Abstract citation ID: gfae069.876

#2118

Monitoring hemodynamics in dialysis: on the feasibility of semi-continuous and multifrequency thoracic bioimpedance measurements by a wearable device

Melanie Schoutteten[1], Lucas Lindeboom[2], Hélène De Cannière[3], Zoë Pieters[3], Astrid Brys[4], Patrick van der Heijden[2], Bart De Moor[3], Chris Van Hoof[5], Willemijn Groenendaal[2], Jeroen Kooman[4] and Pieter Vandervoort[3]

[1]UHasselt, Imec The Netherlands, Hasselt, Belgium
[2]Imec The Netherlands, Eindhoven, Netherlands
[3]UHasselt, Hasselt, Belgium
[4]Maastricht University, Maastricht, Netherlands
[5]Imec Leuven, Leuven, Belgium

Background and Aims: Hemodialysis patients face a high hemodynamic variability in blood pressure and fluid status, which contributes to their cardiovascular mortality. Currently, intradialytic hemodynamic monitoring has to rely on cuff-based blood pressure measurements. During the interdialytic interval, no monitoring system is applied. An interesting alternative to monitor hemodynamics continuously can be found in the bioimpedance technique, and more specifically in bioimpedance measurements of the thoracic segment. Repeated single-point measurements of thoracic bioimpedance at single (low)-frequency are strongly related to fluid changes during hemodialysis. Extension to semi-continuous measurements may provide longitudinal details in the time pattern of the bioimpedance signal, and multifrequency measurements may add in-depth information on the distribution between intra- and extracellular fluid. This study aims to investigate the feasibility of semi-continuous multifrequency thoracic bioimpedance measurements by a wearable device in hemodialysis patients.

Method: Thoracic bioimpedance was recorded semi-continuously (i.e. every ten minutes) at nine frequencies (8–160 kHz) in 68 patients during two consecutive hemodialysis sessions, complemented by an interdialytic single-point measurement at home. The wearable bioimpedance device was provided by imec, The Netherlands (Fig. 1). A linear mixed model was built to integrate all measurements at frequencies 8 and 160 kHz, incorporating the different dialysis sessions up until 240 minutes after the start of dialysis as well as the home measurement that was performed.

Results: On average, the thoracic resistance signals increased during the first hemodialysis session, decreased during the interdialytic interval, and increased again during the second hemodialysis session, at all frequencies.

The average intradialytic increase was larger at 8 kHz (Δ 32.6 Ω during session 1 and Δ 10 Ω during session 2) compared to 160 kHz (Δ 29.5 Ω during session 1 and Δ 5.1 Ω during session 2). By measuring semi-continuously and at multiple frequencies, a different time pattern became clear within and between frequencies. The resistance at 8 kHz followed a linear time pattern, whereas the evolution of the resistance at 160 kHz showed a significant quadratic trend in the first dialysis session ($p < 0.0001$).

During the first interdialytic interval (from the end of the first dialysis session towards the home measurement), the decrease in resistance was more distinct at 8 kHz (Δ -2.27 Ω) compared to a small increase of 0.84 Ω in 160 kHz. This finding reveals a certain inertia in the higher frequencies, mirroring the changes in intracellular volume.

Finally, the statistical model could create individual predicting profiles over time, including as well the intradialytic as the interdialytic interval (Fig. 2).

Conclusion: In this study, we showed that it is feasible to perform semi-continuous and multifrequency bioimpedance measurements by a wearable device during hemodialysis. Semi-continuous and multifrequency measurements provided a broader, and respectively profounder knowledge on the trend of the bioimpedance signal during fluid changes compared to single-point and single-frequency measurements. Measuring thoracic bioimpedance semi-continuously and with a multifrequency current is a major step forward in the understanding of fluid dynamics in hemodialysis patients, by which the road is paved towards remote fluid monitoring and the prevention of hemodynamic instabilities.

current, P bias polar, V voltage

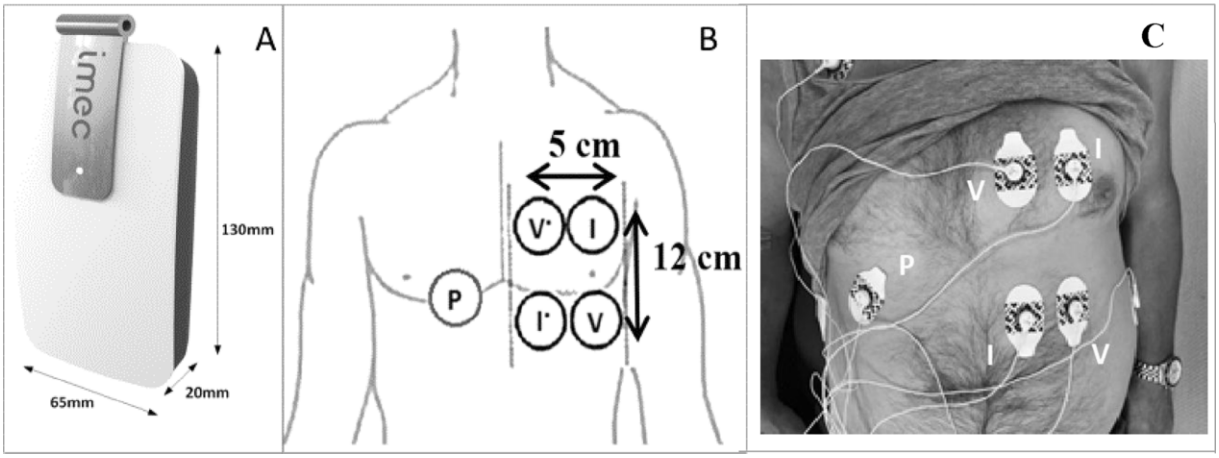

Figure 1: The wearable device (A), schematically presentation of the thoracic electrodes (B), attachment of the electrodes and cables on the thoracic region of a study patient (C).

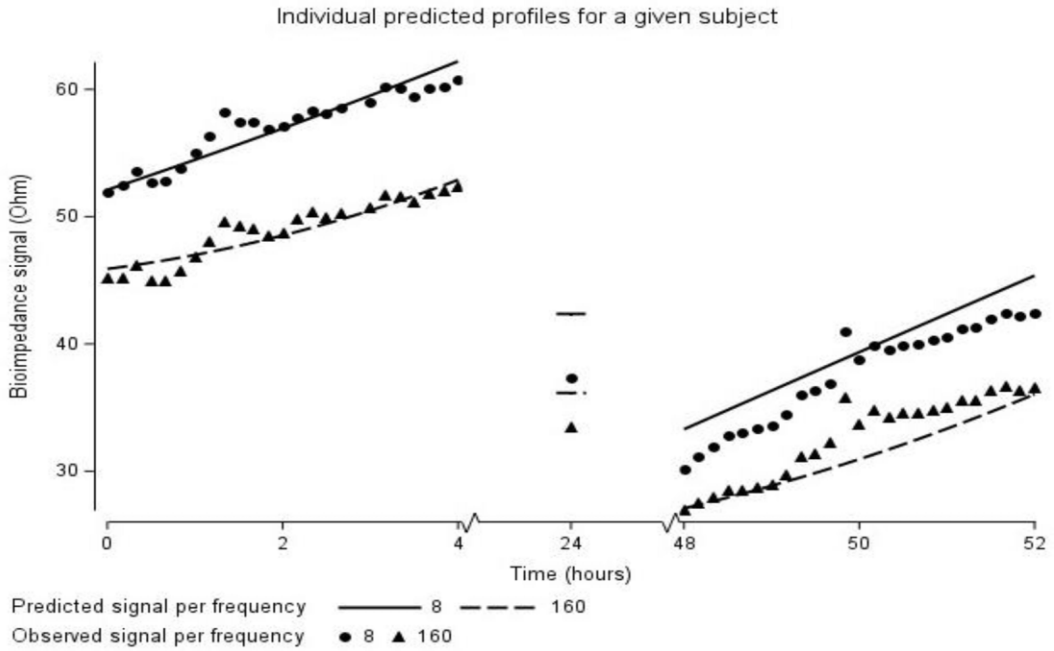

Figure 2: Individual predicted evolution of the resistance at 8 and 160 kHz over time for a given patient.