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Assessment of Temperature Variation Between Automated Digital Thermometers And Mercury Thermometerof Axillary Measurements in Apparently Healthy Adult Persons And Hospitalized Peoples.

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Abstract: *The various method used to measure body temperature has both advantages and disadvantages including the age old mercury–in-glass thermometers. Currently, there are variations in measurements with different methods as well as conflicting opinions about the optimal anatomic site for measuring body temperature. However, In this study, we aimed to assess the accuracy and reliability of thermometric measurements obtained from the axilla with two different automated digital thermometer and age-old mercury-in-glass thermometer. 115 participants were involved in this study,73(33m;40f) of age 24.53±5.67 were students from an higher institution while 42(20m;22f) of age 27.25±26.51 were hospitalized patients. Simultaneous axillarytemperature measurements (n: 115) were performed with the mercury-in-glass, Omron and wellbeing digital thermometers. The mean results of the axillary mercury–in-glass thermometers and axillary digital thermometer were 36.89 ± 0.27, 36.75 ± 0.4, 36.6±0.46 for the student group while the hospitalized group were 37.3±0.77,37.347±0.76 and 37.26±0.75 respectively.The Bland-Altman plot of differences suggests that 95% of the two Digital thermometer readings were within limits of agreement of +0.56 to –0.85°C and 0.44 to -1.01 for Omron and Well-being respectively among the student group .while the hospitalized group was 0.5 to -0.42 and 0.39 to -0.47 for the respective thermometers,when mercury-in-glass thermometer is considered as the standard. Our results showed that limits of agreement were wide between readings of axillary mercury–in-glass thermometers and digital thermometers but narrow for hospitalized groups with higher temperature readings. There was no statistic significant difference among the methods in febrile temperatures except lower temperatures.Result also revealed that digital thermometer under-reads lower temperatures. Furthermore, Higher Axillary readings of mercury thermometer were same with the digital thermometers supported by correlations at r=0.9520 and 0.9595. Therefore, digital thermometercan be used interchangeably with mercury thermometer in clinically febrile patients but neither in apparently healthy persons nor experimental research that are sensitive for lower body temperatures.*

Keywords: *body temperature, axilla, mercury-in-glass, Digital thermometer.*

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I. Introduction

Body temperature was accessed by hand until the discovery of first liquid thermometer1. Thermometer (from the Greekθερμός, thermos, meaning "hot" and μὲτρον, metron, "measure") is a device that measures temperature or temperature gradient using a variety of different principles2. A thermometer has two important elements: the temperature sensor (e.g. the bulb on a mercury thermometer) in which some physical change occurs with temperature, plus some means of converting this physical change into a numerical value (e.g. the scale on a mercury thermometer).Mercury thermometer was invented by physicist Daniel Gabriel Fahrenheit in Amsterdam (1714) and had been in used for more than 200years.In recent years, alternative methods1including chemical and infrared tympanic thermometers began to replace conventional mercury-in-glass instruments in emergency rooms and hospitals.Mercury thermometer has stood the test of time ; it's cheap, durable, accurate1,3and easily calibrated, but fragile, slow to heat response and mercury vapor is poisonous5. On the contrary digital thermometer are fast to read, costly, but regularly needs calibration and adequate power-source to ensure consistent readings. Studies1,5 have shown that there have been variations in temperature readings of different thermometer and in measurement from different site. Due to the variations observed in the hospital while the conventional mercury in glass thermometer was been replaced by digital thermometer,the study was

carried outto compare the accuracy and reliability of measurements obtained from the axilla using mercury-in glass thermometer and alternative digital thermometers.

II. Methodology

The study was an experimental design used to compare temperatures from three devices takenfrom the axilla and each session timed for a least minimum of 3 minutes, for each participant:

Instrumentations used included newly bought digital automated thermometers (Omron and Well-being) with-in built alarm system indicating time of removal for taking the body temperature value.The manufacturer did not provide training in their use for the study. A third instrument that used, was the simple mercury thermometer, which has a red cap (Kris-Aloy flat thermometer).The duration before removal was 3 minutes to allow for stabilization of readings.The reading from this instrument served as control.Consent was obtained from participants after pre-information to participate for the study and students willingly participated, then, those in the hospital had their axillary temperature taken a routine check of their body temperature.The Research ethics committee at the hospital gave permission. All data collected were anonymous. Consideration was given to the fact that participants may present with pyrexia for necessary advice. Room temperature was also taken to ascertain temperature over the area where the study was carried–out,using the room temperature thermometer. The values were recorded. No rainfall was recorded throughout the days of study.First group data were collected within 2 weeks,while the hospitalized group were collected within 3 months.We ensured that students selected were not sick.

Convenience samples of 115 were recruited as subjects. These comprised of73 students of a tertiary institution while 42 were hospitalized feverish patients. The students were healthy adults and fully consented to take part in the study,while the second group included children,adult male and females except pregnant women.Recruitment was carried-out at the higher education institution and then the other was carried- out at the hospital respectively. Data collection sheet was designed and used.Tabulations, summary and statistical analysis was carried out.Statistic analysis was carried out to ascertain the difference between automated thermometers and mercury manual base thermometer and make necessary recommendations.

III. Results

115 participants were involved in this study, 73(33m;40f) of age 24.53±5.67 were students from an higher institution while 42(20m;22f) of age 27.25±26.51 were hospitalized patients. Simultaneous axillary temperature measurements (n: 115) were performed with the mercury-in-glass, Omron and wellbeing digital thermometers. The mean results of the axillary mercury–in-glass thermometers and axillary digital thermometer were 36.89 ± 0.27, 36.75 ± 0.4, 36.6±0.46 for the student group while the hospitalized group were 37.3±0.77, 37.347±0.76 and 37.26±0.75 respectively.

The Bland-Altman plot of differences suggests that 95% of the two Digital thermometer readings were within a wide limits of agreement of +0.56 to –0.85°C and 0.44 to -1.01 for Omron and Well-being respectively among the student group . While the hospitalized group was within a narrow limit of 0.5 to -0.42 and 0.39 to -0.47 for Omron and wellbeing thermometer respectively, when mercury-in-glass thermometer is considered as the standard.

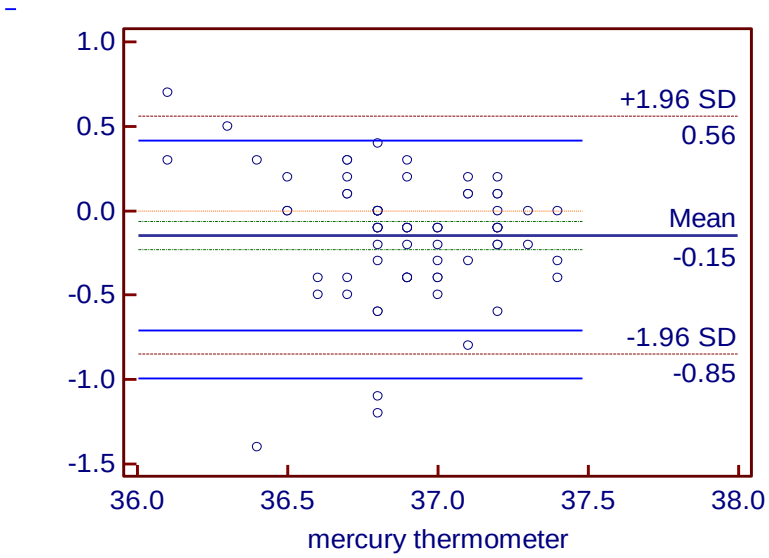

Figure 1. Bland –Altman plot of Omron thermometer readings with difference of mercury thermometer readings as reference among student group.

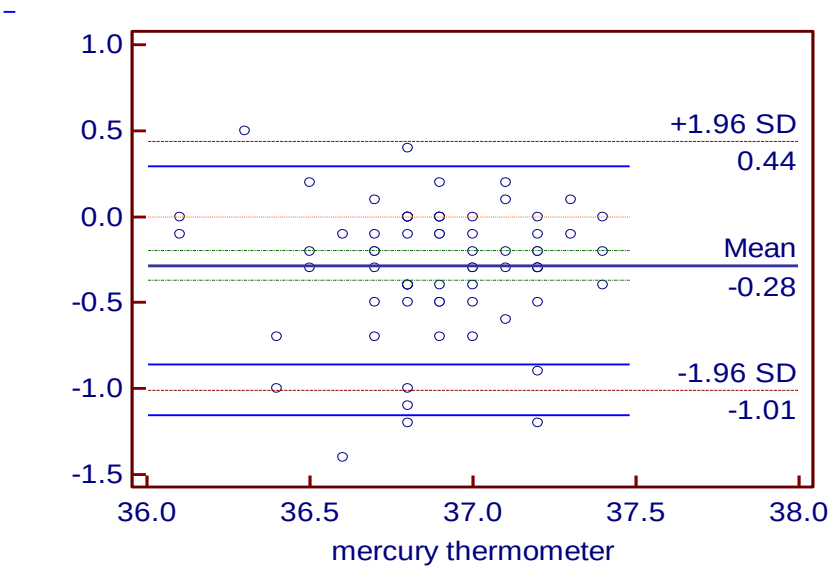

Figure 2. Bland–Altman plot of wellbeing thermometer readings with difference of mercury thermometer readings as reference among student group

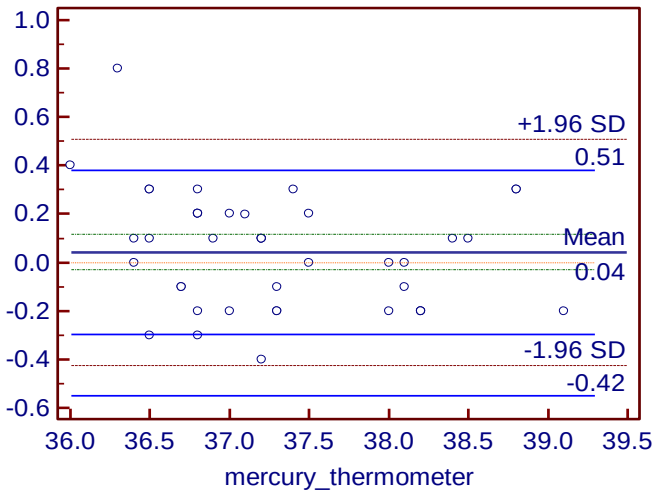

Figure 3. Bland–Altman plot of Omron thermometer readings with difference of mercury thermometer readings as reference among hospitalized group.

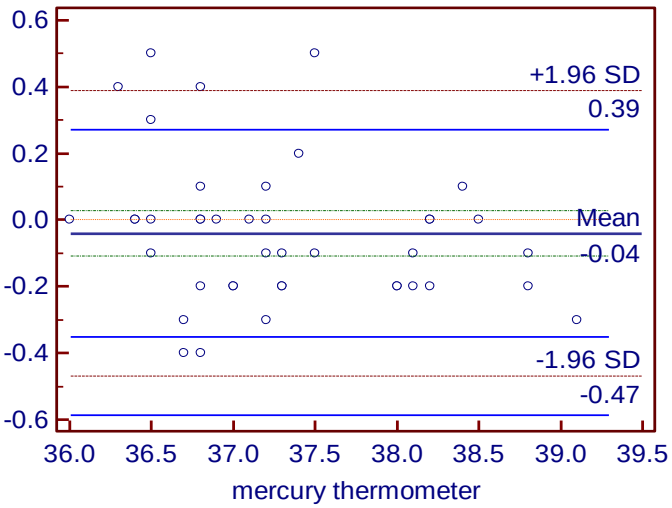

Figure 4. Bland–Altman plot of Wellbeing thermometer readings with difference of mercury thermometer readings as reference among hospitalized group.

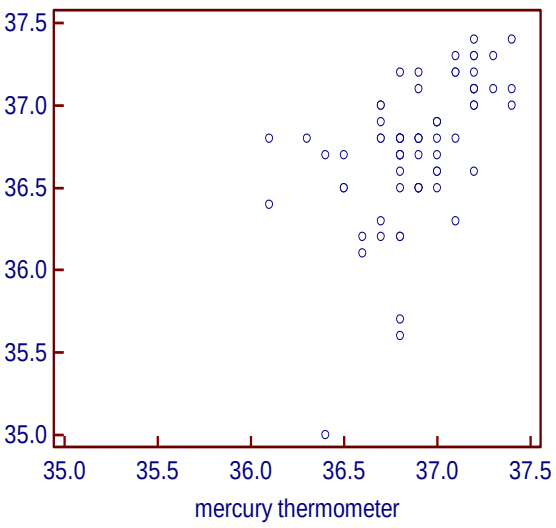

Figure 5.

Pearson correlation plot of Omron thermometer readings with mercury thermometer readings among student group.

Sample size	73
Correlation coefficient r	0.5279
Significance level	P<0.0001
95% Confidence interval for r	0.3390 to 0.6759

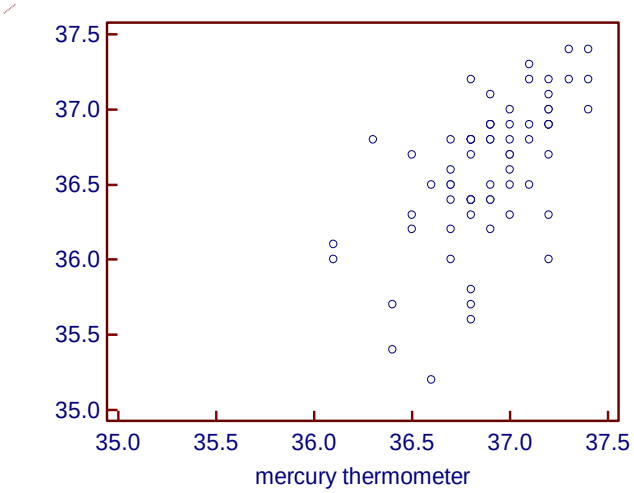

Figure 6. Pearson correlation plot of Wellbeing thermometer readings with mercury thermometer readings among student group.

Sample size	73
Correlation coefficient r	0.5991
Significance level	P<0.0001
95% Confidence interval for r	0.4280 to 0.7287

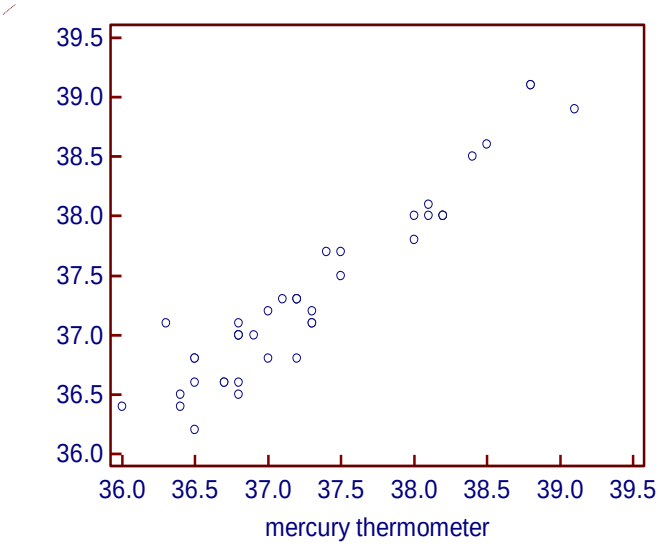

Figure 7. Pearson correlation plot of Omron thermometer readings with mercury thermometer readings among hospitalized group.

Sample size	42
Correlation coefficient r	0.9520
Significance level	P<0.0001
95% Confidence interval for r	0.9120 to 0.9741

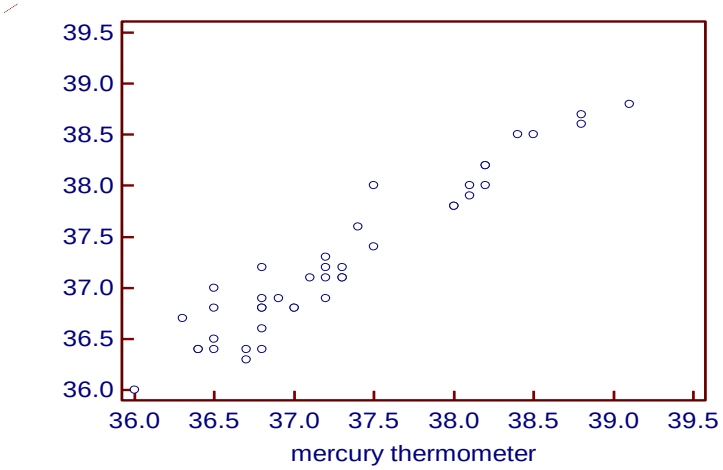

Figure 8. Pearson correlation plot of Wellbeing thermometer readings with mercury thermometer readings among hospitalized group.

Sample size	42
Correlation coefficient r	0.9595
Significance level	P<0.0001
95% Confidence interval for r	0.9254 to 0.9782

Figure 9: summary of correlation pattern of 115 participant's temperature readings with each type of thermometer.

Result also revealed that digital thermometer under-reads lower temperatures.

Population / Variable	Apparently healthy group student (73)		
	mercury	Omron	Wellbeing
mean	36.8918	36.7466	36.6068
t-value	-	-2.468	-4.520
p-value		0.0148	< 0.0001
population	Hospitalised group (warmth to touch) 42		
mean	37.3048	37.3476	37.2643
t-value		0.257	-0.243
p-value		0.7982	0.8085

Figure 10: Mean and t-test analysis between mercury thermometric reading and digital thermometric readings

There was no statistic significant difference for thermometric reading among the hospitalized group except for lower temperatures mostly recorded among the student group.

IV. Discussion

The method for measurement of fever should be accurate and reproducible since it has a great influence in decision making by parents or doctors1.They provide quick results over the body temperature range. Accurate Temperature readings are required for quick clinical intervention6,7. Digital Thermometers are slowly replacing the conventional mercury thermometer due to the ease of taking readings but are faulted with inconsistency as seen in this study and in other reports8, therefore are not as accurate as manufacturers may present them.The results indicated thatdigital thermometer on average under-recorded temperature significantly at ($p<0.05$) compared to a mercury-in-glass reading .This was observed among apparently healthy individuals in this study fig1,2,5,6,9,10.An average negative difference of 0.14 and 0.28oC was observed for Omron and well being thermometers compared to mercury-in glass thermometer where 60 and 68 percent or readings where below mercury-in-glass readings respectively. Similar resultswas reported for under-recordings in two digital thermometers at 68% for oral and 79%for axilla in similar studied group8. Furthermore, at higher temperatures, there was strong correlation of thermometric readings of digital thermometer to mercury thermometric readingfig 7,8,9.Data suggest there may be close sensitivity of material used in the digital thermometers to mercury at higher temperatures therefore, mercury-in glass and digital thermometer may be used

interchangeably only in limited circumstance. Despite fear of mercury poisoning4,mercury thermometer has stood ages of trials in measurement of temperature and should not be completely relegated to the background or abandoned in the light of new technology which are yet to withstand the test of time.

V. Conclusion

Digital thermometer can be used interchangeably with mercury thermometer in clinically febrile patients but neither in apparently healthy persons nor for experimental research that are sensitive for lower body temperatures. Therefore mercury in glass thermometer still remains the most consistent,accurate instrument for reading body temperature.

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