Determining the Ability to Accurately Assess Temperature Differences by Palpation

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Literature Review

- Majority of studies examining body temperature differences utilize:[1-4]
  - Infrared thermography
  - Infrared radiometry
  - Video thermographs
  - Contact thermographs
- Expensive and time-consuming

Literature Review

- Palpation and objective measurements have been used to detect temperature differences in many conditions
  - rheumatoid arthritis[14,15]
  - osteoarthritis[14,15]
  - complex regional pain syndrome[1,2,3]
  - acute trauma wounds[13]
  - charcot arthropathy[17]
  - neuropathic ulcers[17]
  - polyneuropathies[4,16]
  - fever[5-8]

Sensitivity vs. Specificity

- Sensitivity
  - Number of "true positives" divided by all those with the disease
- Specificity
  - Number of "true negatives" divided by all those without the disease

Literature Review

- Much of the literature examines maternal skill in palpation of fever in children
  - Graneto *et al.*[5]
    - Mothers who admitted their children to the E.R. were able to correctly:
      - Detect fever 84% of the time (High Sensitivity)
      - Detect the lack of fever 76% of the time (Mod. Specificity)
  - Singhi *et al.*[6]
    - Mothers correctly identified
      - Fever in 104 out of 117(88.9%) children (High Sensitivity)
      - Absence of fever in 163 out of 184(88.6%) children (High Specificity)

Literature Review

- Nwanyanwu *et al.*[7]
  - Mothers and clinicians evaluating fever in children secondary to malaria
    - Seldom missed detecting fever when present (High Sensitivity)
    - Mothers and clinicians tended to over-diagnose children as febrile in the absence of fever secondary to malaria (Low Specificity)
- Bergeson and Steinfeld[8]
  - Three nursing assistants identified
    - 58 of 138(42%) children with fever to be afebrile (Moderate Sensitivity)
    - 18 of 1011(2%) afebrile children as having a fever (High Specificity)

Literature Review

- Singh *et al.*[9]
  - Compared the ability of pediatricians' manual touch versus digital thermometers to detect the temperature of the forehead, abdomen, and foot
    - 100% sensitivity and 90% specificity in diagnosing abdominal skin temperatures less than 36° C
- Hoeksma and Faber[4]
  - Palpation vs. Infrared thermometry to detect temperature of the foot in patients with leprosy
    - Significant correlation of 0.8 ($p < 0.002$)
    - Palpation is a reliable technique to assess temp. in neuropathic foot conditions

Literature Review

- Skin temperature varies throughout the body depending on the location and distance from the trunk[11-14]
  - Middle finger: 31.25°C (88.25°F)
  - Forearm: 32-33°C (89.6-91.4°F)
  - Thigh: 31.95°C (89.51°F)
  - Knee: 29.5°C (85.1°F)

Literature Review

- Autoimmune disorders and pathological conditions can raise skin temperature during the inflammatory stage
- Hendiani *et al.*[15]
  - Increased knee temperature
    - 1.41°C (+/- .02°) in patients with RA
    - 0.5°C (+/- 0.11°) in patients with OA
- Ring *et al.*[16]
  - Increased knee temperature
    - 2.0-3.1°C in patients with RA
    - 3.0-4.6°C in patients with OA

17,18

Condition	Mean Unaffected Temperature	*Mean Affected Temperature*
Polyneuropathy (unspecified) (Kang PB)	33.1°C / 91.6°F (overall mean)	31.8°C / 89.2°F (overall mean)
NEUROPATHIC ULCERS (Todd WF)	28.7°C / 83.7°F (overall mean)	31.8°C / 89.2°F (overall mean)
Hallux (Todd WF)	28.8°C / 83.84°F	30.6°C / 87.08°F
Metatarsal 1 (Todd WF)	28.8°C / 83.84°F	31.8°C / 89.24°F
Metatarsal 2-4 (Todd WF)	28.6°C / 83.48°F	32.5°C / 90.5°F
Metatarsal 5 (Todd WF)	28.7°C / 83.66°F	32.3°C / 90.14°F
CHARCOT'S JOINT ARTHROPATHY (Todd WF)	27.9°C / 82.2°F (overall mean)	32.4°C / 90.3°F (overall mean)
Tarsometatarsal joint (Lisfranc's joint) (Todd WF)	28.0°C / 82.4°F	32.8°C / 91.04°F
Transverse Tarsal joint (Chopart's joint) (Todd WF)	27.5°C / 81.5°F	32.0°C / 89.6°F
Ankle joint (Todd WF)	28.3°C / 82.94°F	32.3°C / 90.14°F
ASYMPTOMATIC SENSORY NEUROPATHY (Todd WF)	27.4°C / 81.3°F (overall mean)	27.3°C / 81.1°F (overall mean)
Metatarsal 1 (Todd WF)	27.2°C / 80.96°F	27.2°C / 80.96°F
Metatarsal 3 (Todd WF)	27.7°C / 81.86°F	27.5°C / 81.5°F
Metatarsal 5 (Todd WF)	27.4°C / 81.32°F	27.2°C / 80.96°F

Purpose

- To evaluate the ability of physical therapists with manual therapy experience in detecting subtle temperature differences through touch.

Hypothesis

- Clinicians with palpation experience will successfully identify temperature differences ranging from 2-5°C, but not temperature differences of 1°C.

Methods: Subjects

- Sample of convenience
  - 20 healthy clinicians:
    - 12 Females/ 8 Males
- Subject Experience
  - Range: 1 to 35 years
  - Mean: 9 years
- Informed Consent signed by all participants
- Study approved by UTC IRB

Methods: Inclusion/Exclusion Criteria

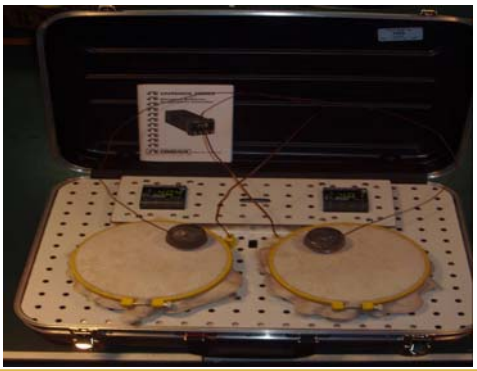
- Inclusion Criteria
  - Healthy individuals with palpation experience
  - ≥ 1 yr clinical experience
- Exclusion Criteria
  - Prior hand and/or wrist fractures/surgeries
  - Sensory deficits
  - DM
  - Circulatory Insufficiencies
  - Neuropathies

Methods: "The Device"

- Designed by UTC Engineering Dept.
- Two palpation surfaces covered with chamois cloth.
- Temperature Range
  - 30-35°C (86-95°F)
  - 1°C increments (30,31,32,33,34,35)
- Calibration Accuracy: ± 0.3°C

Methods: Experiment Adjustments

- Previous constraints of temp. change addressed
- Plates shaved from 2.0 kg to 0.2 kg
- Significant reduction of time to change temperatures
  - Previously: ~ 10 min.
  - Currently: ~ 2 min.



Methods: Subject Prep and Instruction

- Maintain room temperature approx. 21-24°C (70-75°F)
- Acclimate subjects 20 min. prior to testing
- Subject Instruction
  - Do not hold hot/cold objects with palpation hand
  - Do not leave temp. controlled environment
- Subjects monitored for compliance with rules

Methods: Testing Procedure

- Palpate with palmar surface of hand of choice
- 10 second time allotment for palpation of both pads
- Indicate hotter pad
  - Hold up one or two fingers
  - Verbal response
- Subject palpated each temperature difference (1,2,3,4,5° C) on two occasions
  - 10 trials total

Methods: Testing Procedures

- One researcher controlled pad temperatures
  - Blinded to data collection
- Data collector blinded to pad temperatures
- Subjects blinded to temperature readout by cardboard shield

Scoring and Data Analysis

- Each response scored as "correct" or "incorrect"
- Data Analysis using Chi-Square test

Results

	1° Diff.	2° Diff.	3° Diff.	4° Diff.	5° Diff.
# Correct Responses	32/40	25/40	39/40	40/40	39/40
Probability (p)	0.000*	0.114	0.000*	0.000*	0.000*

* Statistically Significant at p = 0.05 level

Discussion

- Clinicians were able to detect temperature differences of 1, 3, 4, and 5° C, but **NOT** 2°.
- Does not follow predicted pattern
  - Logic dictates subjects able to detect 1° difference should be able to detect 2° difference.
- What is the cause of discrepancy between these results?

Possible reasons for discrepancy

1°C trials were first (hardest to detect)

↓

Possibly Guessing

↓

Non-random preference for #1 pad

↓

#1 was the correct answer for both trials by chance

↓

Results were an artifact

Discussion

- Direct comparison of previous data (lay people) with current data is not appropriate due to changes in methodology.
- Tentative comparison may be made for larger temperature differences.
  - Larger differences, 3-5º, are detectable by both laypersons and clinicians.

Discussion

- If current data for 1º difference is an anomaly
  - 1º and 2º C differences are not distinguishable by clinicians, similar to previous study (laypersons)
  - Data does **NOT** suggest a difference in the ability to palpate subtle temperature differences among laypersons and clinicians

Future Research

- Increase sample size of both clinicians and laypersons
- Standardize palpation technique
- Randomization of trials by temperature difference (study was randomized by pad and temperatures used)

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References

1. Cooke ED, Glick EN, Bowcock SA, Smith RE, Ward C, Almond NE, Beacham JA. Reflex Sympathetic Dystrophy (Algoneurodystrophy): Temperture Studies in the Upper Limb. *Brit J Rheumat* 1989; 28: 399-403.
2. Oerlemans HM, Perez R, Oostendorp RAB, Goris RJA. Objective and subjective assessments of temperature differences between the hands in reflex sympathetic dystrophy. *Clin Rehabil* 1999; 13: 430-8.
3. Karstetter KW, Sherman RA. Use of Thermography for Initial Detection of Early Reflex Sympathetic Dystrophy. *J Am Podiat Med Assn* 1991; 81(4): 198-205.
4. Hoeksma AF, Faber WR. Assessment of skin temperature by palpation in leprosy patients: Interobserver reliability and correlation with infrared thermometry. *Int J Lepr other Mycobact Dis* 2000; 68(1): 65-7.
5. Graneto JW, Soglin DF. Maternal screening of childhood fever by palpation. *Pediatr Emerg Care* 1996; 12(3): 183-5.
6. Singhi S, Sood V. Reliability of Subjective Assessment of Fever by Mothers. *Indian J Pediatr* 1990; 27: 811-5.
7. Nwanyanwu OC, Ziba C. Palpation as a method of fever determination in Malawian children who are less than 5 years old: how reliable is it? *Ann Trop Med Parasitol* 1997; 91(4): 359-63.
8. Bergeson PS, Steinfeld HJ. How Dependable is Palpation as a Screening Method for Fever? Can Touch Substitute for Thermometer Readings? *Clin Pediatr* 1974; 13(4): 350-1.
9. Singh M, Rao G, Malhotra AK, Deorari AK. Assessment of newborn baby's temperature by human touch: a potentially useful primary care strategy. *Indian J Pediatr* 1992; 29(4): 449-52.
10. Merrick MA, Jutte LS, Smith ME. Cold Modalities with Different Thermodynamic Properties Produce Different Surface and Intramuscular Temperatures. *J Athl Train* 2003; 38(1): 28-33.
11. Shusterman V, Anderson KP, Barnea O. Spontaneous skin temperature oscillations in normal human subjects. *Am J Physiol (Regulatory Integrative Comp Physiol)* 1997; 273: R1173-R1181.
12. Khalil OS, Yeh S, Lowery MG, Wu X, Hanna CF, Kantor S, Jeng T. Temperature modulation of the visible and near infrared absorption and scattering coefficients of human skin. *J Biomed Opt* 2003; 8(2):191-205.
13. Warren TA, McCarty EC, Richardson AL, Michener T, Spindler KP. Intra-articular knee temperature changes: Ice versus cryotherapy device. *Am J Sports Med* 2004; 32(2): 441-445.
14. Hendiani JA, Westlund KN, Lawand N, Goel N, Lisse J, McNearney T. Mechanical Sensation and Pain Thresholds in Patient with Chronic Arthropathies. *The Journal of Pain* 2003; 4(4): 203-211.
15. Ring EFJ, Dieppe PA, Bacon PA. The thermographic assessment of inflammation and anti-inflammatory drugs in osteoarthritic. *Br J Clin Pract* 1981; 35(7-8): 263-264.
16. Kang PB, Hoffman SN, Krimitsos E, Rutkove SB. Ambulatory Foot Temperature Measurement: A New Technique in Polyneuropathy Evaluation. *Muscle Nerve* 2003; 27: 737-742.
17. Armstrong DG, Lavery LA, Liswood PJ, Todd WF, Tredwell JA, Birk J. Infrared dermal thermometry for the high-risk diabetic foot. *Phys Ther* 1997; 77(2): 169-177.

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