Traceable Calibration for TEWL:- Does it make a Difference in Practice?

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Introduction

There are well known discrepancies between the rates of transepidermal water loss measured with different instruments, even when used under identical conditions on the same skin sites. This has made it difficult to compare results measured with instruments from different manufacturers, or even with otherwise identical instruments from the same manufacturer. One possible cause of these discrepancies may be associated with instrument calibration, where a variety of non-traceable techniques are in use. With the development of a new traceable calibration technique by the TEWL Calibration Consortium, the question needs to be asked to what extent this has made a difference to the results obtained in practice.

We sought an answer to this question by conducting comparative laboratory studies, to determine the differences in the measurements obtained from different instruments to which the new traceable calibration technique can be applied. The studies used open-chamber, ventilated chamber and condenser chamber instruments.

Methods

The following instruments were used:-

OC	Open-Chamber type
CC	Condenser-Chamber type
VC	Ventilated-Chamber type

Two sets of measurements are presented:-

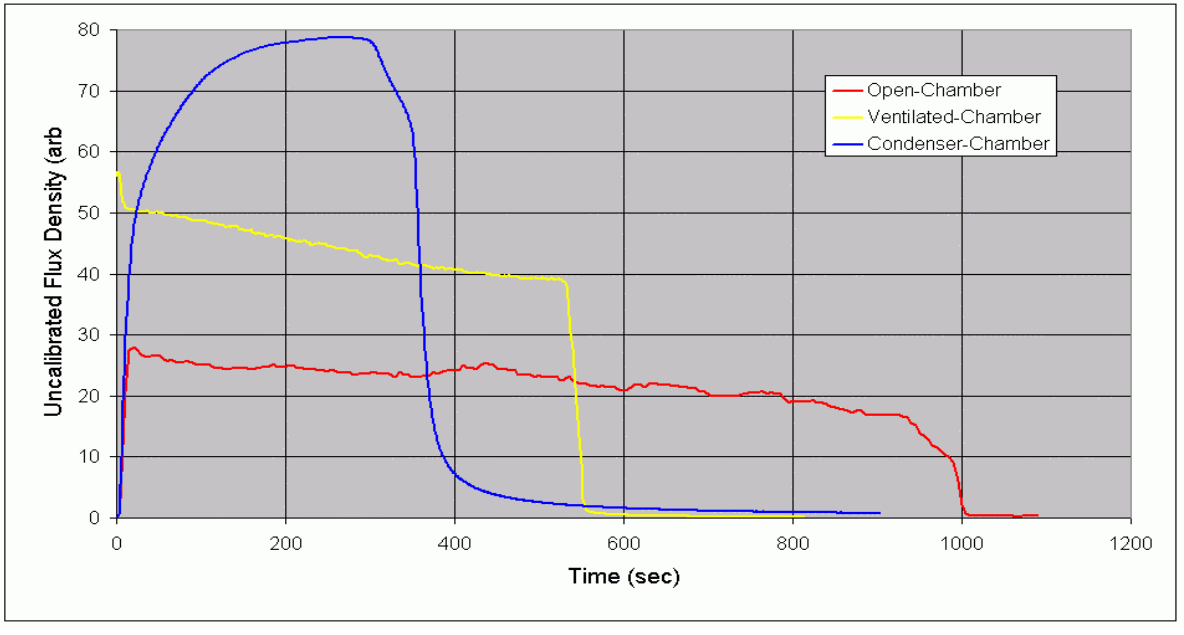
Dataset 1 was measured at the National Physical Laboratories (NPL) on equivalent sites of the volar forearm of individuals with normal skin, following acclimatisation. The study used OC, CC and VC instruments.

Dataset 2 was measured at London South Bank University on equivalent sites of the backs of hands of individuals with normal skin. The data were collected over 7 hours, to study acclimatisation and look for possible diurnal variations in TEWL. The study used OC and CC instruments only.

Calibration

Each study was conducted with instruments as supplied by the manufacturers. Thereafter, they were individually calibrated using the droplet method. The calibrations used 1µl water placed on Teflon substrates. Figure 1 shows typical calibration traces. The calibration factors, calculated from the areas beneath such calibration curves were then used to re-scale the measurements and thus determine any improvements or otherwise of agreement between the readings from the different instruments used.

Figure 1:- Typical droplet calibration curves for OC, VC & CC instruments.



Dataset 1

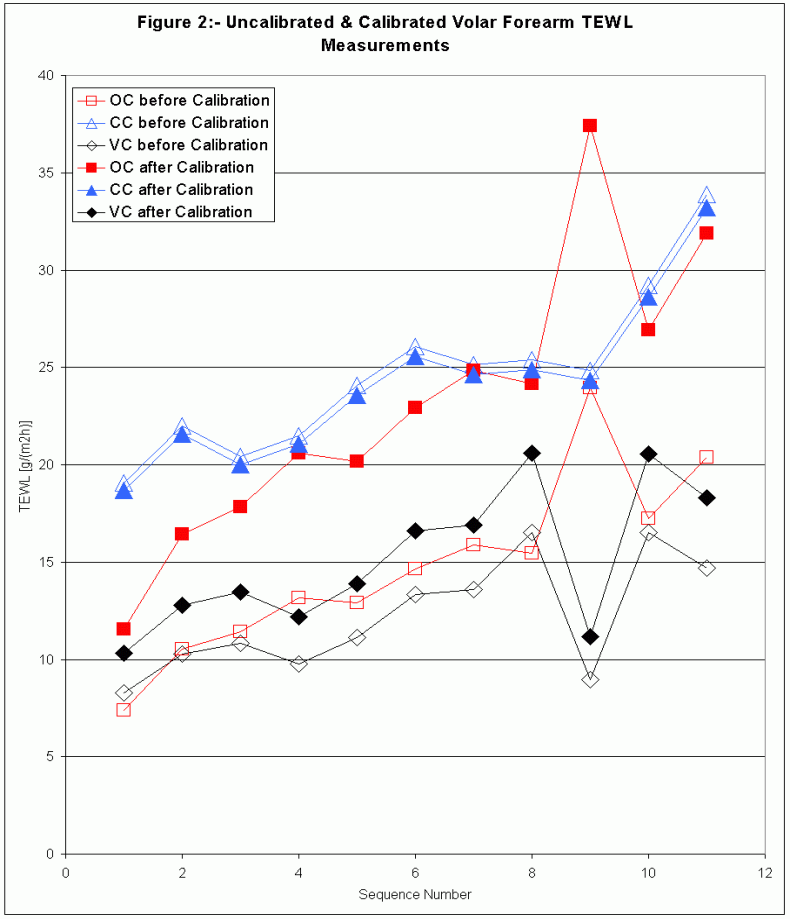


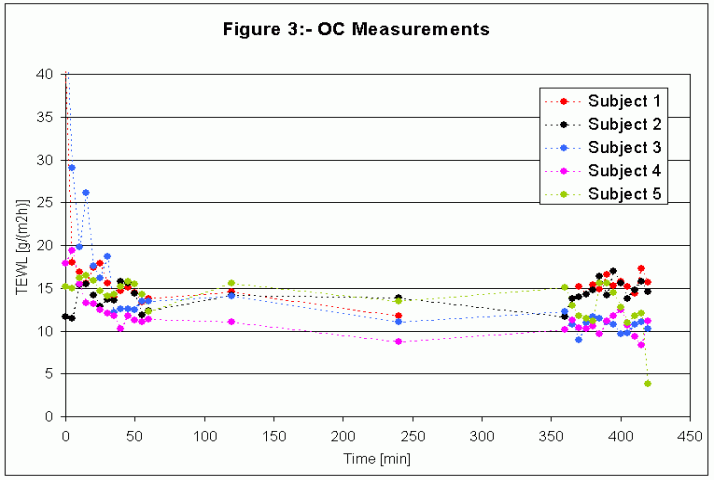
Figure 2 shows volar forearm TEWL values measured on equivalent sites in consecutive measurements with OC, VC and CC instruments. Uncalibrated values are shown with open symbols, calibrated values with full symbols.

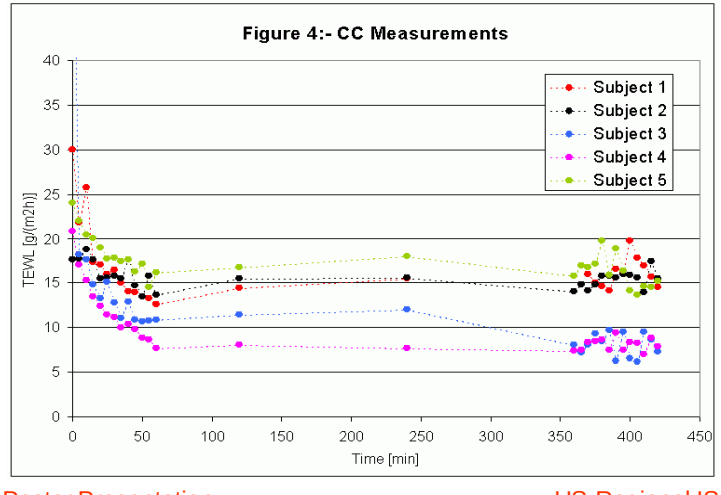
Calibration Factors

Instrument	CC	OC	VC
Calibration Factor	0.98	1.56	1.25

The calibration clearly reduces the deviations between the readings from the different instruments, from a Coefficient of Variation of CV=68% to CV=36%. Some systematic deviations persist, especially with the VC data. These are thought to be due to differences in the ways in which the droplet calibration was applied to the different instruments.

Dataset 2 – TEWL Time-Series





Figures 3 and 4 show TEWL values measured on equivalent sites on the backs of hands of five subjects over a 7-hour period using calibrated OC and CC instruments respectively. The initial ~30 minutes of measurement records changes due to acclimatisation, the remaining measurement time was used to look for diurnal variations.

The two instruments yield comparable values, but the differences between subjects appear to be more pronounced in the CC data. This is thought to be due to differences in the ways in which the droplet calibration was applied to the two instruments.

Dataset 2 – Correlation

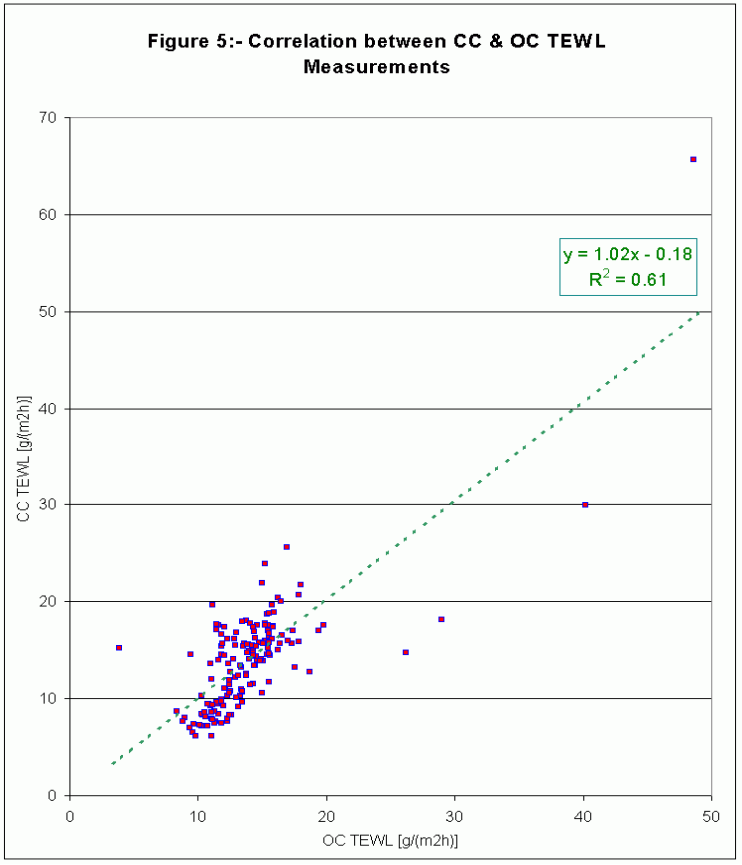


Figure 5 shows the correlation between the OC & CC TEWL values presented in Figures 3 & 4. The fitted correlation gradient shown in the green box is close to unity, as expected for calibrated measurements. The relatively low correlation coefficient of R^2=0.61 is thought to be partly due to noise and partly to the systematic difference referred to in connection with Figures 3 & 4.

Discussion

The experiments show good correlation between TEWL measurements performed with different instrument types. The observed scatter is thought to be due to variations in the placement of the measurement heads, the different measurement head diameters and changes in the physiological functions of the individuals being tested.

The use of the droplet method of calibration was found to bring the TEWL values measured by different instruments into closer agreement. However, systematic differences persist and these are under investigation. In particular, it is thought that the ways in which the calibration has been applied to the different instrument types has not been consistent.

Work is in progress to develop detailed calibration protocols for the different instrument types and to quantify the systematic and random errors of the droplet method, in order to assess the accuracy that can be expected from it.

Conclusions

These preliminary experiments illustrate the promise of the droplet method for calibrating TEWL instruments to a common flux density scale, with traceability to agreed standards.

Acknowledgements

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