Development of an Automated Vascular Access Device (AVAD)

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Background

Vascular access is a critical and early step in the stabilization and treatment of critically injured soldiers and civilians.¹ Traditional peripheral intravenous (PIV) access and central venous cannulation (CVC) access becomes exceedingly difficult in the field, particularly in patients who are volume-depleted from blood loss or dehydration, vasoconstricted, or hypothermic. Such patients might benefit from interventions like Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA), an emerging choice in civilian trauma systems in the USA, ²

Introduction

We seek to develop a self-contained device that significantly simplifies IV and intra-arterial cannulation (IAC) by reliably and rapidly automating vascular access. In Phase I, we developed a preliminary design for a prototype system and demonstrated overall feasibility. In Phase II, we will develop a prototype device and evaluate its effectiveness. In Phase III, we will validate the technology, as needed, through clinical trials and will use that data to obtain FDA clearance.

Methods

The mechanical component of the AVAD consists of a needle for cannulation, an actuator which directs the needle to an anatomical location specified by the Direct Convolutional Neural Network (DCNN), and an ultrasound probe which provides input to the DCNN to identify the desired anatomical structure. The Phase II prototype uses a simplified layout which is easy to modify during testing on porcine models. A vessel was manually identified the porcine model via ultrasound by the team’s medical consultant, Dr. Zachary Soucy, and the needle was directed by the actuator to the vessel.

Results

Over several porcine trials, vascular access was achieved a number of times. Various parameters were modulated, including the speed and angle at which the needle approached the desired vessel, and these parameters were optimized through a trial-and-error method.

References


Conclusions

Due to the to tortuous nature of porcine vessels, perfused human cadaver models will be utilized in future trials. The development of the Automated Vascular Access Device is still in its infancy, and represents a new exciting frontier of medical advancement.