The Big Idea

Q. How did a team of OU-Tulsa graduate students help a young girl learn to play the violin?

A. By creating a custom-fit prosthetic arm with music in mind.

By Ginnie Graham

Nine-year-old Eveline Cavanaugh is the type of kid who jumps into all opportunities she finds, from soccer to swimming to basketball.

The enthusiastic Tulsa resident never lets anything get in her way. Not lack of experience, not fear and certainly not the missing lower half of her right arm. She lost the limb as a toddler from an accident in Uganda before being adopted by a couple in Oklahoma.

When she told her parents that she wanted to play the violin, it presented the unique challenge of finding a specific type of prosthetic for a growing pre-teen.

"She can do anything that anybody else can do. I had no doubt she would figure it out," says her mother, Kristina Kline, M.D., a family physician at OU Physicians at the University of Oklahoma-Tulsa.

And figure it out she did. Eveline persisted in her quest for violin lessons with her mother and father, Michael Cavanaugh, M.D., a specialist in orthopedics and sports medicine at OU Physicians.

"I had no doubt she would figure it out," Dr. Kristina Kline says of her daughter, Eveline, who was determined to play the violin.

"We thought it was a daunting task and put it off for a while. She kept requesting, and we found a colleague who made a suggestion for an instructor," Kline says.

That instructor, Tulsa resident Eric Ryan-Johnson, had a violin student about a decade ago with an underdeveloped arm who used a prosthetic. Back then, the only model was heavy and painful to wear.

He suggested contacting Dr. Mary Isaacson, an occupational therapist and associate professor in the OU-Tulsa Department of Rehabilitation Sciences. Isaacson pitched creating Eveline's prosthetic as a project to a graduate class in assistive technology. Student Ashley Rankin, who graduated in May with a master's degree in occupational therapy, volunteered and worked as a team with Ryan-Johnson, Isaacson, Eveline and her family.

"Eveline wanted to play violin, and I needed to figure out how to make that happen," Rankin says. "When we're analyzing an activity, we want to make sure the device fits well and allows for the necessary movements. Different prosthetics have different functional bases."

Prosthetics are body or electronically powered. With electronics, signals are sent to electrodes from residual muscles. Specialized devices often use a combination for unique purposes.

"We wanted to make sure it would be cost effective, fit comfortably and have the ability to make sure it would work for the activity," Rankin says.

Ryan-Johnson showed the team all the violin-playing motions.

"The human arm is amazing in what it can do," he says. "With all my students, we always talk about arm motions and how the arm works. This was a natural thing for me to slip into."

The design needed to reflect how fingers draw the bow across the strings, the way the instrument moves and the flexible bend of a wrist.

"We were thinking of different ways to be creative, and I was learning to play the violin in the process. I completely immersed myself in it," Rankin says. "It gave me a new appreciation for the amount of detail provided for assistive technologies for individuals who need it."

This multi-disciplinary approach was already a method embraced by Eveline's physician parents.

"When you take information from the violin instructor,

Eveline Cavanagh shows off the prosthetic designed for her by OU occupational therapy students. 3-D printing materials make the prosthetic both lightweight and affordable.

physical therapist and Eveline, and everyone is working together, it opens up a whole realm of possibilities you didn't know existed," Kline says.

The team landed on a more body-powered design that locks the bow at an angle into the end of the prosthetic.

"Getting the sizing right was the most important part," Rankin says. "The prosthetic has to fit well or it can cause problems and injury if not safely attached to her arm."

Next came the manufacturing. With traditional devices, the materials are sturdier but more expensive. Considering Eveline was going to grow out of several prosthetics through adolescence, the team sought a more affordable avenue. It found a 3-D printer with this capability at the OU College of Medicine on the Oklahoma City Health Sciences Center campus.

Rankin found an open source website as a model, learned the code, downloaded files and handled troubleshooting with the printer. The lightweight composition makes it a good match.

"Now that we've worked out the kinks and have the sizing paired with the 3-D printer, it will take less time than the permanent prosthetics and cost way less money," Rankin says. "When you're practicing with an instructor, timing to get a device is crucial. This is cost effective and time sensitive.

"If she does decide to continue with violin the rest of her life, then she can get a permanent, manufactured prosthetic as an adult."

Along the way, Ryan-Johnson began lessons with Eveline that included her mother's help.

"She would learn with her left hand, and I would do the bow for her," Kline says. "We had two-and-a-half months of that, and it was pretty fun. Then, she got the prosthetic, and it was amazing how quickly she was able to learn all the different ways to use the prosthetic holding the bow."

Eveline's attitude is what really made the project come together.

"The hardest thing I have to deal with in teaching students the violin is not how their bodies work but how they think," says Ryan-Johnson. "She is doing great and making beautiful music. Some things we'll have to adapt, but she's definitely got the right mindset and loves challenges.

"Eveline's mom is so supportive of her, and they have such a great rapport and working relationship."

The first meeting of the team was in May 2019, lessons began the following month, and the prosthetic arrived in September 2019. At the holidays, Eveline played in her first recital then took part in a virtual performance in May.

"I feel amazement when I hear her," Kline says. "It's not just when she performs, but it's when I practice with her most days of the week."

Eveline is already outgrowing the prosthetic and a new one is being ordered.

"For now, I'd say she's sticking with it," Kline says. "We made a commitment to keep going. It is something she wanted to do and has done it. With that, her confidence has increased and contributes to the success of everything she does."

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