

# Going with the Flow in Neonatal Peritoneal Dialysis: Low-Cost, Clot Resistant PD Drainage Catheter Development

Sergio Ruiz Vega<sup>a</sup>, Carl Russel III<sup>ab</sup>, Siting Zhang<sup>a</sup>, Mignon McCulloch<sup>c</sup>, Aaron Lottes<sup>a</sup>, Hyowon Lee<sup>a</sup>, Danielle E. Soranno<sup>d,a</sup>



Weldon School of Biomedical Engineering

## Background

- ❖ Pediatric patients in low- and middle-income countries (LMICs) with kidney disease rely on peritoneal dialysis (PD)
- ❖ Due to cost and availability, many patients receive treatment with off-label devices resulting in increased complications



Figure 1. Previously available drainage catheter set

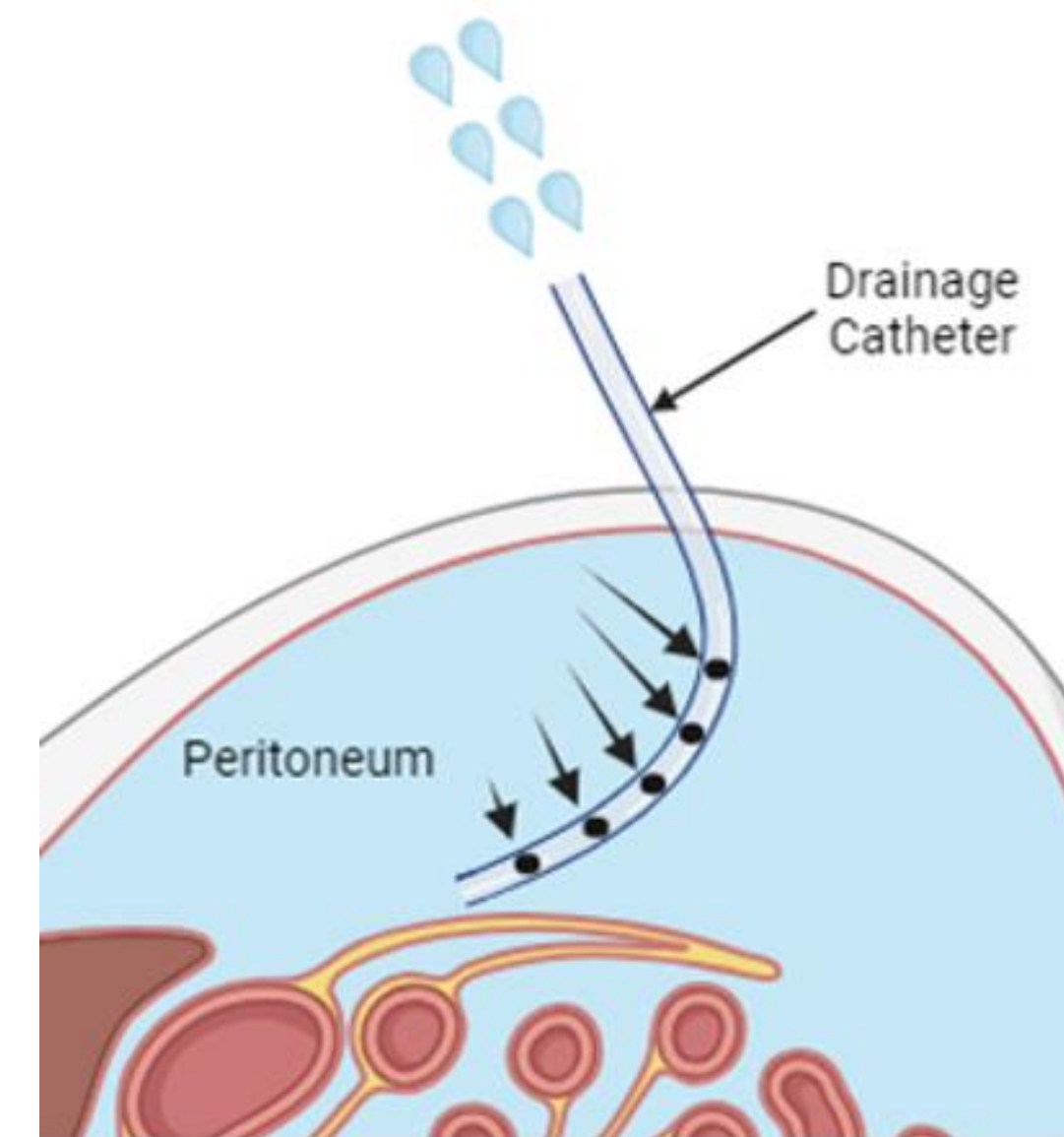


Figure 2. The use of drainage catheters in PD

## Purpose

- Develop a low-cost pediatric drainage catheter for PD
- Evaluate and compare with an existing device under common failure methods

## Manufacturing Methods

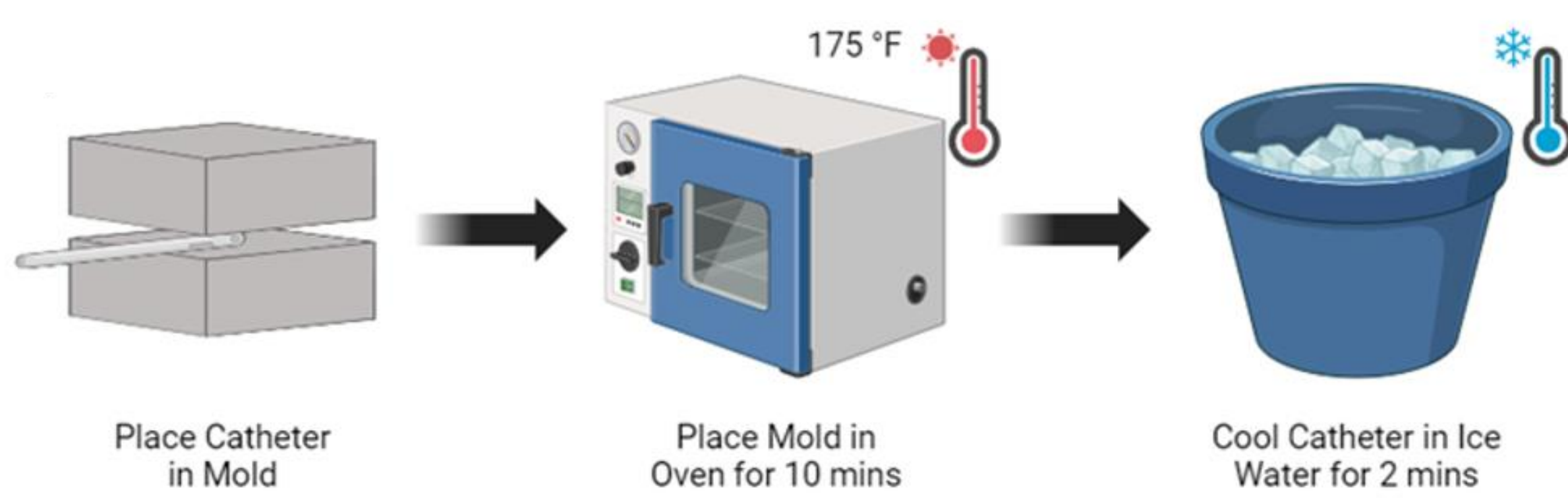


Figure 3. Flow chart of the catheter molding process



Figure 4. Control Catheter

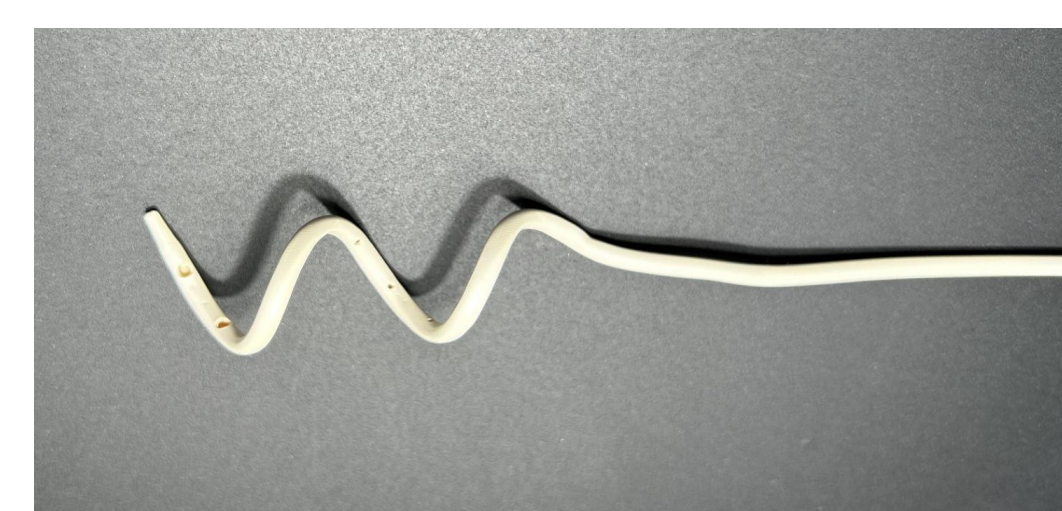
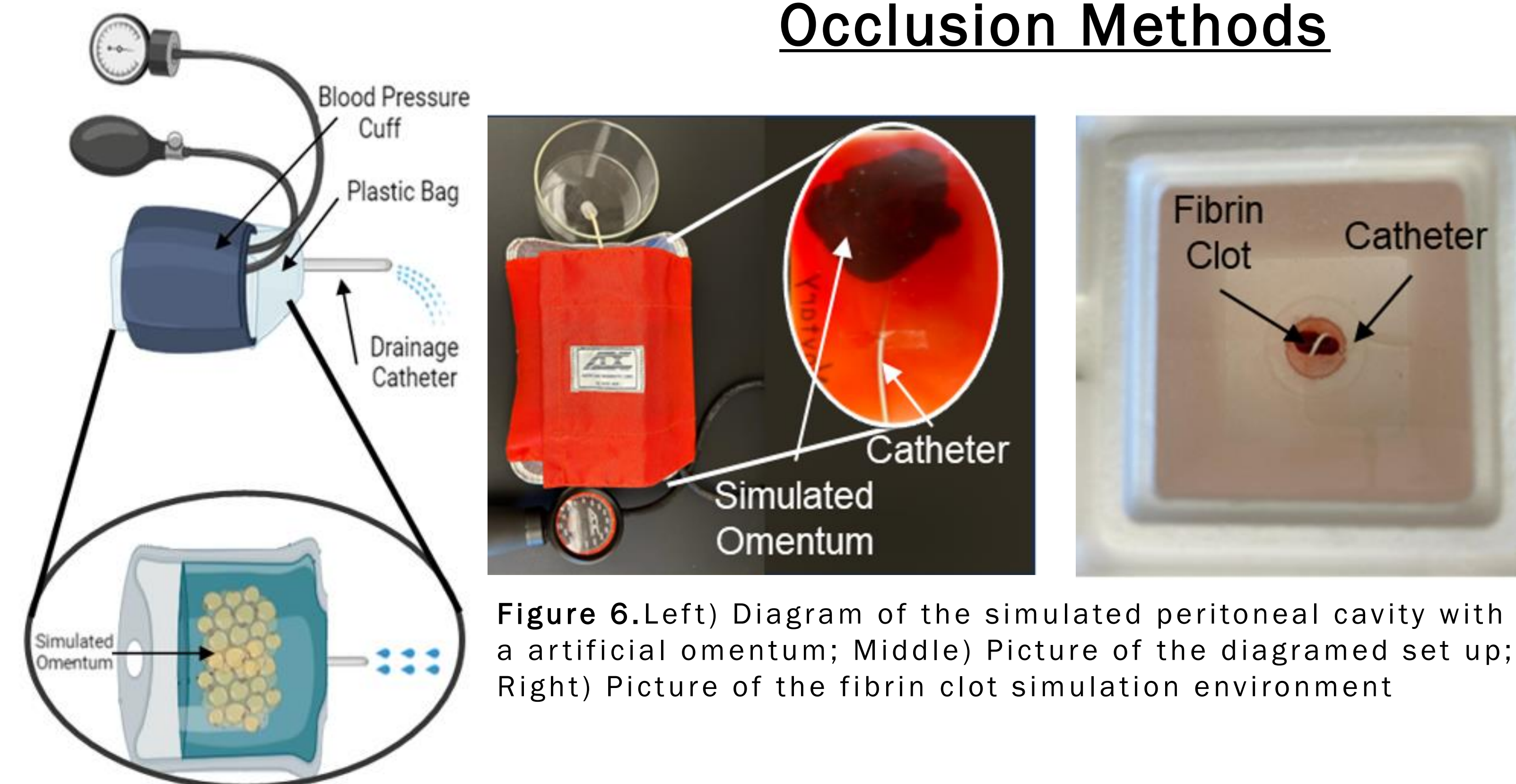


Figure 5. Helix Catheter

## Occlusion Methods



## Results

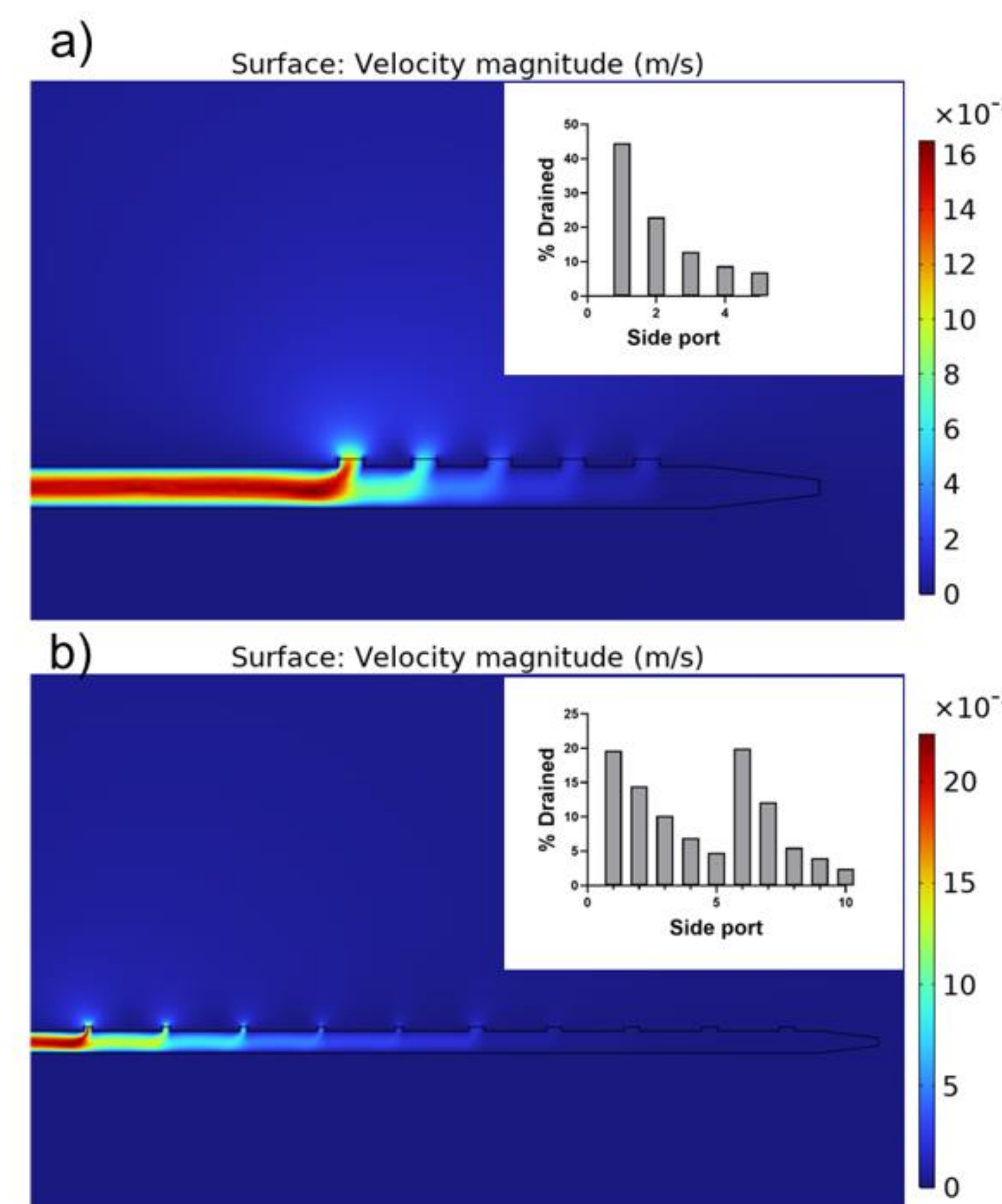
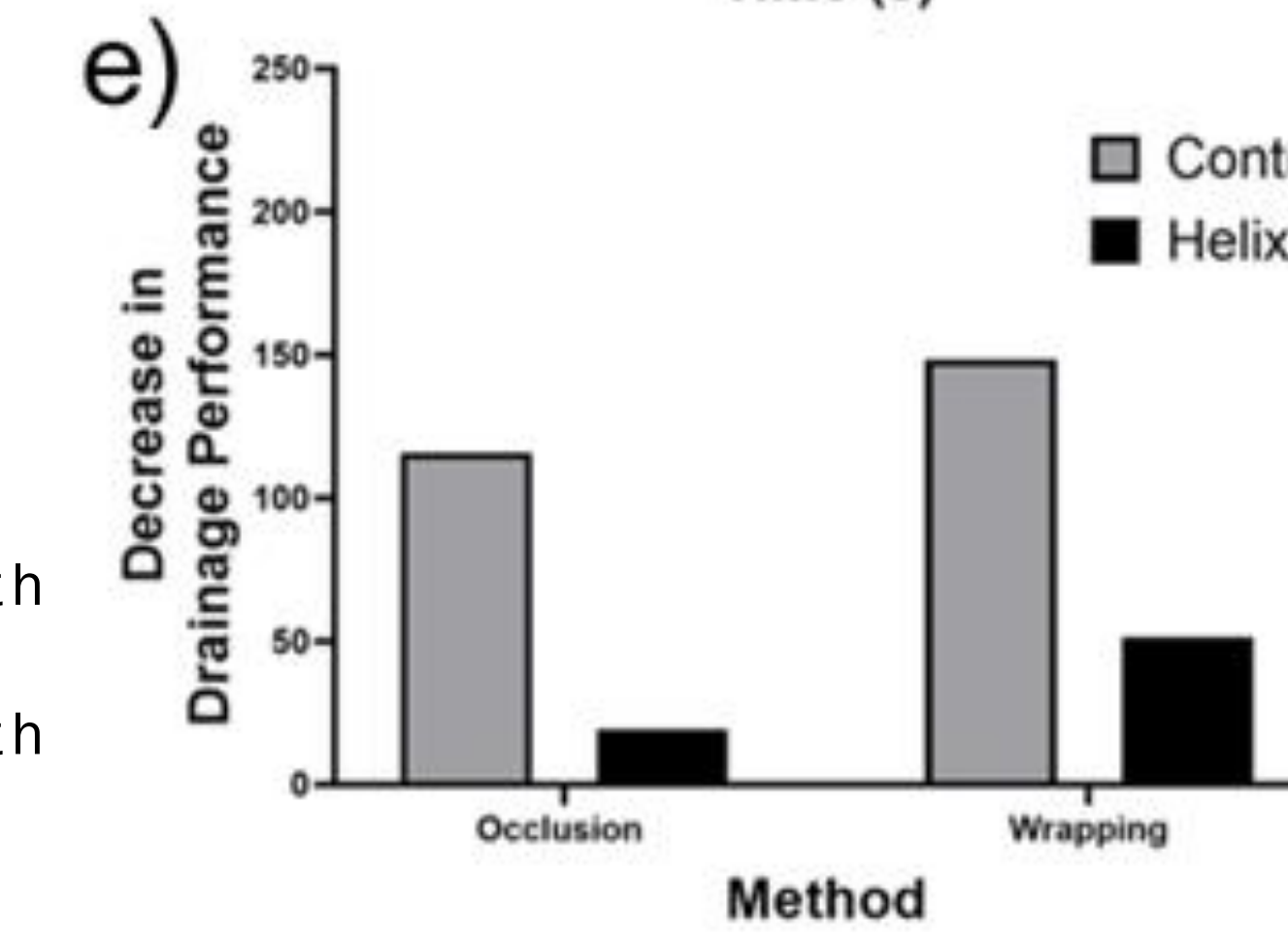
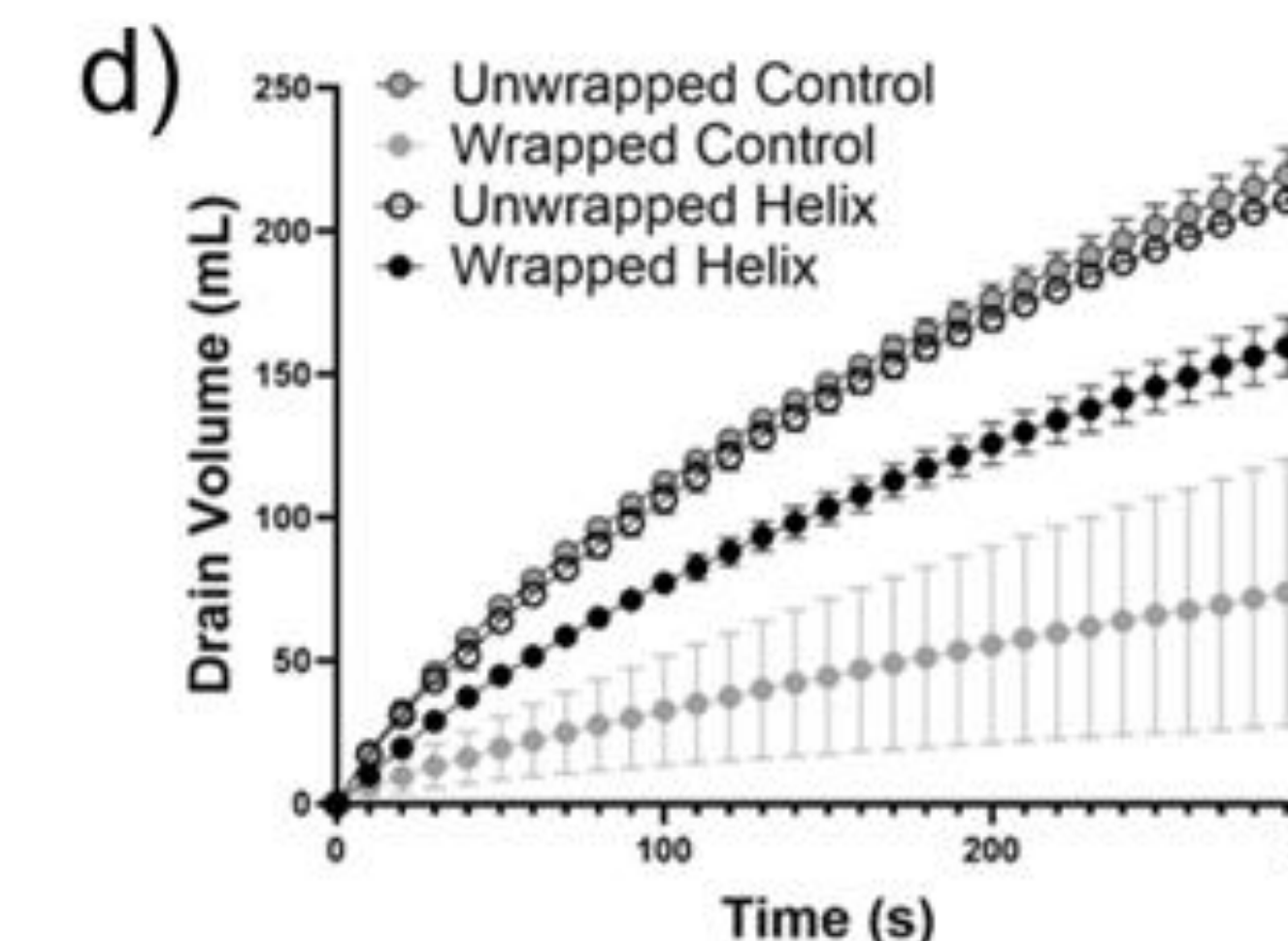
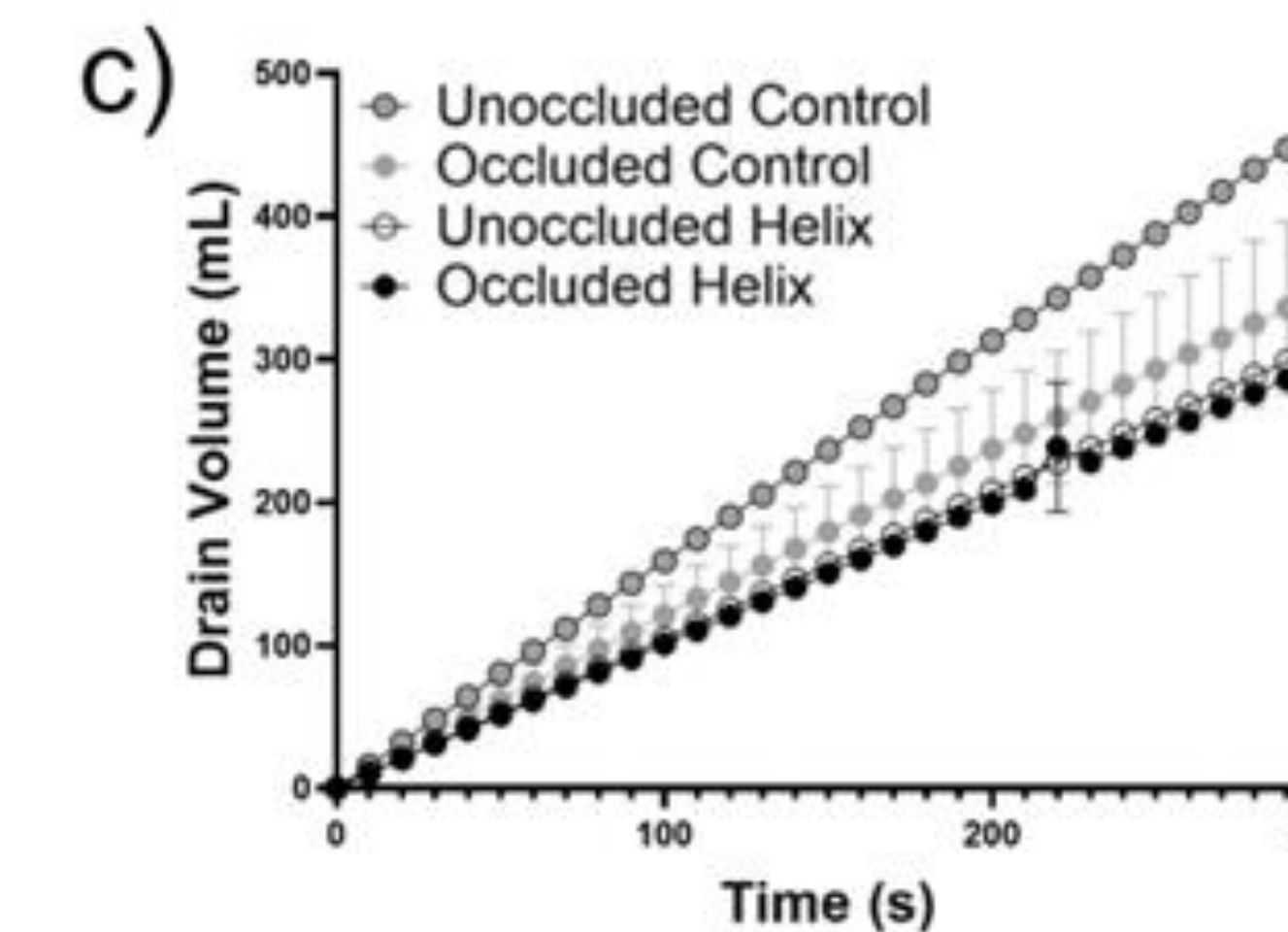


Figure 7. a,b) COMSOL simulations of fluid flow with inserts of the drainage distribution per side port c) Drainage volume of helical and control catheters with the presence or absence of a fibrin clot analog. d) Drainage volume of helical and control catheters with the presence or absence of omental wrapping. e) Difference in drainage in the presence of different occlusion methods



## Discussion

- Varied side port diameters distribute flow evenly
- Varied side ports mitigate high pressure areas
- Helix design of catheter minimizes surface contact with side ports and omentum
- Helix catheter drainage is less affected by occlusion methods

## Impact and Engagement

- ❖ This device has the potential of filling a needed gap in healthcare for LMICs and their pediatric populations
- ❖ Training and use of specific catheters for on label use may lead to less complications
- ❖ Collaboration with physicians like Dr. Mignon McCulloch, MD who train healthcare professionals in LMICs can lead to lives saved if they have access to the appropriate tools

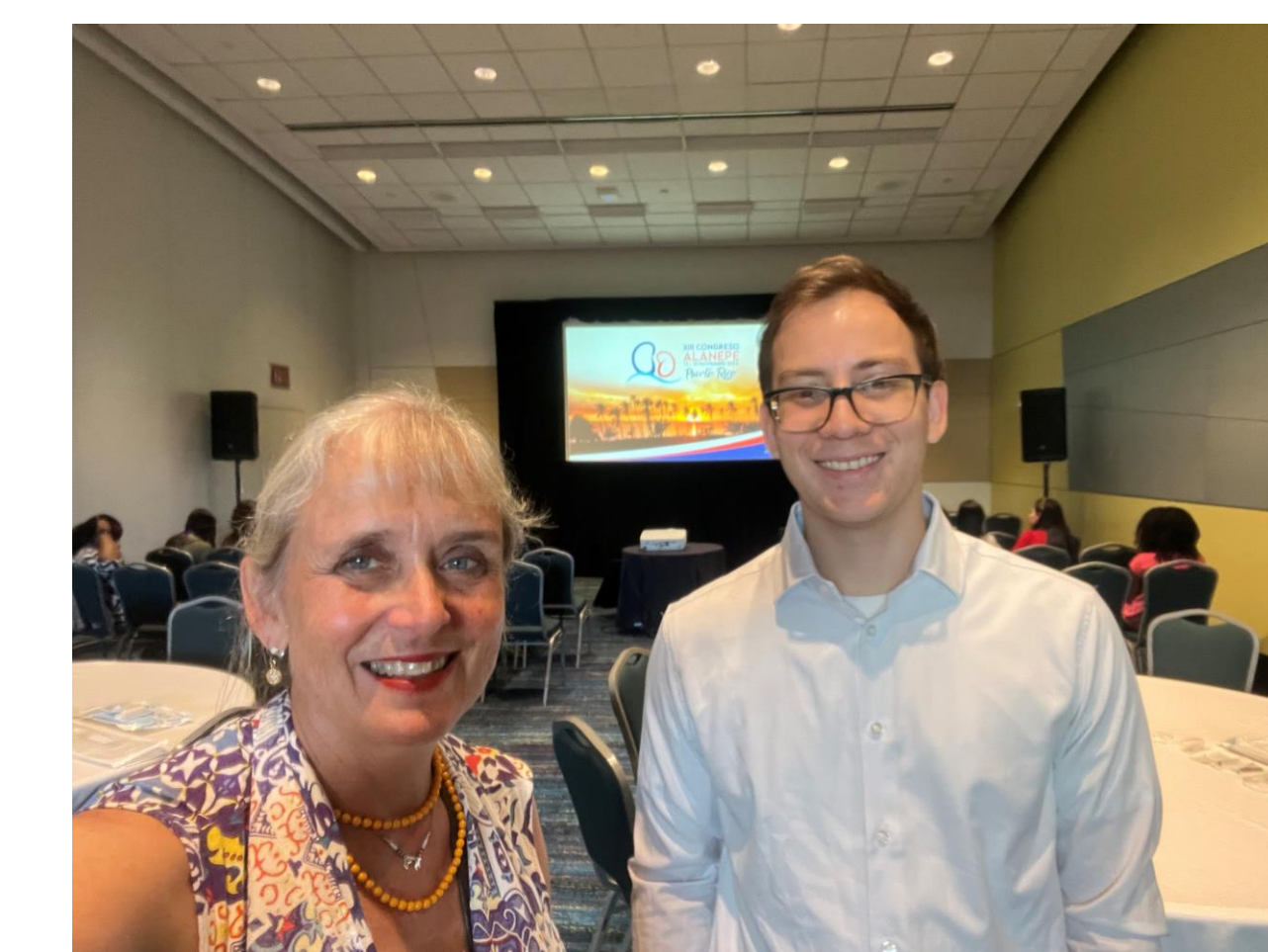


Figure 8. Mignon McCulloch, MD (left) and Sergio Ruiz (right) attending the XIII Latin American Association of Pediatric Nephrology Congress



Figure 9. Testing the catheters on a simulated peritoneum similar to those that physicians use in their trainings

## Acknowledgements

We would like to acknowledge Dyvia Patil for her support in providing knowledge of Cook Medical's products and arranging stock material to be provided for this project. Additionally, we would like to acknowledge Ty Morgan for sharing his concept of a helical-shaped catheter.