



# Changes in finger temperature and blood flow in response to different frequencies of transcutaneous electroacupuncture at LI4 (*hegu*).

Interim analysis and 'real life' methodological issues: many factors, missing data and a multiplicity of measures



© David Mayor,<sup>1</sup> Tony Steffert<sup>2</sup> and Ronakben Bhavsar<sup>1</sup>  
1. University of Hertfordshire; 2. Open University

## Protocol

17 participants each attended for a single session consisting of 10 consecutive 5-minute 'slots'. In the second, fifth and eighth slots, TEA was applied bilaterally at LI4 (*hegu*) at three different frequencies (2.5 Hz, 10 Hz and 80 Hz), in counterbalanced order and at a 'strong but comfortable' intensity. Using finger photoplethysmography, with a thermistor on the same finger, the blood volume pulse (BVP) and temperature were monitored throughout. Electrocardiograph (ECG) signals were collected from wrist electrodes [Fig 1]. Blood flow was assessed from smoothed and unsmoothed measures of BVP amplitude, and pulse transit time (PTT) from the lag between the ECG 'R' and BVP systolic peaks [Fig 2].

## Technical challenges encountered

- Thermistor did not work for 5 participants (missing data)
- Data drop-out of unknown origin and pattern in 62 slots (36%)

## Some other factor findings

Fig 5. Prior experience (of any of acup, EA or TENS) enhances blood flow ( $p=0.001$  during and after Stim) and PTT ( $p=0.04$  during Stim):

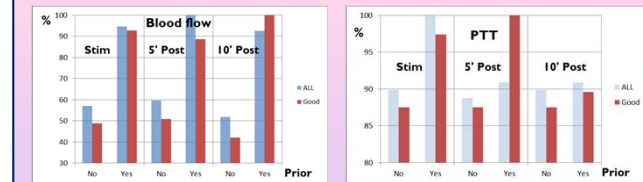
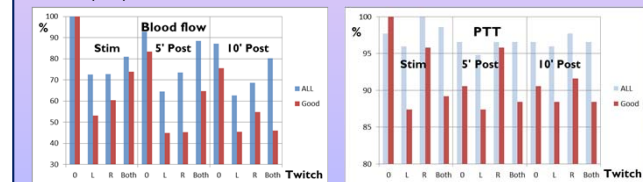


Fig 6. Muscle twitch in the left hand only (L) results in lower blood flow and PTT than no twitch; bilateral twitch leads to more blood flow than L or R twitch, but R twitch appears to enhance PTT more than bilateral twitch (n.s.):



## Where next?

- Further recruitment of participants is planned to consolidate our findings, in part because some data was missing or corrupted;
- PTT may be helpful in assessing short-term changes in acupuncture-related research, but only if high sampling rates are used;
- Future analysis should use multilevel modelling to take account of multiple factors and their interactions.

David Mayor, acupuncture practitioner  
www.welwynacupuncture.co.uk  
davidmayor@welwynacupuncture.co.uk

Tony Steffert, HRV specialist  
www.qeeg.co.uk  
tony@qeeg.co.uk

## Background

- In previous studies, we used finger plethysmography to assess pulse rate variability as a measure of autonomic function. Here we use it to assess local blood flow, itself an index of sympathetic activity, along with skin temperature measurement. Both are commonly used to assess arousal/relaxation levels.
- We also calculated the pulse transit time (PTT), which has been used to assess arterial stiffness, systolic blood pressure and the effects of stress, but has never before been investigated in acupuncture research.
- Transcutaneous electroacupuncture (TEA) is a noninvasive variant of electroacupuncture (EA). The literature is inconsistent about the effects of EA or TEA stimulation frequency on blood flow and temperature.
- The main purpose of this poster is to explore the effects of TEA frequency on local blood flow, PTT and temperature.

## Methods used to assess effect/change

- Data means or medians
- Data raw, or processed to correct for artefacts
- Values compared directly in different slots [DIRECT]
- Ratio (or difference) of slot values compared to baseline [BASE]
- Ratio (or difference) of values compared in slots immediately before and after any 2 slots of interest [PRE-POST]
- During stimulation, or 5 or 10 minutes post-stimulation

- Compare findings for raw and corrected data
- Corrupted/missing slot data omitted ('Good') or included ('All')

- Non-parametric comparisons and correlations
- Correlation ratio  $\eta$  – indicating relative importance of factors
- Sample size estimation, and Cohen's effect size ( $d$  or  $dz$ )

## Some treatment factors considered

- Participant (& Age, Gender)
- Stimulation frequency
- Prior experience (acup, EA, TENS)
- Frequency preferred/disliked
- Slot sequence
- Presence of muscle twitch

### Which factors are important? Some numerical results

Blood flow	Eta ( $\eta$ )	Sample size for significance	Cohen's $d$ (or $dz$ )
Hz	small (0.143)	90	small (0.306)
Prior	large (0.650)	30	large (1.448)
Twitch	medium (0.358)	76 (Left vs 0); 58 (Both vs Left)	medium (0.672; 0.771)
Favourite	medium (0.240)	>100	small (0.479)
<b>Temperature</b>	<b>These figures are only indicative ...</b>		
Hz	medium (0.288)	>100	v small (0.088)
Prior	large (0.560)	>100	small (0.403)
Twitch	large (0.421)	38 (Left vs 0); 82 (Both vs Left)	large (0.965); med (0.643)
Favourite	medium (0.275)	>100	small (0.489)
<b>PTT</b>	<b>... of statistical, not clinical significance!</b>		
Hz	small (0.216)	67	small (0.358)
Prior	medium (0.340)	66	large (0.930)
Twitch	small (0.187)	>100 (Left vs 0); 44 (Both vs Left)	small (0.388); med (0.905)
Favourite	small (0.165)	>100	v small (0.173)



Fig 1

Left: Sensors and electrodes: fingertip BVP, one ECG electrode on right forearm, and TEA electrodes at LI4 and ulnar edges of both hands.

Right: ECG and BVP traces, Showing BVP amplitude and peak-to-peak PTT.

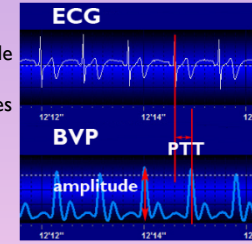


Fig 2

## Objectives

To assess how treatment factors such as stimulation frequency contribute to changes in local blood flow, skin temperature and pulse transit time (PTT)

## Salient RESULTS

Fig 3. TEA at 2.5 Hz consistently but not significantly resulted in greater blood flow, and 80 Hz in longer PTT, than at the other two stimulation frequencies (frequency effects on temperature were inconsistent, small and not significant):

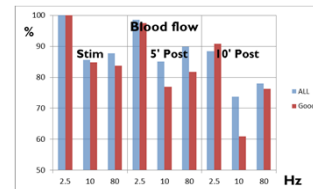


Fig 3. Blood flow (Left) and PTT (Right) at the three stimulation frequencies (normalised to maximal values).

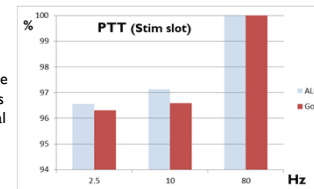


Fig 4. Left: For most participants, the association between skin blood flow and temperature was significant and positive, with both tending to peak together shortly after TEA. Right: However, over the session time both decreased overall:

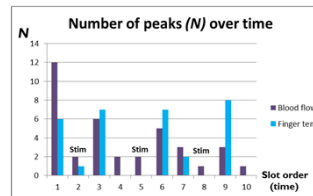
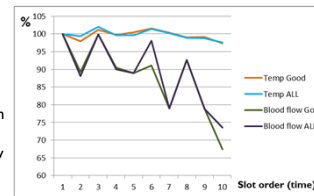


Fig 4. Left: Peaks (maxima) over time in blood flow and temperature. Right: Decrease from 100% in median processed blood flow and temperature over time.



(Overall session change in PTT was small, but group medians peaked in slots 5 and 8.)

## Conclusions

Research questions may be simple, but even non-clinical research can be complicated. The effects of stimulation frequency are likely to be small and masked by other factors.