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The development of novel method for non-invasive continuous blood pressure monitoring during haemodialysis

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Background and Aims

Brachial artery blood pressure is recorded intermittently and often sporadically during haemodialysis, making it challenging to detect subtle changes is pressure that may portend intradialytic hypotension. Current methods of continuous blood pressure monitoring are limited to research tools that restrict arm movement and can be uncomfortable. To address the need for non-invasive continuous monitoring that does not adversely affect patient experience, we aimed to develop a method by which blood pressure can be estimated using pressure sensors on the arterial dialysis needle and venous bubble trap to derive an arterial pulse waveform.

Methods

We placed two additional pressure sensors in the dialysis circuit. An arterial sensor measured pressure from the arteriovenous fistula. A “Y” connector was attached to the standard arterial needle - one lumen was attached to the standard dialysis line, the other to a sterile accessory pressure transducer. A venous sensor was attached to the venous bubble trap on the dialysis machine once priming was complete. Each pressure sensor unit consisted of a pressure sensor (Honeywell Gauge sensor ± 0-300mmHg) and a sealed pressure transducing membrane to separate the pressure sensors from the blood compartment. These were connected to the dialysis blood lines using single-use accessory pressure transducers that maintained a sterile barrier (integrated permeable membranes that occlude if in contact with blood or fluid). Each transducer was suspended vertically on the drip stand of the dialysis machine during study sessions to maintain a column of air in the lumen.
Once the sensors were connected, pressure data were continuously recorded directly into Matlab (Mathworks) via a National Instruments data acquisition device.
Haemodynamic data were concurrently collected using a digital finger cuff for non-invasive continuous blood pressure monitoring (Finopress NOVA). The finger cuff was attached for 1 hour time periods and gives reconstructed systolic, diastolic and mean arterial blood pressure (MAP). Brachial cuff measurements were also taken every 30 minutes on the finometer and were recorded in the same Matlab program. This ensured exact time synchronisation between Finopress and pressure sensor data.

Results

Data from the venous bubble trap were used to accurately derive dialysis pump speed. This allowed the arterial waveform to be separated out from the pressure signals that originated from the peristaltic blood pump. Figure 1 shows an example of data from a study session with the negative arterial pressure, the venous pressure and the derived pump speed and time synchronised brachial blood pressure readings. This method has been piloted in 12 dialysis treatment sessions.

Conclusions

This method shows promise in accurately separating the arterial waveform from the steady-state and dynamic changes in the speed of the dialysis pump to derive arterial blood pressure. Continuous and non-invasive intradialytic blood pressure monitoring without patient discomfort or the need for additional sophisticated equipment may provide a valuable tool for the early detection of blood pressure changes to prevent intradialytic hypotension.