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Validating a method of continuous non-invasive arterial pressure measurement during haemodialysis

Professor Paul Stewart[1], Professor Jill Stewart[1], Professor Maarten Taal[2], Associate Professor Nick Selby[2], Dr Beth Lucas[2], Mr Tom Walker[1], Dr Daniela Viramontes Horner[2], Kelly White[3], Andy Muggleton[3]
[1]Derby University, Derby, United Kingdom, [2]University of Nottingham, Nottingham, UK, [3]Royal Derby Hospital, Derby, UK

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Introduction:
Intradialytic haemodynamic instability is a significant clinical problem, leading to end-organ ischaemia and contributing to morbidity and mortality in haemodialysis patients. Non-invasive continuous blood pressure monitoring is not part of routine practice but may aid detection and prevention of significant falls in blood pressure during dialysis. In this study we sought to perform initial validation of a novel method of continuously estimating blood pressure using pressure sensors in the extra-corporeal dialysis circuit, which does not require any direct contact with the person having dialysis.

Methods:
Participants >18 years old with a well-functioning arteriovenous fistula were recruited from our prevalent dialysis population. Pressure sensors on the arterial needle and venous bubble trap were used to derive continuous arterial pressure waveforms during dialysis sessions, which were corrected for blood pump speed (derived from the venous line waveform) by Fourier analysis. Data were continuously recorded at a sampling frequency of 1KHz and filtered by a moving average filter with a window length of 5 seconds. These pressure traces were then compared with: i) time-synchronised brachial blood pressure values taken at 30-60 minute intervals; and ii) with reconstructed time-domain blood pressure waveforms from digital artery pulse wave analysis (Finometer, Finopress NOVA) using mean absolute error.

Results:
To date, data from 4 participants have been acquired and analysed. Median age is 59 (IQR 42-78) years and three are male. Three have a radiocephalic and one has a brachiocephalic arteriovenous fistula, none of which had ever required intervention for stenosis.
There was a strong linear relationship between derived pressures from the arterial pressure sensor and brachial blood pressure values (Figure 1a), demonstrating that changes in the derived arterial needle pressure (after correction for pressure waveforms from the blood pump) are proportional to changes in systemic blood pressure ($r=0.92$, $p<0.001$). There was also good agreement within individuals between derived pressures from the arterial pressure sensor and the beat-to-beat blood pressure values from the Finometer; an example is shown in Figure 1b (mean absolute error 5.3mmHg). An additional eight participants have been recruited and will be studied by April 2020.
Conclusion:
In this proof-of-concept study, we demonstrate that it is possible to track changes in blood pressure during dialysis sessions using pressure readings from the arterial needle of an arteriovenous fistula, corrected for dialysis pump flow rate. This method may allow continuous non-invasive estimates of absolute or degree of change in intradialytic blood pressure. Further validation is required in a larger number of dialysis sessions.