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PRECISION-LerVAD: A personalized algorithm to detect cardiac arrythmia and major bleeding in LVAD devices

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Extended Abstract

While left ventricular assistant devices (LVADs) have become a common treatment for advanced heart failure, complications still arise, and telemonitoring may improve outcomes by detecting early signs of deterioration [1]. LVAD currently employs a simple monitoring approach, using the same threshold for all patients, which leads to numerous false alerts or inefficient detection of adverse events. To improve this, researchers aim to develop a personalized algorithm that can detect common complications such as cardiac arrhythmia (CA) and major bleeding (MB). The algorithm will be tailored to each patient, allowing for better detection and management of complications.

The personalized PRECISION-LVAD algorithm that was developed is a patient tailored approach. The algorithm uses customized thresholds to identify abnormal power and flow observations. It first applies a linear mixed-effects (LME) model that considers the stable pump parameters of a group of patients and the longitudinal data of each individual patient. This results in a personalized mean pump value that is flexible and reflects the patient's stable historical baseline. For a 30-day calibration period, data from "stable-LVAD patients" is utilized to update and customize thresholds for each patient. In the final stage, the patient-specific mean is subtracted from real-time measurements to obtain residuals that indicate how much the pump parameter differs from the expected value. These residuals are then smoothed with an exponentially weighted moving average (EWMA) and compared to upper and lower control limits (UCL and LCL) determined by the EWMA control chart. If the smoothed residuals exceed these control limits, the algorithm will trigger an alarm. The new algorithm, PRECISION-LVAD, was compared with other methods such as MACD and absolute/relative thresholds, and a true positive alarm was assigned within 14 days prior to admission. Our result showed that PRECISION-LVAD was able to detect 59% and 79% in CA and MB with low false alarm rate of 2%.

Although PRECISION-LVAD showed potential in detecting early signs of cardiac arrhythmia (CA) and major bleeding (MB), some events in CA were still missed. Therefore, the algorithm needs to be refined by using more frequent or even continuous data. Before being clinically implemented, internal and external validation of the algorithm is necessary.

References

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