



## **Capnography: Creating a Culture of Safety An Interview With Peggy Lange, RT**

### **Pat Iyer**

Hi, this is a podcast from the Physician-Patient Alliance for Health & Safety. The podcast that we're presenting today is called "Capnography - [Creating a Culture of Safety]". Welcome to our podcast.

My name is Pat Iyer. I'm a nurse and I'm talking today with registered respiratory therapist, Peggy Lange.

Peggy, thank you so much for joining us for this topic about capnography. Could you please tell our listeners about the facility where you work?

### **Peggy Lange**

Yes, Pat. Thank you.

St. Cloud Hospital has a long tradition of caring for patients in Central Minnesota. We were founded by the sisters of the order of St. Benedict in 1886 and have grown to a high quality regional medical center. We are a 489-bed hospital and we serve a 12-county area.

### **Pat**

Well, that's really a large facility and you cover quite a bit of territory. I understand that you were involved in an evidence based practice project. What was the initial focus of the project?

### **Peggy**

The initial focus really came from a concern from one of the imaging nurses. She was the educator there and she had seen an increased number of articles that talked about monitoring capnography during procedures. From that, we began looking at this as a focus project. However, there was also work being done by the sedation and pain committee and we began to overlap some of the work.

### **Pat**

Then, what prompted the development of the project at your facility?

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**Peggy**

There were a number of things that we looked at. We initially examined our Narcan use, but decided not to focus on Narcan use. We decided to examine our ART [Acute Response Team] calls, our emergency response team, and our code blue events related to sedation. In that report that we made, there's one sentence that says that the patient had procedural or conscious sedation in the 24 hours prior to the event.

So, that was a concern of ours when we saw that number and we thought we could have improvement in that area. There was also concern expressed about the number of planned and unplanned sedation, and opioid reversals that we had, and just how we had differing opinions of quality of ventilation.

**Pat**

I know that you mentioned a team addressing this project. Tell me who was on the team?

**Peggy**

There were many members on the team, many from our pain and sedation committee. But, there were nurses from various areas across the organization, from our outpatient areas like endoscopy and our surgical areas. There were respiratory therapists. There were providers. Our medication safety pharmacist was on the team as well as anesthesia members too.

**Pat**

I would imagine that took a lot of coordination to find a time that was good for all those people who are all busy in their roles.

**Peggy**

Yes.

**Pat**

Did you look at the medical literature at all in the process of beginning your work as a team?

**Peggy**

We did. We reviewed the literature and then budgeted through normal channels for approval for the equipment, and then worked closely with the surgical floor for the trial period. We found that the literature talked about CO2 monitoring was providing an earlier indicator of respiratory compromise before the patient became hypoxic.

So, even before oximetry would be a reading, CO2 monitoring provided that earlier indication. We found that it was recommended as a tool for procedural sedation. And during the recovery for sedation, we found that end tidal CO2 monitoring was recommended to assist with the quality of ventilation. It was a standard of care for anesthesia for a number of years for

intubated and mechanically vented patients, and it's also in the ACLS guidelines for cardiopulmonary arrest management.

My own story is I've been a therapist for a number of years and we've always monitored end tidal CO2 with our ventilation, and with our ventilator management. So, it has been a standard for a long time for invasive monitoring. And now, we want to move towards non-invasive monitoring.

**Pat**

Then it sounded to me that you picked the surgically unit to use, as your trial unit. What were the considerations for choosing that unit?

**Peggy**

We actually picked a couple of units. So, we picked the imaging department as an outpatient area for procedures and we picked a surgical unit, because we wanted to make sure we were actually trialing the equipment and putting it into use. So, some of the considerations were the number of patients that we would see and we would get to monitor. And, also, it was a smaller number of people for the education that we could really concentrate on specific questions or comments that came from those smaller units.

**Pat**

And then as a result of this pilot project, what changed?

**Peggy**

We did develop a policy and I'm actually very proud of that. Our capnography monitoring was going to be used in the adult non-vented patient during the administration of sedation, during the recover for two hours and/or the return of the baseline for the patient, during continuous opioid administration and recovery.

And, the biggest thing for me was any time a nurse or a therapist were concerned, we could put it on without making any other phone calls. We could just implement it on our own concern. In addition to that, in January of 2015, we worked and we added that we could use this policy for our pediatric patients too.

**Pat**

I know that some of our listeners are probably not familiar with all of the terminology involved in your project. Could you take us through some of those terms that you've been using and give us just a quick overview of what those are?

**Peggy**

Oxygenation - really we need it for metabolism. Our listeners will really know that they measure it by SPO2 measurements or oxygen saturation and oxygen saturation is kind of a later change. When you make a change for oxygen, it reflects that in about five minutes.

For ventilation, carbon dioxide is from metabolism and capnography measures the exhaled CO<sub>2</sub> at the point of exit for the patient. So, it could be an endotracheal tube. It could be out the nose. It could be with the mouth. It could be out a trach tube, but it's at the point of exit. And for capnography, the monitoring tools that we have reflect the change in about ten seconds.

**Pat**

So this is a much faster response.

**Peggy**

Yes, it is a breath to breath measurement.

I know that sometimes, go ahead.

The other couple terms that we have is the capnogram, capnography. And I've told people to not get too hung up on what it is, but what they would really want to do is they want to have the waveform and the numerical number in the same reading. So, that's capnography.

**Pat**

And then what is a capnogram?

**Peggy**

That's the real-time waveform. So, that's the waveform of where they exhale in the carbon dioxide is in the respiratory gas. But the capnography is really the end tidal numerical reading, the waveform and the respiratory rate capnogram.

**Pat**

Then it sounds to me like that capnography gives you more data than the capnogram, if I understand it?

**Peggy**

Yes. Yes, it combines two of them.

**Pat**

If you walked into a patient's room and the patient was having end-tidal CO<sub>2</sub> monitoring done, what would you see? What does the equipment look like?

**Peggy**

Well, there's a variety of equipment out there and you can program them to do different things, but the basic thing that I would want to see is the number and I would want to see the waveform.

Then, usually, the respiratory rate is also listed as a numerical data on the screen. The measurement of the exhaled CO<sub>2</sub>, we measure the normal range is 35 to 45 and we want to really work toward the patient's normal. There are some articles that reference a different range and that would be 30 to 43, but we really have taught and see the literature at 35 to 45 millimeters of mercury for the end tidal number.

**Pat**

And how do people who have this equipment in place respond to it? Is there any discomfort associated with it?

**Peggy**

One of the important things that we learned during our project was there are a number of noninvasive devices. So, there is a monitoring cannula with a scoop that would cover the mouth or with a small prong that would cover the mouth that would catch the exhalation part from the mouth.

And, sometimes as patients wake up or they want to talk, that small scoop or piece that comes down over the mouth does get in the way. They see it when they're talking, if they want to take a drink. So, we try to just have patients have the best monitoring and we've actually gone to just a monitoring cannula for patients.

The other important point of that is there are cannulas that have oxygen that can come in them too with the monitoring cannula and the caregivers really need to know where the oxygen comes out of the product, and where the monitoring takes place.

**Pat**

Does this look like a nasal cannula?

**Peggy**

Part of it does look like a nasal cannula, yes. And, I think that has lent to some confusion for people.

**Pat**

Because it looks similar, you mean?

**Peggy**

Yes.

**Pat**

If I were looking at the waveform that was produced by the capnography monitor, what would I expect to see if it was normal?

## **Peggy**

Well, there's a number of waveforms that represents it. So, there is baseline drawing. The expiratory phase, there's an upstroke in the line. There's an expiratory plateau and then there's an end tidal concentration. So, there's one point on the waveform that really tells you where the number or the numerical value comes from and then inspiration happens.

It kind of looks like a square box and that square box repeats. The square box would move, if people are breathing like hypoventilation. It would be a normal shaped waveform. It would just get wider. And certainly, the squares would be wider and there'd be a lower respiratory rate.

For hyperventilation, the squares would be faster. So the waveforms might look a little smaller or closer together and then that number is usually a lower number, but there aren't as many patterns in the waveform for capnography as opposed to maybe like an EKG.

## **Pat**

Okay.

## **Peggy**

For patients that have COPD or asthma or any issue exhaling, the changes that happened to the waveform is there might be a slight curve to that. So, it might take them a little longer to exhale. So, instead of the nice square box pattern, it might be curved on that expiratory plateau. They actually do call it a shark fin.

## **Pat**

I can envision the shark fin.

## **Peggy**

The last of the waveform patterns have to do with rebreathing. So, if the patient does not have enough inspiratory or expiratory flow, the whole bottom axis moves up on the scale. And, normally, that has that higher end tidal reading.

## **Pat**

So far in our podcast series, we've been focusing on oversedation and opioids. What does the waveform look like in that type of a clinical situation?

## **Peggy**

The alteration in the exhaled gas would show obstructed airways or it would show apnea, or a flat line as the other type of waveform. So, it's just important to remember, it's a trending tool. The alarm value needs to be set for every patient and because you see one different number, it doesn't mean that there has to be something occurring, but you want to look over time for trending.

For opioid patients or oversedation, again, the waveform, if it was obstruction, the square would start collapsing. And of course, it could be a flat line if there was no breathing at all.

**Pat**

Well, hopefully, the nurse or respiratory therapist goes into the room before you see that flat line. But, let's say that they see a concerning pattern, who gets notified in that situation?

**Peggy**

Well, number one, the nurse caring for the patient and she might call somebody else to help her. The provider would also need to be notified. Maybe medication rates or doses would have to be changed and, depending on the patient condition, they might call a hospitalist. They might call an ART call and they would take action based on that.

There are a number of things that can happen. Again, this is a trending tool in the room. And, if alarmed, we would want the caregivers to come in the room and then assess the patient. This will never replace the vigilance that a nurse could do or give to the patient.

**Pat**

And you mentioned an ART call, I just wanted to be sure that abbreviation was clear to our listeners.

**Peggy**

It's like a rapid response call or acute response is what we call it and there are a number of terms for that, but it's when somebody wants a second pair of eyes to come and look at the patient.

**Pat**

What would be in the medical record if a patient developed this type of concerning pattern? What would you expect to see?

**Peggy**

I would want to see a full respiratory assessment. And, if you were calling a report to a provider, they would want to know this too. They don't want to just know a capnography number, say, 22. They don't want to hear that. I think what they want is the full assessment, including your level of consciousness or the sedation level.

Maybe when they got the last sedation, they would want to know the depth of the respirations. They would want to know saturation. They would want to know breath sounds, vital signs, as well as that capnography number.

**Pat**

You've mentioned a couple of times about sedation and medications. I think it would help our listeners, if you could give us a little bit of detail about the medications that are fast acting

versus the ones that are slower in their onset

### **Peggy**

There were really four medications that we found throughout our project that we were giving patients. One was fentanyl done in our recovery room. The normal dose is 25 to 50 mcg. The onset of that is really under one minute. For versed, the normal maybe two milligrams, the onset is three minutes. For hydromorphone or Dilaudid, the onset is 15 minutes. And for ativan, for IV, the onset is 15 minutes.

For this project, we worked with our safety pharmacists to help us with those definitions. I certainly realize that other facilities could find other references, but we wanted to be consistent throughout the hospital. So, we went to the safety pharmacists and worked with those onset times.

### **Pat**

And then the other part is, in addition to how fast acting the medication is, would be how long that medications stays in the system? What is the half-life? Could you give us a little bit of details about those pieces?

### **Peggy**

Yes. What we've found for fentanyl is the half-life is from 3 to 12 hours and certainly 12 hours seems like a long time. So, we concentrated at about the three hours. What that would mean is if I was having an endoscopy procedure at noon and I received 200 of fentanyl, the half-life is 3 hours.

So by 3 o'clock in the afternoon, my drug on board would be half of that, so 100 of those micrograms. Then 3 more hours at 6 o'clock, it would be 50. And at 9 o'clock, it would be 25 and so on. So, it's a three-hour half-life.

For the versed, that half-life is 2 hours, unless the patient is obese and then the half life becomes 4 hours. So if you receive two milligrams at noon, then at three o'clock you would still have one on board.

For hydromorphone, the half life is 3 hours, and again we saw in some of our records that patients would received a second dose of hydromorphone because of their pain at under 15 minutes. So, before the first one even had that onset time. And then they would give it more without realizing that half-life of medication. We did a lot of education about half-life of medications.

### **Pat**

Yes, and certainly I could see the potential for a clinical emergency if those medications were given too often without considering the half-life.

## **Peggy**

Right, just like you're kind of alluding to, it's a delicate balance between caring for the patient and the pain that they have. It would be nice to know what they really expected their pain level to be and the medications and being able to educate patients and their families about how that could stack.

## **Pat**

Could you summarize for us the clinical emergencies that capnography will detect?

## **Peggy**

Yes, when you look at the monitor and see the number and the wave form, you would be able to see hypoventilation, you would see airway obstruction and you would see that flat line of no breath.

## **Pat**

I think it would be helpful as we conclude this podcast if you could take us through a case study involving this issue, perhaps a person who received care in your facility to help us understand what occurred.

## **Peggy**

One of the patients that we reviewed with staff, had a surgical procedure on a shoulder. As the patient came out of the surgical area, out of the operating room, the vital signs were normal. So at 10:25 his pulse was 72, respiratory rate was 25, he was on a nasal cannula and his end tidal was 36. He had complained of pain, so at 10:30 50 of fentanyl was given.

At 10:31, the respiratory rate dropped to 18. The nasal cannula was still on and this was still reading 40. By 10:36, the patient's respiratory rate had dropped to 12, the oxygen saturation had dropped, they had turned the nasal up to 6 liters, and capnography was reading 17. Because this was one of the first cases we had, the staff thought that the machine wasn't working. Because we set our alarms at 20 and 55, so certainly a 17 would give an alarm.

At 10:38 the respiratory rate had started to come up, the nasal cannula was still on at 6 liters but reading only 90% sat, and our end tidal reading was still 16. By 10:40, when they talked with the gentleman about his surgery, he took a deep breath and his end tidal reading came to 34.

Again, as you work with patients or you talk to patients they are going to take a deep breath and again a breath-to-breath measurement will have that reading go back to normal. And then when left alone you need to be careful that capnography numbers don't go low again.

I think as caregivers we do really well when capnography readings go high, we know to intubate, we know to put them on a bilevel machine with a CPAP or BiPAP, but when it goes low, we need to start being concerned too.

For this gentleman, he had two other times of receiving fentanyl of 50, and, within a few minutes, his end-tidal reading dropped again. Again, because it was new, they thought it was the equipment, when really it was the patient and there were other things happening.

I believe our electronic medical record can really help us in putting these pieces of the puzzle together. On our surgical floor, we might have caregivers collecting data for patients, their vital signs, and we're monitoring them closely, but as you go in, you wake them up. And breath to breath, if you're waking them up then you're not going to see the low numbers.

We know that when you walk out of the room, that's when the alarm could happen, and that intermittent use is not as good as continuous, and then looking for the other signs of compromise.

The nurses I believe are very good at delivering medication, but they're not putting the pieces together that this medication caused this drop in end-tidal or this change because we don't visually see that very easily unless we look at our medical record and try to find a report that puts them together for real time.

I know that that was a lot to explain.

**Pat**

So it sounds like he was responding to the fentanyl if that was the pattern that you were seeing with the changes in his end tidal CO2?

**Peggy**

Yes, the education that's needed is still that a lot of caregivers, when oxygen saturation goes down, they turn up the oxygen, and it kind of masks the event that's happening. And, you need to think of ventilation and perfusion and use all these pieces together.

**Pat**

Could you share with our listeners what were some of the lessons learned in your project?

**Peggy**

The biggest things we learned, and were already out there, is narcotics and sedatives can cause respiratory depression, especially in a post-op period of time. I encourage all the caregivers to really think that they're in intensive care environment for those first few hours until that patient recovers or starts waking up.

We know that intermittent monitoring can stimulate the patient to a higher level of consciousness. But again, when they're left alone, they can experience that respiratory depression. We want people to document the trended numbers, not just the numbers when you stimulate somebody, because it's not giving the full picture to the next caregiver.

And, giving best care to the patient is over the continuum, not one area to the next area to the next area. Our outcome was really to prevent medication induced respiratory events. We know that high and low CO2, we needed to do staff training about both of those, and we needed to

show the staff the benefits, we needed to share case studies.

And, it's really a tool for early recognition before the serious events happen.

**Pat**

And, is there anything else that you would like to share with our listeners today?

**Peggy**

I do think that capnography is a tool that is very beneficial. I grew up in the time where pulse oximetry was a new tool and that was presented to us and it was presented as this wonderful, wonderful tool. And, now a new tool is coming and we're kind of needing to put oximetry as a late sign.

There are some naysayers in the world of understanding capnography, but I've seen it work for our facility. There are many articles out there being used in endoscopy suites, in PCA monitoring, and again, whenever a caregiver is concerned to be able to put it on.

**Pat**

Well I appreciate you sharing your expertise with us today, Peggy. This has been most useful and I think it will help people get a much better understanding of the use of capnography, especially those important clinical situations where it is helpful to detect emergencies prior to them spiraling out of control.

This is a podcast from the Physician Patient Alliance for Health and Safety. Stay tuned for our next program.

**Peggy**

Thank you.