

***This unedited transcript of a SpeechPathology.com webinar is provided in order to facilitate communication accessibility for the viewer and may not be a totally verbatim record of the proceedings. This transcript may contain errors. Copying or distributing this transcript without the express written consent of SpeechPathology.com is strictly prohibited. For any questions, please contact [customerservice@SpeechPathology.com](mailto:customerservice@SpeechPathology.com).***

Pulmonary Rehabilitation for the Neck Breather:  
Epidemiology Behind the Mucus  
Recorded August 22, 2019

Presenter: Meaghan Kane-Benjamin, M.A., CCC-SLP  
SpeechPathology.com Course #9006

- [Amy] And at this time, it is a pleasure to introduce Meaghan Kane-Benjamin, who is going to be presenting with us today in partnership with Atos Medical. Ms. Kane-Benjamin received her BA in speech and hearing sciences from Montclair State University in New Jersey and an MA in speech and hearing sciences in 1995 from The Ohio State University in Columbus, Ohio. Ms. Benjamin began her career practicing under the mentorship of Mark Singer and Carla Gress. After 8 1/2 years in practice at UCSF Voice Center, including 3 1/2 years as clinical manager of the head and neck cancer rehab program, she relocated to continue her practice with the otolaryngology department at Evanston Northwestern Healthcare in Evanston, Illinois. Having an extensive clinical experience with TE voice restoration, she has directed and been invited faculty at numerous national seminars and training programs in the area of laryngectomy rehab. Ms. Benjamin has been employed by Atos Medical since 2006 and is currently a senior clinical educator. So welcome, Meaghan. It's always a pleasure to have you with us.

- [Meaghan] Thanks, Amy, I'm so excited to be here. I can't believe so many people signed on to talk about mucus during the noon hour. We have a shared passion. So yes, I've been doing this for a long time. And what's been really interesting is I never cease to continue to learn. So I'm hoping today that all of you are gonna learn something new as well. Please feel free to throw out questions as we go through this. If I can answer them during the time, I absolutely will. If not, we will definitely address them by the end. So from a learning outcome standpoint, there's three things that the participants, all of you, should be able to do at the end of this course. First is to identify pulmonary changes that occur in the neck-breather population. Second is describe the anatomical differences between a trach patient and a laryngectomy patient. And third is to describe the correct use and application of a heat moisture exchanger to improve the pulmonary climate in neck breathers. So in order for us to understand what's not

working well, we need to start with normal respiratory system. So this will be a review for a lot of you, but it's important, I think, to recognize just the basics around this to be able to explain to patients why they need to address their pulmonary climate after they've become a neck breather. So oftentimes they have to understand where they started from. As you guys all, and I tend not to read the slides. We'll just discuss them. As you know, the purpose of the respiratory system is essentially for us to be able to live, right. There's a rapid gas exchange. Oxygen goes into the blood, and it removes carbon dioxide. And it's a well-coordinated interaction of the lungs, the central nervous system, the diaphragm, chest wall musculature, and the circulatory system. It's very complex. Where I wanna focus your attention for just a minute is right in here.

So when someone becomes a neck breather, we actually are disconnecting all of these defense mechanisms and allowing air to go directly into the trachea and with a direct path into the lungs. That's very important, because when we disconnect those defense mechanisms, we see massive changes very quickly. So during normal breathing, when we take a look, there's all these little cilia here. And then below that, there's mucus-producing goblet cells. And these cilia line not just the respiratory tract but also the nose. And so each nostril, if you all put your finger up right now and close off one nostril and breathe through the other one, you recognize that you can breathe independently, and every time you breathe in through the nose, you're filtering, warming, moisturizing the air.

Most of the debris in the air, and we know there's lots of stuff floating around, is trapped in the nose and the pharynx, not the trachea. So most of our defense mechanisms actually exist in the upper respiratory system. Now, I'm not sure how many of you guys have studied goblet cells before. But I like to equate a goblet cell to looking like a wine glass, filled not with wine but with mucus. You'll never look at wine the same way. And so the goblet cell is quite complex type of cell structure. But essentially, what it does is it produces mucus, and it works in tandem with the cilia. So

let me unclick this. So the cilia trap large pieces of debris, which is greater than four microns, and push them out of the airways. So your cilia are pushing things up, away from your lungs, and up into your pharynx so that you can swallow down any mucus that comes up. And then the cilia in the nose actually pushes, in the opposite direction, things towards the pharynx so that then you can swallow them down. So cilia is very important, but it works in tandem with the goblet cell. The goblet cell produce more mucus at a basal level. That's what keeps our mucous membranes moist. And that mucous membrane is what traps things that are smaller than the four micron. And it keeps the tract moist, and then the cilia pushes that away so that we don't have our airways filled with extracellular stimuli, let's call it. And then we cough and sneeze when things really build up.

So goblet cells are constantly producing mucus. We all are having mucus produced right now while we're sitting here. And cilia are working constantly to keep our airways clear. So when we look at the ciliary action, what's really important to take away on this slide is that the cilia function is totally dependent on relative humidity. So when the relative humidity in the airway falls below 70%, the cilia become very sluggish. And then when the relative humidity gets below 50%, even if it's 98.6 degrees, what happens is that the cilia become dormant. They just stop working. So as a result, the goblet cells take over and start really hyper-secreting and producing a lot of extra mucus.

So this is interesting, because when we think about how we breathe normally, we have this sort of regulated temperature with the necessary relative humidity. And when we take that away and go right to neck breathing, we see a total shift in the relative humidity, which results in changes in the cilia, function of the cilia, and the goblet cells. Let's take a quick look at this video, because it gives you a visual on what's really happening with ciliated cells in laryngectomized patients who are total neck breathers. So the video, I'll play right now. And what we're gonna be looking at is when the cilia

are functioning versus when they are dormant or not functioning the way they should. Here we go, just a second here. Let's take a look. So here's tracheal cells with loss of cilia. And I'll pause. So let me get my little pointer here. These are the cilia that are functioning. And there should be cilia lining all of this cell, but they're not. So you'll see where there's cilia that's missing and cilia that's functioning. And I'll move this back just a smidge so you guys can take a look here. So you see the cilia here, and you see the loss here. So here's attached ciliated cells with and without movement. So you see the ones that are moving, and you see where they're not moving. And then you see with the coordinated movement, where they're all moving in tandem. And if you look very closely, what you can see is that there's little particles that are floating by that are getting pushing in this direction by the cilia.

So you can imagine, when parts of the cilia aren't moving or become dormant, that those particles will just collect and sit there, and then you'll need to cough or sneeze them out. And your body'll be producing more mucus to trap them, to keep them out of the airway. So it's sort of this connected process. So that gives you a visual idea of what's going on. I like to think of it as the body's nanotechnology. So as we go back into the slides, what we wanna then look at is, getting back to that goblet cells, what's some of the function of the goblet cells.

So now that we leave the video here, there's few things. Goblet cells, as we talked about, secrete mucus to protect the airway. There's a basal level of secretion. So all the time, it's producing some type of mucus. And then what we see is that when you get an extracellular stimuli, cold, dry air, particles that are floating in, what happens is those goblet cells act like whipped cream. So immediately, they increase their mucus production 500-fold in 20 milliseconds. So that's amazing, 'cause that's when, if you could take an example, if you ever walked into a dusty, or started cleaning out something really dusty, and all the sudden, your entire nose stuffs up, and you feel like you have all this extra mucus, that's your goblet cells kicking in to protect your airway

from all of that dust getting down into your lungs. As a sidebar, we do see an additional number of goblet cells in several disease states, such as chronic bronchitis, COPD, or emphysema. The facts about mucus, fun facts you can bring up on a Friday night, sticky, protective, the respiratory tract in all of us produces about two liters of mucus a day. Very high water high content, which is why we constantly tell everyone, but especially neck breathers, that they need to drink a lot of water. And then there's a complex mixture of different things listed here, water, carbohydrates, et cetera. Good to note that mucus also contains an antibacterial enzyme called lysozyme. That's important, I think, because that also is what protects us from different exposures to bacteria and extracellular stimuli. When we look at this slide, what's important to note is 150 microns, which is this top one here, that's the diameter of a hair. Looks huge here, pretty small, as we know.

And then we get smaller and smaller as we go down the list. These are some things, these inhaled irritants, dehydration, excessive caffeine, that it can affect the mucus that we produce. So when you get down into the bottom of the lungs, the last line of defense is macrophages. Because the bronchioles have very, very few cilia and literally no goblet cells. And so airborne debris is removed by these macrophages in the alveoli, and then coughed out. Let's take a quick look at this YouTube video where you can actually see how that's happening. So if we take a look, you could see the macrophage sitting here, and then you can watch as this extracellular debris is getting absorbed into the macrophage. They're kind of like suicide cells in a way, because then they sort of self-implode and get reabsorbed into the body. I want to just play this again, because I think it's important to note that the reason we have all the defense mechanisms in the upper respiratory system is that these macrophages can get inundated and overwhelmed very quickly if we just let everything that's in the air go down into the lower respiratory tract. So it's important that we're managing as much as we can in the upper respiratory system. So now we'll jump out of this, this video, and go back into what the visible results are due to chronic irritation. Many of you probably

work with neck breathers. And I think it's important that when you look at their mucus, you're actually evaluating the health of the respiratory tract and getting some pretty clear visual ideas of what's going on. Back in the day, 20 years ago, people used to bring me samples of their mucus in baggies. So now I say thank god for just iPhones and being able to show me a picture or video. Because yes, the baggies was a lot. So color, quantity, consistency, blood streaks, odor, when you see these changes in mucus, it's telling you that something is happening in the body or in the respiratory system. And oftentimes it's, how do we raise that relative humidity? How do we keep out that extracellular stimuli, such as debris and dust and cold, dry air? And how do we get patients to be hydrated? So what happens beyond this? We might say, oh, that's not a big deal. Drink a little more water. Cover up your stoma or your trach. But what's really happening is that there's cellular changes that result from chronic irritation called metaplasia. Metaplasia is the Greek word for change in form. And it essentially means that there's a replacement of one cell type to another cell type because of the abnormal stimulus. And that second cell type tends to be one that can survive and protect better.

So if we take a look here, what we would wanna see is lots of cilia all along here. But instead, it looks like a barren wasteland. And so what happens is that those cilia become dormant and a layer of cells comes over them. So oftentimes with long-term chronic irritation and that lack of humidity and climatizing of the air, we actually see patients get a very dry trachea, cracked trachea. And we might see another group of patients that just have constant mucus, but it's not even coming up. It's sort of equivalent to a smoker's cough. It just sits in that lower respiratory system because of all that mucus that's been produced, and there's no way to get it out. So these are real changes that have real implications. So when we get into the neck breather anatomy and physiology, what we know is that they're kind of the same. What it means is that when you're a neck breather, you're breathing in through an opening in the neck versus through the nose and mouth. But there's some very big differences. Tracheotomy, by

the way, and tracheostomy are used interchangeably in the literature. But essentially, the tracheotomy is the procedure done to create an opening at the base of the neck to bypass the upper airway and throat, whereas the tracheostomy is the actual opening at the base of the neck. For a laryngectomy, instead of you maintaining your larynx, which you do when you have a tracheotomy or a tracheostomy, with a laryngectomy, they remove the larynx and create a permanent opening at the base of the neck. And so the big difference here is that a laryngectomy only has one airway, whereas a trach, a tracheotomy/tracheostomy patient have two airways.

So when we look at these patients, they look very similar, very similar. I mean, let's take a look here. If you saw this gentleman, you might say, "Oh, he has a trach," which happens often in the hospital. But what happens is that if they had an episode where they needed to be ventilated, the only way to ventilate them is through the here. If they went in through the nose and mouth, they would actually be going right into the stomach. When we get over to a patient that had a tracheotomy or has a tracheostomy, what we see here is that we know that, if we can't get in this way, we can still go up, intubate them through the mouth, potentially.

So we have these diagrams here just to show the difference. This is a total neck breather, nonreversible. This is for the folks in the classroom that have never seen a laryngectomy before. This is technically reversible, meaning that you could close this up, and they could, again, breathe through their nose and mouth. Sidebar, that's why you could put a Passy-Muir valve on this patient and not on this patient. Because they have the ability to exhale through their nose and mouth. When we look at this, there's some other big differences. And this is for you to take home and look at later, but we'll cover them kind of quickly. Laryngectomy, the aerodigestive tract is disconnected from the airway so that they only breathe through the stoma. There is no larynx. Whereas, the tracheostomy patient, they could potentially breathe through the upper airway. They still have a larynx. Laryngectomy patient, unable to tolerate a one-way speaking

valve. You can never plug the trach or put in, you can never plug that stoma, 'cause they would have no way to breathe. And they're technically unable to aspirate during swallowing, because everything's been disconnected, whereas with a trach patient, they still have the larynx. They could tolerate a one-way speaking valve. They may be able to tolerate a trach plugging. And they technically could aspirate, because the aerodigestive tract is connected. So when we look at the respiratory physiology of the neck breather, at the trachea, the air around all of us, give or take, it might be a little different between Maine and Houston, it's around 72 degrees, relative humidity of 45%, and it's dirty. What's key to note is that the ciliary activity, as I said earlier, drops and becomes very sluggish when that relative humidity drops to 70%. And then when it gets below 50%, even if we keep the temperature up, it just ceases activity. So when patients are breathing through the neck, they're not getting the air warmed and humidified through the nose and mouth. They're literally breathing in cold, dry, dirty air. So we see that, the implications with that.

So after surgery, the air is no longer humidified. The temperature's not modulated. Filtering is reduced, increased risk of mucus plugs, because your body's producing all this extra mucus to keep things out of the lungs, complaints of increased mucus production, coughing, overall decreased quality of life. So what are the impacts of neck breathing on the defense mechanisms of the upper respiratory tract? Well, the cilia don't function the way they should. The goblet cells start really producing extra mucus. And then what that can happen, what can happen as a result of that is that the airways become filled with mucus. That mucus is sticky. It might be dry because the patient's relative humidity is off, and they might not be taking as much water as they should. And that's what happens, is that a mucus plug forms. When that mucus plug forms, we all know that's the scariest thing to have happen in the hospital, because we gotta get it out or the patient literally can't breathe. They can cough sometimes, depending on their state, to expel particles from the respiratory system. But we don't want that to be their new norm, where they're coughing. 'Cause that disrupts social interactions. That

disrupts eating. It disrupts how they feel about themselves. It disrupts their rehabilitative process. And then the complaints of coughing and excessive sputum, that's embarrassing for a lot of patients. And they've shared with me, I mean, I was telling people, last year I saw over 1,000 just total laryngectomy patients. And they all say the same thing: "Do you know how embarrassing it is "that I'm coughing this mucus up and I gotta wipe it away?" Or, "It disrupts me going out to dinner." Or, "I feel uncomfortable when I'm at group." So these are real issues. This is what a visual of a mucus plug looks like. Many of you have probably seen it if you work with neck breathers. This is a total laryngectomy patient. So as you see, he does not have a trach tube in. This is the permanent opening in the neck. I wish I had taken a picture, 'cause when you pull this mucus plug out, it literally is about six inches long and almost covered. He showed up at the hospital with this this way.

So this is a patient safety issue, and it's something that we really need to be focused on. Now, from an epithelium standpoint, just take a look at this slide. This is a study that was done where they looked at patients that are neck breathers and the lowest number of normal epithelium after they become a neck breather. What we start to see is hyperplasia, metaplasia, and moderate dysplasia. And this is coming from a tracheal biopsy. So we know that these changes are really happening. Now, what's important to everyone in the room, I think, is unplanned readmission. This was looked at specifically for laryngectomy patients. And what they found is that stomal and TEP complications oftentimes linked to mucus plugging and mucus production resulted in patients showing up at the emergency room and needing to be readmitted. So it's something that we can proactively address to ensure that they don't have that happen. And that's gonna be the second part of the talk is, what do we do about this? So here we are, heat moisture exchangers. It's airway conditioning for neck breathers. Many of you, as I said, probably work with trach patients and/or laryngectomy patients. And as you know, if a patient's on a vent, there's an HME that's in-line with the ventilator to keep that air moisturized and humidified. We also see with pediatric trach patients that they

wear an HME because it's so important that their little airways stay clear. So we're just talking about this for all the other neck breathers. And what's interesting is that there's about 3,500 new total laryngectomies in the United States per year. And there is about 100,000 adult trach patients that come in for unexpected obstruction or trauma that need to be trached for a short period of time, yet most of the studies are looking at those long-term neck breathers in laryngectomy. But what are the goals for pulmonary rehabilitation, regardless of how you're neck breathing? We want a decrease in hypersecretion of the mucus. We want to improve overall stomal cleanliness, social acceptance. We want to improve patient's overall self-acceptance.

And we wanna provide the patient with different speech options. But this decrease, this first one, this decrease in hypersecretion, leads to increased patient safety, patient self-confidence. So there's a lot of factors here that come from that pesky mucus that is actually necessary for us, because it's a defense mechanism when it's not overproduced. So how does a heat moisture exchanger work? Well, it's pretty interesting to me, because it's very simple. What happens is it's a closed system. So when you exhale, you're grabbing the moisture from the mucous membranes that line the respiratory tract. You then load that moisturized air into an HME, which has a foam core and is treated with a salt mixture called calcium chloride. That water vapor condenses and makes a layer of water in the foam core where the salt mixture is sitting so that when you breathe back in, you are breathing this humidified air.

Because of that water layer, it actually helps retain the pulmonary heat so that, in the end, your relative humidity raises significantly in the trachea. Now, if anybody has any questions on that, if I didn't explain that well, please jump in, because I wanna make sure that that's clear. You're essentially exhaling humidified warm air. It's getting trapped in this HME. And then you're breathing that humidified warm air back in when you breathe through there. Secondly, it's a logical barrier to gross airborne matter. So it keeps a lot of these microns out, some of the five- to 10-micron area. It covers the

stoma, it's more hygienic. And it helps the patient to adapt to having a stoma. And even with a trach patient, when we put an HME on a trach patient, they feel significantly better because their mucus production can reduce, and their airway feels more open, but then they can even use the HME to reach up, push in, and talk without putting their finger that's been exposed to all sorts of things directly to the trach tube. So hygiene is a big deal. When we talk about that loading during the inhalation and the exhalation, just remember that the word here, new word of the day, hygroscopic properties. That means that it allows for the retention of moisture, which then retains the heat, which is what is the factor. Mucus and quality of life, tons of studies out there. This is more for you to read next Saturday. You're home, you're like, "What could I look at? "I'm gonna read about incidence and severity "of respiratory symptoms in daily sputum." Just know that patients that went to wearing an HME that were not wearing an HME before had significant reduction in daily sputum production, excessive coughing, need for forced expectoration, reduction in cleaning.

But what's really interesting to me is that they also found that they slept better, and they talked better, and they had more social contacts, and they had less psychological distress, which we as therapists know is massively important in how a patient's gonna be successful in the overall rehabilitative process. So these are things that I think are really important for you to understand and for the patient to understand, which is why we're introducing the HME. When we look at lung function, we found that patients that use an HME actually have better mucus transport velocity. They have significantly more ciliated spells. And the mucus remains a little bit thinner. And the expectoration was a little bit greater, though not significant. But the thinner part of the mucus is the key. When you're dealing with a neck breather, you want that mucus to be thin and clear so they can wipe it away. The mucus will never go away. We need that mucus to trap those smaller microns, but we need the cilia to function to pull that up towards the neck so that the patient can wipe it away. What we don't want is a huge buildup in mucus that then they have to cough out and get suctioned out. Because by the way,

suction is also an extracellular stimuli which results in increased mucus production. So it's kind of a vicious cycle. Let's take a look at this video, 'cause this is actually on the Atos website. It's a great educational material for you to show to a patient. It's animated and helps them understand sort of what we just talked about.

- [Narrator] How is the pulmonary environment affected if you inhale through a tracheostoma instead of your nose? Let's remove the HME and travel into the airways. We have millions of tiny hairs called cilia that sweep back and forth, transporting mucus away from the airways. The mucus traps the dust and germs in the air that we breathe in. The cilia sweep back and forth about 10 times per second. At the microscopic level, we can see how, without the use of an HME, the unconditioned air is affecting the airways. The dry air is causing the cilia to move slower, and mucus is building up. The drier the inhaled air, the lower the activity of the cilia. At a relative humidity of about 35%, they come to a complete standstill, and more thick mucus build up. Now let's see what happens when an HME system is used. Now the inhaled air is moisturized thanks to the HME. The cilia resume their activity, and the situation normalizes. You might experience increased coughing and mucus production during the first period while the lungs are clearing the built-up mucus. The use of an HME will most likely have a significant impact on your daily life. Other users report less coughing, less mucus production, less stoma cleaning, and better sleeping. Change the HME every 24 hours. To fully benefit, you need to use the HME day and night. Remember, it's your new nose.

- [Meaghan] I always find that guy to be a little creepy. But I think one of the key things there is, the reason you have to change the HME is because there is this active ingredient, calcium chloride. And when the patient's breathing through that, after 24 hours, it becomes sort of suboptimal clinical level. So it's not gonna benefit in the same way. And I can tell you, when you see a patient that's been wearing the same HME for seven days, all of the sudden, you see things like black and mold and things building

up, because they're actually creating an unhealthy environment. So it's important that they understand that and that you educate them on why. You also don't rinse out the HME, because then you're rinsing away that calcium chloride so that it's not gonna function in the same way. So these are important factors. And when we look, obviously there's lots of short-term and long-term benefits. And there's lots of education that we at Atos provide and that you can create yourself, but I think it's important that the patient understands what they're doing, why they're doing it, and how these function to replace some of what they are missing now that they are a neck breather. When we look at literature, I always get really excited about this, because most of the studies have all been done specifically on the family of Provox HMEs for neck breathers in over 1,500 patients. And this is independent studies. This is studies looking just at how the HME functions in the laboratory, but then also with patients. This is immediately preoperatively, like the moment the patient gets a laryngectomy, what happens when you put that Provox HME on. This is long term, five years out.

So it's exciting, because I think it's, for some like this, when you're helping a patient understand what they're using, you need to understand how it actually changes the tracheal climate. Lots of different ones in here. We'll talk about when you would select which for what. But there's a few key factors. For the Provox XtraFlow HME, this is a question we get a lot. What's the difference between the XtraFlow and the XtraMoist? Well, if we take a look, right here, you'll look at this foam right here, this is a little bit less dense. So it allows a little more airflow while retaining a fair amount of moisture in the airway. So it's a little easier to breathe through. So for patients with COPD or who've just gotten used to being a neck breather, which this is also used with trach patients, they oftentimes start with this HME, and then move on to ones that are a little bit harder to breathe through. I should throw out there that none of these HMEs are harder to breathe through than breathing through the nose and mouth from a resistance standpoint. But the sensation feels different for the patient, because they don't have the turbinates and the complex architecture of the nose and mouth when

they're breathing through an HME. So this is the XtraFlow. For those of you that do deal with total laryngectomy patients, just know that Atos takes assignment. That means that the patient only comes out of pocket their 20% copay. Very important when you're having somebody wear something that they have to wear every day and change every 24 hours. So now let's take a look at this foam. This is the XtraMoist. And the XtraMoist, as you can see, is a little denser. So it retains more moisture. So it's gonna raise the relative humidity even a little higher in the trachea. But it is still relatively easy to breathe through. Something that oftentimes patients use, and clinicians use, either they just introduce it immediately post-operatively, or they work up to it once the patient has gotten used to wearing the HME. And again, they take assignment for both. When we look at the Micron, the cool thing about this, this is a specialty product. It's actually an HME that has an electrostatic filter on the outside of it. That electrostatic filter is 99% effective in attracting bacterial and viral, or basically, bacterial and viral filtration.

So they get trapped in this electrostatic filter so they can't get into the airway. Patients wear this when they're flying, when it's flu season, when they're around someone else that's sick, when they're volunteering at the hospital, and oftentimes, even when they're having a lot of allergies. So it's a really, really cool product, specifically because it's, the way that it functions. So they get the heat and moisture, because there's an HME built in in the bottom. So they get that benefit. But before anything even hits there, it's filtering out all those tiniest of microns. And this is what that looks like. I don't know if any of you have used it, but it's been really interesting. I've had some really great interactions with patients around this. So how do you put an HME on a patient immediately post-operatively? And why doesn't everyone do it? Well, what I'll tell you is changing process in the hospital is really hard. So when you look at neck breathers, and we'll start with the total laryngectomy, we used to just put an external humidification system on them, because that's what we did. But we found is that it tethers the patient to the wall. And it makes them wet, it's noisy. And 90, let's say,

maybe I'm throwing that number out there, anecdotally, 80% of the time, it's attached to their shoulder or their elbow or their thigh or the wall versus their neck, because they don't wanna wear it. So the key is to find something to allow the HME to be used. And there's two ways to do that immediately post-operatively with the laryngectomy patient. One is a soft silicone Provox LaryTube. You can do unfenestrated. 955 is the most commonly used. And then you put the HME on. And then they just, they don't talk with it or anything. But it functions in lieu of the external humidification. And guess what? It is so much more cost-effective, and amazing outcomes that come with this. Now, let's say you don't wanna use a tube, or the surgeon doesn't wanna use a tube. You can actually use OptiDerm. This is a hydrocolloid material designed to be used immediately post-operatively. And it creates a artificial scab over the suture line. And it keeps out all types of bacteria, bloodborne pathogens, things like that. It can be left on for up to seven days. And then you attach the HME, and it's not having anything inserted in the stoma. That's gonna be institutional preference, surgeon preference, but there's different ways to attach it. If you're using the HME immediately post-operatively with a trach patient, there's a trach adapter.

And you attach the trach adapter, and then you put the HME on there. And so this just attaches. It's a 22-millimeter on the trach with a 155-millimeter hub. If the cuff is deflated, they occlude to speak. Here's the really cool thing. They can wear the HME even with the cuff inflated, because it's two-way. They're inhaling and exhaling through the HME. This is a game-changer for a lot of these patients. They're up, they're around, they're walking. And then, if you wanna pop on the Passy-Muir valve, if they're at that level, you just take the HME off and pop the Passy-Muir valve on. Patients can sleep with this on. There is education and all sorts of things that have to happen, but lots for hospitals starting to introduce this, which is very exciting. When you look at the candidacy for somebody that's a trach patient, because most people see more trach patients than laryngectomy patients, just keep in mind that they should be breathing. Whenever you're introducing something new, they should be spontaneously breathing

on their own. They should have a double canula, and that's mainly because if there's an issue with the canula, you could take it out and replace. If they're using a single canula, this is a patient that's had it for a longer period, you want to make sure the patient can remove and replace the entire trach in a case of an emergency. And the HME's great, because it is not a one-way speaking valve, it's two-way. So even if a patient's not a candidate for the Passy-Muir valve, they can wear the HME, and then they could just push in to talk as necessary. So I get really excited about that. Okay, look at the family. This is a quick chart that just walks you through the resistance, the humidification, if they've addressed bacteria and virus, which is the Micron, and if they can be worn 24/7, meaning they can sleep in it, which all of them can. You wanna select the HME based on situation, especially for patients that are longer-term or a total laryngectomy. Once a patient gets used to, if they can't tolerate an XtraMoist, which is that denser foam core, go to the XtraFlow. Sometimes they'll sleep in the XtraMoist, because they want the maximum moisture retention and relative humidity in the trachea, and then they switch it out during the day. Do they have allergies? They might try the Micron.

Are they using a FreeHands valve for those total laryngectomy patients? Then they would use an XtraMoist or XtraFlow with the FreeHands. Are they traveling? So these are things that you can ask yourself. These are not HMEs. I just wanna make that clear. These are stoma covers. There's foam stoma covers, and there are cloth stoma covers. And this is important, because especially in the laryngectomy community, patients educate other patients based on their own experience, what's is fantastic from a support standpoint, gets a little scary sometimes on what they're making recommendations on, because, might not be exactly accurate. Just know that if your patient is a neck breather, especially laryngectomy, if they are not wearing an HME, they need to be wearing a stoma cover. That's what's most important here. And that's because you don't want things, and I can tell you lots of stories, where a patient got stung by a bee in their trachea, and it swelled up, and they were in the hospital. A

patient that I knew, he came in and he said, "Oh, I was riding my motorcycle, "and I think a fingernail flew into my trachea. "And now I can't really breathe." He had something, I don't know if it was a fingernail. I don't know why fingernails would be flying around when he's riding his motorcycle. But something flew into his trachea, and it was embedded in there, and they had to remove it. And he had a serious, serious infection. So the bottom line is protect that airway. Because it's a direct access down to the lungs, and we do not want something to go wrong there. Post-Operative Pulmonary Rehabilitation.

So when we look at this, we just keep in mind that there is very specific goals. We wanna replace some of the lost function of the upper airway, tracheal climate, improve tracheal climate and pulmonary function, enable patient with the independence around stoma care, and reduce the use of moist air and suction. So patients that use an HME in the hospital immediately post-operatively for total laryngectomy have a significant reduction in the use of, in being suctioned at all and in using moist air. And it's important to note that you don't use moist air trach collar over an HME, because you will saturate the HME. The HME is used in place of the trach collar. So just keep that in mind. Lots and lots of research. And if you guys need any of this, you can contact us. We actually have a lit review.

But there are studies looking at using the HME at Mass. Eye and Ear immediately post-operatively where they found decreased need for suctioning. Then they found, in another study, Merrill, in decreased suctioning in nursing care. Cost effective, reduced stomal crusting, and better handling of secretions. This one's really interesting. Reduced adverse events, mucus plugging, while in the hospital when they compared patients that used an HME post-operatively to patients that did not use an HME, just used external humidification. So lots of good stuff there that I think is exciting. When we look at studies immediately post-operatively using the Provox HME, this is the only randomized controlled trial where they looked at using nothing, an external

humidification, versus the Provox HME. Here's what they found. I love research, right. They found that compliance, external humidifier, of the 26 patients, only 11 used it daily. Only 12 used it 24/7. The rest of the 26 patients didn't use it at all. And as a result, you could see there was more coughing, mucus expectoration, lots of sleeping problems, and really found it a very unfavorable experience. And on average, the nursing care was 30 minutes per day, trying to do suction and manage those issues. When they used the Provox heat moisture exchanger, compliance went 23 of the 23 patients wore it daily. 20 of the 23 wore it 24/7. Their coughing was significantly lower. There was a number of patients that just had zero coughing, six to 10 times. So most of the patients, it was less than five times per day where they had a big coughing episode immediately post-operatively.

Mucus expectoration dropped significantly. And the range was zero to 5.5 numbers of time versus zero to 15. And only four of the patients had any sleeping problems. And all of them found it very favorable. And nursing care went from 30 minutes to 20 minutes and changed from managing secretions to educating the patient. So really, I think, just amazing stuff to see when we look at some of these studies. And guess what? Way more cost-effective. So when we looked, and then we're like, "Oh, in Europe, it's so much more, "everything's cheaper than in the US." So what we did is we looked here in the United States. What's the average cost?

We took a major hospital in the Midwest and looked at their, they pulled their numbers and said it costs them \$176 per day to use the external humidification. Because they have to change the tubing and the suction, and all these other things. The HME system, if we look at the total laryngectomy post-operative kit, it costs \$385 for the whole stay. So there's this huge difference in cost that I think is really exciting and compelling. Because it's very rare in healthcare that we can improve outcomes and reduce cost all at one time. So when we look at those adverse events that we talked about, just look at the significance here. External humidification, there was 21 adverse

events with post-operative complications. And HME, there was three. And those three, this is a hospital that was early introduction of the HME and was still educating people on how often to change the HME. So really interesting stuff. When you look at a post-operative laryngectomy pulmonary program that you might wanna introduce specifically, and we're in the process for creating one, also, for tracheostomy patients, it's just, what are the products you need? What's the education you need? And then how do you roll this out at the hospital? And that's something that there's lots of support for if that's something you're looking to do. Because it is a step-by-step process. It's not a fast process. But I'm gonna tell you it's very worth it. When we look at post-operative protocols, this is for you to go and look at later. But protocols are important because that's what the clinical nurse specialist needs to see. That's what the respiratory therapist needs to see. It's what the whole team needs. So know that this exists, and we can provide a lot more than just this.

But in a nutshell, it's educating the healthcare providers, the clinical team, whoever's managing the patient, as well as the patient themselves. With that trach adapter or with a total laryngectomy patient, they can use a shower guard immediately post-operatively, which blocks that airway, the neck breather airway, from allowing water to get in when they shower. So that's kind of an exciting factor for a lot of patients, because those little things where they feel confident goes a long way in how they start to take over their own care.

So I do wanna spend a few minutes on frequently asked questions around using a Provox LaryTube immediately post-operatively. The LaryTube needs to be cleaned a couple times a day. It's quite easy. You just use water and a brush. But it does need to be cleaned out. The reason for that is, if you let it sit there longer, we all know mucus is sticky. It dries out, and when that happens, it's much harder to get it off the tube. You could just use, if you're trying to disinfect the LaryTube, there's different things that can be used for that. And there's obviously an IFU for that. When do you change the HME

cassette? You're gonna change the HME cassette at least every 24 hours. What they've found in all these post-operative studies is that in the first couple days, the patient will typically go through, it's 2.79 cassettes to be exact, immediately post-operatively, because they have a lot of adaption. I mean, we've just disconnected all of the defense mechanisms, made them a total neck breather. This will decrease after a few days. If a patient comes to see you and they've been a neck breather for five years, it's gonna take them a few weeks to adapt once you introduce the HME. So keep that in mind. What you're training the patient to do as part of this process is remove the HME when they have to cough so it doesn't become clogged. Not hard to do, but something that's gonna be part of your clinical protocol when you're instructing them. And then showing them how to talk with it, if it's with a laryngectomy patient, you might not have them use the talking aspect of the HME if they have a voice prosthesis until they're cleared to talk, so just whatever your protocol is for that. With the trach that, they can wear that HME all the time. They just have to be, when they wanna talk, they just depress the beige lid.

Does the patient still need moisturized air? This is the biggest hurdle to overcome. The HME typically provides enough moisture. If the doctor, for some reason, or the respiratory therapist wants to use a trach collar, you just need to remove the HME. What the trach collar is introducing is moisturized air, or humidity. But what it's not doing is filtering out all those particles. And if you left the HME in place, it would become condensed. Let me see here, we have a couple quick questions that I do wanna answer. "Can you ever reuse an HME?" You cannot. So what happens, you can reuse the same HME with the same patient. That's a question we have here. And oftentimes what'll happen in a hospital is someone'll suction off some of that, if they get mucus on the back, they suction that off and put it back on. But you can't, there's no way to treat and replace the HME. Because it is treated with that calcium chloride that has an optimal level that then reduces over time. And that's why you can't rinse it or retreat it. I hope that answered your question. "Does the presence of an HME assist

"with production of esophageal speech?" Interesting. So I can't say that it assists with the production of esophageal speech, but what it helps with is controlling the stoma blasting that you oftentimes see with new laryngectomies. So what happens is they're trying to do esophageal speech, and those of you that don't know what that is, they're, for lack of a better word, or description, they're injecting air into the esophagus from their mouth. Many boys in your eighth-grade class could probably do this. And then that's creating a sound, and then they're producing words around that sound. And so what happens is that, for a new patient, when they try to inject the air, they're also exhaling hard through the stoma, and it could be a distraction.

So sometimes with the HME there, it helps as a training guide for them not to do that stoma blasting. And then we have a third question. "What do you do for patients that are unable "to physically remove the HME when they need to cough?" So that is something that you would evaluate on an independent basis. That is one area that, the challenge would be, if they can't remove it, and they are coughing, that they could clog up the HME. And so depending on the setting they're in and if they have people that are around them all the time, you would wanna evaluate that on an independent basis. If the patient is gonna be left alone, and they are unable to remove the HME when they need to cough, then I would say that you would not use the HME during those periods of time.

All right, I love the questions. "What is the biggest respiratory issue "with patients immediately post-laryngectomy?" Excessive mucus production, because we've disconnected the upper airway. That's the biggest challenge. And so historically, we treated those laryngectomy patients like a trach patient and put on the external trach collar. What we found was that they are still having the mucus production, which means that they're requiring all this suction that they never required before. And as a total laryngectomy patient, unless they had serious COPD or emphysema, they should be able to bring up those secretions on their own. Because we have so much mucus

production and subsequent plugging, that becomes an issue. So literally, by introducing the HME immediately post-operatively, we've been able to really reduce that issue. And what's really cool is, with the Provox HME has been, it's been used, gosh, over 15,000 patients with total laryngectomy over the last 11 years. And it's just amazing what we've seen the shift in. So that's been exciting in terms of that respiratory issue. And then last question, and then we'll jump into troubleshooting, "Why would a patient still produce excessive mucus "even while using an HME?" Well, that's a good question.

So oftentimes it's because they do have some COPD. And as I alluded to earlier in the talk, if somebody has COPD, they might have excessive goblet cells that are hypersecreting, and that's not reversible. So that metaplasia, where the cilia becomes stagnant, that's reversible. If we have excessive goblet cells or hypersecretion that happens just because we disrupted the defense mechanisms and created a neck breather, that's pretty reversible. But if someone's has chronic irritation due to smoking or chemical irritants over time, and they end up with emphysema, as we all know, or COPD, that's not reversible. So those patients oftentimes continue to produce excessive mucus. We've also seen patients that go home and live in environments where they have high levels of mold, dander, and other chronic irritants in the house.

And those patients, we will see, will have excessive mucus. And sometimes trying the Micron will help with that. But also figuring out if they can change the humidity in the house, or if they can change the environment in some way is very helpful. So I hope that answered your question. Oxygen, you can use oxygen with a trach collar over the HME in the hospital, outside the hospital. It just needs to be nonhumidified. Because the humidity is provided by the HME. We have a whole booklet and CD on how to administer CPR. But you do need to remove any tube for the laryngectomy patient prior to administering the CPR. Discharge, outpatient, equipment, and planning, I'm putting all this out here, 'cause if you're implementing this in your hospital, you need to

think through these things, and there's ways to set this up. But we just wanna make sure that it's comprehensive. As many of you that work with laryngectomies know that the patient also gets a Coming Home Kit to help them transition and have access to supplies, HMEs in particular, once they get discharged from the hospital, while their insurance is getting set up. And then post-op stoma care, we need to instruct patients whether they're a trach patient or laryngectomy patient what that looks like. Here's some basic ideas on how to do that. Of course, you can adapt it to your clinic and your hospital. We know there's long-term benefits with compliance. And we see these same benefits in the goals in the studies that we've looked at, and the goals have been laid out for patients. In addition, just watching, if a patient wears their HME day and night, they see a significant reduction in the frequency of coughing. And this has major implications for patients. So when we get into troubleshooting, the last couple little things is just, if the patient has that excessive mucus, as someone has asked earlier, despite they HME, ask 'em, "Are you wearing it 24/7?" 'Cause if they take their HME off at night, and then they put it back on during the day, they had 12 hours, eight hours of cold, dry, dirty air going in, and their body reacts.

Remember, that 20 milliseconds, 500-fold increase in mucus production, that's gonna happen overnight. And then they put the HME on, and then all that mucus has to thin and clear out. It's called the thinning effect. So asking that question, asking, is the patient rinsing it out? Are they wearing it longer than 24 hours? Are they cleaning their stoma? If they are somebody with COPD, suctioning is necessary. How long have they been using the HME? If this is new to them, it takes some adaption, and that might take more than a couple days. Excessive mucus despite the HME, continued, right. They might have other pulmonary issues. If they have a laryngectomy and they have a prosthesis in, they might be aspirating around or through the prosthesis at a very little bit that's resulting as an irritant that results in increased mucus. If they are a trach patient that's eating by mouth, or they might even be aspirating some of their secretions, these are things that you have to consider. Difficulty Tolerating Breathing

Resistance. Try a lower resistance. Build up over time. Oftentimes when I have a patient that's trying an HME as an outpatient for the first time, I actually put the pulse oximeter on them so that they can see that they're maintaining their oxygen levels, because their perception is it's harder to breathe through. And they have to adapt to that feeling. And I wanna built their confidence in doing that. We sit in a chair. We walk around. And then I give them a plan on how to introduce this for longer periods. And then I'll leave you with this idea, right. 24/7 HME compliance may result in a lot of amazing things. But reduced in-hospital complications, reduced need for chest PT, reduced tracheobronchitis and other pneumonial infections, more cost-effective, no need to use external humidifiers and vaporizers, significantly more ciliated cells, reduced stomal crusting, and decreased frequency of coughing, forced expectoration, stoma cleaning, and better speech, better sleeping. And the cool thing is, all these different studies, over all of these years, have been done with these Provox HMEs that I've just presented to you. And so we have lots of references here. But I just wanna leave you with the idea that, it seems daunting to change process in a hospital, but I gotta tell you, this is one area that is absolutely worth it. And it's life-changing for the patient. And it's very exciting for you as a clinician to be able to be a part of that. So I'll take any other questions you may have that maybe popped up, even if it's related to HME or anything else that I've referenced.

- [Amy] All right, well, thank you, Meaghan. We'll give it just a few moments to see if there are any additional questions. And in the meantime--

- I'll leave it on this slide in case, yeah.

- We do have one here from--

- Oh, I have a question here. Great. "When you push against an HME, does it occlude the airway?" So it does not. So that's a good question. And so basically, just like with a

trach patient, or with a laryngectomy patient, what happens is you have the tube in there that's keeping the airway open. So what happens with the HME is that, when you press down, it closes, it depresses the foam so that the lid closes against the base of the HME itself. And that disrupts the air from going out through the neck and redirects it up through the mouth for a trach patient and through the voice prosthesis for a laryngectomy patient. And I think it's important to note that if you're a laryngectomy patient and you don't have a voice prosthesis, you're still gonna wear the HME. All laryngectomy patients should be wearing an HME. You just won't use the depression function to push in, because you won't have that voice prosthesis. I hope that answered the question. And there is also an HME that can be used that you don't have to push in if your patient has a very sensitive cough. So just reach out to any of us at Atos, and we can walk you through this, 'cause it's a lot of information, but super exciting.

- [Amy] Yes, so thank you, that does make a lot of sense, and I think does answer the question. And Mary says, "Thank you for a fabulous presentation." So I would like to say the same thing. It's always a pleasure to have you here, Meaghan. You do a really fantastic job explaining some complex concepts. So this is great. I think we've addressed all the questions. So we can go ahead and wrap it up there. Thanks to all of our participants for joining us today. We certainly do appreciate your time as well and look forward to seeing everyone again soon, have a great rest of the day, everyone.

- [Meaghan] Thank you, thanks, everyone, for joining. Take care.