Arterial blood pressure changes induced by acceleration during mobile intensive care unit patient transport are not patient related: beware of misinterpretation

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Dear Editor,

Critically ill patients are transferred more safely with a mobile intensive care unit (MICU) and specialised retrieval team [1, 2], although incidents still occur [3]. However, transports are becoming more challenging [4]. During MICU transports, we repeatedly observed arterial blood pressure variations, concurrent with ambulance accelerations and decelerations. We aimed to evaluate whether the observed influence of acceleration on blood pressure is a real blood pressure change or a physical measurement artefact.

Usually, the pressure transducer is positioned at the rear end of the trolley and the distance to the arterial cannula varies between 100 and 150 cm. In an experimental setting, pressure lines (Edwards Lifesciences, Irvine, USA) were positioned on the trolley. At the site of normal catheter insertion, the line was connected to a pressurised bag to simulate a static mean arterial pressure (MAP). The length of the pressure line and the baseline pressure were varied (0, 50, 100, 150 cm and 50, 75, 100 mmHg).

To simulate acceleration and deceleration the trolley was moved forward and backward in several test runs. Pressures and accelerations (accelerometer, University of Twente, Enschede, the Netherlands) were measured for the different pressures and different pressure line lengths. Pressure data were plotted against acceleration data (Fig. 1). The Pearson’s correlation coefficients $r$, $p$ values, $R^2$ and the slopes of the linear regression lines ($\beta$) and their 95% confidence intervals are listed in Table 1. In this experimental setting both an increase in the baseline pressure and in pressure line length were associated with significant increases in pressure variations during accelerations. To confirm the findings that pressure variations may be a physical phenomenon, MAP and acceleration data were collected during six transports. The medical ethics committee approved this study and the need for consent was waived. The pressure transducer was initially positioned at the rear end of the trolley and halfway changed to directly on top of the arterial cannula so that patients served as their own control. The effect of acceleration on MAP was analysed for both positions of the transducer. In patient transfers, a weak correlation was observed between acceleration and blood pressure with the transducer positioned on top of the arterial cannula. The mean Pearson’s $r$ significantly increased from 0.09 to 0.50 when the transducer changed position to the rear end of the trolley.

The inertial mass effect of the fluid column in the tubing explains most of the blood pressure variation. The

Fig. 1 Experimental data with varying baseline pressures (in columns) and varying lengths of the pressure lines (in rows). Slope presented as $\beta$ (mmHg/g)
impact of the blood pressure itself is more difficult to understand. We hypothesise that a relation with the compliance of the pressure tube may explain our findings.

Clinicians involved in patient transport should have knowledge of this phenomenon to prevent misinterpretations of blood pressure changes. To minimise the effect, the pressure transducer should be close to the arterial cannula. These findings underscore that patient transports add a plethora of new difficulties to the already complicated care for critically ill patients. Education and training are required to master these additional challenges [5].

Conflicts of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

References