MEASURING PRESSURE WAVES IN DIALYSIS LINES TO DERIVE CONTINUOUS ARTERIAL BLOOD PRESSURE: PILOT WORK IN AN IN VITRO AND IN SILICO MODEL

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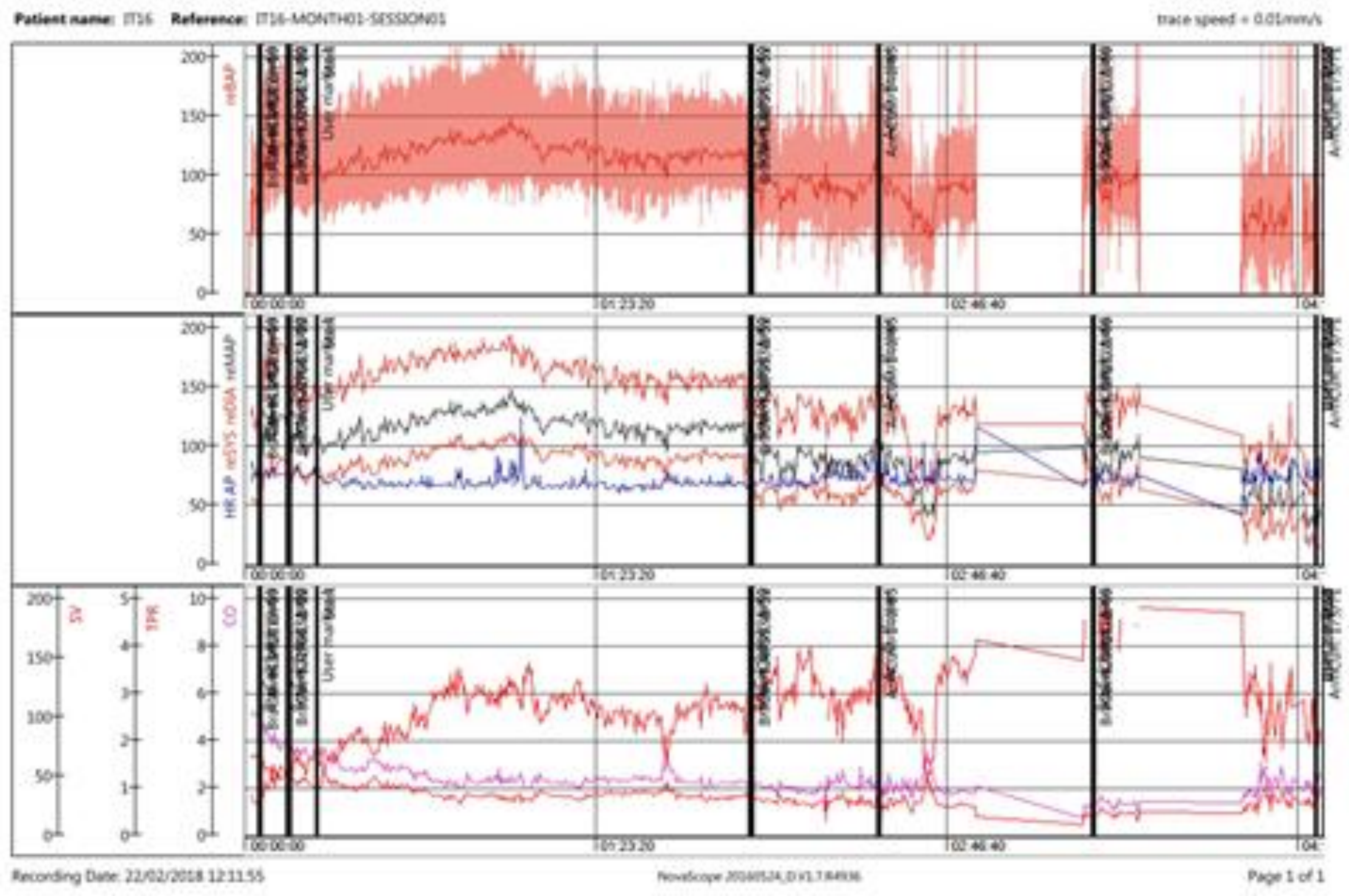
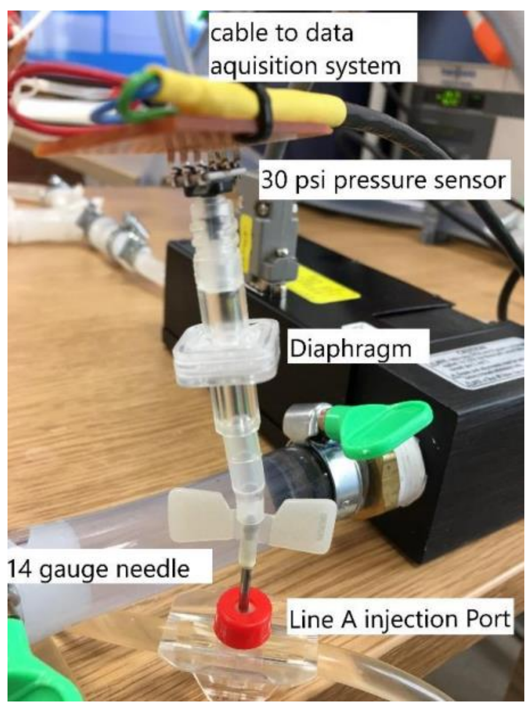
Introduction

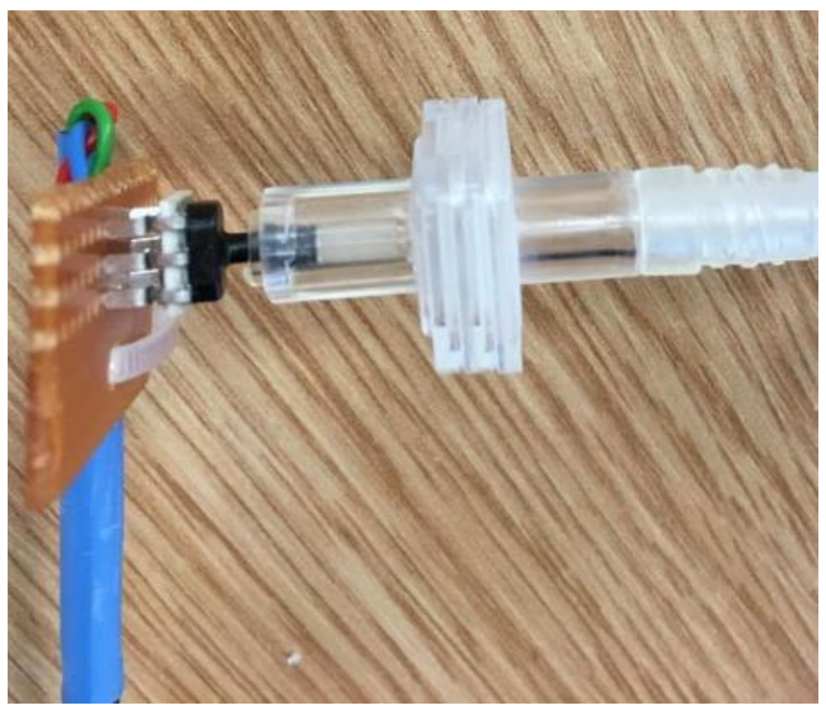
- Intradialytic hypotension remains a common and harmful complication of dialysis.
- Standard arm-cuff blood pressure measurements are taken infrequently and do not allow reliable prediction of events.
- Continuous non-invasive blood pressure measurement may allow the construction of models to predict haemodynamic instability
- Current methods are sensitive to patient movement disturbances and are uncomfortable for patients to wear.
- We have developed a method by which pressure sensors in dialysis lines can be used to reconstruct arterial blood pressure continuously



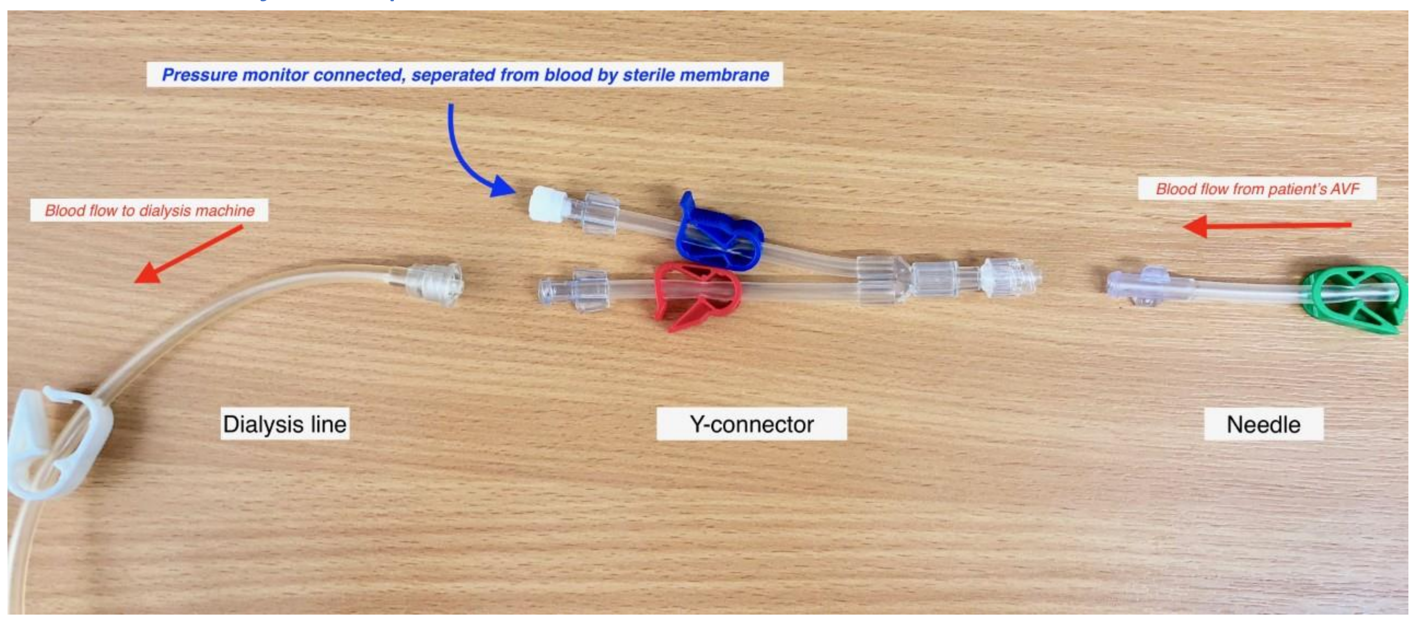
Typical commercial off the shelf patient physiological monitoring during dialysis, showing discontinuities



Sensor via injection port



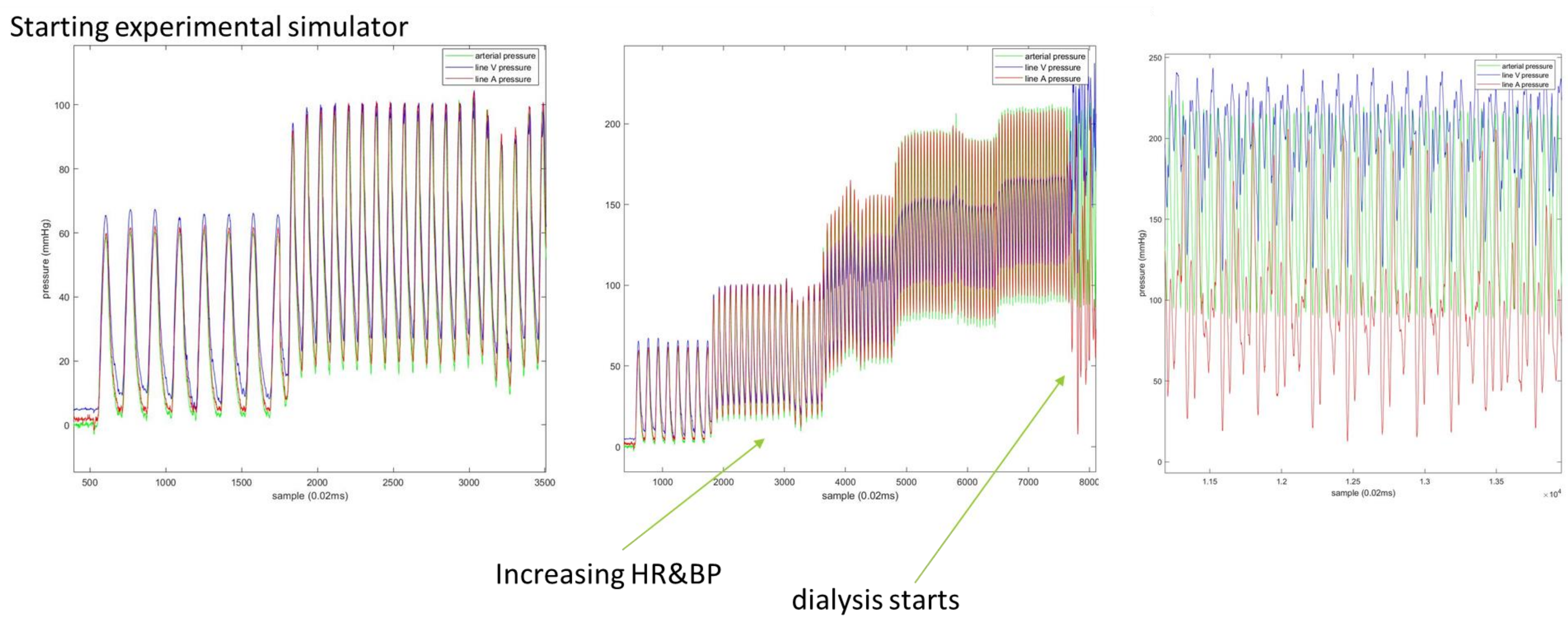
Sensor for 'Y' connector



'Y' connector

Methods

- Process control pressure sensors with on-board signal amplification and linearization have been developed with connectors to fit ports on standard dialysis lines.
- A laboratory simulated cardiovascular system replicates arterial pressure waveforms using pre-recorded patient data, or arbitrary 'synthetic' waveforms.
- Hospal Integra dialysis machine has been adapted to allow computer control of the peristaltic pump speed. Actual arterial pressure in the cardiovascular simulator is available from a dedicated pressure sensor.
- Machine learning of pressure waveforms in the arterial and venous dialysis lines. A novel Fourier Series real-time filter is applied to the line pressure data to reconstruct the arterial waveform.
- Sensors are interfaced to the dialysis lines either via a needle into injection port or via a 'Y' connector



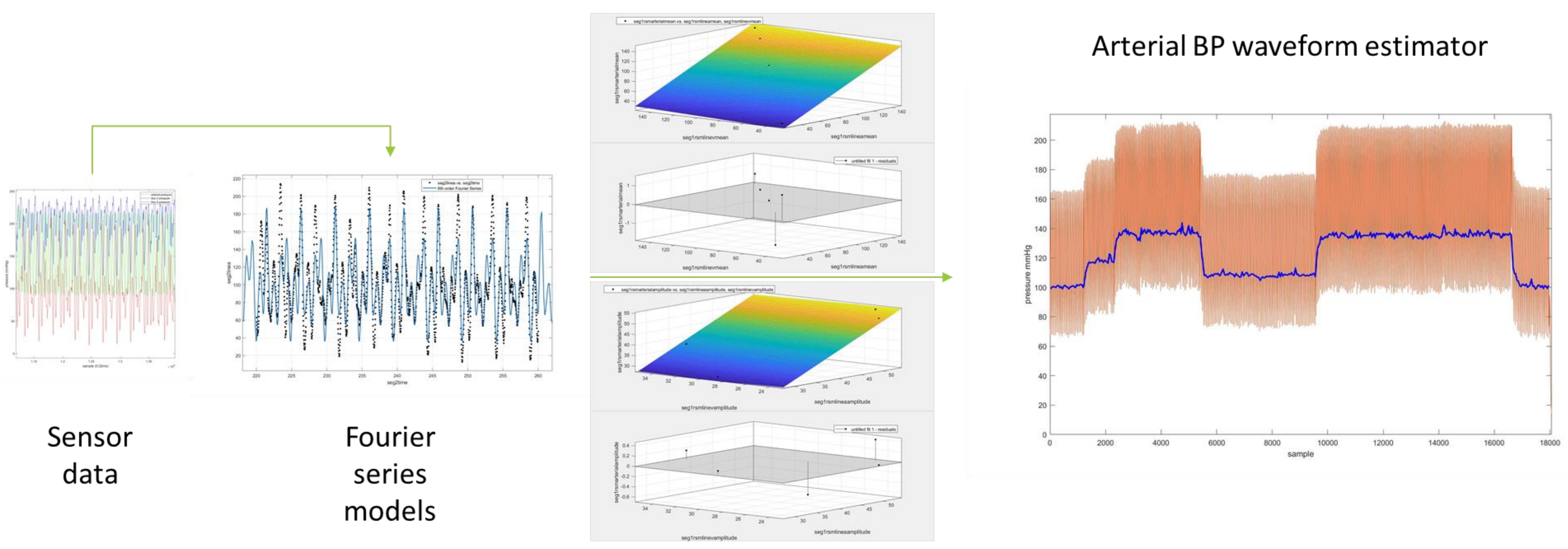
Real-time continuous arterial and line waveform before and after dialyser switched on

Results

- A reliable and robust continuous pressure wave form can be detected by pressure sensors in the arterial and venous dialysis lines.
- A method to self-calibrate across needle/sensor/line/pump position variables is demonstrated.
- A mathematical transform and filter method successfully estimates MAP even in the presence of significant disturbance waveforms from the dialyser peristaltic pump.

Conclusions

- A low cost, non-invasive method of reconstructing continuous real-time blood pressure waveforms and associated hemodynamics which is robust to external disturbance offers the opportunity for continuous intradialytic monitoring and provides a foundation for future development of haemodynamic instability prediction. Initial evidence indicates that accurate arterial waveform reconstruction is also possible



Computational path from raw sensor data to MAP estimation

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iTREND Intelligent Technologies for Renal Dialysis and Diagnostics

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