Transtracheal Oxygen Therapy
Modified Seldinger Technique

Insertion Technique
For
Physician

[Image of catheter and lungs]
Three decades and thousands of patient months of experience has been extremely useful in determining which potential TTO candidates have better outcomes than others. Precautions in and of themselves are NOT reasons to not consider doing a TTO procedure on any particular patient. Many TTO candidates will have more than one precaution. Precautions should alert the physician that these patients will require more attention before, during, and after the procedure. Long term experience however, has proven that there are a small group of patients in whom TTO is contraindicated with overwhelming anxiety being the number one contraindication. Patients with any of the contraindications listed below will predictably have more problems in the weeks and months that follow.

Contraindications

Transtracheal oxygen should not be used in patients who are unable to understand and carry out the patient instructions. Because of the risk of pneumothorax, the procedure should not be performed if a preprocedure chest x-ray shows pleural herniation over the selected puncture site. Transtracheal oxygen also should not be used if subglottic stenosis, bilateral vocal cord paralysis or any other cause of upper airway obstruction is present.

Precautions

1. Patients with hypoxemia which is refractory to nasal cannula therapy should not be treated with transtracheal oxygen until the physician has gained experience with several non-refractory patients. Similar consideration should be given when treating patients with severe impairment of mechanical reserve or PaCO₂ > 50 mm Hg.

2. The transtracheal procedure and initiation of transtracheal oxygen should be undertaken only when the patient is stable and under optimal medical therapy. Individuals with acute respiratory acidosis (elevated PaCO₂ and acidemia) should not be treated with transtracheal oxygen until the acute exacerbation of lung disease and the acidemia have been corrected.

3. Transtracheal oxygen requires special caution when the patient’s baseline clinical state demonstrates severe coughing, copious sputum, bronchial hyperreactivity, or disorder of coagulation.

4. Transtracheal oxygen can exacerbate a baseline anxiety neurosis. This may result from the lack of sensation of oxygen flowing into the body at low flow rates or the perceived complexity of caring for the catheter.

5. Anatomic abnormalities (e.g. severe kyphoscoliosis) which obstruct access to the anterior neck may make it difficult for the patient to care for the transtracheal catheter.

6. Transtracheal catheters are intended for use with tracts created by the MST or FastTract transtracheal procedure. Tracts created by other techniques may become suitable for use with transtracheal catheters if dilated or permitted to close down to the appropriate size. This does not guarantee that the tract will be suitable because it may be located at an unstable location. Printed protocols for adapting a tracheotomy for use with Transtracheal catheter are available on request.

The Modified Seldinger Transtracheal Oxygen Procedure (MST) should only be performed by a qualified Pulmonologist or Surgeon in an endoscopy department or suitable area.

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Modified Seldinger Procedure Checklist

Pre-Procedure Overview
1. □ Review pre-procedure CXR.
2. □ Position patient in chair at 10 degrees back, slightly elevate chin.
3. □ Prepare tray.

Procedure Overview
4. □ Mark notch of the thyroid cartilage, cricothyroid membrane and manubrium.
5. □ Note location for puncture site
6. □ Prep skin with alcohol.
7. □ Using 27 gauge needle, inject 2 cc local anesthesia (2% xylocaine with adrenaline 1:100,000) laterally across selected puncture site, inject 1 cc anesthetic solution into pretracheal tissues.
8. □ Switch to 20 gauge 1 1/2” needle, palpate a tracheal interspace and inject 2 cc anesthetic solution into trachea (warn patient of bad taste, cough, globus) and quickly remove needle.
10. □ Remove upper tier and put on sterile gloves.
11. □ Place sterile field drape.
12. □ Firmly grip the lateral edges of the trachea with the thumb and forefinger. Make 1cm vertical incision at tracheal midline.
13. □ Keeping needle parallel to the floor, insert 18 gauge needle between cartilage rings, aspirate air.
14. □ Remove syringe, orient needle inferiorly and angle downwards 45 degrees.
15. □ Insert wire guide, withdraw needle, position wire with black reference mark at skin.
16. □ Insert 10 French dilator at 45 degree to 2 cm beyond the “give” and hold for 1 minute.
17. □ Remove dilator and insert lubricated stent with 360 degree rotation; remove wire.
18. □ Ask patient to gently cough. You should hear air regurgitate.
19. □ Suture Stent with 3-0 nylon. Tie 6-7 square knots.

Post Procedure Overview
20. □ Patient to x-ray for over penetrated PA and lateral film.
The Transtracheal Procedure using the Modified Seldinger Technique (MST)

Pre-Procedure Routine

In most hospitals utilizing the MST technique, the procedure is performed in the endoscopy department or any other suitable area. If the patient is stable, then the previously ordered pre-procedure medications are administered. These include antibiotics, antitussive, and nebulized bronchodilator if indicated.

The patient is seated in a comfortable chair with a headrest. The chair is angled backward about 10 degrees. The patient is encouraged to sit erect and upright in the chair. Oxygen by nasal cannula is positioned to arrive from behind. The most recent AP chest x-rays should be available. The sitting position is recommended as it both lowers venous pressure in the neck and improves respiratory mechanics. The T-9 procedure tray is conveniently placed next to the patient. The upper tray is used clean, and the lower tier will be used in a sterile fashion after the skin is prepped.

The upper tier contains supplies for site selection, local anesthesia and skin disinfection. It will facilitate the procedure if a few minutes is taken to prepare the items located in the upper tier. An assistant normally pours about 10cc of sterile water or saline into the well designed for the prep solution. An additional 5cc of approved skin prep solution is then added. 5 cc’s of 2% lidocaine with epinephrine should be drawn into the syringe using the 20g needle provided. The 20g needle should then be exchanged for the 27g needle. The upper tier is now fully prepared.

Anatomy Review

The relevant anatomy to the MST procedure is the notch of the thyroid cartilage, the crico-thyroid membrane, and the notch of the manubrium. The first or second tracheal interspace is the desired position for long term catheter stability. A surgical marking pen in the upper tier may be used to identify these landmarks. Accordingly, a stent should never be placed through the crico-thyroid membrane, and certainly not lower than the notch of the manubrium. The upper tier contains two needles to facilitate topical anesthesia.

Skin anesthesia follows. After prepping the skin with an alcohol pad, a 27g needle is used to inject 2cc’s of local anesthethestic laterally across the selected puncture site. Use the full length of the needle so you will anesthetize the area where you will be suturing the stent. After transfixing the trachea between thumb and forefinger, inject 1 more cc of anesthetic into the pre-tracheal tissue, but not into the trachea. Switch to the 20g needle, re-identify your tracheal landmark and prepare to inject the final 2cc of anesthetic. Take a moment to prepare the patient and encourage them to resist coughing for a few seconds. Insert the needle into the interspace, aspirate the syringe to confirm you are in the trachea, and quickly inject the remaining 2cc of anesthetic. Remove the needle immediately and hold an alcohol pad over the injection site.

Prep (scrub) the anterior neck with appropriate skin prep solution following hospital SOP. The 20g needle puncture mark in the center of the blanched skin will identify the future incision site. Dry the skin from clavicle to clavicle to allow better adherence of the Steri-Drape.

Remember that the upper tier is used in a non-sterile way. The lower tier is designed to be used using full sterile technique. While sterile gloves alone may be used at a minimum, hospital policy may dictate the necessity for gowing, gloving, face masks etc. While not technically necessary, it is still highly recommended. The upper tier is removed, and the lower tier may be prepared for use.

The procedurist should familiarize themselves with the lower tier which contains all the instruments necessary for the insertion of the stent. An assistant pours a few cc’s of sterile saline into the fluid well at the top of the tray. 2 cc of saline is drawn up in the syringe that is provided, and the 7 cm 18g needle is attached. A
small dab of water soluble jelly is applied to the tip of the stent. The suture is secured in the needle holder, with the needle tip pointed down and placed back in its impression in the tray.

The Transtracheal Procedure

Making sure to firmly transfix the trachea, a 1cm incision is made over the selected site using the belly of the #15 blade using two or three “feather strokes” to expose the fat. Take the syringe with the 18 gauge - 7cm needle and keeping it parallel to the floor, insert the 18g needle into the chosen interspace and aspirate air. Proper placement of the needle is identified as much by feel as proper knowledge of the anatomy. A classic “popping” sound may be heard upon tracheal entry. The syringe is removed so the needle can now be angled down (at about 45 degrees) and rotated so that the notch on the hub is at the 6:00 position. This insures the bevel of the needle will be oriented in a downward direction towards the carina.

Insert the protruding (floppy)* end of the wire guide through the needle to the 11 cm black reference mark. Have your gloved assistant hold the wire guide as you remove the needle to free the physician’s hands for the dilation step. The 10 Fr. dilator is now passed over the wire guide with a firm yet steady push. It is only necessary to advance the dilator about 2 cm’s (beyond the “give”) into the trachea. Although there is an 8cm black mark on the dilator itself, it is almost never necessary to advance the dilator this far without risking damage to the posterior tracheal wall. The dilator is used to stretch the tissue from the trachea to the skin. It is done for a minimum of 1-2 minutes.

With a gloved assistant holding the black reference mark on the wire guide at the level of the skin, the dilator is removed and the stent with a small amount of water soluble jelly on the tip is immediately inserted over the wire guide. Rotate the stent a full 360 degrees. It’s “beveled” type tip is a natural lumen finder. The changeover from the dilator to the stent should be done quickly to increase the tamponade effect.

The stent is sutured into place with sutures passed vertically through the small eyelets of the flange. Sutures passed vertically as opposed to horizontally anatomically decreases the risk of hitting a small vessel causing bruising. Have the patient cough gently to insure that the stent is in the trachea. A 4 x 4 gauze folded in half can be loosely taped over the hub of the stent. The patient may now be taken back to the pre-procedure staging area.

*The wire guide has both a stiff and a floppy end. The floppy end will be protruding from the plastic sheath that protects it in the lower tier.

Post-Procedure Routine

Following the procedure, the physician should order a PA and lateral CXR. It may be beneficial to instruct the radiology tech to slightly over-penetrate the films so that the position of the tip of the stent relative to the
carina can be documented. The ideal position of the catheter tip is 2-4 centimeters above the carina. You should also be able to document any extravasated air at this time.

Verifying that the stent is correctly located within the trachea is confirmed in several ways. First, the post-procedure CXR will show the position of the tip of the stent as well as any air that might have escaped into the mediastinum, pleural space, or into any subcutaneous tissues. Also, air would be difficult to aspirate when the anesthetic needle was first inserted into the trachea. If the needle was not in the tracheal lumen, it would be almost impossible to insert the wire guide down to the black reference mark, and you would not hear any air escape through the stent if the patient were asked to cough. The stent, by design acts as a surgical drain for air, both through the stent and from around the incision site. It further allows the trachea to begin to adjust to the foreign body it presents. Remember to save the suture scissors and wire guide and place them in the gray envelope provided. You will need them next week when you do the stent/TTOC change over.

Following the procedure the patient is monitored for about one hour. As the topical anesthetic dissipates, some degree of cough can be anticipated. A cough suppression program can now be initiated. In addition to the non-narcotic Tessalon Perles (100mg, 1-2 q 3-4 hours), lidocaine (2cc of 1% plain) can be instilled directly down the stent. Post procedure catheter cleaning instructions are printed in the Patient Reference Manual.

**Rationale for Stenting**

A period of one week post procedure accomplishes several goals. It allows the trachea to begin to adjust to the foreign body before the introduction of transtracheal gas flow which in itself can cause a tickle cough. The stent also has a stiffer wall then the catheter that will follow. It resists the body’s urge to heal itself, and results in the creation of a better tract. Patient safety and comfort are two of the chief goals of stenting. The patient continues to receive their oxygen via nasal cannula during this entire period of time.

**Transtracheal Oxygen with an Immature Tract**

The stent is normally removed and replaced with a functioning transtracheal catheter about 7-10 days following the procedure. The patient is fitted for a properly sized transtracheal oxygen hose, and is given ancillary catheter cleaning supplies. Transtracheal flow rates are determined at rest and with activity. The patient is taught how to clean their catheter in place and must demonstrate proficiency in catheter cleaning during this scheduled visit. The patient is also educated regarding catheter security routines and the possibility of developing mucus balls.

Removing the stent and inserting the first functioning transtracheal catheter is termed the “change over.” It is convenient to have all the necessary supplies for the changeover suitably near the patient. The changeover is normally performed with the patient sitting in a comfortable chair with a head rest. The nasal cannula is placed on the patient so that it arrives from behind. Any mucus crusts seen around the stent can be cleaned with cotton-tipped applicators and half strength hydrogen peroxide or just sterile saline. A new transtracheal catheter is prepared by placing a dab of sterile water soluble jelly on the tip of the catheter. It is helpful to insert the bead chain necklace through the eyelets of the catheter before insertion into the tract. With the catheter ready to insert, you can now instill 2cc of 1% plain lidocaine directly down the stent. The patient may cough but that actually helps spread the topical effect of the anesthetic. The two sutures are then cut with the scissors saved in the gray envelope. The “floppy” end of the wire guide is now passed through the stent so that the black reference mark is positioned at the tract opening. It is clearly visible as it passes through the stent. With an assistant holding the wire guide with the black mark positioned correctly, the stent can be removed. The catheter you have prepared earlier can now be threaded over the wire guide and twirled 360 degrees until the flange is flush with the neck. When the flange comes to rest against the skin, the wire guide is
removed and the bead chain necklace clasp re-connected. Connect the premeasured transtracheal oxygen hose to both the hub of the transtracheal catheter and oxygen source. You may now remove the nasal cannula from the patient.

Use a pulse oximeter to determine adequate oxygen saturation. The oxygen flow rate is initially dropped to half the nasal cannula flow rate. The patient is titrated on transtracheal oxygen to a $\text{SaO}_2 > 92-94\%$ or per physician order. A respiratory therapist or nurse should walk the patient on their own portable oxygen source to determine their TTO flow rate with activity. All TTO patients should have three flow rates documented: 1) a new resting TTO rate, 2) new activity TTO rate, and 3) their previously prescribed nasal cannula flow rate.

Once titrated, the patient is instructed how to clean their catheter in place. A specially designed cleaning kit is recommended for use during the entire period of time while the transtracheal tract is healing (6-8 weeks). The cleaning kit contains 6-75 ml cans of pressurized sterile saline (part # CK-6), and is available from Transtracheal Systems. It is normally ordered at the same time as the MST procedure tray. The catheter is packaged with “Cleaning in Place” and “Removal for Cleaning” written patient instructions. The “Cleaning in Place” instructions are dispensed and the latter are discarded. The patient should also watch the appropriate segment in The Oxygen Program for Patients Training DVD.

A detailed bedside instruction period with a physician, respiratory therapist, or nurse is critical to the short and long term success of the patient. Proper demonstration and then return demonstration is extremely beneficial to the patient and their family if available. Family or significant other should be encouraged to sit through the entire visit if at all possible. Proper in-place cleaning technique must be demonstrated before the patient can be discharged from this first important visit.

Since the tract is not yet fully healed it is not fully lined by epithelium. This means if the catheter falls out of the tract, it may quickly close. Placing a 2” x ½” piece of tape (OpSite, Duoderm, or Tegaderm) over the necklace immediately right and left of the flange is a simple, but effective way to avoid lost tracts, especially at night. If the catheter should pop out of the tract, it is reasonable for the patient to try and reinsert the catheter themselves. (Patients should always put their nasal cannula on when not connected to TTO). However, if they are unsuccessful after 5 minutes of trying to re-insert the catheter themselves, they should call their physician for further instructions.

**Transtracheal Oxygen with a Mature Tract**

Because the Seldinger created tract needs to heal from the outside in and the inside out, it takes between 6 and 8 weeks for the tract to become fully epithelialized. It is desirable to customize a cleaning regimen for each patient based on their transtracheal flow rate, mucus management, ability to cough effectively, their specific underlying lung disease, and the patient’s individual personality characteristics. A personalized cleaning regimen should include a combination of both cleaning in place and catheter removal and reinsertion. Cleaning in place is the fundamental basis of catheter care. Cleaning frequency may easily be escalated or de-escalated based on the patient’s clinical symptomology. Removal for cleaning can be done as often as twice a day or as little as once a week. *Daily or twice daily catheter removal reduces risk of mucus ball formation and is recommended.* Patients who do not experience significant mucus ball development may prefer to remove the catheter for cleaning less frequently. A customized cleaning protocol is essential for each patient to maximize safety and efficiency.

Since the vast majority of tracts will be matured or fully healed in 6-8 weeks, a qualified clinician must verify that indeed the tract has fully matured. This is normally the Pulmonologist and must be determined before the patient may move on from cleaning in place to catheter removal and reinsertion. As was done on “change over” day the patient sits in a comfortable chair with a head rest. Their nasal cannula is arranged to arrive
from behind and the patient receives nasal oxygen at their original flow rate. Since the tract is now assumed to be fully healed, instillation of topical lidocaine is optional. A second catheter is made ready as before by threading the patient’s necklace through the flange and lubricating the tip with water soluble jelly. A wire guide should be immediately available, but the catheter is removed without inserting the wire guide. If the physician or respiratory therapist has any difficulty inserting the catheter, the tract is judged to still be immature. The transtracheal catheter is reinserted using the wire guide if necessary, and cleaning in place is continued for 2 more weeks. If the physician or respiratory therapist can easily insert the catheter, the patient is asked to demonstrate the removal for cleaning sequence using a second catheter.

During the remainder of this visit, the patient’s necklace fitting is checked, the tract site is evaluated, and as always oximetry is used to adjust flow rates. Any specific questions the patient has can be answered at this visit. Catheter care, security, and maintenance are carefully reviewed with the patient. Once the MST tract has completely matured, the vast majority of patients will prefer to remove and re-insert their transtracheal catheter once or twice a day. Removal for cleaning instructions are included in each set of new catheters for patients to review. Additionally patients can visually observe catheter removal and reinsertion on the cleaning segment of the MST DVD that is available free of charge from Transtracheal Systems.

For many patients this supervised session is enough to begin twice a day removal and reinsertion of their catheters. For patients who may be a bit apprehensive, they can remove and reinsert their catheter once a day and clean in place once a day for perhaps the first week. In this way, the first week can be considered a trial period. Once the patient has sufficient practice and confidence, they may easily advance to the preferred twice a day removal and re-insertion. Complete customization of cleaning regimens may take several more visits with updated histories to sort out all variables.

Mucus Balls

A mucus ball is an accumulation of inspissated mucus which develops primarily at or near the tip of the catheter. 10-20% of transtracheal patients produce mucus balls that may be symptomatic. They are far more likely to develop during the period of time the catheter is cleaned in place and the tract not yet mature. Once the patient’s tract is fully healed and the patient is removing their catheter for cleaning, mucus balls virtually disappear. It is common in many patients for mucus balls to decrease in frequency as the trachea adapts to the catheter over the first few weeks. Mucus balls may cause a tickle cough or dyspnea, but true airway obstruction is rare. Mucus balls develop in scenarios that include patients with copious or viscous sputum, a weak cough effort and relatively high transtracheal flow rates. Patients who have not been adequately instructed in cleaning technique, those without appropriate humidification, and those patients who are not routinely having their catheters “stripped” are also predisposed to mucus ball formation. The use of a muco-evacuent is often indicated. Guaifenesin, (OTC name Mucinex), 1200 mg. BID helps to decrease mucus viscosity and may be quite effective in reducing the incidence and severity of mucus balls. Every member of the transtracheal team needs to always be aware of the possibility of mucus ball formation especially during the first few weeks following the procedure. Mucus ball development will certainly vary from patient to patient and each case must be evaluated, especially if they develop in spite of adequate cleaning technique and proper humidification. It should be quite clear... when in doubt... strip the catheter over a wire guide in a controlled environment.

Mucus ball formation is monitored both day to day and week to week over the 6-8 week maturation period. Cleaning frequency, humidification, and catheter stripping over a wire guide can be fine-tuned for each patient to prevent or minimize the development mucus balls. However, no two TTO patients are exactly the same. For that reason, it is not unusual to have to customize a cleaning regimen based on each individual patients needs. For this reason a routine visit is scheduled one week following the initiation of TTO and perhaps more often than that. Changes in cleaning frequency may be modified several times during this 6-8 week healing period while the catheter is cleaned in place.
Patients who are more likely to develop mucus balls are those who use 5 L/min or more transtracheal oxygen at rest, have a major secretion problem (e.g. cystic fibrosis or bronchiectasis) or have significant comorbidities. Any time you have high flows of dry gas, a major secretion problem or weak cough you have created the environment where mucus balls will very likely begin to develop. These patients will need extra vigilance during the entire period of time the tract is maturing. Higher risk patients may need to clean their catheter as often as 4 times per day. Additionally, the standard bubble humidifier may not be sufficient. A servo-controlled heated humidifier should be immediately available if necessary to insure the delivery of 100% relative humidity to the patient’s lower airway. Routine visits for catheter stripping may need to be scheduled twice a week for a period of time. Thereafter, similar visits are scheduled whenever clinically indicated.

Subsequent scheduled and unscheduled visits during the healing period should always include a check of the bead chain necklace fitting, overall appearance and maturity of tract, catheter stripping and oximetry. These do not take much time and yet provide a great deal of information. Additionally, they give the patient the opportunity to ask questions of the clinician. All patients need to be seen at least once weekly for the entire maturation period (6-8 weeks). Clearly some patients may need to be seen more often and the actual follow-up visit schedule is based purely on clinical presentation.

“Catheter stripping” over a wire guide is by far the most important procedure that is performed each time the patient is seen in follow-up. The patients sits in a comfortable chair with their oxygen delivered from behind. Two ccs of plain lidocaine is instilled into the catheter. The wire guide is inserted down to the level of the black reference mark. Wherever possible an assistant should hold the wire guide securely in position. The catheter can now be safely removed, washed with antimicrobial soap, and reinserted over the wire guide back into the tract. The bead chain necklace is secured, and the catheter is re-connected to oxygen. Oxygen saturation is then measured by pulse oximetry. A catheter stripping can quickly determine if a patient’s cough is due to a mucus ball (which will be produced immediately upon stripping) or perhaps due to some other cause.

Lost Tract(s)

Since the tract created using the MST is so small, dislodgment of the catheter while the tract is still healing may well result in the loss of the tract. Early in the healing period, the tract can close literally in a very few minutes. Awareness and pre-planning can go a long way towards reducing the incidence of lost tracts. A spare catheter and wire guide should be kept in a common area (Emergency Dept., Pulmonologists office, RT dept. etc.) Patients will have normally tried to re-insert the catheter themselves before coming to the hospital for help. Once again, the patient’s nasal cannula is positioned to arrive from behind, and the physician should attempt to reinsert the catheter without the wire guide. If this is unsuccessful the physician may attempt to use the wire guide to reestablish the tract. If successful in finding the opening to the tract, the catheter can be slipped over the wire guide and into the trachea. A CXR confirms successful position of the catheter. Multiple unsuccessful attempts will commonly result in swelling, bleeding, and the possibility of creating a false tract. If after a sufficient time, the physician is still unable to reestablish the tract, it is best for all parties involved to re-schedule a new procedure at a later date. Most, if not all patients will elect to have a second procedure even if they were on transtracheal oxygen for only a short time.

Over 30 years of experience with the MST has yielded a number of tract related complications that are not in and of themselves life threatening, but may present varying degrees of aggravation and stress to both the patient and physician. Some of the complications are routine and easy to treat. Problems such as maceration or abrasion of the skin are usually due to the bead chain necklace being too tight around the neck. Loosening the necklace so that two fingers fit comfortably inside the chain, up against the neck will typically correct this
problem. The development of granulation tissue such as seen with a fresh tracheostomy may present itself with the MST procedure. Treatment with AgNO$_3$ sticks is the treatment of choice should this occur. Patients who smear large amounts of an antibiotic cream or jelly around the tract site may well develop a contact hypersensitivity, or even a super infection such as Candida albicans. Patients should be taught to adhere strictly to all cleaning protocols. Patients should only clean around their tracts with true soap (e.g. Ivory bar soap). Bacterial cellulitis is very rare (<1%) but would be treated with an appropriate antibiotic.

Tracheal chondritis may be seen in as many as 10% of MST patients. Since cartilage is a unique, avascular tissue, it has a tendency to become colonized. It is very important therefore to cover the transtracheal patient with a good anti-staphylococcal antibiotic for 1-2 weeks following the MST procedure. The 6-8 week period while the MST created tract is healing will in most patients present the greatest challenge to the transtracheal team. It is during this period of time that minor morbidity is most likely to occur. Once again, the development of a skilled transtracheal team, communicating well and working together, will recognize many of these minor problems and treat them before they have the chance to become major problems. Communication between all team members is crucial. During the entire period of time the MST tract is healing, the transtracheal team should be prepared to encourage and support the patient clinically and psychologically as their clinical course will get much better for them when the tract is fully healed.

The only common late complication of the MST procedure would be the development of Keloids. These may appear months or even years after the procedure. Keloids seem to develop in 4-5% of patients. Some patients have a predisposition to develop keloids (i.e. people of color). They can get large enough to cause difficulty with catheter insertion. Keloids seem to respond well to repeated injections of small amounts of depo-steroid (e.g. Kenalog, Depomedrol) directly into the keloid. Patients who continue to have ongoing tract related problems following the MST procedure can be successfully treated by having their tract completely revised using the Fast Tract procedure.

The Fast tract technique was developed as an alternative to the MST. The Fast Tract procedure surgically creates the transtracheal tract. The procedure is performed by a surgeon, under local anesthesia in the operating room with an anesthesiologist administering conscious sedation anesthesia. A custom designed punch creates the tracheal opening into which a custom stent is inserted. The patient spends the night in the hospital and the next morning the stent is exchanged for a functioning transtracheal catheter. The total healing time is reduced from 6-8 weeks down to just 2-3 weeks. The incidence of lost tracts, chondritis, granuloma formation, and keloids is greatly reduced.

In summary, transtracheal oxygen therapy offers the typical oxygen patient many benefits over oxygen delivered by conventional nasal cannula. It is currently the best and most efficient method for delivering ambulatory oxygen therapy. This document of physician instructions utilizing the Modified Seldinger Technique summarizes and addresses many of the problems encountered since its development back in 1986.
PHYSICIAN OVERVIEW - TRANSTRACHEAL PROGRAM

1. The physician should be familiar with the transtracheal program summarized in the physician instructions (available on request).

2. The transtracheal catheter and cleaning in place are mandatory during the healing phase when the tract is immature. When the tract is mature (epithelialized), the transtracheal catheter continues to be used and accommodates flow rates up to 12 L/min.

3. Depending on which surgical technique was used to create the tract, the stenting device is replaced by a functioning catheter either the next day (FastTract technique), or one week later (Modified Seldinger technique). Topical 1% lidocaine 2 cc is instilled through the stent, and the stent is exchanged for a transtracheal catheter using the wire guide. The patient should be titrated by oximetry at rest and with activity, and an arterial blood gas should be obtained at rest to confirm the PaO2, SaO2 and PaCO2.

4. Cleaning in place should be taught to both the patient and a significant other using the Cleaning in Place insert. Supervise the patient during a cleaning to confirm proper technique.

5. Most patients need to clean the catheter twice daily, but inspissated mucus may require increasing the frequency of regular cleanings to four times per day. A nondisposable bubble humidifier with a gasket seal and ≥ 2 p.s.i. pressure relief valve (e.g. Hudson nondisposable) is recommended on the reservoir oxygen system at home, but a humidifier is not usually needed when the patient is using a portable oxygen source. A servo-controlled heated humidifier may be required for patients with exceptional baseline secretion problems (e.g. cystic fibrosis or bronchiectasis) or transtracheal flow rates of ≥ 5 L/min. A humidifier with a 6 p.s.i. pop-off is also available (e.g. Salter P/N 7600) for patients on higher liter flows.

6. All patients should be seen three to seven days after starting transtracheal oxygen for a routine catheter stripping. This is accomplished by instilling 2 cc of 1% plain lidocaine for topical anesthesia. A wire guide is inserted to the black reference mark, then the catheter is removed, cleaned and reinserted. If stripping yields a mucus ball, the physician should increase the frequency of cleanings and have the patient return for routine weekly stripings for the remainder of the healing period.

7. After the tract is mature, daily or twice daily catheter removal reduces risk of mucus ball formation and is recommended. Individuals with poor dexterity or other physical limitations and those who prefer not to remove the catheter may continue cleaning in place indefinitely. Weekly removal possibly with the assistance of a skilled medical professional is advised to strip mucus from outside of the catheter.

8. Tract maturity should be assessed by a physician. The physician should remove and reinsert the catheter without using a wire guide, and the ease of insertion should be noted. Removal for cleaning should be taught to both the patient and a significant other using the Removal For Cleaning insert. Supervise the patient during a cleaning to confirm proper technique. If either the physician or the patient has difficulty inserting the catheter the physician should use a wire guide to reinsert the catheter, and the patient should return to cleaning in place for two additional weeks. Please consult the Physician Instructions for greater detail in assessing tract maturity.

9. The first week of removal for cleaning by the patient should be considered a Trial Period. During this first week the patient should remove the catheter each morning. The second cleaning in the afternoon and as needed cleanings should be done using the in place technique. Patient failure or difficulty with catheter reinsertion requires immediate reinsertion by the physician, possibly with the aid of a wire guide, and cleaning in place for two additional weeks. This Trial Period approach reduces the risk of losing the tract and makes it easier for the patient to become self-confident about removal and reinsertion.

10. After a successful Trial Period, once daily removal for cleaning may be continued or the patient may advance to twice daily removal. More than two catheter removals for cleaning per day is not advised because excessive removal and reinsertion can cause tract trauma. Cleaning in excess of two per day should be done using the in place technique.

11. Periodic re-titration using oximetry and measurement of the hematocrit and arterial blood gases is advised.

12. ALL TRANSTRACHEAL CATHETERS AND HOSES SHOULD BE ROUTINELY REPLACED EVERY 90 DAYS.

   Earlier replacement is required if the catheter or hose develops cracks, breaks, kinks, or any other sign of damage or failure.
For additional copies of this guide or for ordering information concerning transtracheal products, call or write to:

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