ASPR TRACIE Technical Assistance Request

Request Receipt Date (by ASPR TRACIE): 12 October 2018
Response Date: 23 October 2018; updated 7 November 2018
Type of TA Request: Standard

Request:

The requestor asked ASPR TRACIE for assistance with gathering research materials that compared the durability and accuracy of disposable strip thermometers, infrared skin/ear thermometers, and standard oral thermometers. The requestor noted that the results would be relevant to a scenario involving response to a public health emergency (e.g., SARS, Ebola).

Response:

The ASPR TRACIE Team conducted an online search for published articles and studies related to the durability and accuracy of disposable strip thermometers and infrared thermometers/ear thermometers in comparison to standard oral thermometers. Results also include materials on thermometry in mass screening responses. Section I in this document includes comments from an ASPR TRACIE Subject Matter Expert (SME). Section II includes research/studies specific to non-contact thermometers and disposable thermometers. Section III provides links to resources that pertain to mass screenings and thermometry.

While we summarize key finding in the annotations in this document, overall, the ASPR TRACIE Team found the literature on non-contact/infrared devices to be inconclusive due to many external factors (e.g., scenario, age, ambient temperature, core body temperature changes, and the influence speed during mass screening events may have on and accuracy). Additionally, studies have shown that even within the same categories of infrared thermometers, there is a difference in accuracy/validity of devices based on the manufacturer's standards.

I. ASPR TRACIE SME Cadre Member Comments

Please note: These are direct quotes or paraphrased comments from emails and other correspondence provided by SME Cadre members in response to this specific request. They do not necessarily express the views of ASPR or ASPR TRACIE.

SME Cadre Member 1:

- I agree with the conclusions found in this document. Even with the same devices or category of devices the results are inconsistent.
- Many emergency and other healthcare settings use tympanic thermometry as a rapid screen and then oral as confirmatory once the patient is placed in a room.

II. Studies on the Accuracy of Non-Contact Infrared Thermometers and Disposable Thermometers

Bijur, P.E., Shan, P.D., and Esses, D. (2016). Temperature Measurement in the Adult Emergency Department: Oral, Tympanic Membrane and Temporal Artery Temperatures Verses Rectal Temperature. (Abstract only.) Emergency Medicine Journal. (12):843-847.

This study compared body temperature measurements of the tympanic membrane and temporal artery to rectal temperature readings of 987 emergency department patients. Non-invasive methods failed to meet established diagnostic accuracy benchmarks. Of the three non-invasive measurements, tympanic membrane readings provided the closest diagnostic accuracy reading.

Canadian Agency for Drugs and Technologies in Health. (2014). Mass Thermography Screening For Infection and Prevention: A Review of the Clinical Effectiveness.

The authors examine results of previous studies that tested the effectiveness of infrared thermography screenings aimed to reduce outbreak risks. A total of 339 articles were selected based on their reporting of findings during previous outbreaks such as the 2009 H1N1 pandemic, the 2014 Taiwan Dengue Fever outbreak, and the West Africa Ebola Epidemic of 2014. Results from the review indicated that fever screening was not an effective strategy for detecting infected individuals, and additional research is needed to determine effective border control strategies which mitigate the risk of disease transmission/outbreaks.

Chiang, M.F., Lin, P.W., Lin, L.F., et al. (2008). Mass Screening of Suspected Febrile Patients with Remote-Sensing Infrared Thermography: Alarm Temperature and Optimal Distance. Journal of the Formosan Medical Association. 107(12): 937-944.

The authors of this study compared infrared thermometry readings to other imagers in order to evaluate influences of ambient temperature and operational distances between the imager and the study patients. 1,032 patients participated in the study and received temperature readings from infrared thermal imaging thermometers, thermoguard devices, and eardrum infrared thermometers. Key findings included temperature readings from infrared thermometers, which served as a proxy for core temperature readings. Results also indicated that during public health emergencies, such as SARS or avian influenza epidemic, hospitals can utilize infrared thermometers if strict operating protocols are in place to ensure accurate temperature measurements.

Fletcher, T., Whittam, A., Simpson, R., et al. (2018). Comparison of Non-Contact Infrared Skin Thermometers. (Abstract only.) Journal of Medical Engineering and Technology. 42(2):65-71.

This article provides an assessment of non-contact infra-red skin thermometers' (NCITs) performance capability in relation to the International Temperature Scale (ITS) of 1990. Authors tested nine common NCITs within a temperature range of 15-45 Celsius. Five of the nine NCITs had readings which were outside of the accuracy range stated by their

manufacturers. Researchers concluded that traceable calibration to ITS-90 standards were needed.

Gasim, G.I., Musa, I.R., Abdien, M.T., et al. (2013). Accuracy of Tympanic Temperature Measurement Using an Infrared Tympanic Membrane Thermometer. BMC Research Notes. 6: 194.

This study compared the accuracy of mercury thermometers to non-contact infrared thermometers. Researchers compared tympanic measurements of 174 patients who presented to the emergency room with and without fever complaints. Tympanic membrane thermometry was found to be as reliable and accurate as traditional mercury thermometers. The authors recommended the use of tympanic membrane thermometry in clinical practice due to its easy applicability and ability to provide rapid and accurate temperature readings.

Geijer, H., Udumyan, R., Lohse, G., et al. (2016). Temperature Measurements with a Temporal Scanner: Systematic Review and Meta-Analysis. BMJ Open. 31;6(3):e009509.

The authors conducted a literature review and corresponding meta-analysis related to the diagnostic accuracy of clinical patients through the use of temporal artery thermometers. Researchers selected and analyzed temperature data of 5,026 patients from 37 corresponding articles. Results indicated that temporal artery thermometers did not produce the same level of accuracy as other methods such as rectal, bladder, and other invasive temperature devices.

Khorshid, L., Eser, I., Zaybak, A., et al. (2005). Comparing Mercury-in-Glass, Tympanic and Disposable Thermometers in Measuring Body Temperature in Young Healthy People. (Abstract only.) Journal of Clinical Nursing. 14(4): 496-500.

This study compares the accuracy of disposable thermometers to tympanic thermometers when measured against mercury thermometers. The researchers collected temperature readings from the ear and axillary locations of study participants. Tympanic temperature measurements were higher than axillary measurements collected by mercury thermometers and disposable thermometers. The authors recommend clinical leaders account for the type of thermometers being used for potential limitations, and should ensure mercury thermometers are kept in axillary location for a minimum of eight minutes to ensure accurate readings.

Kistemaker, J.A., Den Hartog, E.A., Daanen, H.A.M. (2009). Reliability of an Infrared Thermometer for Core Temperature Measurements. (Abstract only.) Journal of Medical Engineering & Technology. 30(4): 252-261.

This study evaluates the validity and the accuracy of the SensorTouch thermometer body temperature readings to rectal and esophageal sensor readings during intervals of exercise. SensorTouch core temperature measurements were elevated in comparison to the measurements from the other sensors. Researchers concluded that during intervals of increased body temperature the SensorTouch did not provide reliable values, but it may provide more accurate readings under stable conditions.

MacRae, B.A., Annaheim, S., Spengler, C.M., et al. (2018). Skin Temperature Measurement Using Contact Thermometry: A Systematic Review of Setup Variable and Their Effects on Measured Values. Frontiers in Physiology. 9:29.

The authors of this study examined measurements of contact thermometers based on potential confounding factors such as temperature disturbance, sensor attachments, pressure, sensors used, condition of use, and environmental temperature. Researchers reviewed measurement comparisons results from 21 studies and concluded that certain variables and conditions can impact measured temperatures from contact sensors.

Mazerolle, S.M., Ganio, M.S., Casa, D.J., et al. (2011). Is Oral Temperature an Accurate Measurement of Deep Body Temperature? A Systematic Review. Journal of Athletic Training. 46(5):566-73.

The authors of this study evaluated the validity of oral thermometry in order to measure core body temperatures during rest and changing core temperatures. After conducting a review of 16 studies, the evidence suggested oral temperature measurements were unsuitable diagnostic tools for determining core body temperature due to factors such as ambient air temperature, probe placement, and ingestion of fluids. During emergency situations such as exertional heat strokes, oral thermometers may underestimate body temperatures, potentially delaying accurate diagnosis and treatment.

Opersteny, E., Anderson, H., Bates, J., et al. (2017). Precision, Sensitivity and Patient Preference of Non-Invasive Thermometer in a Pediatric Surgical Acute Care Setting. (Abstract only.) Journal of Pediatric Nursing. 35:36-41.

The authors of this article conducted an eight month study to compare the sensitivity and precision of digital probe thermometer readings to temporal artery thermometer readings in pediatric patients. In addition, patient and family thermometer preferences were assessed through a survey. Results from the study indicated that temporal artery thermometers were preferred by pediatric patients and their families, and acceptable due to their fever sensitive and precise temperature measurements.

Wang, K., Gill, P., Wolstenholme, J., et al. (2014). Non-Contact Infrared Thermometers for Measuring Temperature in Children. British Journal of General Practice.

This resource provides information related to non-contact infrared thermometers (NCITs) and their advantages in pediatric settings. The authors summarize the characteristics of NCITs devices and compare studies for validation and state that while these tools provide a “rapid, hygenic, and non-invasive means of ruling out fever in children,” more research is necessary.

III. Resources Related to Mass Screenings and Thermometry Devices

Ghassemi, P., Pfefer, T.J., Casamento, J.P., et. al. (2018). Best Practices for Standardized Performance Testing of Infrared Thermographs Intended For Fever Screening. PLoS One. 13(9).

The authors of this study evaluated the performance of infrared modalities and their utilization in mass fever screening scenarios, such as Ebola Virus Disease and Severe Acute Respiratory Syndrome. The authors provided suggestions on modifying and evaluating test methods for devices under certain environmental factors to clarify and optimize testing methods.

Nguyen, A.V., Cohen, N.J., Lipman, H., et al. (2010). Comparison of 3 Infrared Thermal Detection Systems and Self Report for Mass Fever Screening. Emerging Infectious Diseases. 16(11).

The authors conducted a cross-sectional study to compare three infrared thermal detection systems in three urban emergency departments. The authors examined the effect of factors such as age, sex, time of day, and room temperature on oral temperature measurements to ensure validity. In comparison to the oral temperature readings, two of the three infrared detection systems (Opto Therm, and FLIR) were found to be reasonably accurate in detecting fevers within the study population.

Ng, E.Y. (2005). Is Thermal Scanner Losing its Bite in Mass Screening of Fever Due To SARS? (Abstract only.) Medical Physics. 32 (1) 93-7.

The authors of this study tested the ability of thermal imagers to identify febrile individuals based on increased body temperature during mass blind temperature screenings. Authors identified facial locations and noted that thermal imagers are useful tools for body temperature measurements during a public health crisis.