Body Temperature Assessment Advisory

Discipline:	Integrated
ICD-10 Codes:	N/A
Origination Date:	07/2020
Review/Revised Date:	07/2024
Next Review Date:	07/2026

The Challenge

The COVID-19 pandemic has highlighted the need for medical providers, hospitals, commercial establishments, airlines, and others to implement an effective screening system for potentially infected persons entering their establishments[1]. The goal is to be able to predict, in a non-invasive manner, persons who may already be mildly symptomatic entering a place where others are at risk for infection. Ebola outbreaks in the earlier part of the 21st century prompted the widespread use of noncontact cutaneous infrared thermometers (NCIT) to screen large cohorts as it is rapid, portable, does not require bodily contact, and does not cause discomfort to the individual being tested. However, there is little actual data to support its use as an effective fever screening tool, whether in a medical setting or a commercial setting.[2]

Studies have shown that handheld cutaneous infrared devices are less accurate than the tympanic thermometer and other infrared systems for fever detection[3,4,5,6]. A study in Singapore in February 2020 found the handheld cutaneous thermometers had a low sensitivity rate of 29.4% when compared to the oral thermometer in detecting fevers.[6] Operator error and a multitude of environmental variables can interfere with precision and accuracy. None of the infrared devices can be used as a sole determinant of infection and are not intended to provide a diagnosis. Among common NCIT instruments evaluated for their ability to measure temperature traceable to the International Temperature Scale of 1990 (ITS-90), the majority performed outside the accuracy range stated by their manufacturers and medical standard.[7]

Thermal imaging systems, performed with standing cameras that do not require the operator to be in close contact with the person being evaluated, are used mainly for testing people in high throughput areas like airports, businesses, and sporting events. They have greater precision and accuracy than handheld devices, but require expertise, constant temperature environments, low ambient humidity, an appropriate background, and the removal of anything obscuring the face, such as masks and glasses. Therefore, they are mostly useful for triaging individuals for high temperatures in large settings. As with other infrared devices, these systems will likely miss most individuals who are contagious, and other diagnostic methods are necessary, as many people with viral infections can be contagious before they have a fever.[8]

Infrared thermometry does not reliably detect febrile patients, because its sensitivity is lower than was expected in studies, and the positive predictive value is low with a lot of false positive results. The gradient between cutaneous and core temperatures is markedly influenced by the patient's age and environment. Outdoor temperatures[9] have been defined as a confounding variable, along with age and comorbidities such as vascular reactivity.[10,11,12] Gender may also be a confounding variable, although evidence is weaker.[13] Skin pigmentation does not appear to have an effect on infrared temperature measurement.[14]

Finally, cutaneous temperatures do not identify pre-symptomatic or asymptomatic patients, and while most patients with COVID-19 develop a fever, a significant portion do not. It is common for hypothermic reactions as well as hyperthermic reactions to occur in the evolution of an infection.[11] Negative readings with infrared may be accurate and reproducible but irrelevant if the patient does not have a fever but has other symptoms or is pre-symptomatic. The high level of false positives in dermal temperature resulting from improper environment and technique also create problems, since confirmation of the result needs to be performed. It is well known that patients suffering from COVID-19 can be infectious without any significant symptoms. Thus, even accurate temperature readings do not provide an assurance of safety.[15] It may be that aggressive temperature monitoring is a means of simply reducing anxiety in the population being tested and easing fear by giving the illusion that an individual is not infected because their temperature appears to be normal.

Regardless of the problems with mass NCIT screenings, the use of a screening technique is an easy method when evaluating asymptomatic persons and can be useful if used intelligently as a simple screen with appropriate follow up, including questionnaires about recent health history, contacts, and an understanding of the variables that can make the NCIT screen unreliable.

Body Temperature Norms (Medline Plus, US Library of Medicine)
Normal body temperature varies by person, age, activity and time of day. The average normal body temperature is generally accepted as 98.6 Fahrenheit (37.0 Celsius). Some studies have shown that "normal" body temperature can have a wide range from 97 F (36.1 C) to 99 F (37.2 C). A temperature over 100.4 F (38 C) most often means that a fever is present caused by an infection or illness.

Benefits of Using NCITs as a Screen[16]

- Non-contact approach may reduce the spread of disease between people being evaluated and those administering the test.
- Ease of use.
- Ease of cleaning and disinfection of the devices.
- Rapidity of measurement.

Limitations of NCITs

- Close distance required to take the temperature may represent a risk of spreading disease between the person using the device and the one being tested.
- Environmental issues during the testing.
- The manufacturer's guidelines must be carefully followed for the use of all NCIT devices, especially when a new device is being used.
- False positive rates can be high, requiring follow-up and causing distress.
- False "negative" results can be dangerous, causing false confidence in patients.
- Temperature taking does not make a diagnosis: e.g. COVID-19 presents without fever in a significant portion of active cases.
- Dermal temperatures are lower than core body temperatures, and so a dermal. temperature of 99 degrees Fahrenheit may indicate a much higher core temperature which is more reliable for detecting possible infection.

Requirements for Accurate Testing Using NCITs[13,17]

Manufacturer's guidelines and instructions must be strictly followed including the following:

Environment:

- NCITs must be cleaned between uses according to instrument instructions. Most cannot be immersed in water or other liquids.
- Test in a draft free space out of direct sunlight and not close to radiant heat sources.
- Environmental temperature should be between 60.8 and 104 degrees Fahrenheit and relative humidity below 85%.
- Place the instrument being used in the room where testing is done 10-30 minutes before use.

Preparation of person being tested:

- The person being tested should be quiet in the room for 15 minutes before testing, especially if they have come in from a warm day or have been sitting in a hot car.
- The forehead must be clean, dry and not blocked by hats or hair while testing.
- Test area temperature can be increased or decreased by excessive clothing or head covers, headbands or bandannas, or by facial cleansing products like cosmetic wipes, as well as facial washing with cool or warm water prior to testing.
- Facial makeup, sweat, sun exposure, anxiety, and sunscreen are examples of things that can affect measuring temperature on the forehead.
- The person being evaluated should wait at least 30 minutes in the testing area after exercising, strenuous physical activity, bathing, or using hot or cold compresses on the face.

- The tester should not assist in moving hair from the forehead as this is unnecessary touching. If the patient is unable to move hair blocking the forehead, fresh gloves must be worn and then removed after testing.
- The patient should not be sitting or standing in direct sunlight during testing, or near air conditioning vents.
- Recent use of anti-inflammatory medications (e.g., NSAIDS), aspirin, and corticosteroids can result in incorrect temperature results and should be considered when analyzing the results.
- Testers must be aware that age and certain diseases such as cardiovascular disease or systemic inflammation can interfere with accuracy of the NCIT.

Using the Instrument:

- Follow manufacturer's guidelines, most specifically for the device being used, as they each have different criteria for the distance between the NCIT and the forehead.
- Hold the sensing area perpendicular to the forehead and instruct the person to remain stationary during testing.
- The sensing area of the NCIT should not be touched, and must be kept clean and dry, and safely stored between tests.

Conclusions

Instruments that are being currently utilized during the COVID-19 pandemic are likely to be more reliable in terms of accuracy and precision when used correctly than the ones used in the early part of the century when dealing with Ebola outbreaks. They are still, however, subject to the errors listed above, and are not capable of detecting or confirming infection.[18] Further specific evaluation needs to take place after the NCIT determined temperature has been confirmed by a more reliable estimate of core temperature. In a protected clinical setting, oral temperatures can be performed, and a history taken to evaluation possible serious symptoms and risk of the individual. Keeping in mind that a significant number of NCIT readings are falsely positive, as well as a lesser number that result in false negative results, clinicians and other testers need to be aware of the need to ensure appropriate follow up for the patient as well as reassurance that the test does not mean that they have contracted COVID-19. Specific antigen and antibody testing must be performed in order to determine if there is infection present.

Clinical Advisory Feedback

CHP desires to keep our clinical pathways and advisories customarily updated. If you wish to provide additional input, please use the e-mail address listed below and identify which clinical pathway or advisory you are referencing. Thank you for taking the time to give us your comments.

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[1] Khan S, Ali A, Siddique R, Nabi G. Novel coronavirus is putting the whole world on alert. J Hosp Infect 2020;104:252-3

[2] Aw JThe non-contact handheld cutaneous infra-red thermometer for fever screening during the COVID-19 global emergency. J Hosp Infection 2020

[3] Bijur PE, Shah PD, Esses D. Temperature Measurement in the adult emergency department: oral, tympanic membreance and temperal artery vs rectal temperatures Emerg Med J 2016; 33: 843-7

[4] Liu CC, Chang RE, Chang WC. Limitations of forehead body temperature detection for fever screening for acute respiratory syndrome. Infect Control Hosp Epedemiol 2004; 25:1109-11

[5] Hausfater P, Zhau Y, Defrenne S, Bonnet P, Riou B, Cutaneous infrared thermometry for detecting febrile patients. Emerg Infect Dis 2008;14:1255-8

[6] Tay MR, Low YL, Zhao X, Cook AR, Lee VJ. Comparison of Infrared thermal detection systems for mass fever screening in a tropical healthcare setting. Publ Health 2015;129:1471-8

[7] Fletcher T, Whittan A, Simpson R, Machin G. Comparison of non-contact infrared skin thermometers. J Med Engng Technol. @018;42:65-71

[8] Thermal Imaging Systems/FDA. www.fda.gov/medical devices/general-hospital-devices-and-supplies/thermal imaging syctems-infrared-thermographic -thermal imaging

[9] Ng EYKaw GJ, Chang WM. Analysis of IR thermal imager for mass blind fever screening. Microvasc Res. 2004;68:104-9

[10] DeGroot DW, Kenney WI, Impaired defense of core temperature in aged humans during mild cold stress. Am J Pysiol Regul Integr Comp Physiol. 2007, 292 R103-8 DOI 10.1152/ajpregu 00074 2006

[11] Anderson SE, Edvinsson ML, Edvinsson L. Cutaneous vascular reactivity is reduced in aging and heart failure association. Clin Sci 2003; 105: 699-707 DOI 10.1042/CS20030037

[12] Infrared cameras overestimate skin temperature during rewarming from cold exposure. Maley MJ, Hunt AP, Bach AJ, Eglin CM, Costello JT.J Therm Biol. 2020 Jul;91:102614. doi: 10.1016/j.jtherbio.2020.102614. Epub 2020 May 3.PMID: 32716864

[13] Ng DK, Chan CH, Chan EY, Kwok KL, Chow PY, Lau WF, et al. A brief report on the normal range of forehead temperature sd determined by non-contact, handled, infrared thermometer. Am J Infect Contrl; 2005: 33: 227-9 DOI 10.10116/j.ajic 2005.01.003

[14] The effect of constitutive pigmentation on the measured emissivity of human skin. Charlton M, Stanley SA, Whitman Z, Wenn V, Coats TJ, Sims M, Thompson JP.PLoS One. 2020 Nov 25;15(11):e0241843. doi: 10.1371/journal.pone.0241843. eCollection 2020.PMID: 33237918

[15] Review of the efficacy of infrared thermography for screening infectious diseases with applications to COVID-19. Kosar Khaksari 1, Thien Nguyen 1, Brian Hill 1, Timothy Quang 1, John Perreault 1, Viswanath Gorti 1, Ravi Malpani 1, Emily Blick 1, Tomás González Cano 1, Babak Shadgan 2, Amir H Gandjbakhche 1 Med Imaging (Bellingham). 2021 Jan;8(Suppl 1) doi: 10.1117/1.JMI.8.S1.010901. Epub 2021 Mar 25. :010901.PMID: 33786335PMC7995646

[16] NCIT/FDA. www.fda.gov/medical-devices/general-hospital-devices-and-supplies/non-contact-infrared thermometers

[14] Ghassemi P., et al (2018) "Best practices for standardized performance testing of infrared thermographs for fever screening" PLoS ONE13(9): e0203302

[17] Non-contact infrared assessment of human body temperature: The journal *Temperature* toolbox. Foster J, Lloyd AB, Havenith G.Temperature (Austin). 2021 Apr 26;8(4):306-319. doi: 10.1080/23328940.2021.1899546. eCollection 2021.PMID: 34901315 **Free PMC article.** Review

[18] Myths and methodologies: Degrees of freedom - limitations of infrared thermographic screening for Covid-19 and other infections. Mekjavic IB, Tipton MJ.Exp Physiol. 2020 Dec 28. doi: 10.1113/EP089260. Online ahead of print.PMID: 33369802