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Research Article

Covid-19 and Nitrous Oxide Inhalation Sedation: Recommendations for a Safe Administration

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Abstract

Conscious sedation with nitrous oxide is a widespread practice in dentistry and allows you to treat patients that are difficult to treat without its use. This work revisited all the material published between 2019 and August 2021 on the topic of recommendations for the safe use of nitrous oxide sedation in dentistry during the COVID-19 pandemic. The results of the work are recommendations to be used using sedation of the patient with nitrous oxide during the pandemic period.

Keywords: *COVID-19; Dentistry; Nitrous Oxide; Inhalation Sedation*

Introduction

At the end of December 2019, an outbreak of emerging pneumonia began in the city of Wuhan [1]. On January 30, 2020, the World Health Organization declared a public health emergency of international concern.

On February 11, 2020, WHO called the new viral pneumonia "Coronavirus Disease (COVID19)".

The International Committee on the Taxonomy of Viruses (ICTV) has suggested this new coronavirus name as "SARSCoV-2" due to the phylogenetic and taxonomic analysis of this novel coronavirus [2].

SARS-Cov-2 is a beta-coronavirus [3]. Coronaviruses contain an enveloped, unsegmented, positive sense RNA genome of ~ 30 kb with high mutation and recombination rates [4].

SARS-CoV-2 uses angiotensin converting enzyme, a glycoprotein located in the endothelium of pulmonary capillaries, as a cellular receptor for human infection.

A group of Chinese scientists reported that the cellular receptor for 2019-nCoV infection, the angiotensin II converting enzyme (ACE2), is highly expressed on the oral mucosa.

In particular, this receptor is present in large quantities in the epithelial cells of the tongue [5].

These results indicate that the oral cavity is a potentially high-risk transmitter for 2019-nCoV infection.

Clinical symptomatology

COVID-19 acts directly on the upper and lower respiratory tract.

The characteristic symptoms of the infection are fever, cough, general malaise, ageusia, shortness of breath and asthenia; Gastrointestinal complications have been reported, although rarely [6]. The most commonly observed outcome with respiratory virus infections in both acute and advanced stages is diffuse alveolar damage [7].

Part of people infected with SARS-CoV-2 are asymptomatic, 80% have a mild form of the disease.

Unidentified cases of COVID-19 are responsible for the infection of 79% of documented cases.

Transmission of COVID-19

It is variable and can occur in different circumstances: first through coughing and sneezing; second, through contact with surfaces directly exposed to the virus, such as contact with oral, nasal and ocular mucous membranes [8] and lastly by inhaling aerosols [9].

Aerosol transmission in dentistry

When performing dental procedures with a high-speed handpiece, the friction between the tooth and the rapidly rotating bur would create excessive heat that could damage the dental tissue.

Therefore, to prevent overheating, it is universal consent to use a water coolant when performing dental procedures [10].

When aerosol is combined with body fluids in the oral cavity, such as blood and saliva, bioaerosols are created.

These bioaerosols are commonly contaminated with bacteria, fungi and viruses including the coronavirus.

Due to the force of gravity, the largest droplets quickly fall to the ground; therefore, droplet transmission requires close physical proximity between an infected individual and a susceptible individual.

On the other hand, small droplets or small residues of evaporated droplet particles have a low sedimentation rate, so they can stay in the air for a longer time and travel farther before they can enter the respiratory tract or contaminate surfaces [11].

The results of some studies have shown that aerosols of highly virulent pathogens such as severe acute respiratory syndrome-coronavirus (SARS-CoV) can travel more than six feet (183 cm) [12].

Conscious sedation apparatus

Inhalation sedation is a conscious sedation method that is performed by inhaling a combination of nitrous oxide (N_2O) and oxygen (O_2).

N_2O is a colorless gas with a sweetish odor, with a relative density greater than air. It is an effective analgesic/anxiolytic agent.

It is administered through an equipment, the sedation machine that delivers the nitrous oxide mixture to a maximum of 70% with an adjustable flow inlet from a flowmeter, N_2O is inhaled by a face mask that is placed on the patient's nose, for this reason it is defined as semi-closed circuit.

The nasal mask is then connected to a tubing system that leads to the gas evacuation system.

An article of Brazilian journal of dentistry published last last year in May [13], it is indicated how sedation by inhalation with nitrous oxide generates aerosols in a semi-closed circuit for a flow of gas that often exceeds the volume of 5 liters per minute.

The contaminated nitrous oxide, can reach up to 2 meters in radius, from where the nasal mask is installed, can reach not only the surfaces of furniture and equipment, but also the dental staff and possibly the accompanying persons of pediatric or disabled patients [13].

It is therefore recommended to not perform dental procedures under inhaled sedation with nitrous oxide during the COVID-19 pandemic, in order to mitigate the aerosol spread and the potential risk of performing life support measures that would involve manipulating the airways.

Aim of Work

In light of the recent COVID-19 pandemic, which involved a modification of our usual habits and procedures, the question arose as to whether the use of the equipment for the administration of nitrous oxide in dental offices was safe and what were the maneuvers and / or precautions to be implemented to ensure the administration in total safety.

Materials and Methods

Sources in the scientific literature were searched using the search string: ("SARS-CoV-2" OR "Covid-19" OR "Novel Coronavirus") AND ("Sedation" OR "Inhalation Sedation" OR "Dental Sedation" OR " Nitrous Oxide ").

Studies from 2019 until August 2021 were considered. The search was performed in the main scientific search engines.

Articles dealing with conscious sedation with nitrous oxide, during the Coronavirus pandemic, in asymptomatic patients declared Covid negative in the dental field were considered.

Results

The initial search identified 240 references in PubMed, 205 in ISI Web of Science, 493 in Scopus, 1 in Clinicaltrials.gov, and 3 in Cochrane Central Register of Controlled Trials.

Only 3 full-text articles were included in the review among these references. The remaining articles were excluded as they did not meet the inclusion criteria (duplicates, irrelevant titles, symptomatic patients, profound sedation).

Discussion

In a letter to the editor, of August 2020 published in the "*Journal of Dental Anesthesia and Pain Medicine*" [13] it is emphasized that, despite screening for COVID-19, the possibility of an asymptomatic carrier must always be foreseen. Hence, every patient should be regarded as potentially positive.

It reaffirms how the passage of gases through the airway systems contributes to the escape of the viral load from the oral cavity to the external environment, exposing the dental team to greater risk.

Therefore, the risks must be weighed against the benefits of using inhalation sedation.

Precautions and indications to be adopted for the use of inhalation sedation are detailed in the following.

The use of PPE, disinfection of surfaces, the use of a suitable nasal mask and rubber dam are recommended to avoid salivary contamination of the aerosol [14].

Once the procedure is complete, disposable masks should be carefully removed, placed in a sealed plastic bag and properly disposed of in biomedical waste.

All tubes and autoclavable masks must be washed and sterilized.

The surface of the sedation machine must be disinfected [15,16].

It is suggested the use of a device for extra-oral suction which is presumed to reduce the risk load, however, the scientific value of this device has yet to be demonstrated.

In a review published on 22 October 2020 in the *Israeal Medical Association Journal*, it is emphasized that no reference was found in the literature, as well as no conclusive solution by national and international experts, on the probability of spread of the virus through the tubes of the equipment for inhalation sedation.

However, as SARS-CoV-2 has been detected in the respiratory system and saliva of infected individuals, transmission of the virus through the inhalation sedation system including the tube appears highly likely.

Consequently, a practical solution to this problem is provided in the article.

It is recommended to:

- Use the system sparingly or prefer intravenous sedation.
- Keep more than one kit of tubes and nasal masks for each equipment, to allow the cleaning and sterilization processes between one patient and another.
- Fit filters, such as those used in anesthesia machines, between the suction tube and the central evacuation system.

The cleaning, disinfection and sterilization procedures are also reported, as indicated by the manufacturer, always to be carried out with all PPE.

Finally, it is emphasized that the effectiveness of this protocol must be fully validated on the basis of evidence.

In a letter to the editor of May 2021, published in the *International Journal of Pediatric Dentistry* it is said that nitrous sedation is a low risk procedure of generating aerosols (comparable to a non-adherent oxygen mask with a flow rate of less than 15 L/min) and in addition:

- The Royal College of Surgeons, England, and other authors (Simond), do not consider sedation with nitrous oxide as a procedure that generates aerosolsit is emphasized how.
- An oxygen mask with a loose fitting has a lower risk of generating aerosols than a sedation mask in a pediatric patient with a normal breathing pattern, where a flow of less than 5 L/min is used.

- The use of nitrous oxide, being anxiolytic, reduces the bioaerosols produced by the talking or crying of the anxious child.

Consequently nitrous oxide does not add much to existing bioaerosols if they can be minimized [17].

Further operational indications to follow are also given, including:

- Basic medical history screening (previous COVID-19 infection, respiratory symptoms and family vaccination status).

In countries where the infection rate is still rising, every child should be regarded as an asymptomatic carrier and any non-essential dental treatment should be postponed.

The use of personal protective equipment is recommended:

- Reducing gas leaks: by continuously monitoring the gasket of the nasal mask, using the sliding clamps.
- Choosing suitable nasal masks, especially in children with short upper lips, to avoid salivary contamination.
- Using the rubber dam positioned in a special way with the dam rolled up on the nasal mask.
- The jet of oxygen should also be avoided as it increases the total flow rate of the gases, which is undesirable as it causes a greater dispersion of the respiratory droplets.
- Here, too, the use of filters similar to those used in anesthesia circuits is suggested.
- The role of room ventilation with 10 - 15 air changes per hour is also fundamental.

The directions to follow for utilization in pediatric patients are given:

- It should be avoided in children who are not cognitively developed enough to accept the nasal mask or who cry when wearing it, because this would increase the production of bioaerosol.
- The child should be instructed to breathe "normally" in the nasal mask and not take slow, deep breaths, as was repeatedly told in the pre-COVID-19 era. (In fact, slow, deep breaths increase the chance of droplets containing mucus in the exhaled air, due to the shear forces produced when the air rushes over the mucus lining the airways. This also strengthens the protocol that the protoxide of nitrogen should not be used on a child who has nasal congestion or with increased respiratory secretions).
- During the treatment, verbal communication should be completely avoided, while hand gestures are preferred.

The choice of the proper procedure to handle the used equipment shall be based on the risk of infection prevention control (ICP). The risk of infection can be classified as low, medium or high depending on how the equipment components come into contact with fresh or exhaled gases from the patient. Based on this either cleansing, disinfection or sterilization are recommended.

To reduce surface contamination of the nitrous oxide delivery system from aerosols generated in a dental procedure, it is recommended that exposed tubes and surfaces shall be covered with a protective barrier.

In Italy, according to the AIFA (Italian drug agency) note of February 2011, the use of this equipment in an outpatient setting is allowed for the general dentist with adequate cardiopulmonary rehabilitation training, to a maximum of 50% of protoxide and, for the sedation dentist, for short periods up to 70%.

The emergency situation created by the Covid19 epidemic led to additional recommendations.

AIFA in July 2020 defined the precautions to be followed in patients who are positive or potentially positive for sars-cov-2, during treatment with medicinal gases.

Systems without active suction are distinguished from those with active suction. The latter must be equipped with a filter, while the former (such as the sedation machine) do not require adding a filter. This because the exhaled mixture is actively conveyed, through an aspiration system, outside the environment where the protoxide is used.

Conclusion

Despite screening for COVID-19, an asymptomatic carrier is always a possibility, it is essential to carry out adequate screening

and weigh the risks versus the benefits of using inhaled sedation during dental treatment.

The recommendations which can be inferred from this bibliographic review are:

- The use of Personal Protective Equipment and surface disinfection in the dental office [14].
- Choose an appropriate nasal mask and use the rubber dam in order to reduce the contamination of the aerosol by saliva [14] minimize verbal communication, maintain good ventilation in dental offices.
- Maintaining a low gas flow rate, ensuring a normal breathing pattern, avoiding forced expirations.

The use of an extra-oral suction device has been suggested to reduce the risk load, however, the scientific value of such a device has yet to be demonstrated [14].

The use of biological barriers, which have proven effective in stopping the coronavirus, between the waste gas pipe and the central evacuation system has been proposed. The effectiveness of this suggested protocol has yet to be validated on the basis of evidence [18].

It is also essential to adopt a rigorous disinfection and cleaning protocol for the equipment, to avoid contamination.

Therefore it is important for each patient to thoroughly disinfect all surfaces of the machine, to autoclave all autoclavable components (tubes, masks) or, alternatively, to use disposable devices [14,18].

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