Improving Glycemic Control in Critical Care Units
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Glycemic Control Bootcamp
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PRESENTER: Have to fly her in from sunny San Diego. She is a hospitalist at Virginia Mason Medical Center here in Seattle. She earned a medical degree from Wayne State University in Detroit, completed her residency internal medicine at the University of Connecticut and earned, recently, earned her fellow of hospital medicine. And her current role is the Inpatient Glycemic Control Team Lead.

She facilitates weekly insulin safety rounds along with bimonthly nursing champion meetings, is responsible for management and upkeep of all inpatient insulin order sets and reports glucometric performance to providers, as well as hospital leadership. So we're real excited to have her here.

And with that, this-- you saw it give Dr. [? Hass ?] a little problem. It's pretty sensitive. But down is forward. So, yeah, there you go.

DR. THERESE FRANCO: OK, thanks. Can you guys hear me? OK. All right, just a couple of quick comments. It seems like most people don't have a dedicated team as yet. It doesn't have to be the traditional clinical rounding team. Most of the work we did at Virginia Mason was with just representatives from different disciplines meeting on a regular basis and then sharing and spreading kind of our shared mental model.

The other thing is, we're showing you kind of what I would refer to as a lot of sexy tech. You don't need to have everything hardwired into your EMR right off the bat. A lot of this stuff you can put on paper and cycle through it a couple of times and improve it before you really commit to the IS work. Because I know the Information Systems or information technology resources are often pretty tight for a lot of us at different hospitals. So start on paper. And go through several cycles before you really commit.

All right, so just a brief outline, I'll give you some learning objectives. We'll cover pretty specifically the principles of DKA. And I'll give you the ingredient list for building a perfect protocol. And we'll talk in some case-based detail around transitioning from IV to sub-Q.

This is a really high-risk time. And it's a transition of care that we don't tend to think about. Because the patient's not physically moving out of the building. But it is a transition of care.

OK, so learning objectives-- implement an IV infusion protocol within a Critical Care Unit. Apply better coordination and communication with bedside nursing related to patient nutrition. This is a huge risk for hypoglycemia, which is focused on hypoglycemia. So you'll see, we'll get into a fair amount of detail around that.

Develop or improve protocols around IV infusion, DKA order sets and transitioning from IV to sub-Q all within the Critical Care Unit. How many of you touch patients in the ICU?

So guidelines, again, insulin is recommended. Anything else really is not recommended in the hospital. IV insulin is recommended for critically-ill patients. One of the things we discussed a lot of my institution was, what is critically ill? That's a clinical judgment.

And for us, it doesn't necessarily mean that they are placed in the Critical Care Unit. So we do have IV insulin infusions for critically-ill patients on our Progressive Care Unit or somebody may call that Stepdown Unit. The decision about who is critically ill is really a clinical judgment shared between sort of nursing and physician.

All right, so indications, DKA or HHS-- and that's kind of a very specific physiology. So they're often glucotoxic with a neuroendocrine feedback loop that really means they need a lot of insulin. It's very aggressive. It's really meant to bring the blood glucoses down rapidly, so that we can avoid the metabolic [INAUDIBLE] that results in coma. So it's very aggressive. And our protocol, for example, doubles the infusion rate almost every hour.

Critical illness with hyperglycemia is really meant to maintain euglycemia and a healthy blood glucose level in somebody who is otherwise critically ill. So it's not your primary pathology. But you want to avoid complications of hyper or hypoglycemia in those patients who are already dealing with so much and multi-organ failure-- so not as aggressive. Really meant to maintain a nice 100 to 180 kind of level.

So for the ADA and the AACE, in critical illness, they're recommending starting at 180. The Society of Critical Care Medicines has started at 150. For us, we compromised. It's 2 over 150 or 1 higher than 180 and we start.

Where do you want the blood glucoses to land? So our institution, we like to keep things simple. So you saw our order set's very simple. Our targets are very simple. Throughout our whole organization, our institution-wide goal is 100 to 180. There are some conflicting-- there are overlapping recommendations between the different professional societies. But they're all pretty consistent.

So the ADA says, start at 180, as we discussed. And try for 140 to 180. Though, lower glucose targets, 110 to 140, may be appropriate in selected patients.

That comes from some of the older evidence in the surgical population. And typically, people who are having surgery are a little more healthy and can tolerate this kind of more-aggressive control. Our medical patients, our frail, our elderly, those with creatinine greater than 2, you're going to want to be a little more gentle.

The Society of Critical Care Medicine-- which is important to be familiar with, because your physicians in the Critical Care Unit are going to tune into these guidelines and may not be as familiar with the ADA and the AACE-- they're recommending a starting threshold of 150 and

absolutely at 180. Use the protocol to achieve a low rate of hypoglycemia. And they don't really commit to a target range.

So just to make it a little more visual down at the bottom, we don't anymore recommend such tight control. We don't want anyone below 100. Try to keep them 110 to 180. Not recommended that you let them drift above 180. Is that clear? OK.

So I don't know how many of you are familiar with the FDA letter about glucometer. So the glucometers are really designed for the ambulatory setting. We do use them in the critical care setting. January 2014, the FDA issued a draft guidance stating that the original pre-mapped market studies were not really applicable to hospital glucose meters, particularly in the Critical Care Unit.

It's not that the meters are problematic. It's that the sample is problematic. So if somebody who was an ICU and clamped down on pressers, by the time that little red blood cell travels its way all the way to the blue finger on Levophed. You can imagine that the sample is not as accurate. So first choice would be an A line, second choice, kind of anything more central. Third choice is the capillary finger stick.

I think most institutions are using glucometers in the Critical Care Unit. But you really ought to take some caution if you're sampling in a blue finger. Maybe switch it up. Particularly, if you have central access, you can use the glucometer.

Cartridge-based technology-- epoc or I-STAT are some of the brands-- are FDA-approved for the critically ill. But that's not for a capillary sample. It's for A line or central. And Other devices may be used with appropriate validation studies.

I know, when we talked to the group in New York, many of the hospitals have actually pursued those validation studies. And some of the devices they were using were NovaSTAT. There were a couple others. So keep that in mind. Again, the problem is the sample. It's not the meter.

OK, so moving on to DKA, kind of a unique physiology, so important to kind of know about. And our DKA order set includes language around these four pillars of treatment, so hydration, electrolytes, insulin, and co-morbid conditions and/or precipitating factors. As with any chronic condition, you want to figure out why you've come off the rails. So it really important. Because otherwise, if you don't figure that out, you're not going to be able to fix it.

So fluids, normal saline, initially 1 to 2 meters in the first hour. And a couple of times in our hospital, we've seen people hydrated over the first hour or two. And we're not checking q1 hour, because they're not on the drip yet. And we wait until they're on the infusion to monitor q1 hour. But you definitely want to check after you're 1 to 2 liters of hydration. Because it does bring the blood glucose down significantly.

So that q1 hour monitoring should start right out of the gate. Don't lose sight of that. If they corrected sodium-- you know, you correct the sodium for the blood glucose-- is normal or elevated, use half normal saline thereafter plus minus dextrose plus minus potassium. So

dextrose if the blood sugar is less than 200-- that would be rare. There are some type 1 diabetics who can enter DKA at 250 or so-- potassium, if the K is essentially normal, 3.3 to 5.2.

Monitor your electrolytes q2 hours to start. You're going to be looking for the gap to close. Monitor blood pressure, urine output and if they have renal or cardiac disease, issues with hypoperfusion or volume overload.

Electrolytes, if you're less than 3.3, you're going to want to replace potassium prior to giving insulin. You're total body depleted. And so when you give the insulin, you're going to have a shift. And you would be at risk of arrhythmias and a fatal arrhythmia. So replace first if you're less than 3.3. 3.3 to 5.2, add potassium to your IV fluids.

Bicarbonate, it used to be much more common practice to include bicarbonate. But now we really reserve it for a pH of less than 6.9. PH, classic teaching was everybody got an ABG. That can be a painful procedure for people.

And I really reserve it for people with co-morbid lung or cardiac disease where I'm worried that they're not going to be able to blow their ketones off. So they've got other compromise where I think they're really not going to be able to cope with that DKA as well. So if you happen to have an ABG, because that clinical scenario exists and you see that the pH is less than 6.9, give the bicarb.

Phosphate, treat if it's less than 1.0 or if they have severe cardiopulmonary compromise. Because they're not going to have-- the ATP will be depleted. They were not going to have the reserve to cope with everything that's going on. But we don't reflexively replace phosphate in everyone.

Insulin infusion, you can bolus at 0.1 unit per kilo and then start at 0.1 unit per kilo. Alternatively, you can just start at 0.15 units per kilo. There was a meta analysis that showed that these are not inferior. So you can either do a bolus and then infuse or start at 0.15 units per kilo.

We elected to do the bolus and then infuse, just because that was the more common practice at our institution. But either way, again, is fine. The goal is to decrease the blood sugar by 50 to 75 points per hour-- so again, really aggressive, trying to avoid the metabolic [INAUDIBLE] and coma.

Evaluate hourly and adjust accordingly. What about the diet? So if somebody's blood sugar is 1 million, are we going to let them eat? Sorry, no. So that's sometimes hard for patients. But And it's good to talk to patients about that and set some expectations upfront.

And then our order set, again, includes this diagnostic work up. Because that's one of the four pillars of treatment for DKA, so urinalysis, complete blood count, electrolytes, osmolality, EKG and work-up for cardiac ischemia. That's actually one of the top three underlying causes of DKA.

And it's the most commonly missed. So don't miss cardiac ischemia. And the blood gas is optional. Infection and-- what's that? Chest X-ray, if you're thinking of infection, I mean--

AUDIENCE: It's not standard

DR. THERESE FRANCO: It's not standard. But rule out infection. So if they're having respiratory symptoms, you certainly want to do that. Or if they've got a heart failure, a concern about volume overload, and we're about to flood this person with fluids, you're going to want to check it. So I think most patients do end up earning a chest X-ray, but not strictly necessary.

Yeah, so infection, cardiac ischemia and then non-adherence to their regimen are kind of the top three drivers. OK, so ingredients for insulin infusion order sets and protocols, this is more recent. This was from The Journal of Hospital Medicine. And I think that, conceptually, the big change in insulin infusion protocols is that not only do we respond to the current blood glucose level, you want to respond to the trajectory.

So if you check my blood sugar and it's 180-- it's one story if my last blood sugar was 220. But if my last blood sugar was 170, that matters. It makes a difference. So you must account not only for the coronary blood glucose value, but for the trajectory of the blood glucose over time. So that's the conceptual shift that occurred over the last decade or so.

You want to identify your thresholds to start. And you want to get provider buy-in on that. So again, we have two thresholds. It's either 2 above 150 or 1 above 180. And you want to identify the glycemic range. And we're kind of noncommittal on that. On our protocols, we just say, 100 to 180.

And that is part of keeping things simple. Because that is the goal in our Critical Care Unit, outside of our Critical Care Unit, everywhere. It's just easier that way. But you want to make sure that that information is on the protocol. And

You want to define the insulin concentration and have a clear protocol that is easy to follow consistently. And then you want to have some criteria for transition and guidance on transition from IV to sub-Q. This is very similar to-- The Diabetes Spectrum recently published this, Ingredients for Insulin Infusion Protocols and Order Sets. Lots of overlap here. You could follow either. The references are on your slides at the bottom there.

Oh, I didn't know it was animated. OK, so insulin infusions highs and lows, top causes of hyperglycemia in the ICU-- maybe the word bad is not-- let's say an adequate insulin infusion protocol or poor adherence to the protocol. So either the protocol is not great and we're committed in following it. Or we're not following it.

If we're not following it, you want to ask why sort of five times and really do kind of a root cause analysis and figure out. So one of the things that occurred to me after just observing administration of insulin infusions in our unit was that we were asking nurses to adjust down to, like, the third significant digit on the units. And our pumps only have one decimal point. So that was a little difficult to manage.

And then the other thing was we were just responding to the current high glucose value. We had no way of accounting for the trajectory. So those were the big observations when I looked at our protocols about six years ago.

So yeah, if it's poor utilization of the protocol, don't assume it's a knowledge gap of that particular nursing provider. It may be that there are some problems with your protocol and that it's hard to follow. So really approach it with some curiosity.

Top causes of hypoglycemia, inadequate insulin infusion protocol, too aggressive. Some of our protocols were really old. And there was a time that we really did advocate for pushing blood glucoses down to 110. And that's fallen out of favor-- so maybe just that your protocol is out-of-date.

Compliance with the insulin infusion protocol, carbohydrate mismatch, which we talked about, or I put here, administration. What I mean by that is that it's q1 hour monitoring that's really complex. And so we had an issue with our patient care technicians are actually the ones to check blood glucoses.

And they were checking lots of blood glucoses and not docking the little device, not docking the meter, because it was cumbersome to kind of, every patient, every time, go. So there was a lag there, and lack of coordination and communication between our nurse and our patient care technician. And these are things that I only learned by really observing administration of the insulin infusions.

I really would encourage you to just go and watch. And I guarantee, you'll learn something. And listen to your nursing colleagues about what's going on. They know. They'll tell you.

Insulin concentrations-- so all insulin infusions should be prepared in the pharmacy, one standard concentration, most common, I think, is 1 unit per mL. You need to have a hypoglycemia protocol. And it should be nursing-driven.

You don't want to wait to page Dr. So-and-so who is in the lounge catching up on soap operas. You want to let the nurse-- that's within scope of practice. And you want to really empower your nurses to practice at the top of their skill set. This is well within the scope of practice of a nurse.

So let them manage it. Just make sure you've got a shared mental model and a clear protocol that's easy to follow. And make sure it matches with your order sets.

So one interesting thing that came up shortly after launching our hypoglycemia protocol is that we have in here that you can administer-- at the bottom here, if they're unable to eat, you may repeat a 1/2 amp of dextrose. And the way it works is that you may need to do that every 15 to 30 minutes. But the way we have the med ordered was the dextrose for q4 hours. So check those things.

All right, so again, because we're really focused on and trying to achieve something by the end of 2017 with hypoglycemia here, we're really going to focus on this. We really need to have a plan

to avoid hypoglycemia. And one of the top drivers is a mismatch between nutritional insulin and nutritional source.

So for example, so the red vertical bars are the nutritional insulin requirements. And the blue is basal requirements, a similar color scheme to what Kristy showed you. Our infusion is the green line we're running at 4 units per hour. And then the blood glucose is this little purple squiggly line.

You can see that, of course, we're nailing it. We're right in the goal zone. So we're on consistent TPN, consistent insulin infusion requirement. And blood sugars are at goal. Our requirements are the same.

Now what happens if there's an interruption in your TPN? You have to do something. So you can decrease your insulin. Or you can increase your dextrose. But you have to respond in some way.

So see here, the insulin is still running at 4 units per hour. And our blood sugars have come crashing down. Very easy-- if you're on an insulin infusion, just dial the rate down. And in our institution, our insulin is in our TPN.

And our pharmacists have a protocol. And actually, our pharmacists are very, very engaged in all of this work. They do a lot of our dosing. I know there's a hospital-- I think it's Peace Health near Vancouver. I think their pharmacists are really engaged in dosing all of their insulin.

So we've really been able to leverage our pharmacists, again, encouraging them to practice at the top of their scope, top of their skill set. They dose our regular insulin in the TPN. And we were able to show decreases in both hyper and hypoglycemia using that. Because if the insulin's in the TPN, your nutritional insulin is kind of married to your TPN. So if the TPN goes off, the nutritional insulin goes off-- so very safe, very effective.

Alternatively, you can add dextrose. So if the TPN is interrupted or your tube feeds are interrupted, for example, you can run dextrose. For tube feeds, we tend to run our dextrose at the same-- D10, at the same rate as our tube feeds. So if tube feeds were running at 60 an hour, we'd run dextrose at 60 an hour.

So this is an algorithm. This is a plan. You need to have a plan. This is from UCSD. This is Kristy's work. We have a trial in progress at Virginia Mason where we've got-- it's a little more simple. We really stick to the keep it simple philosophy over a VM.

And so we've got a bright pink card that says, I'm on insulin and tube feeds. And if something happens with the tube feeds, the nurse can turn the card over. And there's an S bar. And they have a couple options for the different recommendations they can choose, depending on what's going on clinically.

Here is a hard-wired approach from UCSD. It appears for patients with 0 charted for tube feed rate and on insulin. And this is how it looks. So it kind of pops up in the provider's face.

Potential problems, nursing doesn't consistently chart tube feeds. I know that this is a huge issue for us. And if you think about it clinically, if the patient is dealing with agitated delirium and they have pulled their tube feed, the nurse may have bigger fish to fry than charting the 0 on the tube feed rate-- so not uncommon for that to get missed.

And this is what it looks like at UCSD. So that's a pump tree in the ICU. And you can see the pink placard advises caution.

So on rare occasion, we do have patients that are not agreeable to the NPO status for treatment of DKA. And if you really want that person to stay there and they're threatening AMA, you can work around it. We like to use the insulin infusion for the basal needs.

But physiologically, the sub-Q insulin, the sub-Q Depo matches the food better. So you've got your infusion running. And then just use a little bit of sub-Q insulin to match the nutritional needs if your patient is, in fact, insisting on eating on a drip.

So are different approaches. At UCSD, again they're on EPIC. They have a computerized, web-based protocol. Their targets vary. So in the ICU, there are 90 to 150, 90 to 180 in the step down and 120 to 200 in the OR. Blood glucose value and rate of change enters into the formula there. Again, it's a recommendation from the ingredients that I showed you earlier.

We use Cerner for our order sets. We have the Cerner summary page that shows our all our blood glucose values and insulin administered. But our protocol for titration is, actually, paper-based.

So when you click the order set, the nurse is prompted to print it. They tape it on the door. We have a tracking sheet. They use that. Our goal, again, is 100 to 180. So obviously, there's potential for error if we're moving between paper and the EMR.

So here is our order set, pretty straightforward. We have three. We have one for surgical patients who are critically ill, medical patients who are critically ill, or DKA and HHS. And then, actually, we now have our pharmacist dose the initial bolus and the initial rate of infusion.

Because even with the guidance, even with the weight-based dosing table nested in the order set, we were having problems, one, with physicians not ordering the bolus. Even though that was kind of our general approach in the community, for some reason when we did the new order sets, they stopped ordering boluses. And then also, the initial rate, even though given guidance right in the order set, we were getting the initial rate wrong. So they just select which protocol they want-- the physician does-- and then the pharmacist actually doses. And then the nurse titrates.

Epic UCSD, here's their order set. All the associated orders are nested in the order set, so the point of care testing, the diet and the insulin infusion. They have a couple of different ones. Kristy, did you want to provide any detail there?

KRISTY: [INAUDIBLE]

DR. THERESE FRANCO: OK.

KRISTY: [INAUDIBLE]

DR. THERESE FRANCO: So I think this was the really slick thing that they have going over at UCSD, a little more sexy tech. But it's a web-based dose calculator. So they can go over to the computer. And they enter the current blood glucose. And they have to enter it twice for mistake proofing.

So it's one of the principles of QI work, you want to do some mistake proofing. And so they enter the blood glucose value twice. And the rate comes out automatically. It's outside of the EMR. So they do have to step out of their workflow a little bit.

But I think that this is an interesting approach. And it'd be ideal if you could nest it in your EMR, so they don't have to break the flow. But this is nice and I think, definitely, better than the paper protocol, which has obvious potential for error. So here's the calculator. You can see it just produces, bolus with 5.4 units and adjust to 3.6.

So criteria for a transition from IV to sub-Q, these are evidence-based and standards of care. So for DKA, you want to have a blood glucose less than 200. Ideally, your gap is closed, bicarb greater than 15. Those things obviously go together. And if you're following pH, pH greater than 7.3. For HHS, it's OK to transition it at blood glucose less than 300, normal osmoality and normal mentation.

Hyperglycemia on the Critical Care Unit, you want the patient to be relatively stable. You don't want somebody who was on and off, like, norepinephrine. Because obviously, that's going to affect the blood glucoses-- off pressers, and the rate of infusion has been relatively stable for six hours.

OK, so transition from IV to sub-Q, overlap by two hours. Although there's no peak to glargine, it does take about two hours to on board, so two-hour overlap. Know the home regimen and whether or not that was adequate. Because if there are acute stressors resolved and they have a beautiful hemoglobin A1C, you might be able to just put them back on their home regimen.

There are a couple of different ways to calculate the requirements. So there's the average rate methodology-- so take the average rate over the last six hours, assuming that it was relatively stable-- or weight dosing. And you have to really think about, what's going on with the patient? So I always talk to the residents about inserting your brain between your patient and the protocol.

So you really have to think about, what brought them into the Critical Care Unit? Is it over? Are we going to continue steroids? Are we dialing down TPN? You really have to think about it.

So step 1, is the patient and ready for transition from IV to sub-Q? Is the critical resolved? Are we off our pressors? Is the DKA or HHS resolved? Remember, the glucose threshold for DKA, 200, HHS, 300. Is the rate stable for about six hours? So you just have to decide whether or not they're ready as your first step.

Does the patient have a history of diabetes? So many people in the hospital have high blood sugar, and either they are diabetic and didn't know it, or they're just having a hyperglycemic sort of response to whatever acute stressor is going on. It's important to know whether or not they're diabetic. If there is no diabetes and an A1C less than 6, you can get away with correctional insulin and observe them over 24 hours. If they have diabetes or the A1C is higher than 6.0, you want to prescribe a basal bolus regimen based on their nutritional intake.

So step 3, use 80% of the lowest of the following to determine your total daily dose. The dose administered over the last 12 hours multiplied by 2-- so it's 24 hours-- the dose administered over the last 24 hours-- you could go point by point and count up every single hour-- the average hourly rate over the last 6 hours, if stable, and multiply by 20. So you're taking an average rate and then multiplying by 20, which is the 80% of the 24 hours. Make sense? OK. Or use weight-based dosing.

Step 4, determine if the total daily dose that you're observing on the infusion is being used to meet basal requirements only. So it's somebody who's NPO and they have no nutritional intake. And the infusion really is only for basal requirements. Or is the case, the patient's on continuous tube feeds and that insulin infusion is being used to meet basal and nutritional requirements?

If basal only, then the dose can be doubled and divided accordingly if they're going to be eating. If it's basal and nutritional, then give half of that as basal and half as bolus or nutritional. Gives the basal insulin dose. And turn off the infusion 2 hours later.

OK, so we'll work a case here. Well, this is the algorithm. So those are the steps just presented in a visual manner. And we're going to go through a case.

So a 49-year-old man with type 2 diabetes, he's had a CABG. Home regimen is metformin, Humalog 75/25, 50 units in the morning and 30 units at night. So his home dose is 80 units total daily dose with 25% of that. Because it's what 75/25 is. So 25% of that is short-acting.

He weighs 120 kilos. His A1C is above goal at 9.0%. His blood glucose has been well-controlled on insulin infusion. The patient remains NPO on normal saline for IV fluid. The insulin infusion rates have been 2.3, 3.2, 3.0, 2.3, 2.2, 2.5, so an average of 2.6 per hour. That's the last 6 hours of data. He's estimated off pressors and asking to eat.

OK, so first step, is the patient diabetic? Yeah. Is he ready to transition? Yes, he's ready to transition. Is he diabetic? Yes.

We calculate your average rate-- so we found that to be 2.6-- and multiply it by 20. So it's 20 hours or 80% of the day. He's NPO on normal saline. So the 52 units, or 2.6 times 2 is 52 units. And those 52 units, he was NPO. So that's meeting just basal requirements.

All right, so basal insulin, 52 units daily. When your patient starts his carb-controlled diet, you're going to want to start nutritional insulin. You can split it evenly between meals. So 16 units per meal would get you 48, so close enough.

And this is a pretty high dose. He's fairly resistant. So you're going to want to use an aggressive correctional sliding scale, say, 3 units at 150 dial it up by 3 for every 50 points, so higher dosed correctional sliding scale. Otherwise, it'll take you too long to titrate this dose.

All right, so an example, we've hardwired this into our summary page at Virginia Mason. So you can basically just work the steps. So once you decide the patient is ready to come off the infusion-- and you can walk through the steps underneath the table and to the diagnosis. So are they type 1, type 2, or they're hyperglycemia not otherwise specified?

Then you want to know, what was the goal of the infusion? Were we meeting basal needs, basal plus nutritional, or what? And where are we headed? Are they going to be eating or not?

And then you just put those things in. And it will calculate different dosing regimens based on the average rate methodology. It will also calculate a weight-based dosing using our protocol, so the VM protocol, 0.3 units per kilo total daily dose and then also the [? RABBIT ?] protocol, using a 0.5 units per kilo total daily dose.

And then the pharmacist is automatically consulted in our transition patients. And they can help select the dosing regimen that makes the most sense based on what's going on clinically. And then we've got embedded reference text that guides providers about how to select the dosing regimen from three different options.

So common pitfalls, no overlap between infusion and subcutaneous insulin-- this was a big one for us. We observed that time and time again. I think some of it is that our providers got nervous about, I just gave 52 units of Lantus. And I have the IV running. So it would just kind of turn it off automatically. And So that's just a matter of education and talking to people.

Premature transition, so it's difficult to determine a stable rate. So if you have somebody who is having labile blood sugars on the infusion and your rate's all over the place, it's undercooked. Just give it a little more time. So we see that frequently.

Mismatch between insulin infusion and nutritional status on infusion versus transition-- so maybe we had somebody who's NPO and not eating or anything on the drip. But then they're going to eat. And we underdose, not understanding that infusion was really only meeting basal requirements because they weren't eating anything. So then they go to eat and we've underdosed.

Interruptions in tube feeds and TPN is huge. This is a big driver of hypoglycemia at our institution. We're working hard on that. And unclear about whether or not the infusion is-- again, just, what is the infusion being used for?

So key points for the guidelines, insulin infusions are indicated for DKA and HHS in critically-ill patients with blood glucose greater than 180. We do see, particularly in the surgical populations, using some short-term insulin infusions where patients are obviously critically ill. So there is some practice in the community where we're using infusions outside of critical. illness. I'm not saying that's right or wrong. I'm saying it it's happening.

Treatment of DKA centers around the four pillars of hydration, electrolytes, insulin and appropriate diagnostic evaluation. Safe and effective insulin infusions, our protocols are clear, concise, account for the trajectory of the blood glucose values and address hypoglycemia. So you want your nursing-driven hypoglycemia protocol. And you've got to have a plan for interruptions in nutrition.

The transition from insulin infusion to subcutaneous regimen is complex and involves the delicate balance of art and science. Any questions on that? Yes?

AUDIENCE: [INAUDIBLE]

DR. THERESE FRANCO: That's something that we're still working on. And I think Kristy is going to get into it in a fair amount of detail in the hypoglycemia talk after lunch. So I might defer to her on that in the next-- yes?

AUDIENCE: My question is related not to critical care patients, but to elective surgery patients coming in from home. Where would you go with that? Would you want to start and if they had a high blood sugar on a basal right before you sent them into the OR? I'm not sure where you would head with that.

DR. THERESE FRANCO: So We're not covering perioperative. I mean, I think it would be a good next step to this safe table. But that gets complicated.

We do have an anesthesia pre-op clinic. And if a patient's diabetic, we walk through a fairly robust sort of algorithm about how to adjust or not adjust the insulin. And when they land in the pre-op area, we check a finger stick on every patient. And that was the first step, honestly, was getting the blood glucose checked on arrival for surgery-- every patient, every patient. So diabetic or not, we check it.

Just again, it's simple. It's simple. So you don't have to think. You just check it. So there are protocols and standardized approaches. But I think the key is to make sure that you're checking everybody and they have some kind of framework and shared mental model about how you're going to approach it.

And I know things come into play. You know, if it's an ambulatory case, and they're going to be going home later on in the day, you don't want to commit to a really aggressive plan. Because they're leaving and they're not going to be monitored.

But if you're having a lengthy case, say, four hours or longer, and so on, you may want to use infusion. That's a whole big umbrella of--

KRISTY: Megan has a great question and something that we can address in a future, even, like, an hour-long safe table webcast, so that you can call in. And we can focus on that particular patient population.

PRESENTER: That's a great question.

DR. THERESE FRANCO: And I think more of, like, a CMS metric for [? SKIP4. ?] That was CABG patients. And there's more kind of evidence around the surgical patient population, so something that warrants specialized attention.

AUDIENCE: [INAUDIBLE]

DR. THERESE FRANCO: Our executive lead at Virginia Mason for this work was an anesthesiologist, which was really, really helpful. So important to get all the effected parties that kind of buy-in.

AUDIENCE: [INAUDIBLE]

DR. THERESE FRANCO: Yeah, start upstream. And make sure you're checking the blood sugars on arrival. Those were two huge conceptual pieces for us.

AUDIENCE: My question has to do with the insulin drip. I noticed that it was actually weight-based. But isn't the actual protocol not weight-based? I don't--

DR. THERESE FRANCO: It is weight-based for DKA. And it's blood-glucose based for our critical illness.

AUDIENCE: So in the pump and everything is actually weight-based. Or is it actually entered in EPIC as an actual units per hour?

DR. THERESE FRANCO: So at VM, we have three protocols, the DKA HHS as a weight-based. The critical illness starts from a blood glucose value. So you just base it on that.

And then the way you calculate adjustments has to do with the trajectory, your current blood glucose value and where you're coming from. So if you're on the way down, you're not going to dial up, necessarily. Does that answer your question?

AUDIENCE: Yeah. I might need to touch base with you, in terms of what it looks like. I guess, we do have a PDF as well, like a table for nurses to follow this-- is their blood glucose. This is what you adjust it to. But now if you have to take into account previous blood glucose versus current, then it's going to add a whole new--

DR. THERESE FRANCO: Yeah, so a lot of our protocols-- so, again I would like to promote the Society of Hospital Medicine Glycemic Control Mentored Implementation Program. They'll set you up with a mentor. Our mentor happened to come from UCSD at Virginia Mason. It was Diana Childers. But you'll get a mentor. And then you have access to a listserv and access to all sorts of resources, such as other people's protocols, which you can borrow.

AUDIENCE: There was, like, cases where, if the blood sugar's not checked on the hour or the insulin infusion's not adjusted on the hour, like, it's kind of hard to calculate the hourly rate when transitioning sub-Q. Do you have any tools that might be easier to do that calculation?

DR. THERESE FRANCO: [? Bree? ?]

AUDIENCE: It's just an estimate of what they were receiving over a six-hour chunk. [INAUDIBLE]

PRESENTER: There's a lady that's been waiting over here.

AUDIENCE: There were two populations that I didn't hear addressed. One is a type 1 or maybe a type 2 that has an insulin pump as they come into the hospital. And then the other population are people using U-500.

DR. THERESE FRANCO: OK, great questions. This comes up all the time.

AUDIENCE: [INAUDIBLE]

DR. THERESE FRANCO: So briefly, one thing we did notice is that we had a while where providers were putting pump patients on a drip. Now an insulin pump is subcutaneous insulin. So they don't need to be NPO, and on a drip and all that. So you can manage with basal bolus therapy.

If you have the endocrinology expertise-- not everybody does. But if you endocrinology expertise, I think this is a really good use of those specialized skills. Get them involved.

They can do a read of the pump. It's almost like a device check for a cardiac device. They can come over and tell you what the total daily dose is, what the basal rate is. And so we put them on basal bolus.

The issue of U-500 is complex. But I think most institutions are converting them to their formulary basal bolus regimen. For us, it's glargine and lispro. For a while, we were trying to keep U-500 patients on their U-500. But it's just fraught with difficulty. Because their physiology is so different in the hospital. And it's such a potent medication. We were seeing a lot of issues with hypoglycemia.

PRESENTER: OK, we have time for one more.

AUDIENCE: So two things, what's the rationale for the two different targets for transitioning for HHS and DKA, 200 versus 300?

DR. THERESE FRANCO: That's just when you add dextrose.

AUDIENCE: I thought we were talking about transitioning.

DR. THERESE FRANCO: If we're transitioning at our institution, we do transition at HHS at 300. And DKA, we wait until--

AUDIENCE: Tell me the rationale for that, the psychological.

DR. THERESE FRANCO: So I think physiologically, most people with HHS tend to be type 2, more a problem of insulin resistance and would tend to tolerate higher blood sugars better. Because they're resistant, as opposed to a type 1 physiology, DKA physiology. They're sensitive. And so I don't-- I mean, that's just--

AUDIENCE: And then you have three drip protocols. Ones for medical, ones for surgical and one's for DKA.

DR. THERESE FRANCO: Yes.

AUDIENCE: So what are the differences between the medical and the surgical critical care?

DR. THERESE FRANCO: The titration on the surgical protocol, for us, is a little more aggressive.

AUDIENCE: OK. Thank you.

DR. THERESE FRANCO: And that was at the request of our surgeons.

KRISTY: And at our institution, just to let you know, we have one. We have one that works for DKA, surgical, medical, everybody.

PRESENTER: Great.

DR. THERESE FRANCO: Good questions. Thank you.

PRESENTER: Thank you so much.