

# Tracheotomy in the age of the COVID-19 pandemic: up-to-date review

## Tracheotomia w dobie pandemii COVID-19: przegląd aktualnego piśmiennictwa

### Authors' Contribution:

A – Study Design  
B – Data Collection  
C – Statistical Analysis  
D – Manuscript Preparation  
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### ABSTRACT:

**Introduction:** The SARS-CoV-2 pandemic is one of the biggest healthcare challenges that the medical environment has needed to face since many, many years. Clinicians all over the world present their recommendations for everyday procedures in order to provide safety to the medical staff as well as to patients. The disease leads to ARDS in many cases and some patients will require prolonged intubation; therefore, to avoid the negative aspects of this condition, a number of patients will undergo tracheostomy. Tracheostomy is an aerosol-generating procedure, therefore, when performed on a SARS-CoV-2-positive patient, there is a high risk of contamination both of the medical team and the operating theatre.

**Aim:** We describe a set of guidelines that we believe should minimize those risks. We focus on aspects like: presurgical testing, proper preparation of the operating theatre prior to the patients' arrival, initial education of the medical staff participating in the surgery, patient' transport and tracheostomy. We describe the critical points during every step and suggest ways to minimalize the risk of viral transmission.

### KEYWORDS:

ARDS, coronavirus, COVID-19, pandemic, SARS-CoV-2, tracheostomy

### STRESZCZENIE:

**Wprowadzenie:** Pandemia wywołana przez wirusa powodującego ostrą chorobę dróg oddechowych 2 (SARS-CoV-2) w 2020 roku jest jednym z największych wyzwań, z jakimi musi zmierzyć się opieka zdrowotna na całym świecie w ciągu kolejnych kilkudziesięciu lat. Każdego dnia lekarze podejmują próbę dostosowania codziennych procedur, tak aby zapewnić bezpieczeństwo na najwyższym poziomie zarówno sobie, jak i pacjentom. Z uwagi na to, że choroba ta prowadzi do zespołu ostrej niewydolności oddechowej (ARDS), wielu chorych wymaga przedłużonej intubacji. Aby uniknąć licznych powikłań, część chorych na ostrą chorobę dróg oddechowych wywołaną przez wirusa SARS-CoV-2 (COVID-19) wymaga bądź będzie wymagało wykonania tracheotomii w warunkach bloku operacyjnego. Podczas tracheotomii wytwarza się aerozol stwarzający bardzo duże ryzyko zakażenia personelu medycznego oraz skażenia bloku operacyjnego.

**Cel:** W pracy przedstawiamy zbiór wskazówek mających na celu jak najbezpieczniejsze przeprowadzenie tracheotomii. Skupiamy się na aspektach, takich jak: wykonywanie testów wykrywających RNA wirusa przed zabiegiem, odpowiednie przygotowanie sali operacyjnej, dokładne przeszkolenie personelu biorącego udział w na każdym etapie zabiegu, transport pacjenta oraz procedura tracheotomii. Przedstawiamy punkty krytyczne podczas wykonywania każdej z tych czynności i staramy się wyjaśnić, jakie kroki należy powziąć, aby zminimalizować ryzyko transmisji wirusa.

**SŁOWA KLUCZOWE:** ARDS, COVID-19, koronawirus, pandemia, SARS-CoV-2, tracheotomia

## ABBREVIATIONS

**BAL** – bronchoalveolar lavage

**COVID-19** – acute respiratory disease caused by SARS-CoV-2 virus

**ICU** – Intensive Care Unit

**PEEP** – Positive end-expiratory pressure during the expiratory phase

**PPE** – Personal protective equipment

**RT-PCT** – Reverse transcription polymerase chain reaction

**SARS-CoV-2** – virus causing acute respiratory disease 2

## INTRODUCTION

A new type of SARS-CoV-2 coronavirus causing a disease known as COVID-19 has now taken on pandemic proportions. Due to the high infectivity of the virus via a droplet infection, the number of infected people worldwide at the beginning of May of 2020 reached 3.5 million, while the number of people who died due to disease – 250,000. In the USA, Italy, Spain and China, the number of infected people is very high, resulting in a huge overload of health care systems [1].

The number of infected healthcare workers in Italy accounts for around 10% of the total infected. According to the report of 02/04/2020 of the Chief Sanitary Inspectorate (GIS) in Poland, about 17% of health care workers are affected. Medical personnel, in particular anesthesiologists and otorhinolaryngologists, are at the highest risk of infection with SARS-CoV-2 virus.

COVID-19 may cause acute respiratory distress syndrome, or ARDS, often requiring intubation and ventilator therapy. Intensive Care Unit (ICU) patients in whom intubation is prolonged require a tracheotomy. There is some evidence that performing an early (up to day 7 after intubation) tracheotomy effectively reduces the risk of hospital-acquired pneumonia, mortality, duration of mechanical ventilation, postintubation tracheal stenosis and ICU length of stay [2]. Tracheotomy is a procedure that affects approx. 24% of ICU patients. The risk of SARS-CoV-2 infection during surgical tracheotomy by the operator(s) and the anesthetic team is significant. Direct manipulation of the open trachea with concomitant mechanical ventilation multiplies the exposure to aerosol in the respiratory tract, thereby creating the risk of viral infection when it is performed [3].

There are two main routes to perform a tracheotomy. Surgical, or open tracheotomy is the most common procedure in the operating theater. Simplistically, it consists in making an incision on the skin, dissecting and opening the trachea, and inserting a tracheotomy tube into the lumen of the airway. Percutaneous tracheotomy, on the other hand, is mainly performed by anesthesiologists in the ICU. It consists in puncturing the trachea through the skin (under guidance of laryngoscope or bronchoscope), dilatation of the puncture canal and insertion of a tracheotomy tube by this route [4]. With the increasing number of infected people and that of individuals requiring intubation and ventilation, the count of patients in need of tracheotomy has also been growing. Many countries have developed the principles of tracheotomy in patients with COVID-19, including the CORONA system produced in Italy, or the so-called “5T” in Great Britain [5, 6].

## MATERIAL AND METHODS

We have analyzed the latest reports on tracheotomy in patients with COVID-19 published in 2020 in English-language scientific journals. In our search of articles, we have used the MEDLINE, PubMed and Scopus bases. The search was performed using the keywords “tracheostomy”, “COVID-19”, “SARS-CoV-2”, “ARDS”, “respiratory distress syndrome” and synonyms of these words.

## RESULTS

We have presented below the most important steps that must be taken for a safe tracheotomy.

### Personal protection equipment

The primary way of reducing the transmission of SARS-CoV-2 virus to healthcare personnel is the use of personal protective equipment

(PPE), which fulfils the function of a barrier against the virus. Prior to its application, it is necessary to remove the watch, jewelry (chains, rings, bracelets) and thoroughly wash and sanitize hands.

The required PPE includes:

- surgical cap and special footwear,
- a protective suit or two protective aprons,
- safety glasses and/or a face shield to protect the eyes,
- mask – it is recommended to use FFP3 (Europe) or N99 (USA) masks, in the absence of FFP3 masks it is allowed to use FFP2 /N95 masks with the additional use of a surgical mask,
- a double pair of nitrile gloves.

PPE should be used by all personnel playing an active role in the procedure, including the anesthesiologist and nurses (both anesthesiological and theatre nurses). Due to cases of asymptomatic infections with COVID-19 and the exceptional exposure to aerosol in the respiratory tract during the procedure, it is suggested to use a similar type of protection in both COVID-19 positive and negative patients. It is vital to address the appropriate method of removing PPE after the procedure is completed [5–7].

### Postponement of tracheotomy in COVID-19 positive patients

The decision to postpone tracheotomy in COVID-19 positive patients should be considered on a case by case basis and multidisciplinarily in the anaesthesiologist-otorhinolaryngologist team. It is suggested to delay the decision to perform a tracheotomy for 14 to 21 days after intubation. This is directly connected with the severity of the patient’s infection (viral load), which decreases after this time. Doing so will reduce the risk of exposure to infection for personnel. A further argument for delayed tracheotomy in COVID-19 positive patients is the low survival rate (<20%) in patients requiring mechanical ventilation [8, 9].

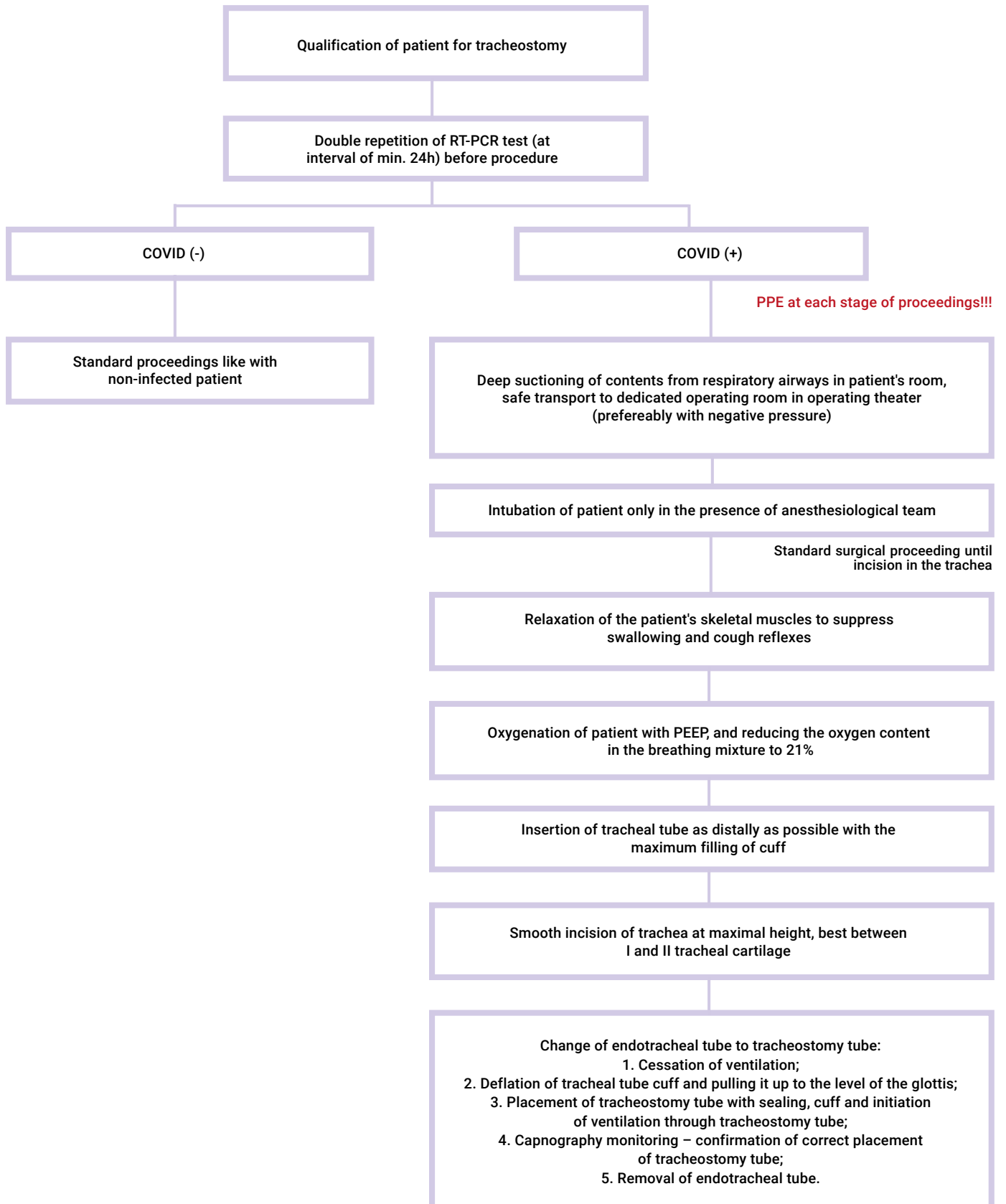
### Preoperative testing

The diagnosis of SARS-CoV-2 infection consists in demonstrating the presence of the genetic material of the virus in the material obtained in the swab from the nasopharynx or in the bronchoalveolar lavage, or BAL by means of RT-PCR (Reverse Transcriptase Polymerase Chain Reaction). BAL screening is the most sensitive method of virus detection available and is recommended for intubated patients. The genetic material of the virus in the respiratory tract is detectable on average for 20–24 days after the onset of the first clinical symptoms. The longest documented presence of the virus in the respiratory tract was 37 days [10, 11].

Interestingly, in both asymptomatic and symptomatic patients, the amount of genetic material of the virus in exhaled air turns out to be at a similar level, which merely intends to confirm the need to use all possible personal protective equipment for both groups of patients.

The aim of preoperative testing is to detect infected patients and asymptomatic carriers. Over a pandemic period, patients should normally have two RT-PCR tests with an interval of 24 hours immediately prior to elective tracheotomy.

Fig. 1. Protocol of patient management during a tracheotomy at the time of COVID-19 pandemic.



RT-PCR is also pertinent in determining the optimal timing of tracheotomy in COVID-19 positive patients. Tracheotomy in patients requiring prolonged ventilation is performed on average 10–14 days after intubation. In a pandemic situation, it is suggested to postpone the procedure in infected patients by about 7 days longer to minimize the virus concentration in exhaled air and thus the risk of infection of healthcare personnel and contamination of the operating theater. A follow-up RT-PCR test performed 10-14 days after intubation helps to make the decision about the optimal time of the procedure. A persistently positive result will lead to postponing the tracheotomy, while a negative result will contribute to performing it at an earlier time [12, 13].

### Preparation of the operating room for surgery

Tracheotomy in a COVID-19 patient should be performed in an operating room dedicated to patients infected with the virus. Very often, due to the avoidance of contamination at the operating theater, tracheotomies are performed in a prepared ICU treatment room.

The most appropriate solution is to use a room with negative air pressure. The room in which such treatment is to be performed should be closed: it must not have open windows or doors.

The personnel involved in the procedure must be limited to a necessary minimum. The best solution is to create a permanent team responsible for performing this type of surgery. The team should consist of: two experienced operators, an anesthesiologist and two nurses.

The patient should be intubated before surgeons enter the operating room [5, 6, 14].

### A few significant indications for surgery

The procedure itself is no different than classical tracheotomy, but the use of electrocoagulation should be eliminated. The use of several maneuvers during the procedure should be emphasized to minimize the risk of infection of the staff and contamination of the operating room.

Patient positioning as for classic tracheotomy. The face should be covered with surgical drapes. Subsequent stages of the procedure until the trachea is opened are standard. Skeletal muscle relaxants should be given prior to incision of the trachea. Such a proceeding is to disable the swallowing and cough reflexes, which aims to reduce the production of aerosol that could contain the virus. Initially, the patient must be oxygenated using positive end-expiratory pressure (PEEP). Just before incision of the trachea, the oxygen content in the breathing mixture should be reduced to 21%. The anesthetist inserts the tracheal tube as low as possible in the lumen of the trachea, reducing the risk of perforation of the cuff of the endotracheal tube during the incision of the trachea. The endotracheal tube cuff should be inflated as much as possible to seal the lower airway and prevent air leakage into the trachea. The tracheal incision should be made cranially at most, e.g. between the 1st and 2nd cartilages of the trachea, in the shortest possible time.

The riskiest stage of the procedure in terms of the potential spread of the virus is the moment of swapping the endotracheal tube to a tracheotomy tube. This stage of the procedure should be done quickly and efficiently. At this point, ventilation of the patient should be stopped, and the endotracheal tube cuff should be deflated and pulled up to the subglottal level without extubating the patient. Then the tracheotomy tube must be inserted into the lumen of the trachea. Ventilation can be resumed only after the tracheotomy cuff has been sealed. Confirmation of the correct placement of the tracheotomy tube should be based on obtaining a capnography; it is not recommended to use a stethoscope for this purpose to avoid contamination during chest auscultation. With the certainty that the tracheotomy tube is placed in the lumen of the trachea, the tracheal tube can be safely removed [5, 15, 16] (Fig. 1.).

## DISCUSSION

Tracheotomy is a very common procedure performed in hospital settings also by specialists other than otorhinolaryngologists. Healthcare personnel contacting patients potentially suffering from COVID-19 should maintain maximum protection against the virus for the safety of other patients and themselves. All surgical airway procedures are very dangerous because potentially infectious aerosol is generated during their performance. Surgical and percutaneous tracheotomy are the most dangerous due to direct interference with the lower respiratory tract. To date, no recommendations have been made regarding the management of tracheotomy in patients infected with SARS-CoV-2 based on EBM (Evidence-Based Medicine). All literature recommendations rely on own experience and reflections of multidisciplinary surgical-anesthesiologic-epidemiological teams.

Adequate protection of the personnel involved in tracheotomy in PPE does not raise concerns. The use of masks with the FFP3 or FFP2 filter is a necessity. It is very important to train healthcare professionals on proper attachment and removal of PPE to avoid infection. The hospital should provide the appropriate quantity and quality of PPE which unfortunately, to this day, is often lacking in wards and the operating theater [5, 6].

Preparation of the site of the surgical procedure is also very important. The room should be locked, with no windows or doors open. Only people directly involved in the procedure should be present in the room. The use of a room with negative atmospheric pressure seems justified, but still often impossible from a financial perspective. There is an open debate on whether tracheotomy should be performed in a specially prepared ICU room or in an operating theater. The unquestionable advantages of the first option are avoiding transportation of the patient to the operating room and thus reducing the number of people contacting the patient. Performing the procedure in an operating theater has numerous benefits: aseptic conditions of the procedure, availability of surgical and anesthetic equipment, and an experienced team. Many hospitals (like ours – the University Clinical Center in Gdansk) have one central operating theater. Transportation of the

patient from the ICU to the operating theater must be done via an open corridor. Transport is performed by an anesthesia care team, which should be protected with PPE. Prior to patient transport, secretions from the respiratory tract and from the pharynx and oral cavity should be suctioned with a closed-circuit aspirator to minimize their amount. Transport time should be as short as possible. During transport of the patient, the corridor should be protected against unauthorized access. After the patient is taken to the operating room, another crucial and risky moment is to switch ventilation to the apparatus in the operating room. That stage may include spraying of infectious aerosol [6].

Decisions on how to perform a tracheotomy are made jointly by anesthesiologists and ENT specialists, and often depend on the guidelines in force in the center performing this procedure. In some countries, such as Spain or France, percutaneous procedures are more often preferred. In other countries, such as Italy, Germany or Singapore, open procedures are more common.

The advantages of percutaneous tracheotomy include: performing the procedure in the ICU (avoiding the risk of contamination of the operating theater), short duration of the procedure and reduced risk of puncturing the endotracheal tube. The risk of potential blood vessel damage and associated hemorrhage during tracheal puncture can be reduced by performing a preoperative ultrasound/carotid Doppler. Surgical tracheotomy provides better management of potential hemorrhage. However, it requires

the involvement of a larger number of healthcare personnel, appropriate equipment and the availability of an operating theater or an adapted treatment room at the ICU [5, 17–19].

The technique of the procedure is not very different from classic tracheotomy. It is important to use several maneuvers at critical stages of the procedure, during which the spread of a potentially infectious aerosol may occur. The timing of the tracheal incision and replacement of the tracheotomy tube is crucial for the safe performance of the procedure. Relaxation of the respiratory muscles, avoiding damage to the endotracheal tube cuff by placing it as low as possible in the lumen of the trachea, and stopping ventilation when inserting a tracheotomy tube are to limit aerosol spread [5, 6, 20].

## CONCLUSION

During the SARS-CoV-2 pandemic, tracheotomy puts healthcare personnel at high exposure to the virus contained in the aerosol of the patient's respiratory tract. In addition to routine aseptic and disinfection activities, it is necessary to minimize the risk of infection of the operating team. The current procedures result from the experience of individual centers and the recommendations of multidisciplinary teams to date. It is necessary to develop homogeneous procedures/guidelines for the management of tracheotomy in a COVID-19 positive patient.

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