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Techniques

Extended Cable for Left Ventricular Assist Devices for Monitoring Isolated Patients during the COVID-19 Pandemic

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Neal Waxali,[1] James M. Kenward,[1] Yasser Varona,[1] Laurie Loza,[1] and Arvind Bhimaraj[2,*]

[1] Houston Methodist J.C. Walter Jr. Transplant Center, Houston Methodist, Houston, TX
[2] DeBakey Heart and Vascular Institute, Houston Methodist, Houston, TX

*Corresponding author: Abhimaraj@houstonmethodist.org

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Abstract

We present a method to create an extended cable for patients who are supported by left ventricular assist devices (LVADs) while infected with SARS-CoV-2. The arrangement described facilitates the LVAD monitor console's positioning outside of the patient's room to minimize exposure of the mechanical circulatory support team to the novel coronavirus.

Background

The coronavirus pandemic has pushed humanity to its limits. The need for physical distancing has been at the forefront of efforts in the community to minimize spread. In the hospital setting, physical distancing is needed for the healthcare workers' safety and to minimize transmission within the healthcare setting. To achieve this mission, many institutions created innovative methods. In COVID units, extended intravenous drip lines and elongated connections to ventilators have been used so that the consoles can be outside of the infected patient rooms. We present our technique to create an analogous extended cable for left ventricular assist device (LVAD) monitors.

Technique

The standard length of the cable for the Heartmate II™ and HeartMate 3™ devices (Abbott) is 21 feet. The HVAD device (Medtronic) has a cable that is 10 feet long. To keep the monitors outside the patient rooms, one would need to extend these cables to reach a total distance of at least 45 feet. Neither manufacturer sold extended cables that will meet the current need. After discussions with engineers from both Abbott[1] and Medtronic,[2] it was concluded that to safely and consistently transmit data for 45 feet, a cable with <1 ohm resistance would be required.

For HeartMate devices, we tested the three data cables that were all 35 feet long (10 feet original length + added 25 feet) (Table 1) in a machine shop. The category 5e (ISO/IEC 11801) and category 6 (TIA/EIA 568B) cables (Hosiwell Technology Co., LTD) failed to sustain the signal beyond 31 feet of extension. We then tested the L-4E6S (605) model cable (Canare® Corporation). Our institution uses L-4E6S (605) model cables as trigger cables for intra-aortic balloon pumps because they have a low signal-to-noise ratio. The L-4E6S (605) cables sustained signal for a total cable length of 56 feet for the Heartmate device. Also, unlike the other two cables, the L-4E6S (605) is shielded (in order to ground out any interference on the data cable) thereby reducing the signal to noise ratio.

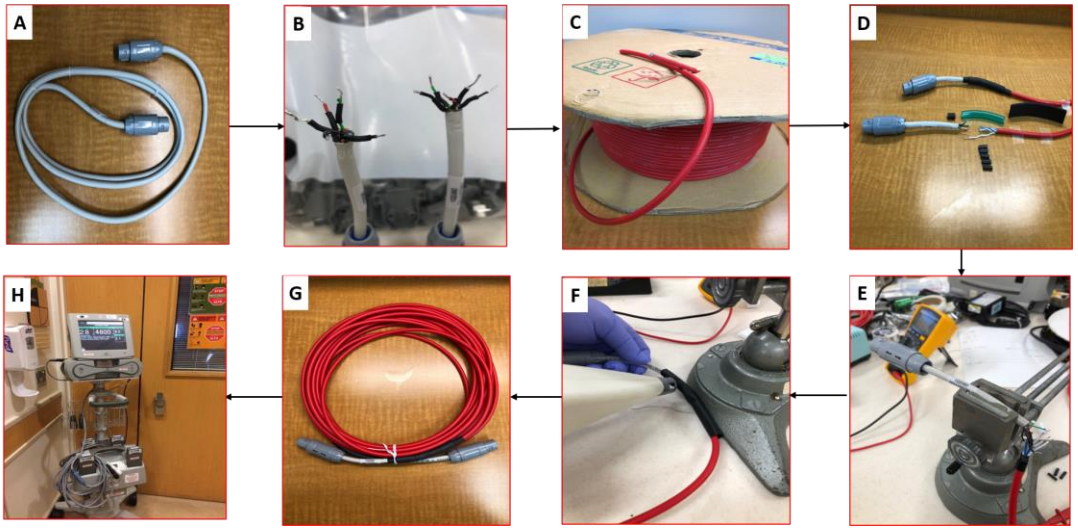
Table 1. Testing of cable types with Heartmate™ and Heartware™ devices.

Cable Type Tested	***Length of Cable***	***Device***	***Length of Signal***	***Outcome***
category 5e (ISO/IEC 11801)	35 feet	Heartmate	<31 feet	Failed
category 6 (TIA/EIA 568B)	35 feet	Heartmate	<31 feet	Failed
L-4E6S (605)	35 feet	Heartmate	56 feet	Passed
DB9 Connection	35 feet	Heartware	45 feet	Passed

The materials used for the extension were: a) 35 feet of the low signal-to-noise ratio cable, L-4E6S (605)**;** b) Silver solder; c) System monitor to power

module data cable; d) Monitor to controller data cable; e) Heat shrinkable tubing**.** Figure 1 depicts and describes the stepwise execution of creating an extended cable. The L-4E6S cable has been implemented in two hospitalized patients with no reports of viral transmission.

Figure 1. *A step-by-step pictorial of the process to extend the cables for isolated patients supported by left ventricular devices is provded. A) Obtain the manufacturer provided LVAD power module data cable. B) Cut the system monitor to power module data cable in half and strip 1 inch of insulation back from each side of the cable exposing the 6 conductors. C) Acquire a 35 foot, low signal-to-noise ratio cable. D) Strip 1 inch of insulation back from each side of the cable. E) Solder the wires of each end of the 35-foot cable to the two halves of the power module data cable halves. F) Apply heat shrinkable tubing to prevent shorting of the solder joint. For additional strength, use additional heat shrinkable tubing to cover the splice on each end. G) The extended cable will have a total length of 55 inches H) Connect to the LVAD monitor in the usual manner and place console outside of the patient's room.*



For the HeartWare HVAD system, we tested a 35-foot low voltage computer data cable and found that there was a loss of data transmission at a total of 45 feet. A DB9 serial extension cable was tested and we found it was able to maintain the signal for 45 feet. Importantly, it is readily available at most computer or electronic stores.

The DB9 data cable was not compatible with creating an extended cable for the HeartMate devices due to a connection pin disparity. Signal loss occurs when used with the Heartmate devices due to the increased signal-to-noise ratio and the resistance of the cable was >1 ohm.

As cases of infection continue to occur, providers need solutions to allow for safe isolation and monitoring of our patients on LVAD support. We have successfully created and utilized an extended cable for this purpose. We want to caution that the extended cable is not FDA-approved. While the two cables

discussed here have only been tested in our machine workshop, our institution has approved its use as an emergency measure in the current COVID crisis.

Acknowledgment

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References:

1. Waxali N. [Email communication with Abbott, E. Karadisian]. 2020.
2. Waxali N. [Email communication with Medtronic, J. Graham] 2020.