Article Type: Research Brief

Title: Evaluation of a telethermographic system for temperature screening at a large tertiary referral hospital during the COVID-19 pandemic

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Abbreviated Title: Telethermographic fever screen for COVID-19

Word Count: 899
Introduction

Since the outset of the COVID-19 pandemic, the United States Centers for Disease Control and Prevention has recommended to screen and triage everyone entering a healthcare facility for signs and symptoms of infection.\(^1\) Everyone entered our hospital (a tertiary 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 United States Food and Drug Administration issued guidance for initial temperature assessment during a triage process using telethermographic systems (thermal cameras) which are able to determine surface skin temperature from a distance without skin contact.\(^2\)

Our objective was to determine the feasibility of replacing temporal artery thermometers with a telethermographic system and examine the impact 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, Inc. Austin, TX). Exergen reports their instruments to be accurate within \(0.2^\circ\text{C}\) and \(0.1^\circ\text{C}\), respectively.\(^3,4\) The Athena telethermographic system uses artificial intelligence to detect human faces, measuring the temperature of multiple points on the face relative to a blackbody temperature reference source.\(^5\) Per Athena Security, the system is accurate within \(0.3^\circ\text{C}\).\(^5\) Systems were purchased from Athena Security.
Accepting manufacturer specifications, detecting 0.2°C difference between devices (assuming standard deviation of ±0.3°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, one 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 15 SE software. Summaries were reported as means [95% confidence interval] and differences were tested by one-way ANOVA with a two-sided p-value <0.05 considered statistically significant.

Results

Temperature measurement

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

**Fever detection by the Athena system**

HotHands® warmers reach up to 115°F / 46.1°C 15 to 30 minutes after activation and were held at the forehead. A “symptomatic” individual in single-file line 6 feet between “normal” individuals passing the camera at a rate of 1 individual per second, was detected in 8 out 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 (Figure 1) 5 of 5 attempts as above.

**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-time from person to person passing in a single-file line.

**Discussion**

The COVID-19 pandemic has led to implementation of temperature screening in a wide variety of facilities. While temperature screening was used in public settings during previous infectious diseases outbreaks, the usefulness of temperature screening to detect potential infections has been questioned. However, temperature screening may discourage symptomatic individuals from entering public places, and may increase comfort for healthy people.

Our study using non-invasive devices was not designed to test the accuracy of devices, though temporal scanners are widely considered reliable enough for professional use. In our usage, 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 time period, desired throughput rate of 1 person per second, keeping 6 feet social distancing, but maintaining 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 two 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 similar temperatures to temporal scanners, with acceptable investment recovery time.

Acknowledgements

Financial support. No financial support was received from Exergen or Athena Security. Telethermographic systems were purchased at negotiated discounted price from Athena Security.

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

Manuscript preparation. The authors completed the study, data collection, and manuscript with no support from Exergen or Athena Security.
References


Figure Legend

Figure 1. Top half: Initial test run for fever detection by telethermographic system. Individuals passed camera in single-file line at rate of 1 individual per second approximately 6 feet apart with warmers held to forehead and then removed. 13 total tests were then conducted as described. Maximum temperature detected in frame of 105.7ºF identified as a warmer. Bottom of figure illustrates facial detection, normal temperature, and location of blackbody temperature reference within camera frame.