# Comparative Evaluation of Non-Mercury Thermometers in a Hospital Setting in Lebanon.

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## Abstract

Global initiatives are taking place to phase out mercury use. In Lebanon, some hospitals have replaced mercury thermometers but the majority has not. The aim of this study was to evaluate different non-mercury thermometers available in the Lebanese market based on the attributes of cost effectiveness and clinical performance. A market survey and a costing exercise were undertaken to determine the two most cost-effective types and brands of thermometers in the Lebanese market. Then the readings of the two most cost-effective brands of thermometers were evaluated to determine the possibility of using them interchangeably. Compact electronic and electronic thermometers were the most cost-effective types of thermometers, with the electronic thermometer being more cost effective on the long run. The readings of the two thermometers had a statistically and clinically significant. difference. Poor agreement of readings between the two thermometers leaves cost effectiveness to be the sole determinant of the best alternative, namely, the electronic thermometer.

## Introduction

Mercury is one of the world's most ubiquitous heavy metal neurotoxic substances used in healthcare facilities. The United Nations Environment Programme (UNEP) and the World Health Organization have identified the adverse effects of mercury pollution as a serious global environmental and human health problem. The World Health Organization is leading a global initiative to achieve virtual phasing out of mercury-based thermometers and sphygmomanometers over the next decade and their substitution with accurate, economically viable alternatives.

## Purpose

In Lebanon, some hospitals have replaced mercury thermometers but the majority has not. One obstacle is the lack of an evidence-based methodology to determine the best non-mercury alternative thermometer. The aim of this study was to evaluate different non-mercury thermometers available in the Lebanese market based on the attributes of cost effectiveness and clinical performance, in order to inform the process of mercury phase-out planning for the healthcare sector in Lebanon and internationally.

## Methods

Two approaches were utilized in this descriptive study:

1) A market survey and a costing exercise were undertaken to determine the two most cost-effective types and brands of thermometers in the Lebanese market. The aim of the market survey was to identify suppliers, types, specifications and costs. Ten vendors were identified and contacted .

2) Statistical and clinical comparison of the readings of the two most cost-effective brands of thermometers to determine the possibility of using them interchangeably. The clinical study was conducted in a tertiary rural medical center, to determine correlation between the readings of the two alternative thermometers. A convenience sample of 150 patients were recruited by the assigned staff from five clinical units, namely, medical/surgical unit, obstetrics and gynecology, adult intensive care, pediatrics, and neonatal intensive care.

## Procedures

1) Data for the costing exercise were obtained from vendor's quotations, hospital data, user manual, personal assumptions. The costing model was adopted from that by Crawford et al. (2006) and included thermometer costs, disposable supply costs, personnel costs, and equipment service costs. Costs were categorized as investment costs and running costs. Investment costs included cost of thermometers and accessories while running costs included cost of probe covers, batteries, alcohol wipes, maintenance, calibration, personnel, and mercury spill handling.

2) For the clinical evaluation, each patient had two temperature measurements using each thermometer. Oral, rectal and axillary measurements were taken depending on the units' applied procedures. All electronic thermometers were calibrated and met the maximum permissible error (0.1 – 0.3 ° C) specified in international standards (ASTM & BS EN). No calibration was done for the compact electronic thermometers since they already satisfy ASTM and BS EN standards as per the manufacturer. Temperature readings were analyzed using two approaches, paired-samples t-test and Bland-Altman analysis. Bland and Altman is a statistical technique to study the agreement between two clinical measurement technologies when the true value of what is being measured is unknown. If the level of agreement between the two technologies is sufficient, in other words the difference between the readings is not clinically significant (< ±0.5° C), the two technologies could be used interchangeably.


## Results

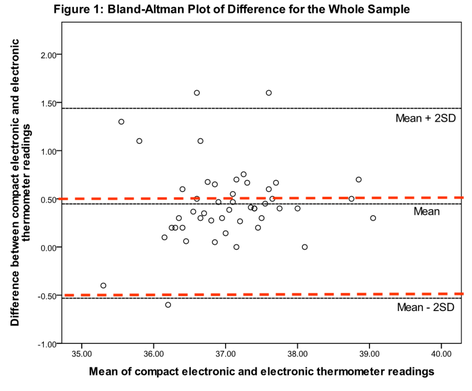
**Comparative cost of different types of thermometers in USD**

| Type of thermometers | Electronic | Compact electronic | Infrared tympanic | Infrared temporal | Mercury |
|---|---|---|---|---|---|
| Total investment cost | 10,029 | 2,719 | 3,292 | 6,580 | 23,092 |
| Total annual running cost | 8,807 | 15,603 | 30,543 | 33,556 | 31,213 |
| Total cost at year one | 18,836 | 18,322 | 33,835 | 40,136 | 54,305 |
| Total cost at year ten | 98,099 | 158,749 | 308,722 | 342,140 | 543,050 |

**Comparison of the measurements of the two thermometers for the total sample and per measurement site.**

| | Total sample | Oral | Axillary | Rectal |
|---|---|---|---|---|
| Sample Size (readings) | 150 | 60 | 60 | 30 |
| Mean difference of readings (SD*) | 0.45 (0.49) | 0.2 (0.35) | 0.775 (0.47) | 0.31 (0.41) |
| Range of difference of readings | -0.7 to +2.2 | -0.7 to +1.4 | 0 to +2.2 | -0.4 to +1.3 |
| 95% confidence interval | 0.37-0.53 | 0.11-0.29 | 0.65-0.89 | 0.15-0.46 |
| t-test | 11.27 | 4.46 | 12.64 | 4.11 |
| P value | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| Correlation coefficient (Pearson R) | 0.64 | 0.7 | 0.65 | 0.81 |

Figure 1: Bland-Altman Plot of Difference for the Whole Sample




## Discussion

Poor agreement of readings between the two thermometers leaves cost effectiveness to be the sole determinant of the best alternative, namely, the electronic thermometer. Replacing mercury thermometers will remove a notorious reservoir of mercury from the healthcare system.

Limitations:
- The study was done in a rural governmental hospital that may differ from other Lebanese healthcare institutions in various ways.
- the clinical evaluation of the thermometers regarding accuracy lacked a standard reference thermometer which might impact the validity of the comparison.

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