Fixing cerebral shunt catheter blockage

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**Background**

- Hydrocephalus which causes elevated intracranial pressure (ICP), affects 1 in 500 newborns [1]
- Shunting relieves ICP by removing excess cerebrospinal fluid from the brain’s ventricles
- 40% of shunts fail within 2 years of implantation [2]
- Obstruction account for 50% of failures [3]

**Drainage setup**

- Clinical cerebral shunts have dimensions of \( L = 170\text{mm} \) & \( r = 0.38\text{mm} \)
- Clinical unobstructed shunt flow of \( Q = 2.5\text{ml/min} \) was required
- Following Eq. 1, the hydrostatic pressure was adjusted to \( \Delta P = 230\text{mmH}_2\text{O} \) to achieve the desired flow
  \[
  Q = \frac{\Delta P r^4}{8\mu L}, \quad \text{where } \mu \text{ is the dynamic viscosity}
  \]
  *Equation 1. Hagen-Poiseuille Equation*
- Peristaltic pumps were used to unblock catheters

**Flow measurement setup**

- Gage pressure sensors tapped pressure along the shunt-line
- NI USB-6009 DAQ card sampled pressure signals at 10Hz
- Flow rate calculated using Eq. 1

**Results**

- Flow reduced to 0.2ml/min within 20 minutes after microfibers were added (Fig. 3, Top)
- Patency was restored temporarily after a flushing procedure (Fig. 3, Bottom)
- Spikes could be explained by a sudden dislodge of fibers out of the drainage holes

**Replicating blockage**

- A bench-top catheter drainage unit was built to investigated the effectiveness of flushing for unblocking catheters
- Catheter dimensions: 1.6mm x 0.7mm, 0.025mm drainage holes
- Microfibers were seeded into the drainage reservoir

**Future work**

- Investigate the effect of microfiber length on time-course of obstruction
- Experiment with filler materials capable of coagulating microfibers
- Tune microfiber parameters to fit blockage flow profile patterns of clinical external ventricular drains

**References**