
NKP
OKP
INR 2,93

Simple Simon® PT towards Health Care Supervised Home Laboratory Diagnostic Testing.

Mats Rånby[2], Xerxes Rånby[2] and Marie Danielsson[1,2]

[1]Department of biomedicine of surgery (IBK), University Hospital of Linköping, Sweden

[2]ZAFENA AB, Borensberg, Sweden

The idea:

Near patient, and smaller laboratory methods should, as closely as possible, adhere to the fundamentals of the methods of larger laboratories. This is because:

- The methods of the larger laboratories are well proven and represent the “state of the art”
- The results of larger laboratories are axiomatically more correct.

The minimal deviations here deemed necessary in PT testing were:

- Analysis at ambient room temperature, rather than 37℃, to radically reduce hardware complexity and a persistent source of error.
- Analysis on whole blood, rather than anticoagulated plasma, because plasma preparation at a near patient site defeats much of advantages of near patient testing. This deviation makes EVF information a prerequisite since the concentration of PT differs between the volumes of plasma and cells.

Proof of concept:

A set of 59 centrifuged citrated blood samples with (plasma) INR known through analysis by the central laboratory of the University Hospital, Linköping, were homogenized by repeated head over end inversion of the containers. The thus obtained citrated blood was analysed for PT by the above-described method (Simple Simon PT). The INR by Simple Simon PT was plotted against the known INR. A blood INR is thus plotted against a known plasma INR. Also, a set of 45 capillary blood samples obtained from the same finger puncture was analysed by the routine capillary method of the Anticoagulation Centre of the above mentioned hospital and by Simple Simon PT. The plots and descriptive text are found below.

Hardware.

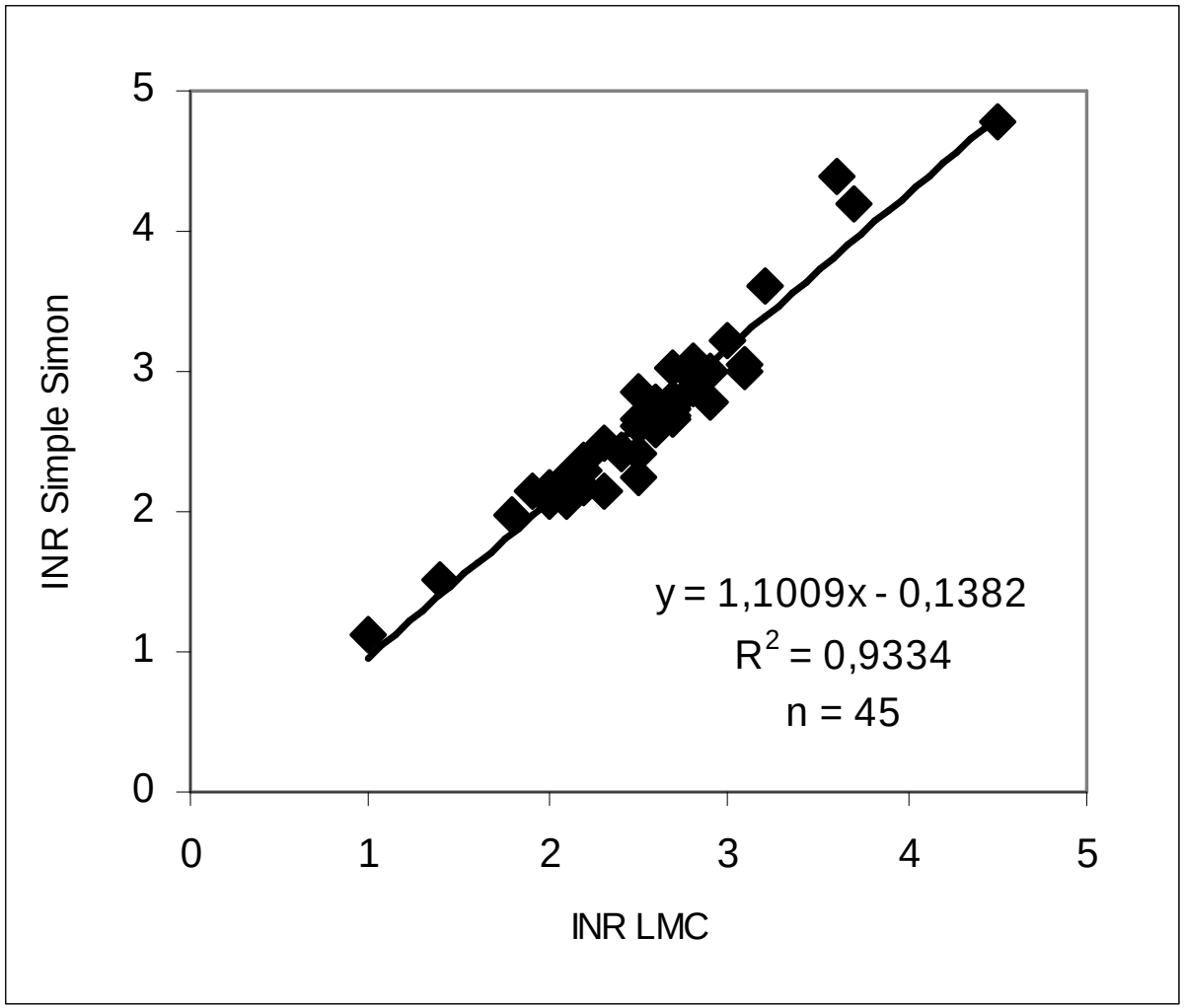
The by us constructed measuring device featured:

1. A one-chip computer, PIC18F4455 from Microchip Technology Inc, Chandler, AZ, with 2048 byte of RAM and 24 kbyte ROM, 40 connectors, internal 10 bit analog/digital converter (ADC) and integrated USB support.
2. A liquid crystal display (LCD) to instruct and inform the operator.
3. A one-button interface to interact with the operator.
4. A sample holder with a light gap composed of light emitting diode (LED) light source and a light diode, both operative at 940 nm near IR. The LED is feed current in the range 0,3 to 16 mA at 64 levels spaced at 0,3 mA.
5. A thermistor entrenched in the aluminium material of the sample holder.
6. A 24 position reagent tube holder of aluminium to assure thermal equilibrium with the samples holder.
7. Three 1.5 V dry batteries in series with targeted sufficiency of 2000 assays over 24 months period.
8. Ejection moulded thermoplastic casing to protect and house the various components of the unit**.**

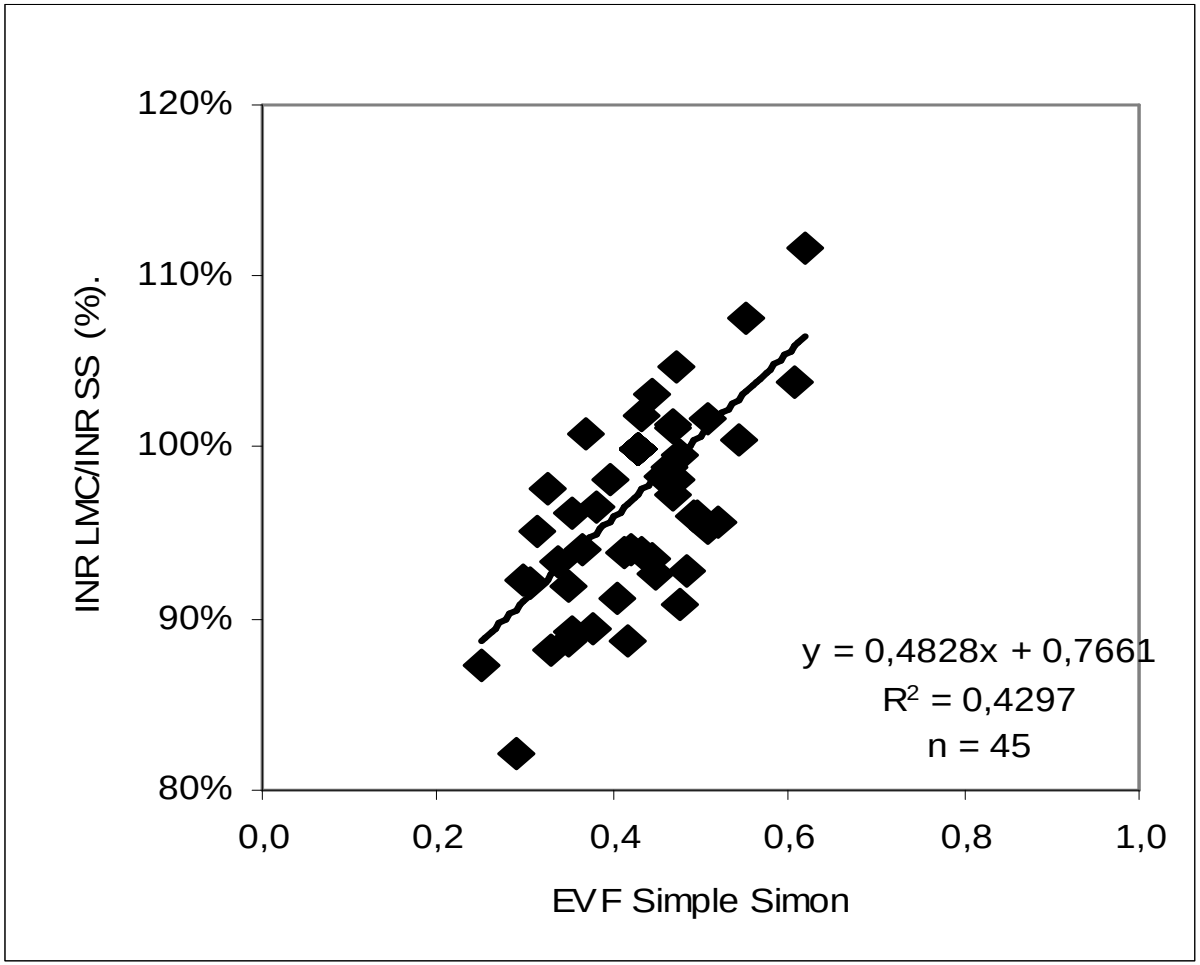
Software.

The software needed to drive the measuring device was written in C code and compiled by the PCWH from Custom Computer Services Inc., Brookfield, WI. About 2900 lines of code statements were needed of which about 240 were an mathematical library included in the compiler, and the remaining written by us. Some of the accomplished functions were:

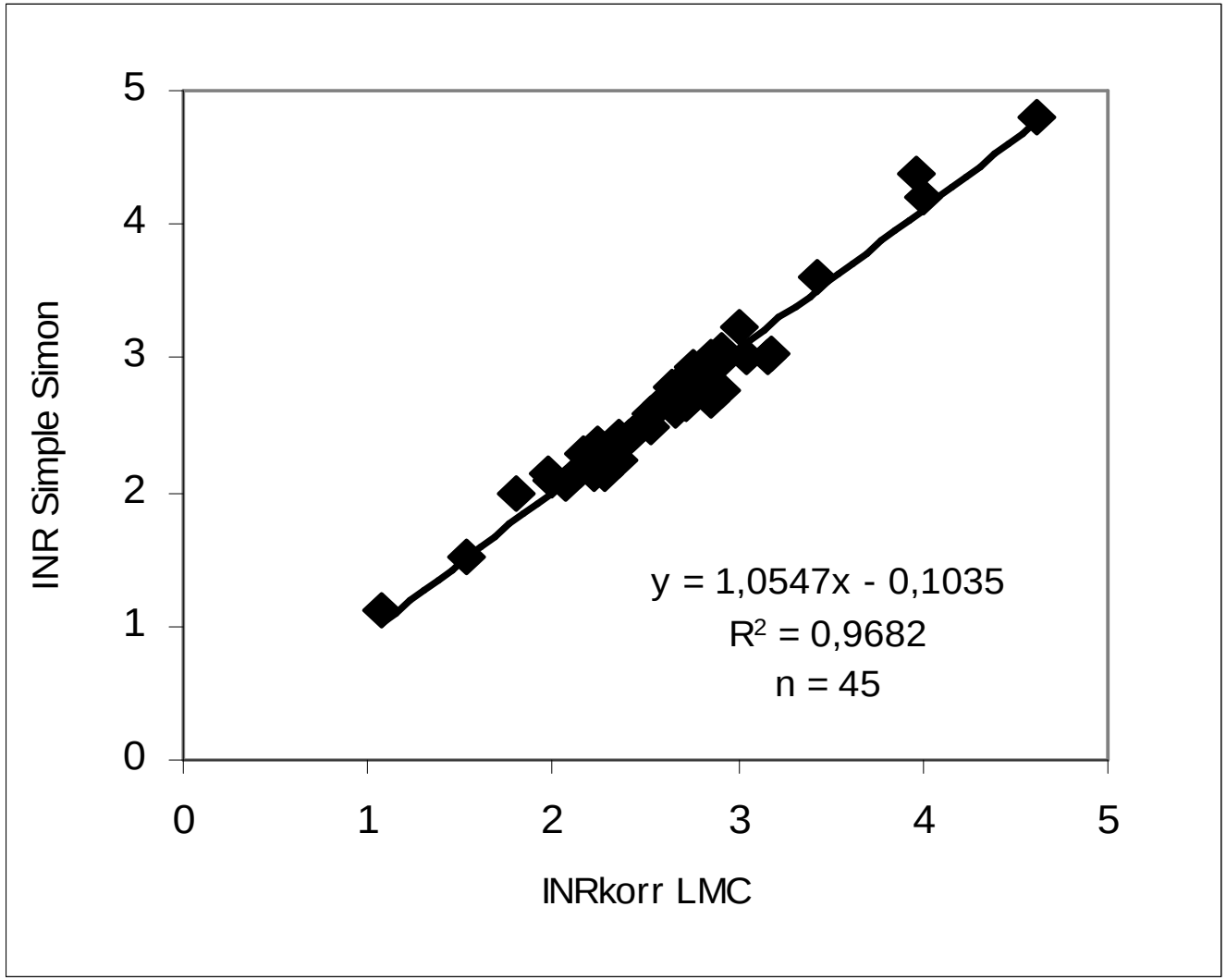
1. Measured the temperature of the sample holder and the reported the results in ADC units.
2. Required the operator to insert a sample tube with 400 µL of Owren type PT reagent.
3. Measured and recorded the LED light that passed through the reagent and hit the diode (ADCo)
4. Required the operator to add and mix 20 µL of blood to the reagent and start the timer.
5. Adjusted the LED current to give just in excess of 200 ADC units from the diode (record I) and calculate, record an Io as the ADCo multiplied by the current ratio and record Io/I
6. Commenced search of fulfilled clot detection criteria at 15 seconds and record the time of first fulfilment.
7. Calculated an INR level from stored, by calibration determined, temperature functions of ISI and NCT.
8. Corrected the INR value for the effects of EVF by multiplication with a linear function of Io/I.
9. Upon a press of the button, the INR value for corresponding citrated blood sample was displayed.



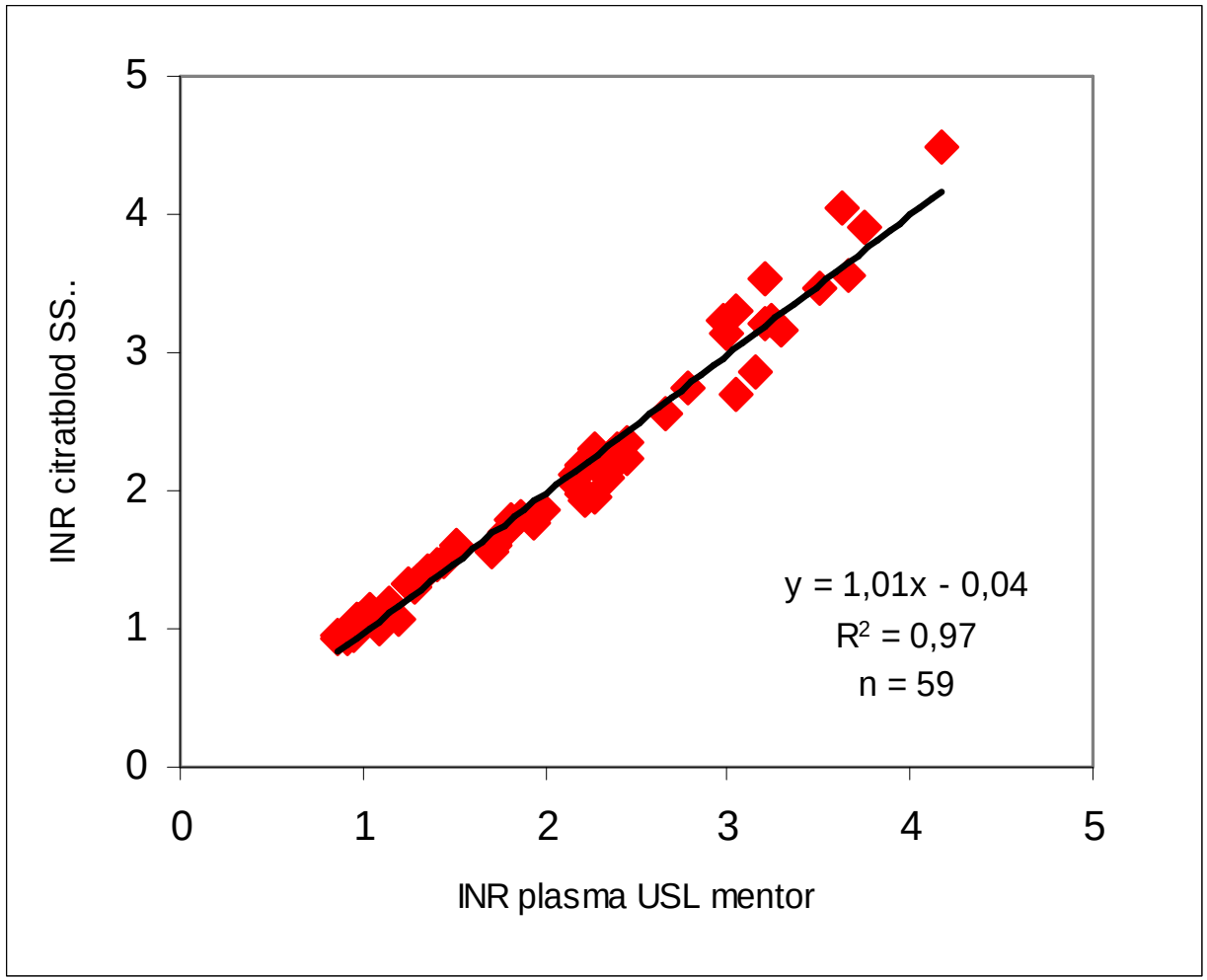
In connection to routine PT analysis at LMCs Anticoagulation Clinic, US, Linköping, from the same finger prick, PT was established by Simple Simon (SS). Both plotted INR values, the LMC and the SS, are the mean of two analysis, n = 45



The ratio between INR LMC and INR SS plotted against the EVF value by Simple Simon PT. As only the SS PT is adjusted for EVF effects, a non-random regression is expected. The linear regression relationship found was subsequently used to correct LMC INR values, data as in the preceding figure.



Simple Simon PT INR values plotted against EVF corrected LMC ditto. As aforementioned, both LMC and SS values are the mean of two analysis (duplicates), data from 45 patients.



Centrifuged citrated blood samples, n=59, in original tubes, with plasmas PT values determined by a reference instrument, the mentor, at the central laboratory, University Hospital, Linköping. The tubes were inverted repeatedly to recreate citrated blood samples, which were analyzed by Simple Simon PT.

The structure of a suggested system for health care supervised home laboratory diagnostic testing of PT using Simple Simon® .