



STUDENT TEAM

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JOHNS HOPKINS
BIOMEDICAL ENGINEERING

PROBLEM

HEMODIALYSIS

→ Filters waste from blood
→ Requires reliable blood flow through a **central venous catheter (CVC)**

THE SYRINGE TEST

→ The **current gold standard** method of CVC functionality assessment
→ Clinicians pull blood through the CVC manually and **judge resistance to flow by feel**

DURING DIALYSIS

→ Patient requires **300-500 mL/min** flow
→ If pressure required to pull blood at this rate is too high, **dialysis machine may alarm and stop**

CONSEQUENCES

→ CVC may pass syringe test, but **fail during dialysis**
→ Causes **delays in treatment** and **emergent troubleshooting/CVC exchanges**.

CURRENT GOLD STANDARD

Why does the current gold standard fail?

$$\Delta P(t) = \underbrace{RQ(t)}_{\text{Hemodialysis}} + L \frac{dQ(t)}{dt}$$

Syringe Test

The syringe test creates a **rapid, accelerated pull** that adds an inertial term. If pulled too hard, the **inertial term can overpower the viscous term** and mask true resistance. If pulled too gently, resistance may be underestimated. This makes the syringe test **highly operator dependent** and **less representative of dialysis conditions**.

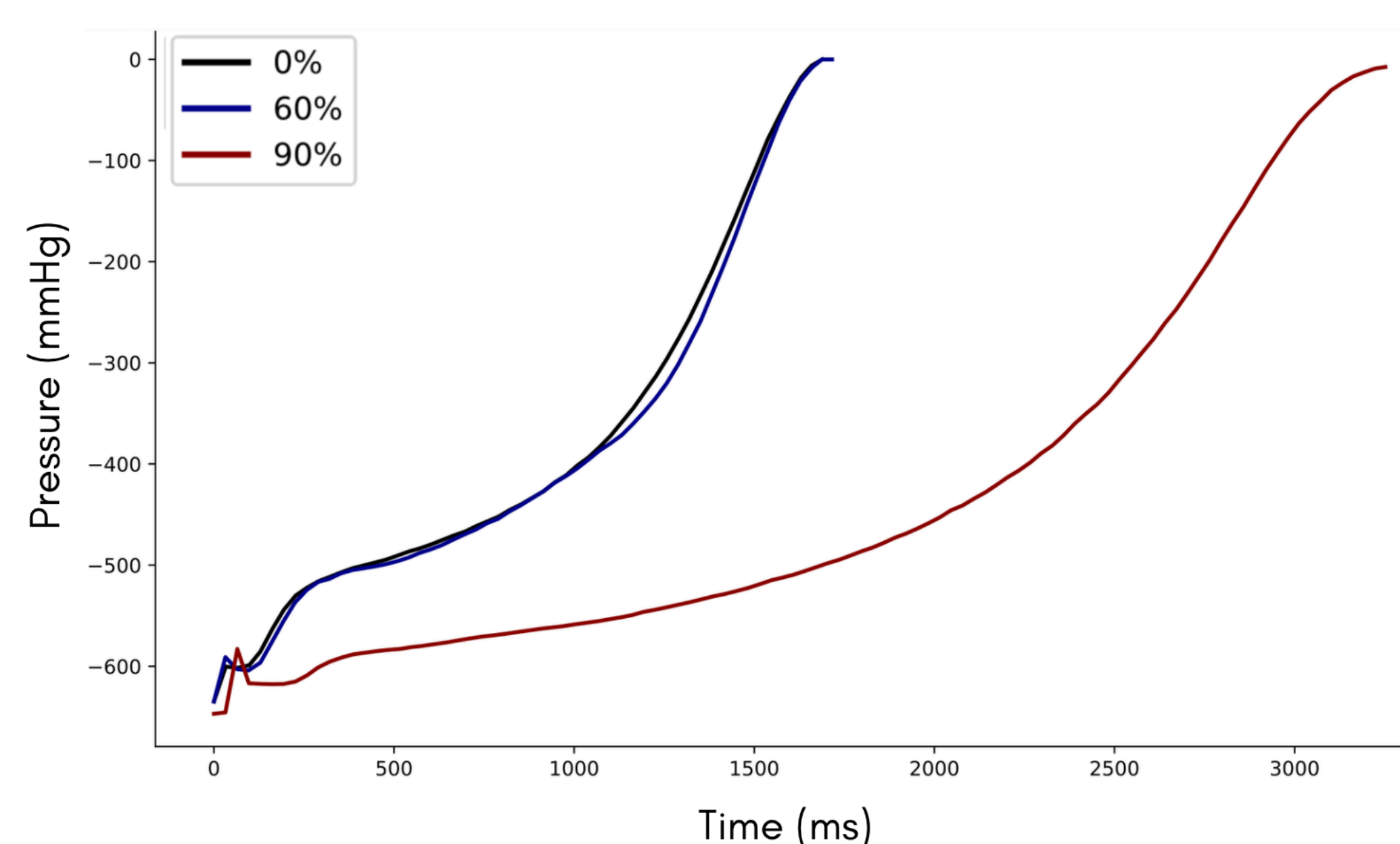
NEED

“ **Interventional radiologists /nephrologists/dialysis nurses** need to ensure **adequate flow*** through a hemodialysis central venous catheter (HD-CVC) to **prevent delays in hemodialysis treatment**

*Adequate flow defined as flow rates of 300-500 mL/min

OUR SOLUTION

We've developed a **handheld device** that detects **quantitative changes in CVC flow** with increasing occlusion



Occlusion	Fill Time (ms)	Time Constant τ (ms)
0%	1,690	1,351
20%	1,630	1,320
40%	1,660	1,350
60%	1,720	1,382
80%	2,249	1,856
90%	3,252	2,702

IMPACT

131,000+

Americans are diagnosed with End Stage Renal Disease (ESRD) annually (since 2018).¹

70,000+

initiate CVC hemodialysis annually.^{2,3}

Up to **33%**

require catheter removal due to inadequate blood flow.⁴

Our solution will:

- **Standardize** flow testing throughout CVC **insertion** and dialysis **treatment**
- **Reduce unnecessary delays** in dialysis and **emergent CVC exchanges**

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