

Do non-contact infrared thermometers work to measure body temperature?

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Non-contact infrared thermometer (NCIT)



During the Covid-19 pandemic, the use of non-contact infrared thermometers to detect fever has become widespread.

The NCIT is a radiation thermometer configured/adapted to measure the temperature of human skin.

The thermometer incorporates a correction to convert the result of a measurement at one site (measurement site) to another site (reference site).

Maximum permissible error = $0.3\text{ }^{\circ}\text{C}$, $t \in [20, 40]\text{ }^{\circ}\text{C}$
(ASTM E 1965-98).

Site correction



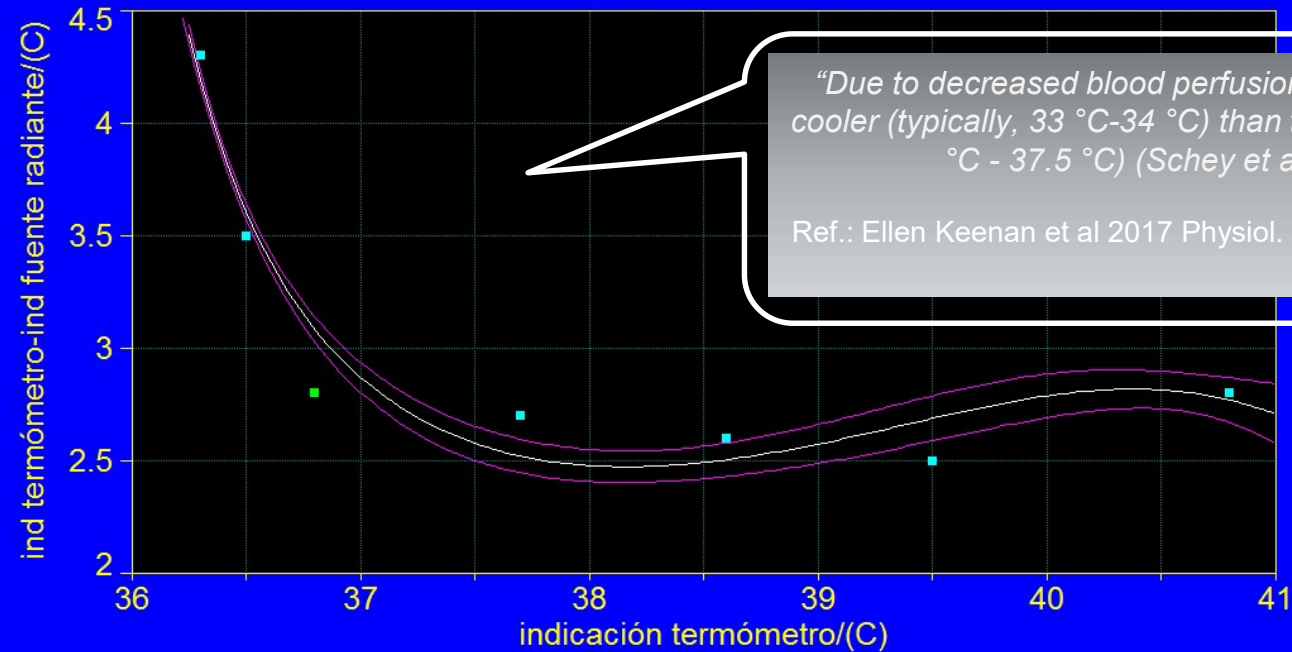
ASPEN YT1 (2), dia.disco=63 mm, dist.enfoque=30 mm, emi F8140=0.97, ago 2020.

Rank 31 Eqn 6111 $y^{-1}=a+bx+cx^2+dx^3$

$r^2=0.92757036$ DF Adj $r^2=0.78271109$ FitStdErr=0.24637965 Fstat=12.806503

a=-555.73689 b=42.549953

c=-1.0843431 d=0.0092038544



Measurement site: skin (simulated with FLUKE 8140)

Reference site: axila or oral cavity (not always indicated by manufacturer)



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**DUT
forehead
temperature
measurement**



number of people $\gg 1$

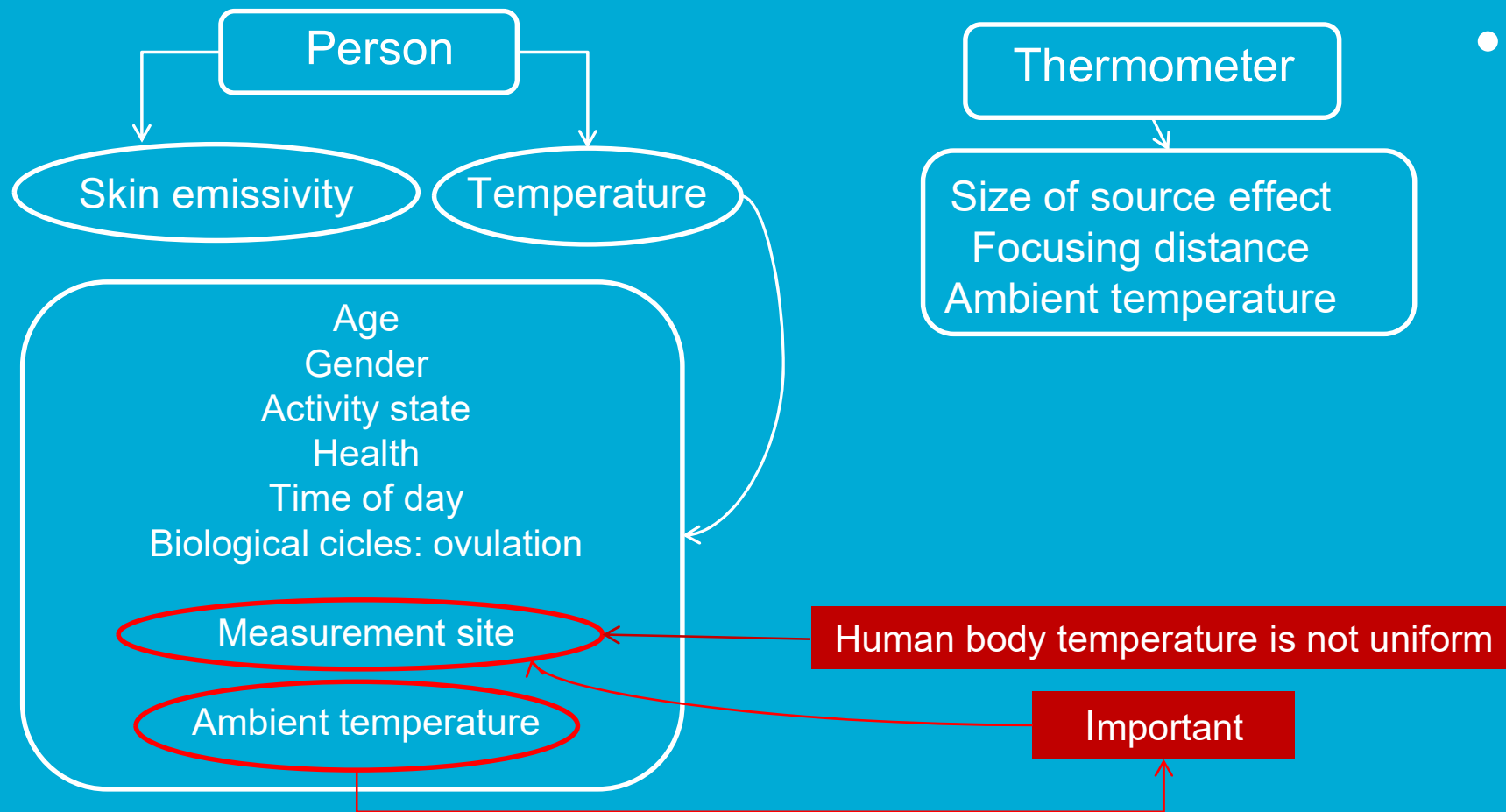
Reference site: oral cavity (sublingual)
 Δt temperature correction = $t_{CT} - t_{DUT}$



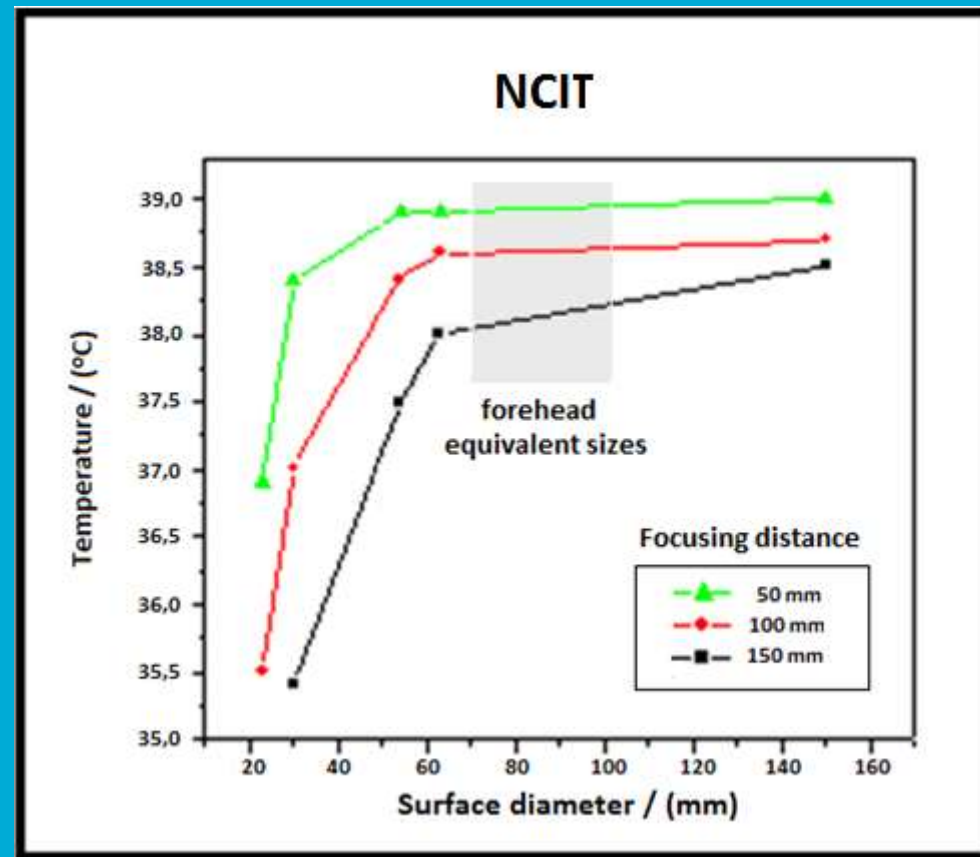
**Clinical thermometers (CT)
used as reference to measure
oral temperature.
Metrological controls OK**



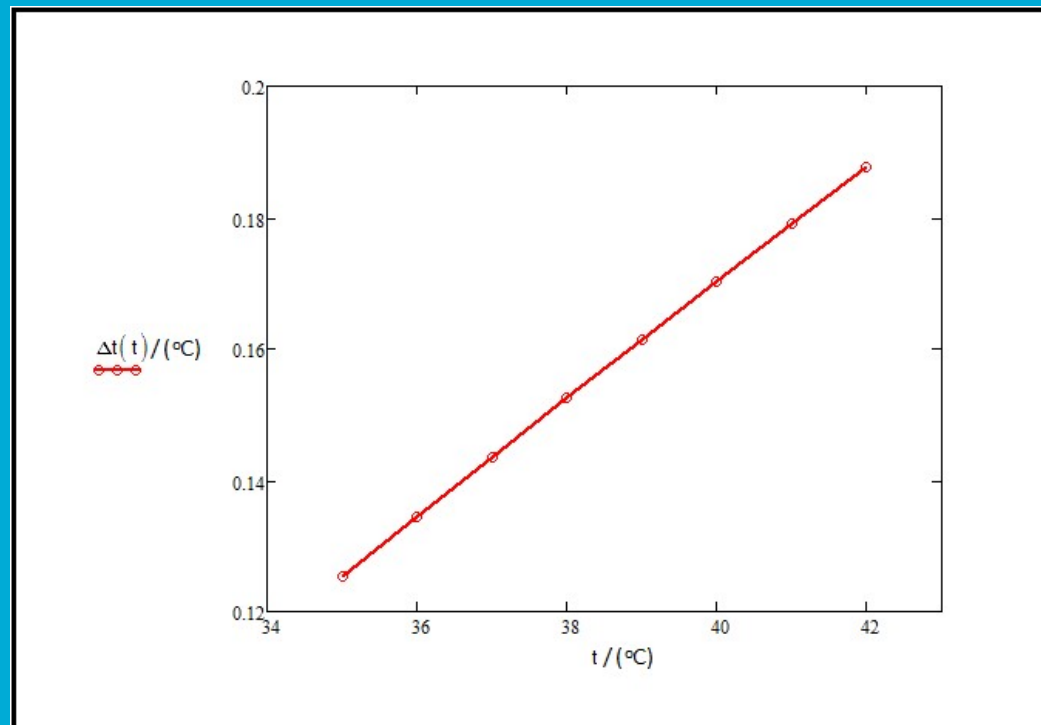
Temperature output



Size of source and focusing distance effects



Dependence of temperature output on skin emissivity



Values obtained from the measurement equation of a radiation thermometer

Spectral band. = [8, 14] μm

Ambient temperature = detector temperature = 22 °C

Skin emissivity values lie between 0.975 and 0.985



Influence of ambient temperature on forehead skin temperature

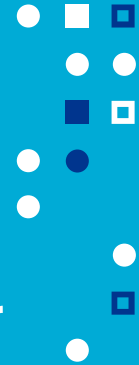
$$\Delta t_{\text{eye inner canthi}} / \Delta t_{\text{amb}} = 0,11.$$

$$\Delta t_{\text{forehead}} / \Delta t_{\text{amb}} = 0,20.$$



Temperature measurement uncertainty (NCIT)

Scenario 1		Scenario 2	
Indoor measurement		Outdoor measurement	
Low variability of ambient temperature ($\pm 1\text{ }^{\circ}\text{C}$)		High variability of ambient temperature ($\pm 6\text{ }^{\circ}\text{C}$)	
Low size of source effect (1 %)		High size of source effect (3 %)	
Uncertainty			
Source	Value/($^{\circ}\text{C}$)	Source	Value/($^{\circ}\text{C}$)
Reference temperature	0,09	Reference temperature	0,09
Repeteability	0,20	Repeteability	0,20
Skin emissivity	0,05	Skin emissivity	0,05
Infl. amb. temp. on meas. site	0,12	Infl. amb. temp. on meas. site	0,75
Size of source effect	0,04	Size of source effect	0,14
Infl. amb. temp. on indication	0,01	Infl. amb. temp. on indication	0,08
Combined expanded uncertainty	0,5	Combined expanded uncertainty	1,6



Conclusions

1. Worse uncertainty values are obtained for measurements performed with NCIT than those obtained with ear thermometers.
2. Lowest uncertainty values are between 0.3 °C and 0.5 °C.
3. In use uncertainty of 1 °C to 2 °C, not sufficient to detect fever or not.

Thanks



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