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Evaluation of a transcutaneous carbon dioxide monitor (''TOSCA'') in adult patients in routine respiratory practice

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KEYWORDS
Transcutaneous carbon dioxide;
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Summary
Background: Non-invasive measurement of oxygenation is routine in adult clinical practice but transcutaneous monitoring of PCO_2 ($PtcCO_2$) is used much less due to technical difficulties with earlier transcutaneous electrodes.
Objective: Our aim was to determine the reliability of estimating arterial PCO_2 ($PaCO_2$) using a recently introduced combined $SaO_2/PtcCO_2$ monitor (''TOSCA'', Linde Medical Systems) in adult patients in routine clinical respiratory practice.
Methods: $PtcCO_2$ was measured in patients requiring arterial blood gases for clinical reasons. Ten minutes after the probe had been attached to an earlobe $PtcCO_2$ was recorded, immediately before arterial blood sampling. The PCO_2 values obtained were compared by Bland–Altman analysis.
Results: Samples were taken from 48 unselected patients with varied pathology. There were no technical problems. Median age was 56 years (range 20–86 years). The mean difference between $PaCO_2$ and $PtcCO_2$ was −0.04 kPa, SD of the difference 0.67 kPa. Bland–Altman analysis showed generally good agreement between the two measurements across the range of $PaCO_2$ values (4–10.9 kPa). Four of 48 measurements showed a PCO_2 difference >1 kPa with no technical or clinical explanations apparent.
Conclusions: The accuracy of estimation of $PaCO_2$ by the TOSCA transcutaneous electrode was generally good and the device appears promising for use in routine clinical respiratory practice.

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Introduction

Non-invasive estimation of arterial PCO_2 by measurement of transcutaneous carbon dioxide ($PtcCO_2$) has been possible since 1972 but for many years measurement of $PtcCO_2$ was inaccurate and impracticable with sensors being fragile and expensive and requiring frequent calibration.[1] More recent $PtcCO_2$ monitors have proved to be more reliable and are routinely used in infants but are not widely used in adult patients. If accurate they would usefully complement the 'gold standard' measurement of arterial blood gases which is invasive, intermittent and may be unpleasant. Preliminary studies of the reliability of a combined $PtcCO_2/SpO_2$ monitor (TOSCA, Linde Medical Sensors, Basel, Switzerland) have shown good agreement in adult volunteers and anaesthetised adults.[2–4] The current TOSCA sensor has been evaluated in anaesthetised children,[5] anaesthetised adults[6] and ill neonates[7] with all these studies again showing good agreement between $PtcCO_2$ and $PaCO_2$. However, one study involving acutely ill adult patients receiving intensive care[8] suggested a significant difference between measured $PtcCO_2$ and $PaCO_2$, but this study included only a small number of subjects ($n = 8$) with multiple measurements from individuals.

To our knowledge no studies have been reported evaluating the accuracy of the TOSCA monitor in adult patients in routine respiratory practice. We have therefore determined the reliability of estimating $PaCO_2$ using the TOSCA monitor in unselected adult patients in routine respiratory practice.

Methods

After approval from the Local Research Ethics Committee and obtaining informed patient consent, we prospectively enrolled 48 patients into the study. All were inpatients in a respiratory ward (including general and subspecialty respiratory medicine) who required arterial blood gas analysis for clinical reasons. A detailed technical description of how the TOSCA sensor works is provided elsewhere.[5] $PtcCO_2$ is measured (along with SpO_2) via a sensor attached by a low-pressure clip to an earlobe. The sensor probe heats the earlobe to 42 °C to enhance blood flow. After automated calibration the TOSCA sensor was attached to an earlobe to monitor $PtcCO_2$; after 10 min $PtcCO_2$ was recorded immediately prior to arterial blood sampling for blood gas analysis in the usual way (Gem Premier 3000, Instrumentation Laboratory, Lexington, MA, USA). Co variables recorded included inspired oxygen concentration, diagnosis, age, gender, heart rate, blood pressure, temperature and any technical problems with the measurement.

Statistical analysis

The level of agreement between $PaCO_2$ and $PtcCO_2$ measured by TOSCA was assessed by Bland–Altman analysis.[9]

Results

Forty-eight adult patients were recruited prospectively. Their median age was 56 years (range

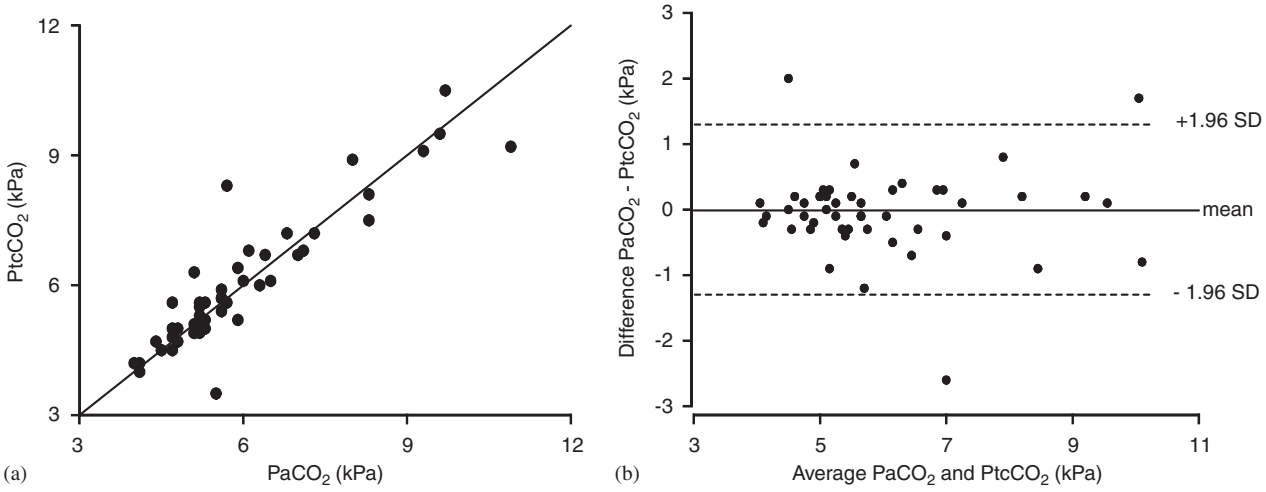

Figure 1 (a) Comparison of transcutaneous and arterial PCO_2 in 48 patients showing line of identity. (b) Bland–Altman plot of difference between 2 estimates of PCO_2 and their average.