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REVIEW ARTICLE

Prevention of COVID-19 aerosol exposure during orotracheal intubation

Prevenção da exposição ao aerossol COVID-19 durante a intubação orotraqueal

Prevención de la exposición a aerosoles de COVID-19 durante la intubación orotraqueal

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ABSTRACT

Background and objectives: during orotracheal intubation (OTI), it occurs the exposure to COVID-19 aerosols and consequent contamination of the professionals involved, observing the need to apply preventive measures. The objective is to know, in the scientific literature, which are the main preventive measures for health professionals to aerosols generated during OTI of patients suspected or confirmed for COVID-19. **Contents:** this is an integrative review, with search in the LILACS, SciELO, BDENF, MEDLINE, PubMed and Cochrane Wiley databases. Primary articles, with full text in Portuguese, Spanish and English, which contemplated the research objective, were selected. Of the 335 articles found, 22 were selected according to the inclusion criteria. In 18 (82%) of articles, they highlighted the use of barrier methods when performing the intubation procedure, such as acrylic box and plastic tarpaulin. In other studies (3; 14%), it was observed the need to include qualified intubation teams in hospital institutions to reduce the contamination of professionals, in addition to the application of checklists that guide the procedure. A single article brought the use of an orthopedic protective cover adapted to protect the intubator. **Conclusion:** the measures are defended to reduce exposure to aerosols and allow the safety of health professionals. The use of an intubation box must be used with caution, weighing the risks and benefits against the possibility of aerosolization during its use in orotracheal intubation.

Descriptors: *COVID-19. Aerosols. Health Personnel. Intratracheal Intubation.*

ABSTRATO

Justificativa e objetivos: durante a intubação orotraqueal (IOT), ocorre a exposição a aerossóis de COVID-19 e consequente contaminação dos profissionais envolvidos, observando a necessidade de aplicação de medidas preventivas. O objetivo é conhecer, na literatura científica, quais são as principais medidas preventivas dos profissionais de saúde aos aerossóis gerados durante a IOT de pacientes suspeitos ou confirmados para COVID-19. **Conteúdo:** trata-se de uma revisão

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integrativa, com busca nas bases de dados LILACS, SciELO, BDENF, MEDLINE, PubMed e Cochrane Wiley. Foram selecionados artigos primários, com texto completo em português, espanhol e inglês, que contemplassem o objetivo da pesquisa. Dos 335 artigos encontrados, 22 foram selecionados de acordo com os critérios de inclusão. Em 18 (82%) dos artigos, destacaram o uso de métodos de barreira na realização do procedimento de intubação, como caixa de acrílico e lona plástica. Em outros estudos (3; 14%), observou-se a necessidade de incluir equipes de intubação qualificadas nas instituições hospitalares para reduzir a contaminação dos profissionais, além da aplicação de checklists que orientam o procedimento. Um único artigo trouxe o uso de uma capa protetora ortopédica adaptada para proteger o intubador. **Conclusão:** defendem-se as medidas para reduzir a exposição aos aerossóis e permitir a segurança dos profissionais de saúde. O uso da caixa de intubação deve ser feito com cautela, ponderando os riscos e benefícios em relação à possibilidade de aerossolização durante seu uso na intubação orotraqueal.

Palavras-chave: *COVID-19. Aerossóis. Pessoal de Saúde. Intubação Intraqueal.*

RESUMEN

Justificación y objetivos: durante la intubación orotraqueal (OTI), ocurre la exposición a los aerosoles de COVID-19 y la consecuente contaminación de los profesionales involucrados, observándose la necesidad de aplicar medidas preventivas. El objetivo es conocer, en la literatura científica, cuáles son las principales medidas preventivas de los profesionales de la salud ante los aerosoles generados durante las IOT de pacientes sospechosos o confirmados de COVID-19. **Contenido:** se trata de una revisión integradora, con búsqueda en las bases de datos LILACS, SciELO, BDENF, MEDLINE, PubMed y Cochrane Wiley. Fueron seleccionados artículos primarios, con texto completo en portugués, español e inglés, que contemplaran el objetivo de la investigación. De los 335 artículos encontrados, 22 fueron seleccionados según los criterios de inclusión. En 18 (82%) de los artículos, destacaron el uso de métodos de barrera al realizar el procedimiento de intubación, como caja de acrílico y lona plástica. En otros estudios (3; 14%), se observó la necesidad de incluir equipos de intubación calificados en las instituciones hospitalarias para reducir la contaminación de los profesionales, además de la aplicación de listas de verificación que orientan el procedimiento. Un solo artículo trajo el uso de una cubierta protectora ortopédica adaptada para proteger al intubador. **Conclusión:** se defienden las medidas para reducir la exposición a los aerosoles y permitir la seguridad de los profesionales de la salud. El uso de una caja de intubación debe hacerse con precaución, sopesando los riesgos y beneficios frente a la posibilidad de aerosolización durante su uso en la intubación orotraqueal.

Descriptores: *COVID-19. aerosoles Personal sanitario. Intubación Intraqueal.*

INTRODUCTION

In December 2019, Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-Cov-2) was responsible for the first cases of pneumonia of unknown etiology in the city of Wuhan, China.[1] It is an RNA virus of family *Coronaviridae*, widely distributed among humans and other animals.[2] The exponential growth of cases in China, reaching hundreds of countries, led the World Health Organization (WHO) to declare the disease called Coronavirus Disease 2019 (COVID-19) as a pandemic.

The disease can occur as flu-like syndrome (FLS), through fever, simultaneously with the onset of dry cough, tiredness, nasal congestion or sore throat.[3] However, the clinical manifestation can present as Severe Acute Respiratory Syndrome (SARS) and pneumonia, ranging from low to high criticality in patients.[1] Severity is related to age and the presence of comorbidities, such as diabetes, obesity and cardiovascular diseases, with mortality of 14.8% in older adults over 80 years and with an association of fatal outcome for the presence of comorbidities for all ages.[3,4]

The number of patients admitted for hospital care without progression to criticality is higher when compared to those who need beds in the Intensive Care Unit (ICU).[5] However, when assessing patients who evolve to the ICU, between 33% and 75% of critically ill patients require artificial respiratory support by invasive mechanical ventilation (IMV), with mortality of 10.2% for all those affected by COVID-19 and 14.6% for mechanically ventilated patients.[5,6] Mortality occurs in 61.5% of critically affected patients, in 28 days of ICU admission.[1]

Thus, health professionals should be prepared for the assistance of those who evolve to ventilatory failure, with the imminent need for orotracheal intubation (OTI). However, during the assistance for definitive airway management, the team is exposed to aerosols resulting from the procedures, with risk of contamination associated with the different routes of transmission, contact with patients for a longer period of time, intense working hours and greater complexity of care tasks.[7]

The National Health Commission of China reported that 3,300 health professionals were infected during care until March 2020, with 22 deaths.[8] For the care of these patients, it is imperative to use all personal protective equipment for standard precaution, droplets and aerosols, especially for aerosol-generating procedures (AGP).[9]

Health professionals who participate in critical AGP, such as OTI, cardiopulmonary resuscitation and airway aspiration, must be equipped with personal protective equipment (PPE), such as gloves, caps, face shield or goggles, N95 mask and waterproof apron.[10] Furthermore, it

is advised to perform these procedures in isolation rooms of respiratory infection with negative pressure and the use of special filters of the high-efficiency particulate air (HEPA) type in mechanical ventilators.[10]

New guidelines for the use of PPE constantly emerge, as well as aerosol prevention measures are updated to the knowledge of professionals and health establishments. Considering the cases of critically ill patients who require OTI and permanence in IMV, associated with the risk of exposure during PGE by the care team and the need to constantly update the guidelines for infection control, we see the need to compile the main guidelines to facilitate the reading, access and understanding of these professionals who are on the front line. Thus, this research aims to know in scientific literature what are the main prevention measures for health professionals to aerosols generated during OTI of patients suspected or confirmed for COVID-19.

METHODS

This is an integrative review, in which the six methodological steps necessary for its development were followed, namely: 1) guiding question elaboration; 2) search or sampling in literature; 3) critical analysis of included studies; 4) data collection; 5) discussion of results; and 6) integrative review presentation.[11] Through the strategy PICo, the research question to be investigated was elaborated: what are the aerosol exposure prevention measures during OTI by health professionals in patients suspected or confirmed for COVID-19? Population would be health professionals, Intervention, measures to prevent contamination of health professionals by the virus, and Context, exposure to aerosols during OTI.

The inclusion criteria were articles from primary studies published in Portuguese, English or Spanish, available as full texts for reading in full. This integrative review excluded studies that did not answer the research question or did not contemplate the objective, in addition to articles in the format of letters, consensus and guidelines, in addition to review articles (narrative, integrative and scoping review).

The selection of articles took place through the Virtual Health Library (VHL), in the Latin American and Caribbean Literature in Health Sciences (LILACS), Medical Literature Analysis and Retrieval System Online (MEDLINE) and Database in Nursing (BDENF) databases. Likewise, the search was carried out in the Scientific Electronic Library Online (SciELO), and, for the selection of randomized clinical studies, a search was carried out in Cochrane Wiley. To expand the selection of international studies not included in the VHL, the search was carried out through the National Library of Medicine (PubMed). During the selection in virtual libraries, the international indexed Medical Subject Headings (MeSH) descriptors were used: "COVID-19", "aerosols", "intubation", "protect". With the help of the Boolean operator AND, sets of descriptors were applied to the following databases: BDENF, LILACS, MEDLINE and Cochrane Wiley, "(COVID-19) AND (aerosols) AND (intubation)"; SciELO, "(COVID-19) AND (aerosols)"; and PubMed, "(((COVID-19) AND (aerosols)) AND (intubation)) AND (protect)".

After the identification of primary articles, the selection process was carried out from the exclusion of duplicates, subsequent reading of titles and abstracts to exclude those that did not contemplate the research topic. The steps of identification, selection and inclusion of articles were carried out between May and June 2021 and followed the PRISMA method (Figure 1).[12]

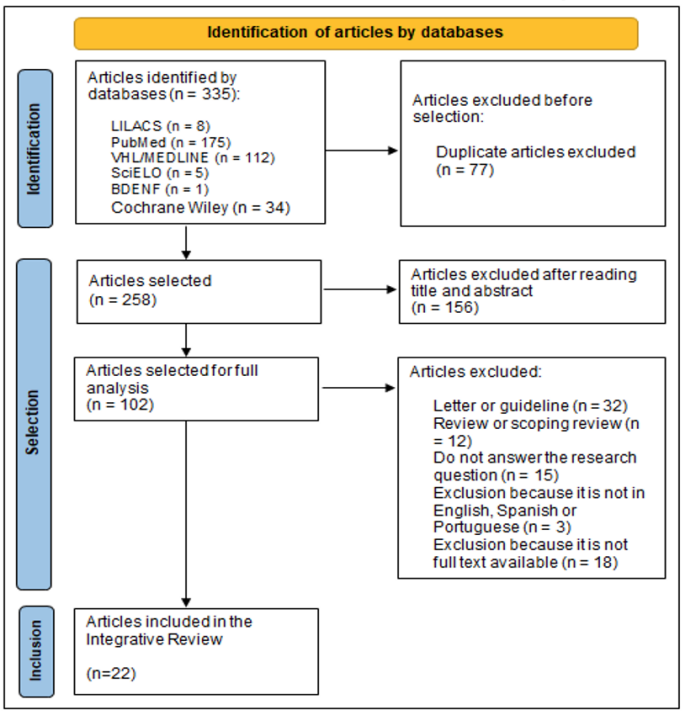

Figure 1. Updated PRISMA flowchart 2021, including database searches.

The 22 selected primary studies were assessed for methodological scientific rigor, classified according to the level of evidence (LoE).[13] Articles with LE I were considered to be systematic reviews or meta-analyses; LoE II, randomized controlled trials; LoE III, controlled studies without randomization; LoE IV, case-control or cohort studies; LoE V, systematic reviews of qualitative or descriptive studies; LoE VI, qualitative or descriptive studies; and LoE VII, opinions or consensus.[13] Subsequently, the information contained in the studies was summarized, according to author, year and place of publication, objective, design and LoE, and measures to prevent aerosols from COVID-19 during OTI.

RESULTS AND DISCUSSION

A total of 22 primary studies were selected to make up this integrative review. Almost all studies were found in PubMed (20; 92%), followed by MEDLINE (1; 4%) selected through VHL and Cochrane Wiley (1; 4%). The United States published 12 (55%) articles, Canada, four (19%), Australia, two (10%), Israel, one (4%), Turkey, one (4%), England, one (4%), and Malaysia, one (4%). No studies published in Brazil or other countries in Latin and South America were identified.

Regarding the methodology, no meta-analysis studies were identified, considered the best scientific evidence among scientific studies. Randomized clinical trial-type studies made up most of the sample, with 11 (50%) whose LoE is II; non-randomized or quasi-experimental studies comprised eight (36%) of LoE III; cohort studies comprised one (5%) of LoE IV; while descriptive studies, of the case study type, totaled two (9%), of LoE VI.

Article synthesis was carried out regarding author, year and country, objective, design and level of evidence, and the main protection measures highlighted in the scientific articles, as shown in Chart 1.

Of the studies analyzed, it was found that 18 (82%) highlighted the use of barrier methods during the

Chart 1. Synthesis and level of evidence of selected articles.

Main author / year / place	Objective	Design and LoE	COVID-19 aerosol prevention measures during OTI
Rose P, 2020, Canada.[14]	Assess the risk of droplet and contact contamination for healthcare professionals using 3 intubation techniques as part of a quality assurance study.	Double-blind randomized quality assurance study LoE II	Intubation was assessed simulating droplet dispersion with: a) no protective barrier between manikin and intubator; b) use of transparent plastic; and c) acrylic box, covering the dummy's head. The use of plastic barrier did not add any benefit when compared to the other techniques. When using plastic, the risk of droplet dispersion and subsequent contamination to the intubator increased when compared to the acrylic box.
Azhar MN, et al., 2021, Malaysia.[15]	Investigate the relationship between the use of a protective aerosol box and contamination of health professionals before and after personal protective equipment (PPE) donning and doffing.	Randomized double-blind controlled study LoE II	Simulation of intubation with and without plastic box, through videolaryngoscopy in dummy. The use of a box for intubation reduces droplets and aerosols contaminants in PPE of health professionals involved in the procedure. There was an increase in mobility and visualization during intubation, in addition to the decrease in success in the first attempt.
Turner JS, et al., 2020, United States.[16]	Measure the effects of a box to contain aerosols on intubation in different simulation scenarios in the Emergency Department.	Randomized double-blind controlled study LoE II	Five intubation scenarios were used, with the participation of 48 medical residents, performing 96 intubations. OTI time was significantly longer with the use of a protective box, compared with no use. There was greater difficulty in intubating in difficult-to-manage emergency airways. The box use can increase intubation time and hinder the procedure (17 versus 10 seconds, respectively).
Derrick J et al., 2020, Australia.[17]	Investigate whether the use of a plastic casing could reduce aerosol exposure during laryngoscopy.	Randomized double-blind controlled study LoE II	Simulation of 90 intubations on a dummy, with saline nebulization to simulate aerosols. The measured mean aerosol count was significantly reduced when the wrap was worn over the patients' head. Thus, casings during intubation can avoid the chance of increased levels of dispersed aerosol particles. There was no difference in OTI time compared to the conventional technique.
Feldman O et al., 2021, Israel.[18]	Assess the time to OTI of paramedics wearing personal protective equipment with and without an aerosol protection box.	Randomized double-blind controlled simulation study LoE II	A total of 18 paramedics simulated intubation by laryngoscopy with and without an aerosol protection box. The results suggest that professionals wearing adequate PPE (N95, face shield, apron and gloves) and adequately trained can successfully intubate using the box, however, the procedure time can be prolonged compared to non-use (27 versus 37 seconds, respectively).

Fong S, et al., 2021, Canada.[19]	Explore the impact of using a protection box for aerosols during normal and difficult-to-handle OTI.	Randomized double-blind controlled simulation study LoE II	The performance of 296 intubations with and without the protection box was verified in 4 difficult airway scenarios. The mean intubation time with and without the box was 31 versus 25 seconds, respectively. With the protection box, there were more OTI attempts, damage to the PPE entirety and optimization of maneuvers to achieve intubation.
Burnett GW, et al., 2020, United States.[20]	Assess intraoperative contamination and decontamination of an aerosol protection box and the impact of a preoperative educational visual aid.	Randomized double-blind study LoE II	It was divided into groups that could previously see contamination points in the box and without access. Those who could see contaminated themselves less and the box was completely cleaned. It should be considered to educate professionals for correct use. There is a potential risk of contamination when removing the box after intubation for both professionals and the environment.
Ozbek AE, et al., 2021, Turkey.[21]	Compare the use of conventional PPE, protective box and transparent plastic, and its impacts on intubation time by experienced emergency workers.	Randomized, prospective, double-blind LoE II study	OTI was assessed in different scenarios: a) only with the use of PPE; b) use of PPE and transparent plastic; and c) PPE and box. The use of box increased the time required to intubate compared to other scenarios, but without statistical significance. Although participants were successful in the first OTI, there was greater difficulty in mobility and visualization using the barriers compared to just wearing PPE.
Querney J, et al., 2020, Canada.[22]	Assess the acceptance of the use and airway management of two modalities of protective aerosol barrier.	Double-blind randomized simulation study LoE II	In an intubation scenario with a) only PPE and b) PPE added to protective box and plastic barrier, there was no significant difference between intubation times. For participants, adding protection barriers does not affect visibility, mobility, and communication in OTI.
Begley JL, et al., Australia.[23]	Assess the impact of two aerosol protection boxes on the OTI of patients with COVID-19.	Randomized study without blinding LoE III	When assessing two acrylic box formats for OTI, both showed an increase in the time required to intubate, compared to non-use. There was also a violation of PPE integrity when using both barrier box formats. It was concluded that barrier box increases OTI time, putting patients at risk of hypoxemia.
Madabhushi P, et al., 2020, United States.[24]	Determine whether the use of a barrier box with videolaryngoscope delays intubation time to acceptable parameters.	Double-blind randomized clinical trial LoE II	After allocating 76 patients in a group (without barrier and with barrier to intubation), it was observed that. with the use of videolaryngoscope, there is no delay in intubation time in patients with normal airway conditions, when professionals are well trained previously.
Ben-Yakov M, et al., 2020, Canada.[25]	Determine the degree of protection offered by barrier methods and explore the usage factors by two popular barrier systems.	Randomized clinical trial LoE II	Comparing three methods of OTI using PPE (without barrier, box and frame with plastic tarpaulin), there was greater contamination of the environment with the box, without statistical significance. Barrier systems increase OTI time (no barrier 24 seconds, frame 54 seconds, and box 34 seconds), $p<0.001$. Tarpaulin and frame reduce contamination, but at the expense of mobility and visibility.
Fidler RL, et al., 2021, United States.[26]	Describe the behavior of aerosols using 7 protection models during OTI, for how long each barrier limits aerosols and protection outside barriers.	Near-experimental study* LoE III	After assessing 7 barrier methods, the fully or partially closed ones reduce the particle count directly to the intubator, which does not include the acrylic protective box in the group, as it contains holes for the entry of the intubator's arms. Thus, methods that are not fully closed, allow aerosol dispersion. Barrier methods should be used in conjunction with PPEs, as there was aerosol in the environment.
Bryant J, et al., 2020, United States.[27]	Verify the effectiveness of a barrier method in reducing the risk of exposure to aerosolized pathogens in airway management, including OTI.	Near-experimental study* LoE III	In the operating room of a surgical center, when using a transparent plastic barrier and air flow outlet (suction), there was a decrease in the exposure of aerosols to the environment. The use of this barrier method in association with airflow through suction methods can reduce the contamination of professionals.

Gore RK, et al., 2020, United States.[28]	Assess the effectiveness of aerosol containment in a new protective barrier system, compared to the protective box, and without the use of a barrier.	Near-experimental study* LoE III	The new barrier system consists of protectors that prevent the exposure of the intubator's arms, in addition to a plastic cover that covers the patients' chest. Compared to the traditional acrylic box, the new method exposed the intubator less to aerosols, but both are more effective when no barrier method was used.
Patel GP, et al., 2020, United States.[29]	Describe the Emory Healthcare Hospital intubation team during the COVID-19 pandemic.	Descriptive study, case study LoE VI	About 16 OTI teams formed, performing 253 intubations in the hospital. Protocols were created with the use of devices for clamping the OTT (orotracheal tube), use of HEPA filters, minimal participation of people in the OTI, and proper use of PPE (cap, gloves, gown and N95). Only one limb was contaminated by SARS-CoV-2. The use of skilled OTI teams allows the safety of professionals.
Wills TT, et al., 2020, United States.[30]	Describe the integration of an orthopedic cover as an item for COVID-19 protection.	Descriptive study, case study type LoE VI	It is an additional protective equipment that can be used in health professionals during the performance of procedures such as OTI. The disadvantage is the lack of a ventilation system for those who use this PPE.
Ahmad I, et al., 2020, England.[31]	Report the experience of a Rapid Endotracheal Mobile Intubation Team and the outcomes in patients in a seven-week observation period.	Observational, prospective cohort study. LoE IV	About 150 OTI were analyzed. Videolaryngoscopy was used in 91.3%, with single pass success in 80%. In all, 11 of the 63 professionals were contaminated and only one incident of PPE violation. Trained intubation teams followed by protocolized rapid sequence OTI are beneficial in promoting patient and staff protection.
Brant-Zawadzki GM, et al., 2021, United States.[32]	Create an alternative design of protection of the patients' head during aerosol-generating procedures.	Near-experimental study* LoE III	A transparent plastic barrier fixed on an iron support was used. When simulating aerosol scattering with an aspiration system connected to the HEPA filter, there was little concentration of aerosols within the barrier system and in the arms of the intubator, and minimal concentration in the environment.
Fried EA, et al., 2020, United States.[33]	Test two commonly used protection barriers (intubation box and transparent plastic) and observe the impact on containing aerosol spread.	Near-experimental study* LoE III	Comparing the effectiveness between the protective box and a plastic barrier, it was found that both retain the aerosols, but can redirect the dispersion to the head, neck, chest and intubator's arms. Reverse trendelenburg position can avoid direct contact. The use of barriers is ineffective and removal allows contamination of professionals.
Tronnier A, et al., 2020, United States.[34]	Create a quality improvement framework to ensure safe practices for intubation providers and describe a multidisciplinary model to track adherence to OTI protocols.	Near-experimental study* LoE III	A model was created to assess adherence to the safe intubation checklist and a multidisciplinary group that reassessed procedures to program improvements. The authors emphasize that the creation of intubation teams and protocols can be used to guarantee a safe procedure among professionals during the COVID-19 pandemic.
Turer DM, et al., 2021, United States.[35]	Quantify the ability of protective barriers to contain aerosols using industrial assessment protocols.	Near-experimental study* LoE III	The use of a commonly used protective barrier was compared, and another associated with a vacuum and air filtration system. Barriers without vacuum system allow aerosol exhaust in open areas for intubator handling. In OTI simulation, there was high concentration in the environment. When using barriers, associate vacuum and air filtration systems to contain particles.

**Articles whose methodology was not described, classified according to the authors' understanding.*

orotracheal intubation procedure, such as transparent plastic and acrylic box. It was observed in 3 (14%) the need for previously trained multidisciplinary intubation teams, as well as structured checklists to perform the definitive airway management procedure. According to the authors, trained intubation teams and protocols would make it possible to reduce the risks of exposure of professionals, as well as minimize unfavorable outcomes for patients infected by COVID-19. Still, 1 (5%) reported the use of an adapted orthopedic covering, which would cover the head of the intubator as a new PPE, but the disadvantage refers to mobility and diffi-

culty in ventilation for professionals.

The need for OTI occurs in up to 75% of critically ill patients affected by COVID-19 who require direct ICU care.[5,6] However, the performance of this procedure by health professionals puts them at risk of exposure to the virus. Intubation, along with orotracheal extubation procedures, non-invasive manual ventilation, tracheostomy, oxygen support by high-flow cannula, bronchoscopy and suction of secretions by suction, are among the critical assistance supports that generate aerosols.[36]

In an example of OTI, doctors and nurses are the professionals who are most contaminated, as they handle the upper and lower airways with very close contact, as a result of the high risk of exposure.[37] During the collapse in public health seen in Italy in early 2020, where the country reached the highest number of contaminations and deaths by COVID-19, about 9% of those infected were health professionals.[37] Thus, it is crucial to know measures that prevent exposure to the virus and the contagion of those who work in critical sectors such as emergency and ICU.

Among the articles assessed, the mandatory use of PPE is unanimous to those involved in intubation. Considering the public health emergency and the high risks of contamination of professionals during aerosol--generating procedures, it is recommended to use a N95 mask, aprons, face shield and gloves, because these devices protect professionals from direct exposure to SARS-CoV-2 viruses.[9,10] We emphasize the need for correct donning and doffing of PPE used during service, as well as the correct disposal after the OTI procedure. Carrying out the correct processes for both times of use and disuse of PPE avoids both inadvertent exposure and the risk of contamination with aerosols accumulated on professionals' mask, gloves, face shields or apron.[38]

When dealing with preventive measures during OTI, studies mostly bring the use of protective barriers in association with the use of PPE: devices in acrylic box format, protective plastic and cover that cover the patients' headboard.[14-28,32,33,35] The hypothesis raised is that only the use of PPE does not adequately protect, requiring the association of protective barriers to ensure safety.[36] Intubation boxes are acrylic boxes containing two holes, where the intubator allocates the arms for access to the airway, and an opening in its lower portion to attach the patients' head.[19] The application of barriers such as an acrylic box makes it possible to concentrate the aerosols inside and prevent dispersion to the environment during the procedure.[15,22,28] However, there was an increase in intubation time compared to non-use, difficulty in mobilizing the intubator and access to the airway, as well as the risk of error in the first attempt to intubate.[15,16,18,19,21,25]

In emergencies, the delay and difficulty of access to intubate inadvertently expose patients to hypoxemia and worsening of their clinical condition.[16,23] When trying to handle the airway, there was a violation of the apron and glove due to the holes in the acrylic box, exposing to risk of contamination.[19,23] The two openings designed to accommodate the intubator's arms allow for the redirection of aerosols to the environment, with evidence of accommodation on professionals' arms, chest and head.[14,20,26,33]

Some articles highlighted the need to associate airflows with negative suction systems inside the acrylic box, coupled in HEPA filters, showing less contamination of the intubator, as well as the almost minimal dispersion to the environment.[29,32,35] The post-procedure risk was also evidenced: at the end of intubation, the removal of the acrylic box allows the dispersion of aerosols concentrated inside it directly to the bedside, procedure materials, as well as the team involved.[26,28,30] If the association of barrier protectors with OTI is chosen, teams must be trained in the decontamination of boxes and plastic barriers, with additional risk of exposure during removal after completion of the procedure.[20,33]

The use of protective acrylic boxes should be based on team familiarization and training of those involved in handling, in order to reduce exposure to aerosols.[20,24] The use of a video laryngoscope facilitates the visualization of the airway and avoids the increase in intubation time, providing greater safety for both professionals and patients.[24] Thus, teams should analyze care routines on the benefit and risk of adding barrier protectors to intubation, and the possibility of increasing the videolaryngoscope in daily life. The training of professionals to perform OTI in emergency and ICU, as well as the use of checklists that guide the methodology of the procedure, show safety for both teams and patients.[29,31,34]

In a study developed in the United States, after the creation of a protocol containing guidelines on intubation (number of professionals present in the room to reduce exposure, use of tube clamps and HEPA filter, training in airway management and rapid OTI sequence), it was observed that, after 253 intubations, only 1 professional was contaminated and there was success in the first attempts, demonstrating that the application of protocols and the constant training of teams enable safety.[29]

On the contrary, in another study, despite the complete use of PPE and training for intubation skills, of the 63 professionals, 11 were infected. First-attempt OTI success occurred in 80% of procedures.[31] The creation of intubation teams, similar to the rapid response teams, can benefit from the guarantee of safety in performing high--risk care for teams.[34] Only one study addressed the use of tube clamps when passing the airway and the application of a HEPA filter to the expiratory circuit of the mechanical ventilator, as they were part of the OTI protocol.[29]

During the assessment of articles obtained in research, it was observed that the vast majority of published studies were guidelines and experts' recommendation letters. Recommendations regarding the association of certain OTI devices and methods in suspected or confirmed COVID-19 patients come from experts in the field to guide professionals during intubation.[10,36,37,39,40] Among the guidelines, the following stand out: performing OTI preferably in negative pressure rooms; minimum permanence of professionals (in a negative pressure room, the permanence of a doctor, a nurse and an assistant physician in a critical room, and in an auxiliary circula-

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ting anteroom with a cardiopulmonary resuscitation cart; drugs and complete airway material); HEPA filters in the mechanical ventilator's expiratory circuit; avoid bag-valve-mask inflation, clamps to clamp the OTT when disconnecting the ventilation system.[10,36,37,39,40]

Although the guidelines are sources of experts in the area, there is a lack of original primary studies highlighting the efficiency of these recommendations in protecting professionals from exposure to COVID-19 aerosols. As this is a very recent topic, considering the emergence of guidelines for professionals regarding the care of critically ill patients who need a definitive airway, it is believed that there was not enough time to assess all these guidelines in methodology studies with a high level of evidence.

The limitation of this study is the research method, because it is an integrative review, and not systematic literature. Due to the very recent emergence of COVID-19, robust studies on the safety of devices such as clamps, HEPA filters, the separation of procedure rooms to avoid contamination of professionals, as well as oxygen therapy devices for the pre-oxygenation stage prior to OTI have not been identified.

Thus, with the acquisition of experience in the care of infected patients who need OTI, there is a need for original research on aerosol prevention measures for professionals involved in the procedure. The exclusion of 3 articles in other languages and 18 articles not available in full are limitations regarding the research method, inclusion and exclusion criteria.

Knowledge about methods of preventing dispersed aerosols during definitive airway management is crucial for the protection of professionals.[36] In this way, constant updates from studies with a high level of evidence allow teams to be confident in the implementation of these measures in the daily care of patients suspected or confirmed for COVID-19.

CONCLUSION

The use of barrier protectors such as the intubation box in everyday care should be analyzed with caution. Despite concentrating the aerosols in its interior, the risk of escape in its openings directly to the intubator is evident. There is difficulty in mobility and visualization, requiring previous training and experience from professionals so that there is no harm to patients with its use. Likewise, without familiarity with the device, there is an increase in procedure time, exposing patients to hypoxemia.

On the other hand, the intubation teams, the use of protocols and the training of teams demonstrate effectiveness in reducing contamination to professionals. It is necessary to observe the need for more clinical studies on safety and guarantee of protection, using other recommendations described in guidelines and expert guidance.

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AUTHORS' CONTRIBUTIONS

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