence, produced over the time frame of the Covid-19 pandemic.
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