

## A novel training and validation simulator for cardiac pacemaker lead extractions

### Background

Cardiac pacemakers are the most common biomedical implants. Due to device failure or infections, they need to be removed in certain cases. Unfortunately, tissue adhesions between the pacemaker leads, the heart and veins (Fig.) can make it challenging to remove the leads without major surgery. Laser tools, mechanical abrasive sheaths, steerable “grabbing” catheters and ultra-compliant balloon catheters are used to extract leads and prevent complications. Despite a sophisticated toolbox, catastrophic complications like the perforation of the heart or veins can lead to massive internal bleedings and even death. Thus, familiarity of physicians with extraction tools and further improvement of these tools is crucial. Due to the complexity of lead extractions, a simulator for training and tool assessment is desired.

### Aim

In this project, the student will develop a training simulator for lead extraction. The simulator will be used to train physicians and should support the assessment and improvement of extraction tools.

### Materials and Methods

The student will first familiarize with the concept of lead extraction. Subsequently, an anatomical 3D model will be developed for the bench simulator using silicone moulding and additive manufacturing techniques. Realistic properties of the model (pulsatility, tissue and valve adhesions, vessel compliance, possibility for internal bleeding) will be implemented by close collaboration with physicians. Experimental tests with extraction tools will be performed to assess the behaviour of the simulator and evaluate its potential to support further improvement of extraction tools.

### Nature of the Thesis

Analytical: 25%  
Hardware development: 45%  
Experimental testing: 20%  
Documentation: 10%

### Requirements

Interest in applied device development.  
Experience or interest in additive manufacturing and silicone molding is considered an advantage.

### What we provide

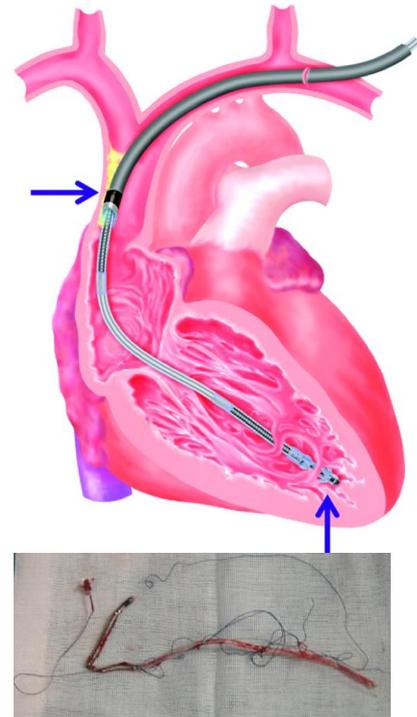
We provide expertise in cardiovascular technology and device development. The candidate will work in a dynamic team of engineers and physicians, where creative and innovative work is highly appreciated. She/he can attend lead extractions and is involved in the improvement of a potentially life-threatening intervention.

### References

- Wazni O, Wilkoff B: Considerations for cardiac device lead extraction. *Nature Rev. Cardiol.* 2016;13:221-229.

### Contact

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**Fig.:** Top panel: Adhesions (blue arrows) of the lead and the surrounding tissue may require dedicated tools to extract pacemaker leads. For instance, cutting laser sheaths (grey) are used to destroy adhesions. Bottom panel: During the extraction process, the pacemaker lead is subjected to strong mechanical forces, which may completely destroy its integrity (lead fragmented).

### Supervisors

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### Institutes

- Dept. of Cardiology, Bern University Hospital  
- Swiss Institute for Translational and Entrepreneurial Medicine