CCT TG BTM

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10th International Temperature Symposium (ITS-10)

CCT WG NCTherm

03 April 2023

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OVERVIEW OF CCT TG BTM

International action: global Task Group on Body Temperature Measurement

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- The Consultative Committee for Thermometry (CCT) is the highest global authority for temperature measurement
- https://www.bipm.org/en/committees/cc/cct

- In June 2020 CCT established a Task Group for body temperature measurement (TG BTM)
- Focus was to improve non-contact body temperature measurement (ear, forehead, thermal imaging) to establish reliable clinical thermometry on a global basis

International action: global Task Group on Body Temperature Measurement

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- Its objectives are:
- Lead global comparison of calibration systems for body temperature thermometers (ear/forehead/thermal imagers) – reliable foundation – Spring ‘23
- Collect current best practice for body temperature scanning in a) health services b) airport and other screening around the world

  - develop definitive best practice for fever screening – published
- Collect current best practice of body temperature measurement by IR methods - develop definitive best practice for body temperature measurement – published
- Review standards and work with appropriate standardisation bodies (e.g. ISO/IEC) - produce fit for purpose standards for body temperature measurement devices – ensure reliable metrology input into relevant standards

International action: Global Task Group on Body Temperature Measurement - Guides

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- CCT TG BTM best practice guides on body temperature measurement ear and forehead thermometry published and freely available for download and distribution @ (Section 4):

https://www.bipm.org/en/committees/cc/cct/guides-to-thermometry

- Two versions (in English and Spanish):

  Long guides – full metrology details

  Short (1 page) guides – for user community

GUÍA DE BUENAS PRÁCTICAS

USO DE TERMÓMETROS DE FRENTE DE INFRARROJO PARA LA MEDIDA TRAZABLE SIN CONTACTO DE LA TEMPERATURA DEL CUERPO HUMANO

M. J. Martin (CEM, España), L. Knazovicka (CMI, República Checa), H. McEvoy (NPL, Reino Unido), G. Machin (NPL, Reino Unido), I. Pusnik (UL, Eslovenia), D. Cardenas (CENAM, México), M. Sadli (LNE-CNAM, Francia), B. Chengdu (NIM, China), W. Li (SPRING, Singapur), P. Saunders (MSL, Nueva Zelanda), F. Girard (INRiM, Italia)

Traducido por: M. J. Martin (CEM, España) y D. Cardenas (CENAM, México)

3ª versión. Mayo 2021

- **Best likely uncertainties (*k*=2 [~95% confidence])**

  Ear: ±0.5 ºC

  Forehead: ±0.9 ºC

Assuming: (among other things) that forehead is a good measurement site, that both it and the thermometer are thermalised with the environment, there are no sources of extraneous thermal radiation (hot or cold) and that the correction of surface skin temperature to core body temperature has been established in a traceable way and implemented correctly in the device

International action: Global Task Group on Body Temperature Measurement - Guides

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- CCT TG BTM best practice guides on fever screening by thermal imaging also published and freely available for download and distribution @ (Section 4):

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- Two versions

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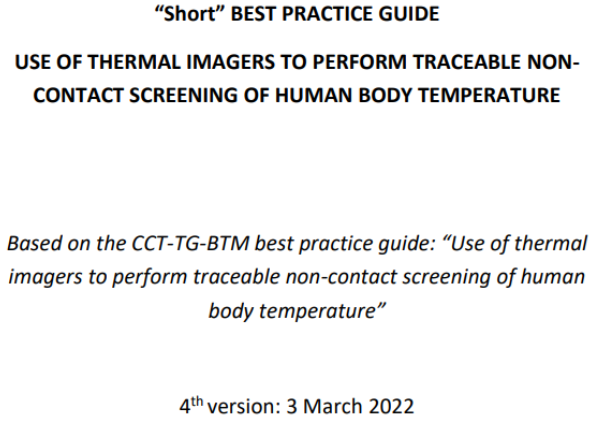

"Short" BEST PRACTICE GUIDE

USE OF THERMAL IMAGERS TO PERFORM TRACEABLE NON-CONTACT SCREENING OF HUMAN BODY TEMPERATURE

Based on the CCT-TG-BTM best practice guide: "Use of thermal imagers to perform traceable non-contact screening of human body temperature"

4th version: 3 March 2022

- **Best likely uncertainties (*k*=2 [~95% confidence])**

  Thermal imaging (inner canthus): ±0.6 ºC

Assuming: (among other things) measurements are taken in a well controlled environment AND inner canthus is a good location for determining body temperature

International action: Global Task Group on Body Temperature Measurement – engagement with standards

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- Three main standards:

  ASTM E1965 – 98 (2016) “Standard Specification for Infrared Thermometers for Intermittent Determination of Patient Temperature”

  JIS T 4207:2005 (E) “Infrared ear thermometers”

  ISO 806001-2-56:2017 “Medical electrical equipment – Part 2-56: Particular requirements for basic safety and essential performance of clinical thermometers for body temperature measurement”
- JIS standard does not cover forehead thermometers at all
- ASTM and ISO standards treat forehead thermometers differently with the ASTM standard treating them (it seems) as only skin thermometers (i.e. no correction to core body temperature), the ISO standard allows such a correction
- Allowable temperature ranges and uncertainties are different in the documents
- Evidence seems that the correction to core body temperature (even if possible) appears quite different depending on the manufacturer

International action: Global Task Group on Body Temperature Measurement – engagement with standards

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- We would recommend:

- Standards bodies cooperate globally to prepare one unambiguous standard for clinical thermometers
- That standards for ear thermometers and forehead thermometers are completely separated to avoid ambiguity in terminology
- That manufacturers engage with metrology specialists to ensure their background measurements for any corrections to core body temperature are traceable to national temperature standards through ISO17025 – ideally determined by objective 3rd parties

International action: Global Task Group on Body Temperature Measurement – key comparison of calibrators

- Key comparison of blackbodies for calibrating ear and forehead thermometers

- Purpose: Ensure a robust metrological framework in place for calibration of such thermometers

- Pilot: NIM (China) with two loops
  PTB (Germany) co-pilot for EURAMET loop
  NIM (China) co-pilot for APMP loop
- Temperature range 34.0 – 43.0 ºC
- Protocol agreed with CCT WG on Key Comparisons
- Measurements to begin Spring 2023
- Target Key Comparison Draft A by end 2024

International action: Global Task Group on Body Temperature Measurement – key comparison of calibrators

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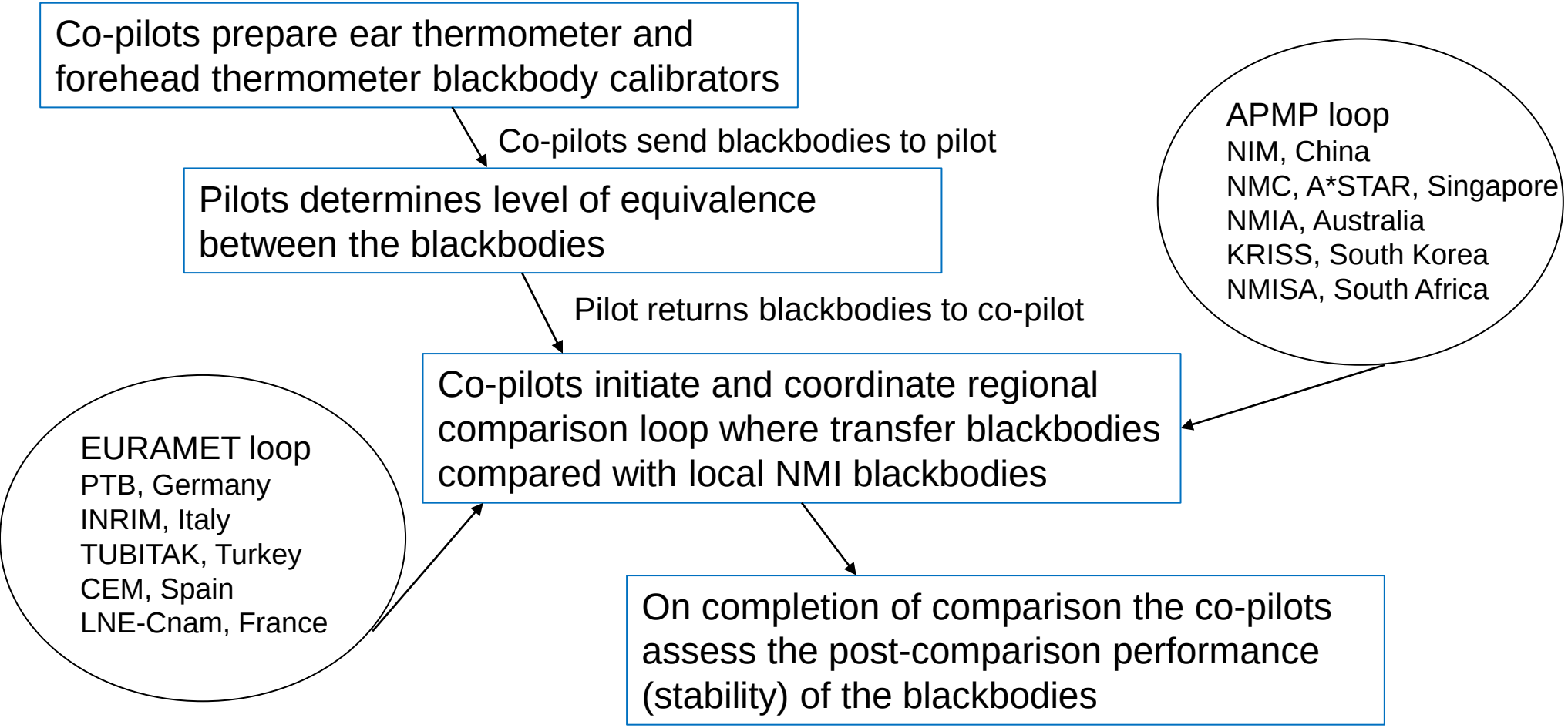
- Comparison mechanism



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OVERVIEW OF UK NATIONAL BTM GROUP

The National Body Temperature Measurement Group (NBTMG)

Inaugural meeting 26th April 2019, NPL

Current members:

- Professor Graham Machin FREng, Head, Temperature Standards, NPL (Current chair)
- Professor Mark Tooley FREng, Digital clinical advisor, West of England Academic HSN
- Professor David Brettle, Chief Scientific Officer, Leeds teaching hospitals NHS trust
- Dr Rob Simpson, Head of Thermal Imaging, NPL and Technical Director Celsius Health
- Associate Professor Richard Stevens , Deputy Director, Statistics Group & Dr Susannah Fleming, Senior Quantitative Researcher, Nuffield Department of Primary Care Health Sciences, Oxford
- Dr Chris Hacking, Clinical Applications Engineer, United Lincolnshire Hospitals NHS Trust
- Hannah Leonard, Consultant Midwife University Hospitals Southampton NHS Foundation Trust

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NHS The Leeds Teaching Hospitals NHS Trust

University of Oxford Nuffield Department of Primary Care Health Sciences

NHS Royal Surrey NHS Foundation Trust

NHS England and NHS Improvement

The NBTMG mission is to…

- To ensure robust and reliable body temperature measurement throughout the NHS and wider community
- To gather case studies, share stories and study data
- To tell the community; GPs, nurses, doctors
- To propose and implement what needs to be done to solve the problem

- In essence to: Reinstate reliable body temperature measurement in health care settings

NBTMG – current activities

- Gathering objective evidence of poor clinical thermometer performance in use (even when precautions taken – i.e. before/after use calibration – suitable user training)
- Gathering evidence of thermometry practice and experience in the community (PPI initiative - Oxford)
- Clinical thermometry audit in oncology and sepsis (proposal for July 2023)

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NBTMG sponsored study

BATH UNIVERSITY AND NPL CLINICAL THERMOMETER STUDY

Laboratory assessment of forehead thermometers

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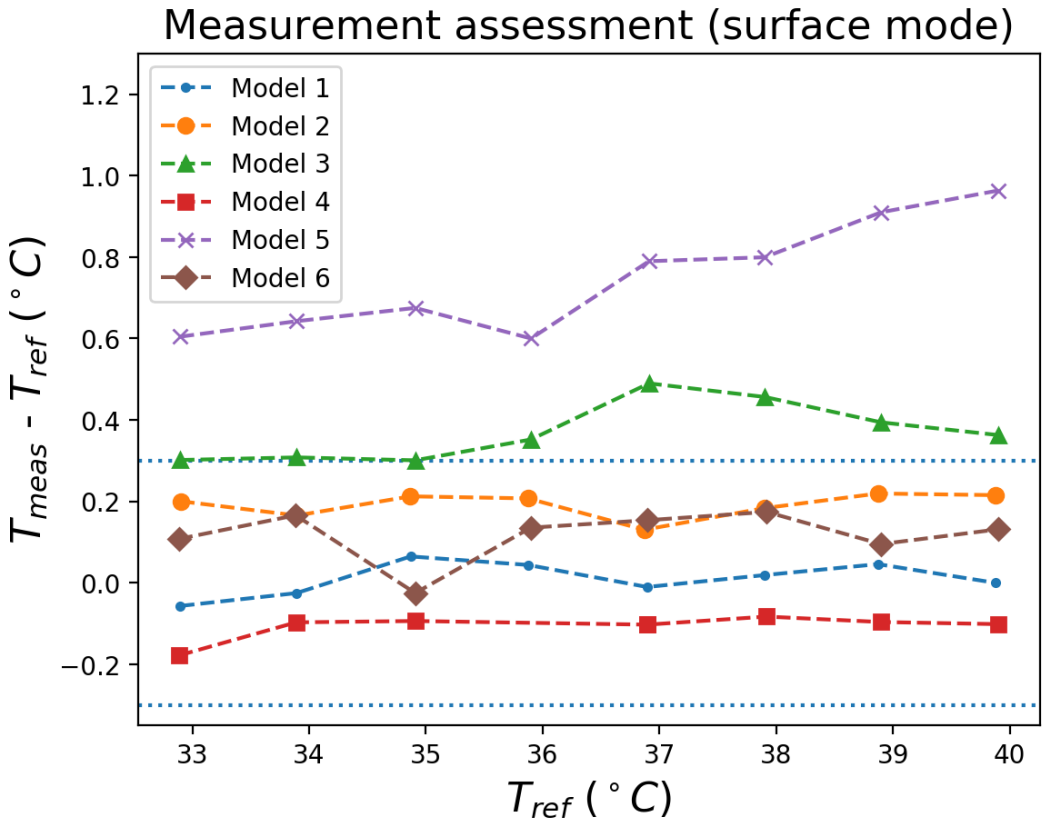
- Six forehead thermometers typical of those in NHS trusts
- Devices assessed against national reference sources of temperature to determine measurement performance
- Only 4 of 6 forehead thermometers met their stated accuracy (± 0.2 ˚C) when measuring reference source



Laboratory assessment of forehead thermometers

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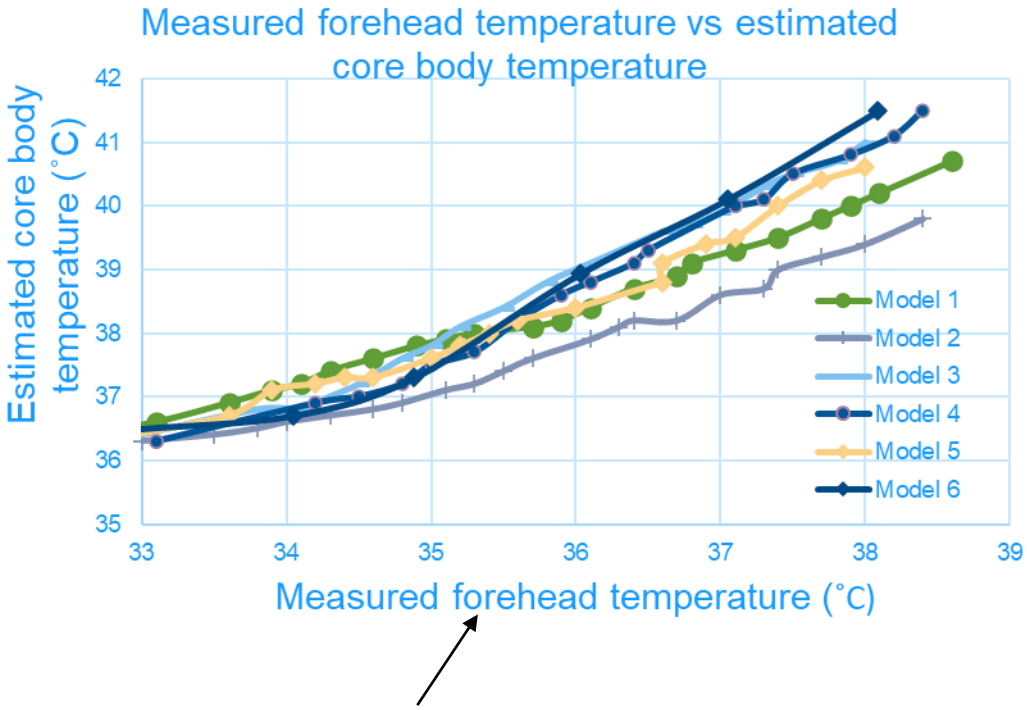
- Forehead thermometers estimate patient core temperature by applying a correction factors which appear different for every device type - often based on some small sample set by manufacturer, no peer review or external scrutiny
  - Different models measuring the same forehead may report drastically different core temperatures



That is when viewing a blackbody reference – to provide uniform test surface of known radiance temperature (optimum conditions)

Laboratory assessment of tympanic thermometers

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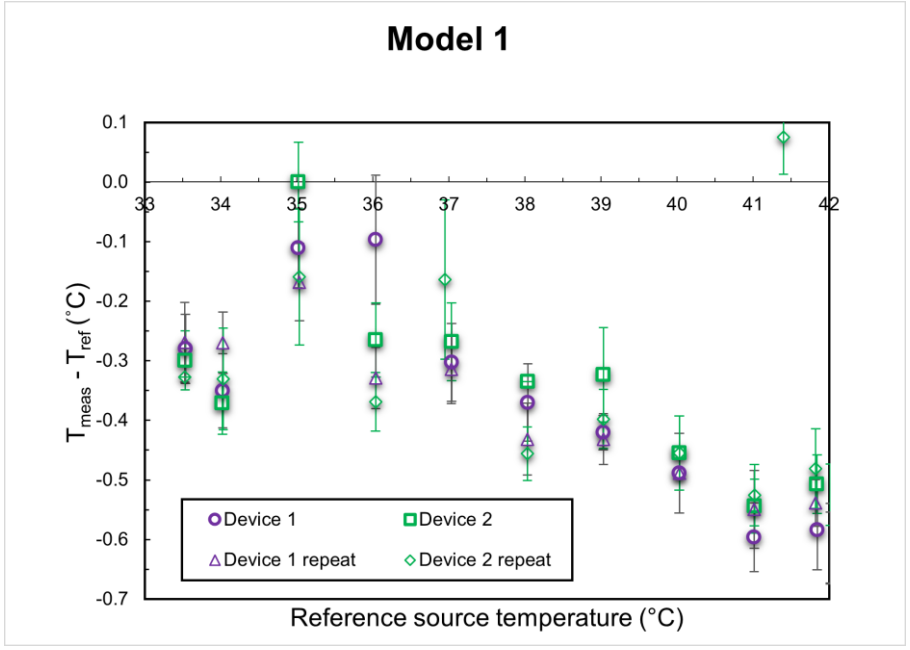
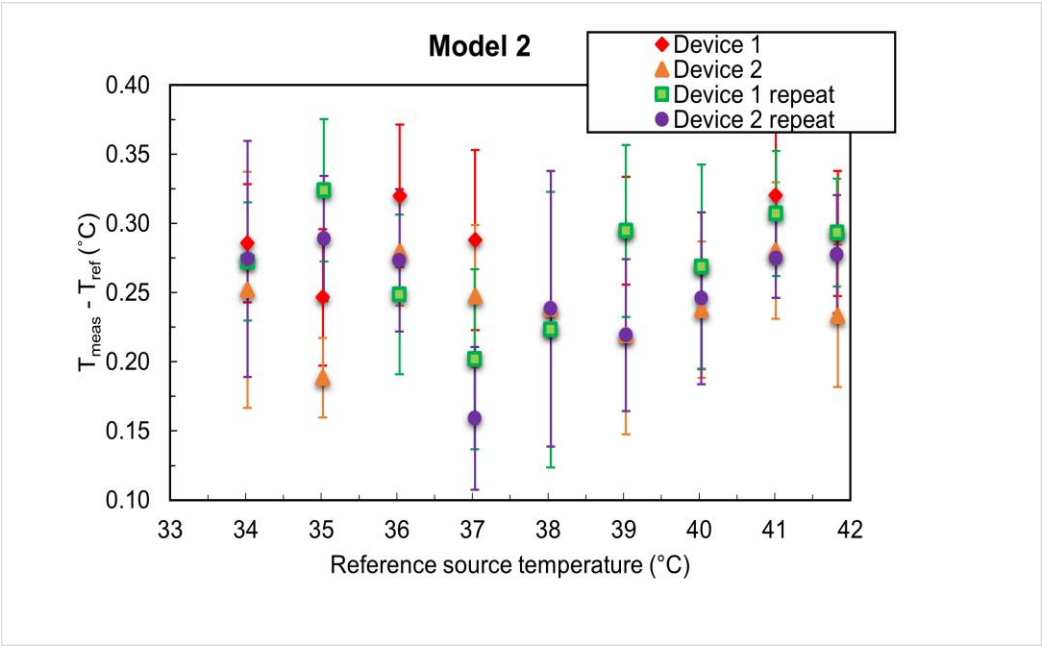
- 2 tympanic thermometer models commonly used in hospitals were compared to the national temperature reference source for calibrating tympanic thermometers
- Model 1 demonstrated substantially worse measurement error (and reported low values which would miss fevers)

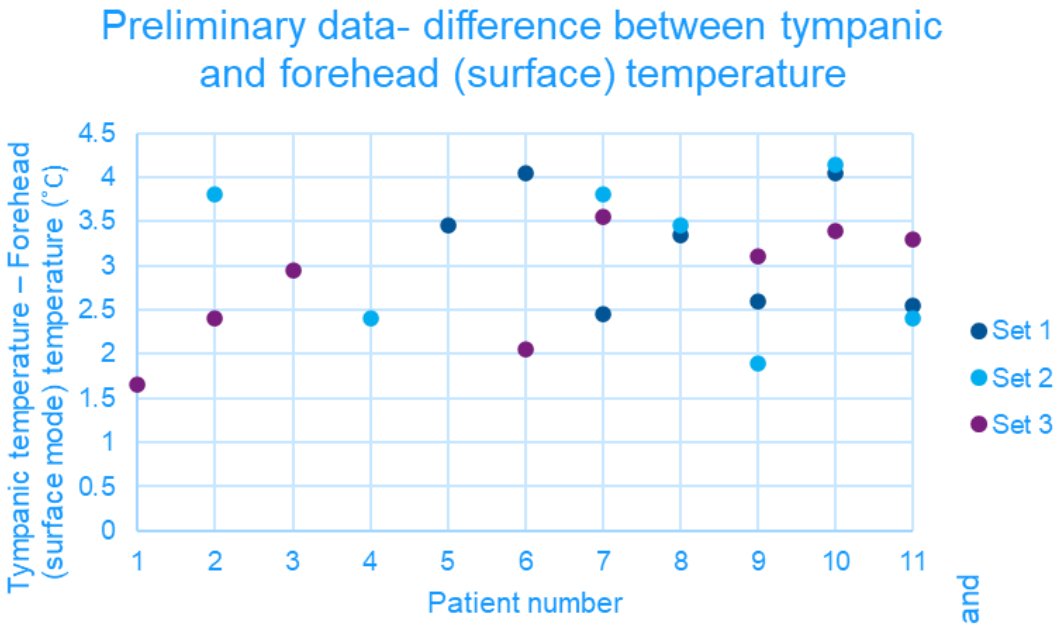


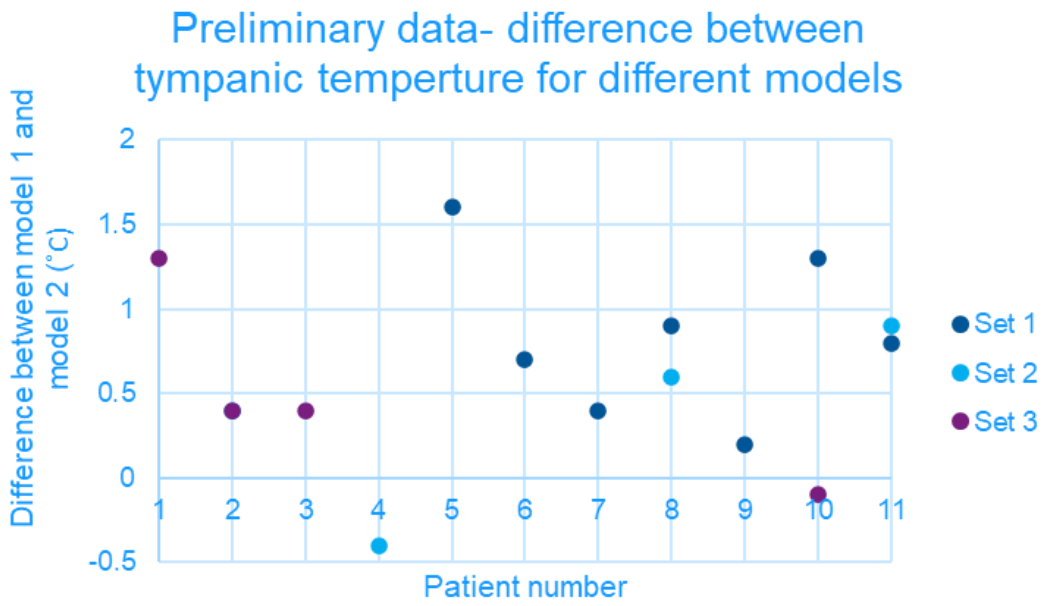


Field trial at the University of Bath

- Colleagues at the University of Bath have used these calibrated thermometers on a cohort of healthy subjects
- Subject forehead and tympanic temperature measured with selection of devices
- Preliminary data indicates substantial variation in difference between forehead (surface) and tympanic temperature as well as between different models of tympanic thermometer

Field trial at the University of Bath





Summary

- CCT TG BTM
- UK BTMG

- Salutary to think
  a) that current uncertainties ≥0.5 ºC **are too high** when treatment thresholds fix decision boundaries at 0.1-0.2 ºC and
  b) b) previous liquid-in-glass technology was more reliable

Papers arising from BTMG activities

Machin, G., *et al* “Is current body temperature measurement practice fit-for-purpose?”, *J. Med. Eng. Technol.,* (2021) https://doi.org/10.1080/03091902.2021.1873441 (Open Access)

Machin, G., *et al* “Improving body temperature measurement on a global basis”, *Thermology International* **31** 5-10 (2021)

Machin, G., Xiaofeng Lu, del Campo, D., Martin, M-J., Pusnik, I., Wang Li, “Progress in improving body temperature measurement on a global basis”, *Thermology International* **31(3)** 79 (2021)

Castro, P., Machin, G., “Body temperature measurement uncertainty arising from ear canal geometry and temperature gradients”, *Measurement: Sensors*, **24** 111725 (2022), https://doi.org/10.1016/j.measen.2022.100417

Simpson, R. *et al* **“A comparative study of forehead and ear thermometers on healthy subjects using traceably calibrated clinical thermometers”** *In preparation* (2023)