Original Article

J Nepal Health Res Counc 2021 Jul-Sep;19(52): 608-12

DOI: https://doi.org/10.33314/jnhrc.v19i3.3511

A Comparative Study on the Recording of Temperature by Thermo- Graphic Camera, Thermal Gun and Digital Clinical Thermometer in a Tertiary Hospital of Nepal

Anil Poudyal,[1] Meghnath dhimal,[1] Ram Prasad Rimal,[2] Laxman Prasad Rimal,[2] Neelam Dhakal,[1] Ashok Pandey,[3] Pradip Gyanwali[1]

ABSTRACT

Background: Body Temperature is one of the most common and an important sign of health and disease. Considering the need of keeping physical distance, newer methods have evolved such as; thermal imaging systems which have been used by several countries during epidemics. Therefore, the present study was conducted to compare body temperatures obtained with thermo graphic camera and commercially available thermal gun with reference to standard digital clinical thermometer.

Methods: The study was comparative analytical in nature and quantitative method was used to collect data. Temperatures in degrees Fahrenheit were taken simultaneously using the three different thermometers in 101 patients at the outpatient fever screening clinic at Tribhuvan University Teaching Hospital, Kathmandu. The Bland Altman statistical test was used to assess the concordance by the 95% limits of agreement.

Results: The thermo-graphic camera gave concordance (limits of agreement-0.0360 to 0.0440 °F) with standard digital clinical thermometer. Similarly, commercially available thermal gun gave the concordance (limits of agreement 0.0042 to 0.1293 °F) with standard digital clinical thermometer.

Conclusions: The results of the present study show that both thermo-graphic camera and thermal gun were found to be concordant compared to digital clinical thermometer. Therefore, it could be a preferable option for the screening of fever in mass number of individuals as part of an initial check at entry points.

Keywords: Nepal; non-contact infrared thermometers; temperature; thermometer

INTRODUCTION

Infrared thermography also known as thermal imaging is a non-contact and noninvasive imaging approach that has been used for a wide range of biomedical and non-biomedical applications.[1] Infrared (IR) modalities represent the only currently viable mass fever screening approaches for outbreaks of infectious disease pandemics such as Ebola virus disease, severe acute respiratory syndrome and current Corona virus diseases (COVID-19).[2]

Thermal imaging systems have been used by several countries during epidemics, although previous studies provide mixed result about their diagnostic accuracy, correlation and their utility for mass fever screening.[3-5] In addition, there are few published comparisons of the efficacy of different Infra-red Thermal Detection System (ITDS) and their suitability for mass fever screening.[6] Therefore, this study aims to compare body temperatures obtained with thermo graphic camera and commercially available thermal gun with reference to standard digital clinical thermometer.

METHODS

Comparative analytical study design was used to compare body temperature measured by using the three different types of devices namely thermo-graphic camera, commercially available thermal gun and digital clinical thermometer in fever screening clinic at Tribhuvan University Teaching Hospital (TUTH) Kathmandu Nepal. This hospital was chosen because of a higher number of patient visits. Based on previous research evidence, we calculated that 101 patients were required to evaluate the sensitivity of ITDS for fever/ temperature detection (assumed to be 80% from previous research) to within

Correspondence: Anil Poudyal, Nepal Health Research Council, Ramshahpath, Kathmandu, Nepal. Email: poudyalanil123@gmail.com, Phone: +9779851212716.

±10% with 95% confidence.[7,8]

Participants were recruited consecutively among patients who sought care at the Outpatient Department of fever screening clinic at TUTH. The period of data collection was from 5th to 31st July 2020. Participants were enrolled in the study if they were willing to participate and gave written informed consent. Patients who were non-ambulatory, mentally incompetent or required immediate medical attention were excluded from the study.

The data collection tool was developed after review of literatures and consultation of expert. The tool included Part I: demographic characteristic and Part II: recording temperature result. The demographic information was filled before starting the Part II: recording temperature result. This study was performed following manufacturer information for each of the thermometry instruments.

Body Temperature measurements were taken simultaneously using the three different types of thermometers: Thermo graphic camera model RL-TIO7 which is developed and assembled in Nepal by Ramlaxman Innovations Pvt Ltd.[9] Similarly, commercially available thermal guns model of CONTEC infrared thermometry model TP 500, contec medical systems co., ltd.[10] and model of Microlife. MT 600 of digital clinical thermometer were used.[11]

All measurements were taken following manufacturers recommendations. The thermo-graphic camera was positioned at the optimal distance (3-6) meter from each participant as recommended by the manufacturers. Thermo-graphic camera field of view was preset to capture the patient's face and neck. Participants were asked to remove eyeglasses and hats and instructed to stand facing the cameras until temperature measurements from devices have been recorded The digital thermometer was left under the axilla until the device beeped. Likewise, thermal gun was placed 5 to 15 cm away from the patient and typically measured temperature on the forehead as recommended by manufacturer guidelines.

The data were analyzed using Statistical Package for the Social Sciences (SPSS) Version 17 software. The data was expressed as percentages, mean, standard deviation (SD) and range for nominal data. To assess the concordance between three instruments the Bland Altman test was used. The study was approved by the Ethical Review Board (ERB) at the Nepal Health Research Council (NHRC) and Institutional Review Committee of Institute of Medicine, TUTH. Written informed consent was obtained from all the subjects.

RESULTS

A total of 101 participants were enrolled in this study. Female accounted for 58 (57.4) participants; the mean age was 31.5 years (range 5-80 years with mean 31.5± 12.6 SD). Majority (91.1%) were collected in the morning. More than two third of the participants (69.3%) had not taken antipyretic medicines 30 minutes before they were subjected to temperature measurement. Majority (90.1%) of the participants had normal body temperature.

A summary of the temperatures taken by the three instruments is shown in Table 2. With the exception of the differences in the minimum and maximum measurements, there seems to be a close concordance between the three methods. The mean temperatures average around 97.64°F.

Table 1. Summary measurements of temperature.

Thermo-meter	Obser-vations	Mean °F	Standard deviation	Min °F	Max °F
Thermo-graphic camera	101	97.66	1.22	96.00	104.10
Thermo-meter guns	101	97.60	1.27	95.90	104.00
Digital clinical thermo-meter	101	97.67	1.23	96.10	104.00

Table 2 depicts the summary of the Bland Altman analysis. Overall, the thermo-graphic camera gave the smallest limit of agreement (-0.0360-0.0440) across the range of temperatures compared to commercially available thermometer guns.

Table 2. Summary of the results of the Bland Altman plot.

Comparison	Mean difference	Limits of agreement
Thermo-graphic camera ver digital clinical thermometer	0.0040	-0.0360-0.0440
Thermal gun ver digital clinical thermometer	0.0667	0.0042-0.1293

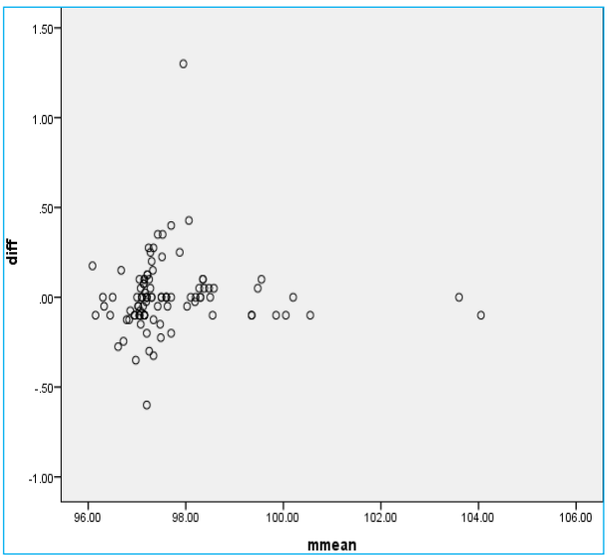

Figure 1. Bland-Altman plot of thermo-graphic camera and digital clinical thermometer.

Figure 1 represents Bland-Altman plot of the thermo-graphic camera readings and the clinical digital temperature readings. On x-axis, the mean of thermo-graphic camera and the clinical digital temperature is plotted, and on y-axis the difference between the temperature readings of thermo-graphic camera and clinical digital thermometer is plotted.In this plot, a line of mean differenceand the lines of limits of agreements are presented. Almost all of the readings were falling within the lines of limits of agreement, that is, upper limit of 0.0440 and lower limit of -0.0360

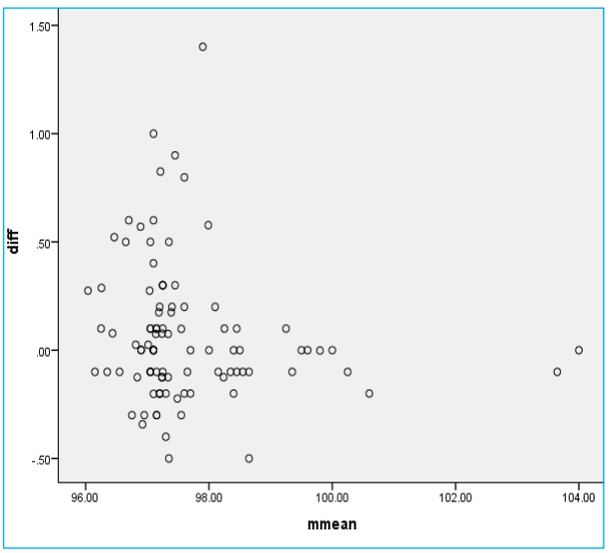

Figure 2. Bland-Altman plot of thermal gun and digital clinical thermometer.

Fig 2 depicts the Bland -Altman Plot of the thermometer guns temperature readings and the clinical digital temperature readings. On the X- axis the mean of the thermometer guns and the digital clinical temperature are plotted and on Y- axis the difference between the temperature readings thermometer guns and digital clinical thermometer are plotted. In this plot a line of mean bias and the lines of 95% limits of agreements are present.Most of the readings were falling within the lines of limits of agreement, that is, upper limit of 0.1293 and lower limit of 0.0042.

DISCUSSION

Non-Contact Infrared Thermography (NCIT) has been shown to be a valuable method for temperature measurements due to its non-contact, rapid processing, and hygiene maintenance attributes. Therefore, this study was conducted to find the concordance of thermo graphic camera and commercially available thermal gun with reference to standard digital clinical thermometer.

In our study, first, the mean body temperature of the thermographic camera (97.66°F) and thermal gun (97.60°F) was in agreement with that of the reference digital clinical thermometer (97.67°F). Second, using the Bland Altman analysis, the mean bias between thermo-graphic camera ver digital clinical thermometer was 0.0040 °F and the mean bias between thermal gun ver digital clinical thermometer was 0.0667. The findings show that the thermo graphic camera agreed best with the digital clinical thermometer. Few studies suggested that NCIT is an accurate and reliable devices based on its sensitivity and specificity and lower mean difference when compared to alternate temperature measuring devices, among various age groups including newborns.[12-15] In a similar study conducted by Ring et al, reported that NCITs can be considered as a potential tool for fever screening and found that, the temperature of the axilla (measured by conventional thermometer) and that of the inner canthi of the eyes measured by Infrared thermography (IRT) were highly correlated.[16] The prospective study from Hong Kong also found higher correlations between IRT readings and conventional temperature readings among febrile and non-febrile participants.[17]

The retrospective study conducted at an international airport in Korea found that there was no statistically significant difference between IRT readings and tympanic temperature readings (average temperature 36.83°C versus 38.14°C, respectively).[18]

Our study compare the body temperature obtained from thermo graphic camera and thermal gun with reference to standard digital clinical thermometer so

interpretation and comparison of findings were made difficult by the limited number of selected studies and their wide heterogeneity in terms of design, methods and study setting.

The most important limitation of our study is that body temperature measurement taken by the digital clinical thermometer used as a reference method was not the golden standard method. In our study we used the digital clinical thermometer as the standard as it was most practical to do so. However, most externally accessible measuring sites have not represented the body core temperature with a specific quantitative relationship. Pulmonary artery catheterization is the reference standard to measure core body temperature, though very accurate, requires specialized skills and poses not only practical but ethical problems.[19] An important aspect of this study is that the conditions for temperature measurement of the face must be optimal. Standardization of technique is very important. Hence, for the measurements with a thermal imaging system to be widely accepted, and to achieve inter-centre agreement on temperatures, it is essential that the imagers be regularly calibrated traceably to national and international standards of radiance temperature.

CONCLUSIONS

Both thermo-graphic camera (limits of agreement -0.0360-0.0440°F) and thermometer gun (limits of agreement 0.0042-0.1293°F) were found to be concordant compared to digital clinical thermometer. Thus, these findings suggest that thermo graphic camera could be useful non-invasive screening tools of mass number of individual's and can be used as a part of an initial check at entry points to identify people who may have elevated temperatures.

Author Affiliations

[1]Nepal Health Research Council, Ramshahpath, Kathmandu, Nepal

[2]Ramlaxman Innovation Pvt Ltd, lazimpat Kathmandu, Nepal

[3]Policy Research Institute, Kathmandu, Nepal.

Competing interests: None declared

REFERENCES

1. Dey N, Ashour AS, Althoupety A. Thermal Imaging in Medical Science. In: Computer Vision: Concepts, Methodologies, Tools, and Applications. 2017.[Article]
2. Ghassemi P, Joshua Pfefer T, Casamento JP, Simpson R, Wang Q. Best practices for standardized performance testing of infrared thermographs intended for fever screening. PLoS One. 2018;13(9):1–24.[Article]
3. Chiang MF, Lin PW, Lin LF, Chiou HY, Chien CW, Chu SF, et al. Mass screening of suspected febrile patients with remote-sensing infrared thermography: Alarm temperature and optimal distance. J Formos Med Assoc [Internet]. 2008;107(12):937–44.[Article]
4. Chiu WT, Lin PW, Chiou HY, Lee WS, Lee CN, Yang YY, et al. Infrared thermography to mass-screen suspected sars patients with fever. Asia-Pacific J Public Heal. 2005;17(1):26–8.[Article]
5. Aggarwal N, Garg M, Dwarakanathan V, Gautam N, Kumar SS, Jadon RS, et al. Diagnostic accuracy of non-contact infrared thermometers and thermal scanners: A systematic review and meta-analysis. J Travel Med. 2020;27(8):taaa193.[Article]
6. Bitar D, Goubar A, Desenclos JC. International travels and fever screening during epidemics: a literature review on the effectiveness and potential use of non-contact infrared thermometers. Eurosurveillance. 2009 Feb 12;14(6):19115.[Article]
7. Nguyen AV, Cohen NJ, Lipman H, Brown CM, Molinari NA, Jackson WL, et al. Comparison of 3 infrared thermal detection systems and self-report for mass fever screening. Emerging infectious diseases. 2010 Nov;16(11):1710. [Article]
8. Bach AJE, Stewart IB, Disher AE, Costello JT. A comparison between conductive and infrared devices for measuring mean skin temperature at rest, during exercise in the heat, and recovery. PLoS One. 2015;10(2):1–13.[Article]
9. Ram Laxman innovation pvt ltd. Brief catalogue. Artificial intelligence, Model : RL-TI07. kathmandu; 2020. Available at https://www.ramlaxmangroup.com
10. Contec Medical Systems Co. L. TP500 C infrared thermometer model [Internet]. p. 1–2. Available at: https://contecmedical.en.made-in-china.com/product-group/SqhxCEDJqUYp/Thermometer-catalog-1.html
11. Microlife. MT 600 [Internet]. 2020 [cited 2021 Jul 8]. p. 9443. Available at: https://www.microlife.com/consumer-products/thermometers/digital-thermometers/mt-600
12. Kocoglu H, Goksu S, Isik M, Akturk Z, Bayazit YA. Infrared tympanic thermometer can accurately measure the body

temperature in children in an emergency room setting. Int J Pediatr Otorhinolaryngol. 2002;65(1):39–43.[Article]

13. Van Staaij BK, Rovers MM, Schilder AG, Hoes AW. Accuracy and feasibility of daily infrared tympanic membrane temperature measurements in the identification of fever in children. Int J Pediatr Otorhinolaryngol. 2003;67(10):1091–7.[Article]

14. Chiappini E, Sollai S, Longhi R, Morandini L, Laghi A, Osio CE, et al. Performance of non-contact infrared thermometer for detecting febrile children in hospital and ambulatory settings. J Clin Nurs. 2011;20(9–10):1311–8. [Article]

15. Nimah MM, Bshesh K, Callahan JD, Jacobs BR. Infrared tympanic thermometry in comparison with other temperature measurement techniques in febrile children. Pediatr Crit Care Med. 2006;7(1):48–55.[Article]

16. Ring EFJ, Jung A, Zuber J, Rutkowski P, Kalicki B, Bajwa U. Detecting Fever in Polish Children by Infrared Thermography. 2008;(figure 1):35–8.[Article]

17. Chan LS, Lo JLF, Kumana CR, Cheung BM. Utility of infrared thermography for screening febrile subjects. Hong Kong Med J. 2013;19(2):109–15.[Download PDF]

18. Cho KS, Yoon J. Fever screening and detection of febrile arrivals at an international airport in Korea: association among self-reported fever, infrared thermal camera scanning, and tympanic temperature. Epidemiol Health. 2014;36.[PMC4101989]

19. Dunleavy KJ. Which core body temperature measurement method is most accurate? Nursing (Lond). 2010;40(12):18–9.[Article]