



@rimaruf

Performance evaluation of the commonly-used portable cholesterol sensors for telehealth services in the unreached communities

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Usages of Portable Medical Sensors

Individual Home Use



Developed World

Public Community Use

- Rural Community Clinic
- Diagnosis Center
- **Telehealth Service**



Under-Developed & Developing World



TeleHealth: Portable Health Clinic (PHC)

Health Worker Collects
Vital Information



Online Server
System



Remote Doctor's
Tele-Consultation



PHC Apps (Doctor)

- Access to patient data
- Video call to patient
- Create prescription





List of Devices & Sensors in the PHC Box



1) Body Temperature

2) Blood Pressure

3) Pulse Rate

4) Arrhythmia

5) Height, Weight and BMI

6) Waist, Hip and W/H Ratio

7) Oxygenation of Blood

8) Urinary Sugar

9) Urinary Protein

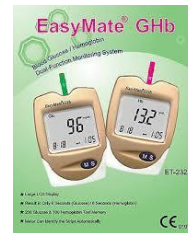
10) Blood Glucose

11) Cholesterol

12) Hemoglobin

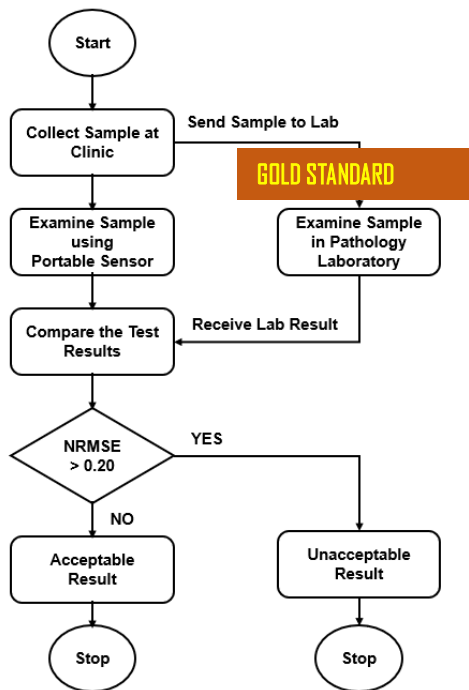
13) Uric Acid

Available Products





Evaluation Platform



The clinical pathology laboratory uses the following test methods as **Gold Standards**:

■ Blood Glucose

Hexokinase UV Method

■ Cholesterol

Enzymatic Determination Method

■ Hemoglobin

Automatic Analyzer (EDTA-2K)

■ Uric Acid

Uricase POD Method



Test Methodology

- **Gold Standard:** The test result of a Japanese Laboratory has been considered as "Gold Standard"
- **Samples:** Sample was collected from the regular patients of a Japanese Internal Medicine clinic
- **Subjects:** 20 years and above
- **Sample Size:** 50-100 subjects



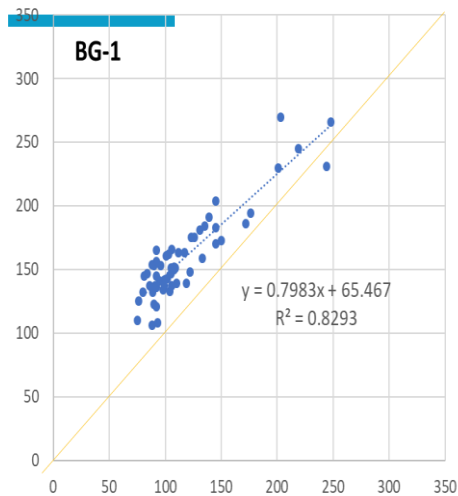
Strip-based Blood Glucose Sensors (Asia+US)

- ❖ Varieties of Blood Glucose sensors are available in almost all Asian countries at an affordable price.
 - *Device price varies between 20.00-35.00 USD and each test-strip costs about 0.25 USD.*
- ❖ A good number of Blood Glucose sensors are available in the Japanese market mostly from Japanese manufacturers.
 - *The device price varies between 150.00-200.00 USD and each test (strip) costs about 1.00 USD.*

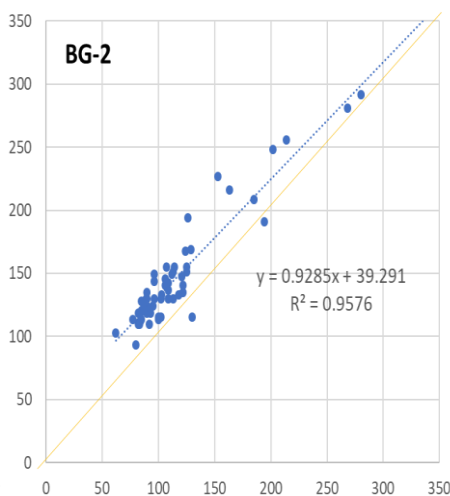


Strip-based Blood Glucose Sensors (Asian Market 1)

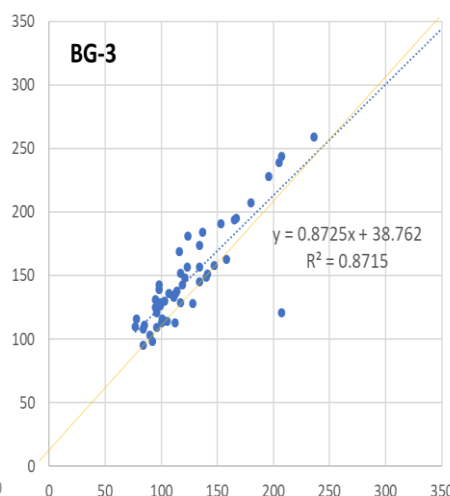
y-Axis: Portable Sensor Test Result



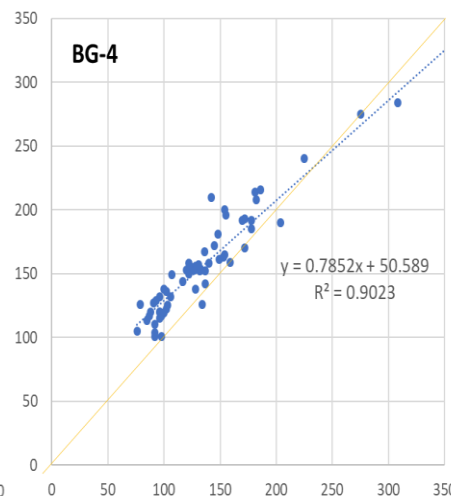
Sample Size	RMSE	NRMSE	Error Count	Error Rate
57	44.11	0.28	0	0%



Sample Size	RMSE	NRMSE	Error Count	Error Rate
60	34.26	0.22	1	2%



Sample Size	RMSE	NRMSE	Error Count	Error Rate
55	30.95	0.20	2	4%



Sample Size	RMSE	NRMSE	Error Count	Error Rate
63	25.22	0.16	0	0%

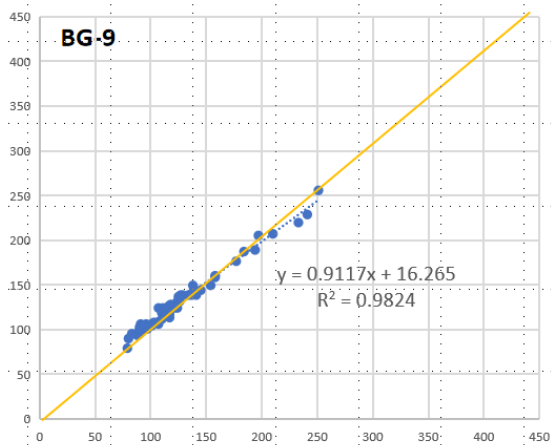
x-Axis: Lab Test Result (Gold)

RMSE: Root Mean Square Error // NRMSE: Normalized RMSE

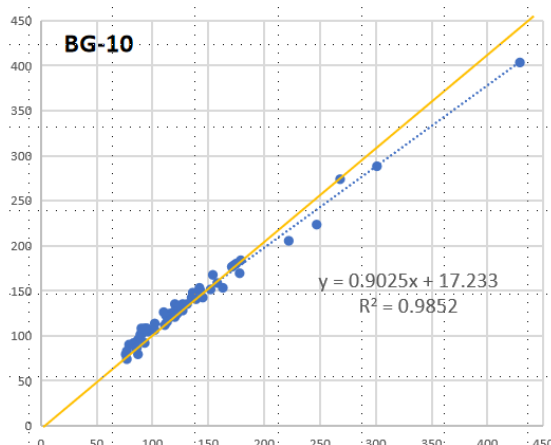


Strip-based Blood Glucose Sensors (Asian Market 2)

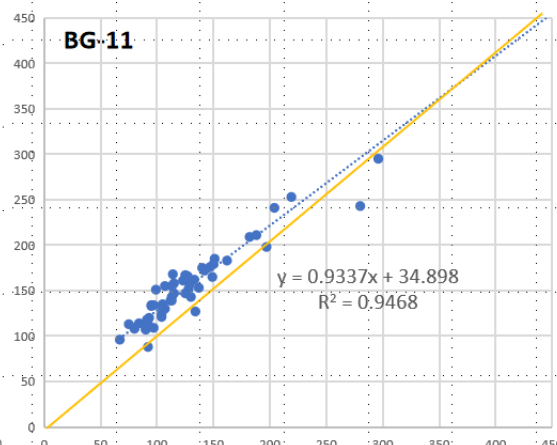
y-Axis: Portable Sensor Test Result



Sample Size	RMSE	NRMSE	Error Count	Error Rate
58	7.80	0.06	0	0%



Sample Size	RMSE	NRMSE	Error Count	Error Rate
60	9.85	0.07	1	2%



Sample Size	RMSE	NRMSE	Error Count	Error Rate
55	84.13	0.53	0	0%

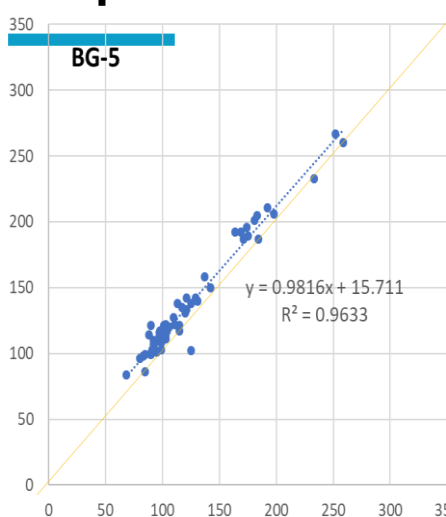
x-Axis: Lab Test Result (Gold)

RMSE: Root Mean Square Error // NRMSE: Normalized RMSE

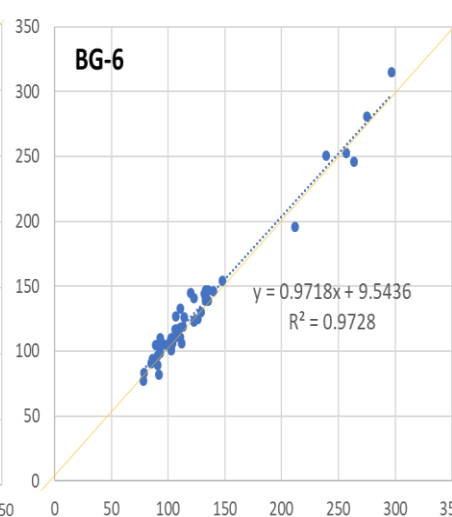


Strip-based Blood Glucose Sensors (Japan)

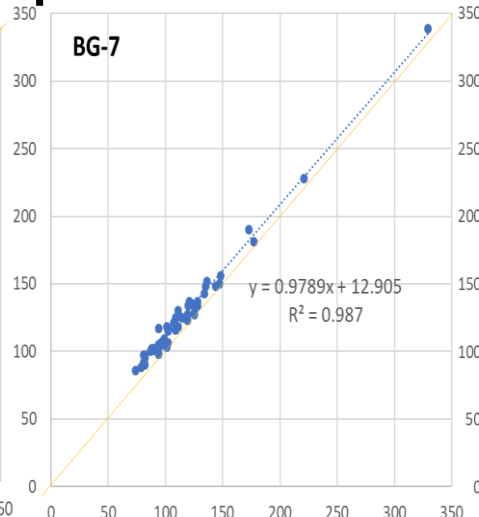
y-Axis: Portable Sensor Test Result



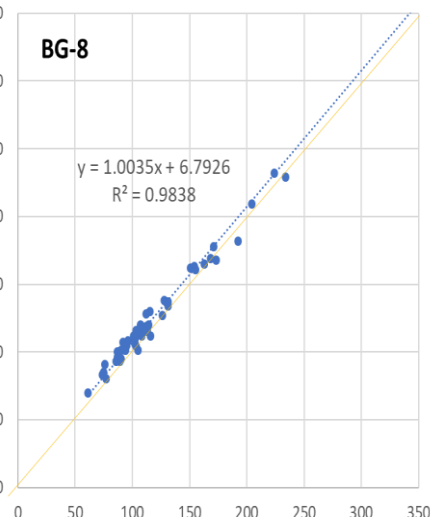
Sample Size	RMSE	NRMSE	Error Count	Error Rate
55	15.84	0.11	0	0%



Sample Size	RMSE	NRMSE	Error Count	Error Rate
53	9.93	0.07	2	4%



Sample Size	RMSE	NRMSE	Error Count	Error Rate
52	11.44	0.09	0	0%



Sample Size	RMSE	NRMSE	Error Count	Error Rate
54	21.72	0.17	1	2%

x-Axis: Lab Test Result (Gold)

RMSE: Root Mean Square Error // NRMSE: Normalized RMSE



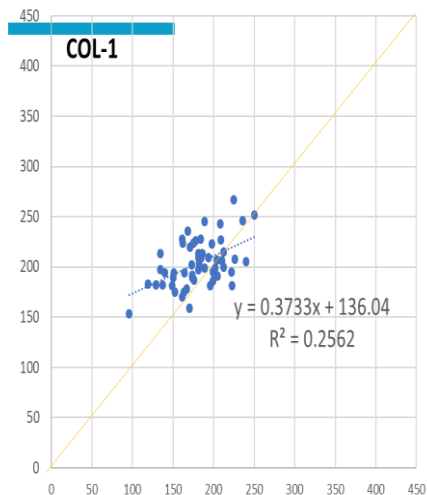
Strip-based Cholesterol Sensors (Asia+US)

- ❖ Very few (Total) Cholesterol sensors are available in the Asian markets at an affordable price.
 - *Device price varies between 35.00-40.00 USD and each test-strip costs about 0.80 USD.*
- ❖ No portable Cholesterol sensors are available in the Japanese market.
- ❖ Two commonly used portable Cholesterol sensor was collected from the USA market.
 - *The device price varies between 120-125 USD and each test (strip) costs about 2.50-3.10 USD.*

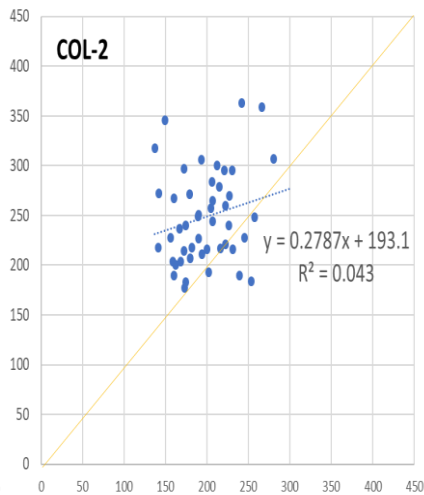


Strip-based Cholesterol Sensors (Asian Market)

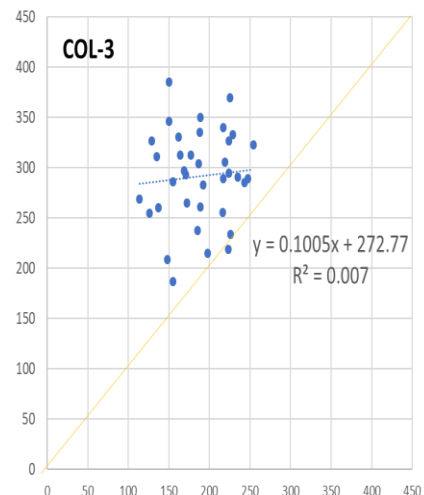
y-Axis: Portable Sensor Test Result



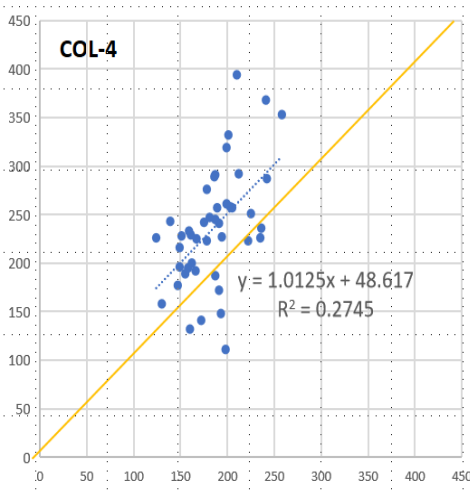
Sample Size	RMSE	NRMSE	Error Count	Error Rate
61	35.86	0.18	6	10%



Sample Size	RMSE	NRMSE	Error Count	Error Rate
57	72.40	0.29	10	18%



Sample Size	RMSE	NRMSE	Error Count	Error Rate
51	123.58	0.42	14	27%



Sample Size	RMSE	NRMSE	Error Count	Error Rate
58	71.20	0.30	15	26%

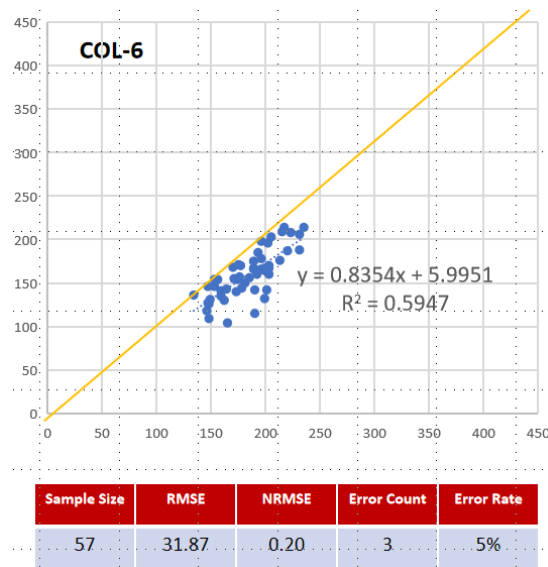
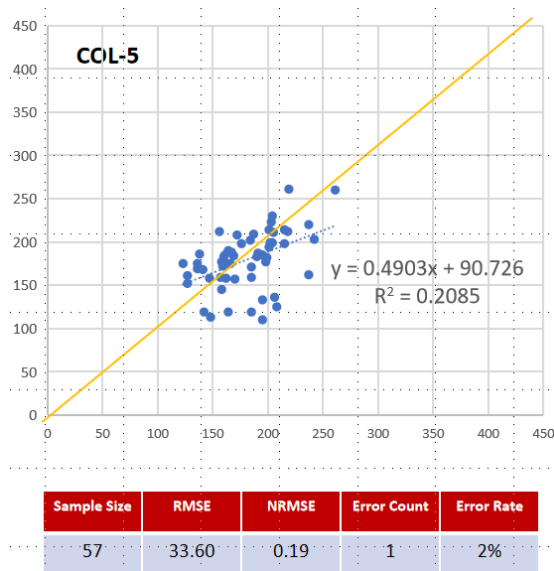
x-Axis: Lab Test Result (Gold)

RMSE: Root Mean Square Error // NRMSE: Normalized RMSE



y-Axis: Portable Sensor Test Result

Strip-based (Total) Cholesterol Sensors (USA)



x-Axis: Lab Test Result (Gold)

RMSE: Root Mean Square Error // NRMSE: Normalized RMSE



Comments

- ◆ Every country has its medical device approval authority, but there are **many erroneous devices available in the markets** of the developing world.
- ◆ A few **better quality portable sensors** are available in **Japanese** and **USA** markets but they are **very expensive**. Also, these are **not available** in the local markets **of developing countries**.
- ◆ There is a huge **shortage** of quality portable **medical sensors**. It **requires manufacturers more attention** to exploring it.
- ◆ A **medical sensors evaluation platform** like this **is very much needed** for confirming the performance of the sensors to reduce the risk to the patients.



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Thank you very much.

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