


Research Brief

Evaluation of a telethermographic system for temperature screening at a large tertiary-care referral hospital during the coronavirus disease 2019 (COVID-19) pandemic

Katherine C. Leach MD¹, Misti G. Ellsworth DO¹, Luis Z. Ostrosky MD², Cynthia S. Bell MS¹, Kathy Masters MS, Six Sigma MBB³, John Calhoun MS, Six Sigma MBB³, Lance Ferguson MHA, MBA³, Susie Distefano MSN, RN³ and Michael L. Chang MD¹ 

¹Department of Pediatrics, UTHealth McGovern Medical School, Houston, Texas, ²Department of Internal Medicine, UTHealth McGovern Medical School, Houston, Texas and ³Memorial Hermann Hospital, Texas Medical Center, Houston, Texas

Since the outset of the coronavirus disease 2019 (COVID-19) pandemic, the United States Centers for Disease Control and Prevention has recommended screening and triage for signs and symptoms of infection for everyone entering a healthcare facility.¹ In compliance, everyone entered our hospital (a tertiary-care referral center in a large metropolitan area) in several single-file lines, and underwent individual symptom screening and temperature check by temporal artery thermometer that required skin contact and cleaning of the probe cone between uses. Despite optimizations, temperature screening resulted in long lines during employee shift changes, which compromised social distancing and exposed screeners to hundreds of individuals in close proximity. During this period, the US Food and Drug Administration issued guidance for initial temperature assessment during a triage process using telethermographic systems (thermal cameras) able to determine surface skin temperature from a distance without skin contact.²

We sought to determine the feasibility of replacing temporal artery thermometers with a telethermographic system and the impact of such a system on our screening process.

Methods

Temperatures were measured with TAT-2000 and TAT-5000 TemporalScanner thermometers (Exergen Corp, Watertown, MA) and the Athena Elevated Temperature Detection System (Athena Security, Austin, TX). Exergen reports their instruments to be accurate within 0.2°C and 0.1°C, respectively.^{3,4} The Athena telethermographic system uses artificial intelligence to detect human faces by measuring the temperature of multiple points on the face relative to a blackbody temperature reference source.⁵ According to Athena Security, the system is accurate within 0.3°C.⁵ Systems were purchased from Athena Security.

Author for correspondence: Michael L. Chang, E-mail: michael.l.chang@uth.tmc.edu

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Accepting manufacturer specifications, detecting 0.2°C difference between devices (assuming standard deviation of $\pm 0.3^\circ\text{C}$) required 26 measurements from each device. One subject was measured 104 times with 4 different TAT-2000s (26 measurements per device) and 104 times with 4 different TAT-5000s (26 measurements per device) by a single operator, and 13 times with the Athena system at a single location within 90 minutes to minimize subject and environmental temperature variation. We repeated measurements with the same subject and thermometer operator at a second location with 3 additional TAT-5000s, 1 TAT-5000 used previously (104 measurements, 26 per device) and a second thermal camera (13 measurements). We simulated fever using air-activated hand warmers (HotHands, Kobayashi Americas, Dalton, GA) held to the forehead. Descriptive statistical analyses were performed with Stata version 15 SE software (StataCorp, College Station, TX). Summaries were reported as means with 95% confidence intervals and differences were tested by 1-way ANOVA. A 2-sided $P < .05$ was considered statistically significant.

Results

Temperature measurement

During the first session, the TAT-2000s measured higher temperatures [mean, 98.3°F (95% CI, 98.2–98.3) or 36.8°C (95% CI, 36.8–36.8)] than the TAT-5000s [mean, 97.8°F (95% CI, 97.8–97.9) or 36.6°C (95% CI, 36.5–36.6)] or the Athena system [mean, 97.9°F (95% CI, 97.8–98.0) or 36.6°C (95% CI, 36.5–36.7)] ($P < .05$). There was no significant difference between the TAT-5000s and the Athena system [mean difference, -0.07°F (95% CI, -0.23 to 0.09) or -0.04°C (95% CI, -0.13 to 0.05)], but the TAT-2000s measured temperatures significantly higher than the Athena [mean difference, 0.40°F (95% CI, 0.24–0.56) or 0.22°C (95% CI, 0.13–0.31)]. During the second testing session, the TAT-5000s measured 0.34°F (95% CI, 0.20–0.48) or 0.19°C (95% CI, 0.11–0.26) [mean, 98.1°F (95% CI, 98.1–98.2) or 36.7°C (95% CI, 36.7–36.8)] higher than the Athena system [mean, 97.8°F (95% CI, 97.7–97.9) or 36.6°C (95% CI, 36.5–36.6)] ($P < .05$).

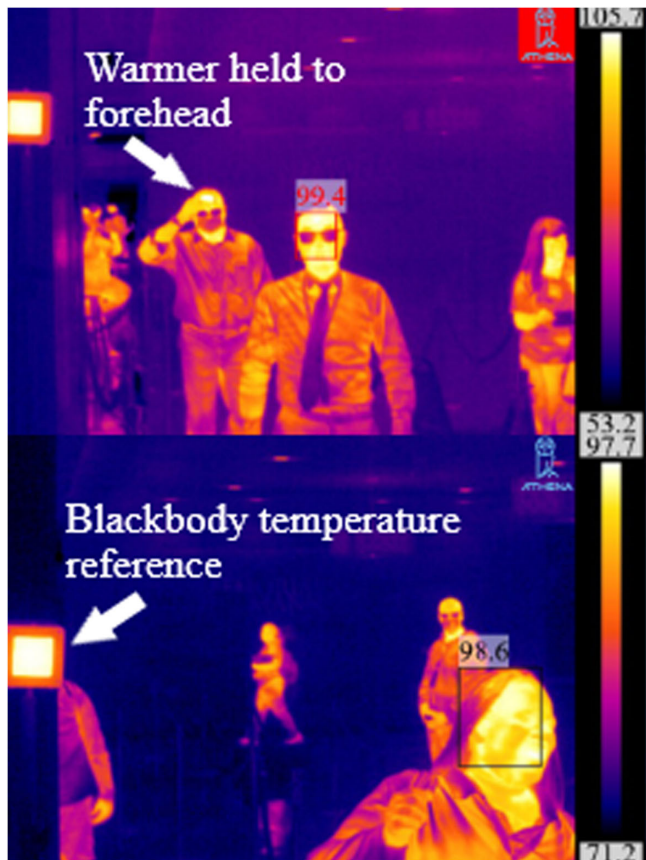


Fig. 1. (Top) Initial test run for fever detection by telethermographic system. Individuals passed camera in single-file line at rate of 1 individual per second ~6 feet (~2 m) apart with warmers held to forehead and then removed. In total, 13 tests were then conducted as described. Maximum temperature detected in frame of 105.7°F (40.94°C) identified as a warmer. (Bottom) Facial detection, normal temperature, and location of black body temperature reference within the camera frame.

Fever detection by the Athena system

HotHands warmers reached up to 46.1°C (115°F) 15–30 minutes after activation and were held at the forehead. A “symptomatic” individual in single-file line 6 feet (2 m) between “normal” individuals passing the camera at a rate of 1 individual per second, was detected in 8 of 8 attempts. Additionally, when the forehead was warmed and the warmer then removed, the Athena system was able to detect temperatures of >99°F or 37.2°C (Fig. 1) in 5 of 5 attempts.

Screening time

Screeners using TAT-5000s took a median of 16.5 seconds from the start of taking the temperature through cleaning the device until the thermometer was ready again. The Athena system has no effective delay from person to person passing in a single-file line.

Discussion

The COVID-19 pandemic has led to the implementation of temperature screening in a wide variety of facilities. Although temperature screening has been used in public settings during previous infectious diseases outbreaks,^{6–8} the usefulness of

temperature screening to detect potential infections has been questioned.^{6,7} However, temperature screening may discourage symptomatic individuals from entering public places and may increase comfort for healthy people.⁸

Our study using noninvasive devices was not designed to test the accuracy of devices, though temporal scanners are widely considered reliable enough for professional use.^{9,10} In our use, temperatures measured by telethermographic systems were similar to those obtained by temporal scanners, suggesting similar performance.

Cost is the biggest barrier to implementation for telethermographic systems. For our investment recovery analysis, we considered turnaround time difference between temporal scanners and a thermal camera for each screened individual at a high-entry location with large groups arriving in a short period, desired throughput rate of 1 person per second, maintaining 6-feet (2-m) social distancing and single-file lines for individual symptom screening. We estimated needing 6 temporal scanner operators for every 1 thermal camera operator. With our organization’s direct labor rates and overhead costs, investment recovery was estimated to occur in months, leading to adoption of 4 telethermographic systems at our 2 highest-entry locations. We reduced screening staff from 24 to 4 individuals, and there are now no waiting lines at these locations.

In conclusion, our experience demonstrates that a telethermographic system improves screening throughput and reports temperatures similar to those recorded by temporal scanners, with acceptable investment recovery time.

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Conflicts of interest. All authors have no conflicts of interest or financial relationships to disclose relevant to this manuscript.

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Risk of coronavirus disease 2019 (COVID-19) acquisition among emergency department patients: A retrospective case control study

Jessica P. Ridgway MD, MS¹  and Ari A. Robicsek MD²

¹Department of Medicine, University of Chicago, Chicago, Illinois and ²Providence St. Joseph Health, Seattle, Washington

With the onset of the coronavirus disease 2019 (COVID-19) pandemic, emergency departments (EDs) have seen significant declines in patient volume, partly due to patients' fear of contracting COVID-19 in the ED.^{1,2} Nosocomial transmission of severe acute respiratory coronavirus virus 2 (SARS-CoV-2) has been reported in some healthcare settings,³ but little is known about the risk of acquiring COVID-19 in the ED. The objective of this study was to determine whether ED colocation with COVID-19 patients is associated with COVID-19 acquisition.

Methods

Study design and participants

We performed a retrospective case control study among patients treated in 39 EDs in the western United States. Patients were included as cases if they visited (and were discharged home from) an ED between March 1, 2020, and July 19, 2020 and subsequently had a positive SARS-CoV-2 PCR test 7–21 days following the ED encounter. Cases were matched with 2 controls who visited (and were discharged from) the same ED within 6 days of the case patient. Controls differed from cases in that they had a negative SARS-CoV-2 PCR test 7–21 days after their ED visit. To ensure that study participants did not have COVID-19 at the time of their ED encounter, we excluded patients who presented to the ED with fever, chills, cough, or shortness of breath. Symptoms were identified using natural language processing of the ED provider notes and chief-complaint documentation. We also excluded patients tested for or diagnosed with COVID-19 during the ED visit.

Data collection and analysis

For cases and controls, we collected demographic information and the Emergency Severity Index (ESI)⁴ from the electronic medical record. To assess exposure to COVID-19 in the ED, we measured the number of COVID-19 patients in the ED in the 24 hours prior to each patient's arrival and the number of minutes each patient

was collocated in the ED with COVID-19 patients. As a proxy for the incidence of COVID-19 in a patient's community, we also measured the percentage of positive tests in the patient's home ZIP code in the 14 days prior to ED visit.

We performed a bivariate analysis comparing characteristics of cases versus controls using the χ^2 and the Student *t* tests, and we used multivariate conditional logistic regression to determine whether ED colocation with COVID-19 patients was associated with case versus control status. This study was approved by the Providence St. Joseph Health Institutional Review Board.

Results

We identified 102 cases. All cases were matched to 2 controls, except for 3 cases for whom only 1 control could be identified, resulting in 201 controls. In the bivariate analysis, cases were younger (mean age, 46.4 vs 52.2 years; $P = .026$), more likely to be Hispanic (39.2% vs 18.4%; $P = .0003$), more likely to have an ESI of 4–5 (31.7% vs 18.9%; $P = .006$), and more likely to live in a ZIP code with >14% COVID-19 test positivity compared to controls (47.1% vs 33.3%; $P = .024$). There was no difference in the bivariate analysis between cases and controls in the number of ED COVID-19 patients or in length of time colocating with COVID-19 patients in the ED (Table 1).

In the multivariate model, patients of Hispanic ethnicity were more likely to acquire COVID-19 compared to whites (aOR, 7.04; 95% CI, 2.85–17.40), and patients presenting to the ED with an ESI of 4–5 were more likely to acquire COVID-19 than patients with an ESI of 2 (aOR, 3.36; 95% CI, 1.11–10.22) (Table 1). In the multivariate model, neither time of ED colocation with COVID-19 patients nor number of ED COVID-19 patients was associated with COVID-19 acquisition.

Discussion

In this retrospective case-control study, we found that ED colocation with COVID-19 patients is not associated with COVID-19 acquisition. Our findings provide reassurance that SARS-CoV-2 transmission occurs uncommonly in EDs. Many EDs have implemented various strategies to limit SARS-CoV-2 transmission, including the use of personal protective equipment such as face masks and eye protection, cohorting patients with respiratory symptoms, social distancing, and limiting visitors.^{5–7}

Author for correspondence: Jessica Ridgway, E-mail: Jessica.ridgway@uchospitals.edu

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