A transcutaneous carbon dioxide monitor is a useful tool with known caveats

To the Editor:

We have read with great interest the article by Mummery *et al.* [1] on the use of transcutaneous carbon dioxide tension (P_{tcCO_2}) as a means of measuring carbon dioxide in the acute, unselected medical setting. The authors compared the results of gold standard arterial blood gas analysis sampling with values of P_{tcCO_2} measured by Resmed SenTec monitor (SenTec AG, Therwil, Switzerland) in 50 patients admitted to hospital for different diseases, including respiratory problems, non-respiratory sepsis, cardiovascular diseases and other medical diagnoses.

Bland–Altman analysis showed that the bias of the P_{tcCO_2} tended to be 0.16 kPa (95% CI ±1.54 kPa) lower than the arterial carbon dioxide tension (P_{aCO_2}) with 95% limits of agreement −1.67 to 1.35 kPa. Furthermore, the limits of agreement for the two techniques for measuring P_{tcCO_2} was also significantly outside of "what may be an acceptable difference" of ±0.25 kPa. Therefore, Mummery *et al.* [1] concluded that P_{tcCO_2} measured by the Resmed SenTec monitor should not be used in acute clinical settings as an alternative to the P_{aCO_2} measured by arterial blood gas analysis sampling. The limitations to the study highlighted that only the Resmed SenTec monitor was tested and that only the forehead position was used to place the sensor.

In a previous real-life study, we have evaluated the accuracy of a similar transcutaneous carbon dioxide sensor (TOSCA; Linde Medical Systems, Basel, Switzerland) for non-invasive estimation of arterial carbon dioxide in 35 severely obese patients affected by different respiratory disorders and admitted to an acute, unselected medical setting [2]. In our study, 18 patients presented arterial pH less than 7.35 and severe hypercapnia. We showed a general good agreement between P_{tcCO_2} measured by the transcutaneous electrode and P_{aCO_2} measured from sampling arterial blood. In our study, the mean difference was of −0.15 kPa, with a standard deviation of the difference of 0.17 kPa and a 95% limit of agreement of −0.53 to 0.15 kPa. We also reported a discrepancy >0.25 kPa (>2 mmHg) between P_{tcCO_2} and P_{aCO_2} in 11 of the 55 paired measures, in our study probably due to the heated sensor, which improved the local perfusion [3] but increased the local production of tissue carbon dioxide [4].

Our findings were consistent with those of Mummery *et al.* [1], showing several samples outside the difference of ±0.25 kPa, although using a different electrode and a different measuring site (in our study, the earlobe). Differently from that study, we have considered this difference clinically acceptable in almost all patients, as the differences we have found between P_{tcCO_2} and arterial blood gases did not change the clinical outcome in our patients. However, considering as clinically acceptable a maximum difference of 1 kPa (7.5 mmHg), as in other studies [5], we found only three paired measures outside this limit.

Accordingly, P_{tcCO_2} has shown good accuracy when compared to P_{aCO_2} in 25 non-intubated and spontaneously breathing patients with acute respiratory failure admitted to the intensive care unit [6]. P_{tcCO_2} has also been used as a monitoring tool during spontaneous breathing trials in intubated patients, showing a good correlation and agreement between P_{tcCO_2} and P_{aCO_2} (bias −1.5 mmHg; lower limit of agreement −4.4 mmHg; upper limit of agreement 7.4 mmHg) [7]. From these and other studies [8–10], it appears that P_{tcCO_2} overall is relatively accurate and median difference between P_{tcCO_2} and P_{aCO_2} is relatively low (generally lower than the difference between end-tidal carbon dioxide and P_{aCO_2}), although large outlier readings even within the same patient are common, can occur at any time and are unpredictable.

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Although transcutaneous carbon dioxide measurement cannot completely replace conventional blood gas analysis, transcutaneous carbon dioxide sensors could be used in patients with variable levels of hypercapnia also in an acute setting http://bit.ly/2kliEXx

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Although we agree that the measurements of P_{tcCO_2} are less informative than arterial blood gases, as isolated elevated CO_2 levels give an incomplete picture, in our experience it may be well accepted by patients and staff, as clearly shown also by MUMMERY *et al.* [1]. For example, in patients with COPD, we often use measurements of P_{tcCO_2} in conjunction with arterial blood gas measurement. This is done to follow the trends after an initial arterial sample because it provides a continuous measurement and reduces the need for frequent invasive sampling of arterial blood.

In conclusion, we think that although P_{tcCO_2} measurement cannot completely replace conventional blood gas analysis, transcutaneous carbon dioxide sensors could be used with caution in patients with variable levels of hypercapnia, also in an acute setting, although in a minority of cases, clinically relevant differences to arterial P_{aCO_2} can be observed.

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