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Midline Catheter Failures: Exploring the Role of Infusate Properties

Announcer:
This is ReachMD, and you're listening to Vascular Viewpoints, sponsored by Becton Dickinson, advancing the world of health.

Here's your host, Dr. Matt Birnholz.

Dr. Birnholz:
Catheter failures are an unfortunate reality in vascular access care. While several device selection algorithms and catheter insertion protocols have been developed over the years to reduce the risk of catheter failures, the definitions get hazy over which drugs are peripherally compatible, which infusion timelines should be observed, and which infusate properties increase complication risks. These question areas and others ahead on today's program.

This is Vascular Viewpoints on ReachMD, and I'm Dr. Matt Birnholz. Joining me to help sort through common confusion points around catheter failure risks is Dr. Marcia Ryder, a Research Scientist at Ryder Science and Principle Investigator of a recent study exploring the role of infusate properties related to midline catheter failures. Dr. Ryder, it's nice to meet you.

Dr. Ryder:
Thank you. It's a pleasure to be here today.

Dr. Birnholz:
So, to start, I want to get a sense of what prompted the need for you and your colleagues to evaluate the use of midlines for extended periods in the first place. What can you tell us?

Dr. Ryder:
Okay, well, to answer that question, we have to go back a little bit to the original use of midlines. The midline catheter was brought into the market in the early 1990s. And the first midline was made of a novel material, Aquavene, that was thought to have a reduced inflammatory response from the vessel that would allow the catheter to remain in place for a longer period of time. Unfortunately, this catheter, as well as other midline catheters that became available, were introduced without the evidence for safe drug delivery in the peripheral vessels of the upper arm. Soon, we began to see increased failure rates, and that particular product was pulled from the market due to allergic and anaphylactic type responses. So, with that increased failure rate for midline catheters I went back and reviewed the literature and found that the risk of failure was associated with the catheter tip position. So, if you take the catheter tip that we normally place for central venous catheter in the superior vena cava and right atrium, as you move back towards the periphery, there seems to be a linear curve as to the increased risk of complications. I found two things: one, there was an increased incidence of thrombotic events, occlusion, phlebitis, and thrombosis. And second, there was a decrease as you come back from the superior vena cava in the mean dwell time and also the percent of completed therapy. So, the results of this was published in the Surgical Oncology Clinics of North America in 1995. And soon after that, the use of the midline pretty much declined in use in favor of the peripherally-inserted central venous catheter. And with the increased use of that over time, we began to see a significant increase in upper extremity DVT. So, the use of PICC was really coming into question. So, with that regard of what we already learned, the midline was believed then to be the best choice to avoid upper extremity DVT. In addition, the penalty for CLABSI became the driver for the reduction of CDC use, without regard for the effect of drug properties on the thrombotic risk, because they're using the midlines to infuse many drugs and solutions that were previously only given through a central line. To make matters worse, the American Society of Parenteral and Enteral Nutrition changed their recommendations for the infusion of peripheral parenteral nutrition from 600 milliosmoles per liter to 900 milliosmoles per liter. And the Intravenous Nursing Society standards changed to state that the pH of drugs was not a parameter to be used in and of itself for device selection. So, soon, to no surprise, we began to see high rates of failure in midline catheters. And this is

what prompted us to investigate drug properties and their effects on peripheral vessels to better understand the appropriate use of midline catheters.

Dr. Birnholz:
Well, that's an excellent background, Dr. Ryder. And, certainly, the drug properties elements sounds like a driving force behind this particular line of investigation. Can you speak to that a little bit in more detail?

Dr. Ryder:
With the confusion and the impetus, if you will, to use midlines over central venous catheters, and again in the increase of failure rate, we felt that there was an obvious need for investigation of the parameters of drug properties for the safe delivery in peripheral vessels of the upper arm. So the drugs that we chose to investigate were the upper and lower limits of three specific drug properties: one, osmolarity; the other, pH; and the third was nononcologic cytotoxicity.

Dr. Birnholz:
And, with respect to this study and the modeling that was used, I understand your team used an ovine model to monitor the effects of certain drugs on vascular health over a 14-day window. One question: Why choose this animal model over others?

Dr. Ryder:
Well, because the sheep is the animal that is closest to the human vascular anatomy and physiology. The sheep is the preferred model for vascular access studies. In fact, for all vascular devices. And this is due to the ease of handling of the animal and the ability to maintain the dressings for longer periods of time.

Dr. Birnholz:
Now, looking over the findings of your study, as I see it here, you reported that catheter failure was observed in all but one of the test catheters over the 14-day window. Maybe you can contextualize that for us and let us know whether that was a surprise for you?

Dr. Ryder:
Actually, it was not. You know, based upon the history and the use of the midline catheters and reviewing the literature and looking at the types of drugs and solutions that were given in midlines and midclaviculars, it told the story. And here we are, you know, 10, 15 years later, and we're repeating the same thing that we already learned. So, actually, no, it really was not a surprise.

Dr. Birnholz:
What about any other findings that you came across? Were there any surprises in what you're examining or that didn't match standard practices? Or maybe that mismatch was what you were expecting all along?

Dr. Ryder:
Yeah, it was very interesting because we placed the midline catheter in the upper leg, if you will, of the sheep, one in each leg and then randomly selected which leg and which catheter would receive the test solution and which would receive the control. The control solution was normal saline, and it was infused at the same rate and the same volume as the test solution. And we actually saw a very high rate of failure in the control leg as well as the test leg; not as much, which was obvious that the drug properties did have an effect, but we were surprised to see the high rate of failure in the normal saline leg. So this led to the understanding that it's not only about the drug, which has a very big influence, but it's also about catheterization in and of itself. We were able to determine that because when we looked from a pathophysiological and histological perspective, we could see the differences and the effect of the area of the vessel of the catheter, as well as the area where the drug was infused. So that was a bit of a surprise to us.

Dr. Birnholz:
Excellent. Well, for those just tuning in, you're listening to Vascular Viewpoints on ReachMD. I'm Dr. Matt Birnholz, and today I'm speaking with Dr. Marcia Ryder about her study on risk factors for midline catheter failures. So, Dr. Ryder, coming back to that and continuing where we left off, how do these findings from your investigation reflect back on vascular access device selection protocols? Are we simply missing the mark on which devices to use in scenarios like a two-week or less infusion window?

Dr. Ryder:
Yes, I think we might be. The MAGIC device selection recommendation designate the use of midline catheters for peripherally-compatible solutions for less than or equal to 14 days. But they do not define what peripherally-compatible solutions are, so we examined the histopathologic effects of these drugs in the vessel and the perivascular tissue, and we found profound effects at an average of about seven days.

Dr. Birnholz:
So that certainly sounds like one big takeaway from this study. What about other takeaways that you and your colleagues might have

come away with for reducing the risk of catheter failures in patients receiving infusates for up to two weeks?

Dr. Ryder:
Well, the findings indicate that the risk of vessel damage and thrombotic events may be reduced if we only use midline catheters with the proper drugs and solutions for less than six days of infusion.

Dr. Birnholz:
So, I get a sense then for where current vascular access device algorithms need to go, perhaps other guidelines, as well, on catheter failures, how they need to evolve. Can you just tell us a little bit about where you think these updates will take guidelines down the road?

Dr. Ryder:
Well, the results provide the evidence to consider revision of the standards and recommendations and to incorporate the drug parameters to mitigate the potentially devastating effects of infiltration, extravasation, thrombosis, and loss of the vasculature.

Dr. Birnholz:
And, Dr. Ryder, before we close, any other concepts or takeaways you want our audience to know regarding your study or some of the takeaways from it?

Dr. Ryder:
Yes. I would like clinicians to understand that the inappropriate use of midline catheters in place of central venous access for the purpose of CLABSI reduction is a significant patient safety issue and can result in substantial patient harm with severe depletion of the vascular of the upper extremity and that the patient-centric decision for the appropriate device for a patient should be made by a multidisciplinary vascular access team.

Dr. Birnholz:
Well, with those recommendations in mind, I very much want to thank Dr. Marcia Ryder for joining me to walk through her study investigating risk factors for catheter failures. Really insightful stuff, Dr. Ryder, and very much appreciate having you on the program. Thanks so much.

Dr. Ryder:
Thank you.

Announcer:
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