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Research paper

Comparison on Difference in Conventional Electronic Device and IoT (Internet of Things) Enabled Sensors Readings of Vital Signs in Patients

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Abstract

The comparative study was carried out on difference in reading of conventional bedside monitor and IoT (Internet of Things) enabled sensors recordings of vital signs like temperature, heart rate and spo2 in patients of PKC hospital, Vashi. The study was conducted on selected 10 patients. For each subject conventional device and IoT sensors readings of temperature, heart rate and spo2 were recorded for 5 minutes for 3 days. Readings from conventional devices and IoT sensors were recorded simultaneously. Data included readings of temperature, Spo2 and heart rate. Total samples collected are minimum 324 and maximum 330.Clinically approved results are present in the paper. The recordings were compared to know difference between conventional device readings and IoT enabled sensors reading. The study findings discovered that there is no momentous difference between the conventional device readings and IoT based sensors readings.

Keywords: *vital signs, conventional readings, IoT enable sensors*

1. Introduction

Vital parameters of any human body are the signals of survival. All these vital parameters can be continuously measured and monitored by different sensors [1]. Functioning accuracy of any human body can be accessed by using these vital parameters [1]. Range of vital parameters changes with two factors age and health condition of a person [1]. Patient's observations are important they allow progress of patient to be monitored and prompt detection of change in patient's treatment for better recovery.

Vital signs are the evidence of the current physical functioning of the body. Vital parameters are immediate and resourceful way of tracking a patient's health status and will help in assessment of patient's response to a treatment. Vitals parameters need to be measured frequently. There is only partial information available regarding the frequency with which vital parameters should be recorded this is based on survey of nurses, clinical practice reports and expert opinion [2]. Monitoring these parameters is an important task in the satisfactory care of seriously ill patients. Heart patients require monitoring of heart rate and spo2 continuously. Generally these parameters are recorded by nurses, physician, and physician's assistant. Healthcare expert's has responsibility of interpreting these readings, identifying abnormalities from person's normal state and judging effect of current treatment on patient's body[1].

Continues monitoring of patient is a very important task in care of critically ill patients. ICUs, CCUs, operation room and anaesthesia ward needs the continuous observation of the patient [3].The conventional, manual method requires a considerable amount of time. Current investigation shows that the monitoring and recording of the five vital signs manually is most of the times partial which has the potential to worsening health condition of a patent [4]. Whereas continuous electronic monitoring is beneficial and it alarms patients health is deteriorating [6]. For measuring these parameters more accurately hospitals are using bedside monitors from different vendors like OLAMPUS, GoodHealth etc. All sensing devices are bundled in bedside monitor is attached to the patient's body. It displays the body's vital parameters in the form of continuous waveforms or numbers. Some of the common functions to be monitored are blood pressure, heart rate and ECG, breathing rate, body temperature and Spo2 [5]. Few of them have wired and wireless central monitoring system with local storage of data [6]. With these entire advancement milestone achieved is local storage of all vital parameters.

Bedside monitors are monitoring vital parameters all the time. These parameters never directly send to doctors or nurses or caretaker of patient on their hand hold devices (like mobile). No analysis is performed on this data to alert patient's health status. Data reading and it's reporting to the doctor is still a manual process in most of the hospitals. Nurses, Assistant doctors are observing those parameters and reporting them to doctors. In the era of IoT and mobile sending real time vital parameters of critically ill patient to doctor will help to give better treatment to the patient [7]. IoT enable health care system reduces chance of human errors, delay in communication and helps doctor to give more time in decision making with correct interpretation [8]. We decided to study this and to come up with a solution so that patient

and doctors can be connected in minimum cost for better care of a patient.
We had discussions with doctors to know their perspective about using IoT enabled devices in healthcare. Result of the same has been published in a paper [9]. One important point came out from discussion is doctors are concerned about accuracy of data collected from IoT based sensors. We developed an IOT enabled circuit for proof of concept which has sensor attached for Temperature, Heart rate and Spo2. All these sensors were connected to

arduino controller and *ESP8266* - low-cost Wi-Fi microchip with full TCP/IP stack for sending reading to cloud. Device had a simple function for security. The module has been developed for data collection; no analysis has been done on data. The main purpose is to collect data and check its accuracy. Patient's readings were taken from actual device at the same time from IoT circuit which was developed by us.
Statistical tool used for calculations is Minitab. MiniTab is a statistical tool which helps to analyze the data. This is generally used by Six Sigma professionals. It provides a simple way to input the statistical data, identify trends and patterns, and then come up with proper conclusion. This is most widely used software in industry. Six Sigma projects require a quick, effective solution for the detailed analysis which is provided by MiniTab [10]. In this paper Paired- t test has been applied in Minitab for all data sets.

The Paired samples t test compares two means that are from the same source. The purpose of the test is to check mean difference in the pair is different from zero. The variable used in this test is known as dependent variable, measured at two different times or for two related conditions or units [11].

2. Comparison of Readings from Iot Enabled Sensors and Conventional Electronic Device

Reading from actual device is compared with reading from IoT enabled sensor circuit. 10 subjects were enrolled for the study for three days their heart rate, temperature and spo2 were measured for 5 minutes three times a day. We had patients were in the age group of 30-70 years, out of these 90% was males and 10% were females. Total 330 readings were recorded with conventional device and IoT enabled temperature sensor. Total 324 readings were recorded with conventional device and IoT enabled heart rate sensor. Total 324 readings were recorded with conventional device and IoT enabled spo2 sensor.

2.1 Temperature Sensors Accuracy

Generally body temperature of a person varies depending on gender, activity, food and liquid

consumption, time of day, and, in female, the period of the menstrual cycle. Body temperature of a human begin ranges from 97.8° F (36.5°C) to 99°F (37.2°C) for a fit grown-up[13][14][15]. Total 330 readings were recorded for temperature. Paired T test applied on temperature reading from conventional device and IoT based device. It is a statistical method used to conclude whether the mean difference between two sets of observations is zero. It also has two hypothesis null and alternate hypotheses. Following hypothesis has been designed for our study.

Ho: There is no significant difference between the temperature measured by conventional method and IoT sensors

H1: There is significant difference between the temperature measured by conventional method and IoT sensors

Since p value is greater than significance level (0.05) the decision is to fail to reject the null hypothesis. As p value is greater than 0.05 then accept null hypothesis i.e there is no significant difference between reading from conventional device and IoT device. Table 1 gives more details about paired T test on temperature data from conventional device and IoT enabled sensors. We can conclude that the difference between the population mean is not statistically significant.

Table 1 paired T test on temperature data from conventional device and IoT enabled sensors

Paired T-Test and CI: IOT-Temp, Con-Temp

Paired T for IOT-Temp - Con-Temp

	N	Mean	StDev	SE Mean
IOT-Temp	330	36.2000	0.9936	0.0547
Con-Temp	330	36.1333	0.8926	0.0491
Difference	330	0.066667	0.685351	0.037727

95% CI for mean difference: (-0.007551, 0.140884)
T-Test of mean difference = 0 (vs not = 0): T-Value = 1.77 P-Value = 0.078

2.2 Heart Rate Sensors Accuracy

The pulse rate is a measurement of the heart rate, or the number of times the heart beats per minute. As the heart pushes blood through the arteries, the arteries expand and contract with the

flow of the blood [13][14]. Total 324 readings were recorded for heart rate. Paired T test applied on heart rate reading from conventional device and IoT based device. It also has two hypothesis null and alternate hypotheses. Following hypothesis has been designed for our study.

Ho: There is no significant difference between the heart rate measured by conventional method and IoT sensors

H1: There is significant difference between the heart rate measured by conventional method and IoT sensors

Table 2 paired T test on heart rate data from conventional device and IoT enabled sensor

Paired T-Test and CI: I-HR, c-Hr

Paired T for I-HR - c-Hr

	N	Mean	StDev	SE Mean
I-HR	324	80.0710	6.0096	0.3339
c-Hr	324	79.8364	5.3260	0.2959
Difference	324	0.234568	2.211826	0.122879

95% CI for mean difference: (-0.007177, 0.476313)
T-Test of mean difference = 0 (vs not = 0): T-Value = 1.91 P-Value = 0.057

Table 2 gives details about paired T test on heart rate data from conventional device and IoT enabled sensor.
Since p value is greater than significance level (0.05) the decision is to fail to reject the null hypothesis means there is no significant difference between the heart rate measured by conventional method and IoT sensors.

2.3 Spo2 Sensors Accuracy

SpO2 stands for oxygen saturation, an approximation of the quantity of oxygen in the blood. Eventually, it is the percentage of haemoglobin containing oxygen compared to the total amount of oxygenated and non-oxygenated haemoglobin in the blood [13][14]. Total 324 readings were recorded for spo2.

Table 3 paired T test on spo2 data from conventional device and IoT enabled circuit

Paired T-Test and CI: IoT - spo2, Con-Spo2

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Paired T for IoT - spo2 - Con-Spo2

              N      Mean     StDev   SE Mean
IoT - spo2  324   97.0000    3.1010    0.1723
Con-Spo2    324   97.0123    2.9995    0.1666
Difference  324  -0.012346  0.914199  0.050789


95% CI for mean difference: (-0.112264, 0.087573)
T-Test of mean difference = 0 (vs not = 0): T-Value = -0.24  P-Value = 0.808
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Paired T test applied on spo2 reading from conventional device and IoT based device. It also has two hypothesis null and alternate hypotheses. Following hypothesis has been designed for our study.

Ho: There is no significant difference between the spo2 measured by conventional method and IoT sensors

H1: There is significant difference between the spo2 measured by conventional method and IoT sensors

Table 3 is detail information on paired T test on spo2 data from conventional device and IoT enabled circuit. Since p value is greater than significance level (0.05) the decision is to fail to reject the null hypothesis that means there is no significant difference between the spo2 measured by conventional method and IoT sensors.

3. Results and Discussion

Table 4 shows summarized report of Paired T test applied on the readings of all three sensors. Null hypothesis of the work was there is no major variation between the reading from conventional devices and IoT enabled devices at level of 0.05 significance. This has been accepted as the study findings revealed that statistically there was no major difference between the conventional and IoT readings of temperature, heart rate and Spo2.
Present study revealed that the temperature by conventional method showed mean difference of -0.008 +0.140 from the IoT reading which is neither statistically significant nor clinically significant[12]. So result showed that IOT sensor readings are as accurate as conventional devices. The mean difference of heart rate is – 0.007+0.476. So even the mean difference is not statistically significant we can say that the conventional method and IoT method are evenly correct. Spo2 rate did not show any major difference between reading from conventional devices and IoT devices.

Fig 1 shows graphical representation of Spo2 data in form of box plot, horizontal line connects mean of both methods. Same way Fig 2 and Fig 3 shows box plot for heart rate and temperature respectively.

Mean of conventional device reading for temperature is 36.13 and IoT device reading is 36.2 which has difference of 0.07 which clearly shows that readings from both devices are closer. Similarly for heart rate mean for samples collected from conventional devices is 79.84 and an IoT device is 80.07 with difference of 0.23. Spo2 data from conventional devices and IoT devices has mean 97.01 and 97 respectively very least significant difference of 0.01. In clinical study findings are readings varies from machine to machine.
Result of coefficient of variation for two methods of different parameters like temperature, heart rate and spo2 signified that variation in both methods was similar.

Table 5 gives detail calculations. Both the methods were found to be consistent.

4. Conclusion

This research exposed readings of Temperature, Heart rate and SPo2 from conventional devices and IoT enabled sensors, do not have statistically noteworthy difference. This research had a null hypothesis that there is no significant difference between the vital signs measurement by conventional devices and IoT enabled method at significance level of 0.05. The null hypothesis of the study has been accepted. Conventional bedside monitor and IoT devices are found to be consistent as variations in both methods were found similar. Results of Coefficient of variation for two methods, conventional devices and IoT measurements of different parameters like temperature, pulse, and SPo2 signified that variation in both methods was similar.

Table 4: Mean difference of parameters between conventional and IoT sensors measurement

		Conventional Device	**IOT Device**	**Conventional Device**	**IOT Device**	**Conventional Device**	**IOT Device**	**CI mean difference**	**P Value**
	N	Mean	Mean	SD	SD	SE Mean	SE Mean		
Temperature	330	36.1333	36.2	0.8926	0.9936	0.0491	0.0547	- 0.008 , 0.140	0.078
Heart Rate	324	79.8364	80.071	5.326	6.0096	0.2959	0.3339	- 0.007, 0.476	0.057
SPO2	324	97.0123	97	2.9995	3.101	0.1666	0.1723	- 0.112, 0.088	0.808

Table 5: coefficient of variation for two methods

		Conventional Device	**IOT Device**	**Conventional Device**	**IOT Device**	**CV- Convention**	**CV-IOT**
	N	**Mean**		**SD**		**Coefficient of variance**	
Temperature	330	36.1333	36.2	0.8926	0.9936	2.470297482	2.744751
Heart Rate	324	79.8364	80.071	5.326	6.0096	6.671142486	7.505339
SPO2	324	97.0123	97	2.9995	3.101	3.091875979	3.196907

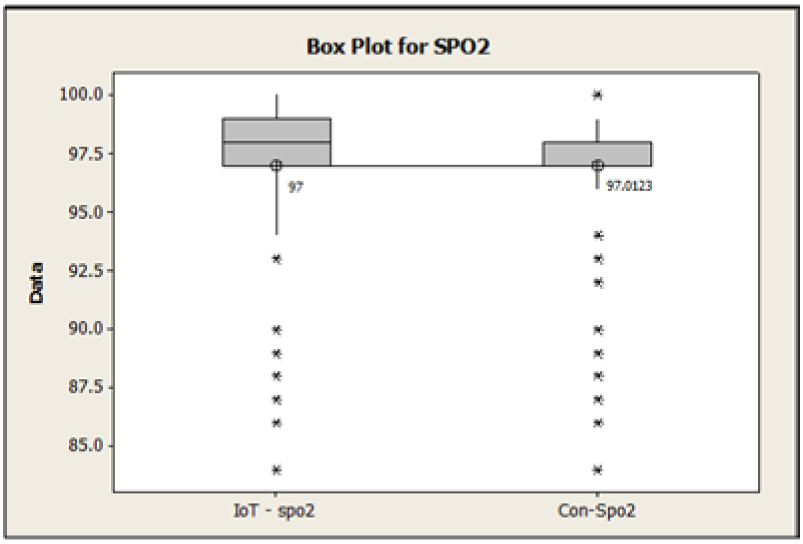

Fig 1. Box Plot for SPo2

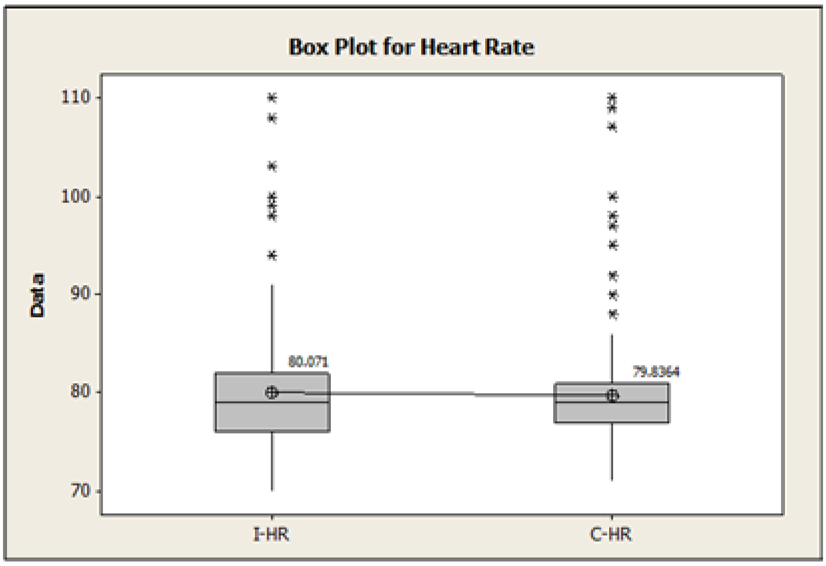

Fig 2. Box plot for Heart Rate

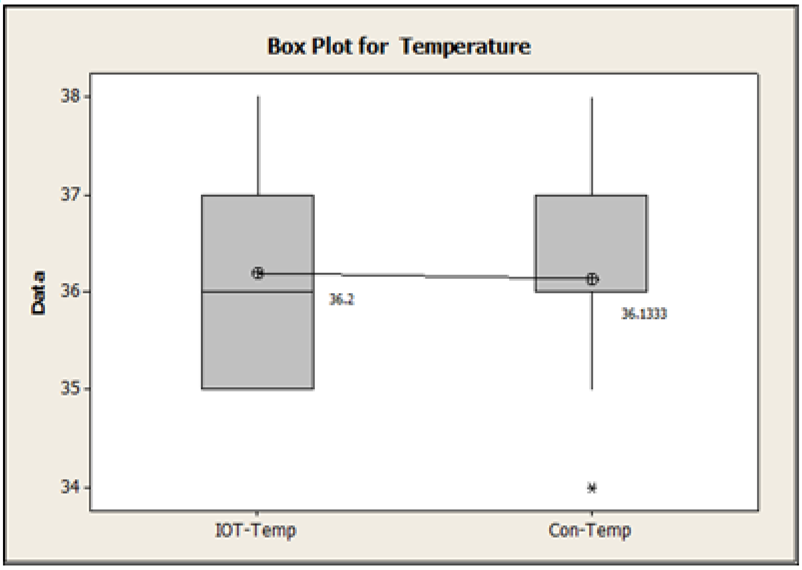

Fig 3. Box Plot for Teamrature

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References

[1] http://www.surgeryencyclopedia.com/St-Wr/Vital-Signs.html
[2] Adelaide, S. Aust, Best practices evidences based practice information sheet for health professionals,
Australian nursing journal: ANJ, 1329-1874
[3] Barro, S., Presedo, J., Félix, P. et al. Dis-Manage-Health-Outcomes (2002) 10: 291. https://doi.org/10.2165/00115677-200210050-00003
[4] Cardona-Morrell, M., et al. "Vital signs monitoring and nurse–patient interaction: A qualitative observational study of hospital practice." International journal of nursing studies 56 (2016): 9-16.
[5] https://www.indiamart.com/proddetail/bedside-monitor-6176902612.html
[6] Medical buyer's guide MedTech, care http://www.medicalbuyer.co.in/index.php/buyers-guide/buyers-guide-medtech/4542-bg-patient-monitoring-equipment
[7] Antonio J. Jara, Miguel A. Zamora and Antonio F. G. Skarmeta," An architecture based on Internet of Things to support mobility and security in medical environments", IEEE CCNC 2010
[8] An Intelligent Real Time IoT Based System.https://www.researchgate.net/publication/319161021_An_Intelligent_Real_Time_IoT_Based_System_IRTBS_for_Monitoring_ICU_Patient [accessed Apr 29 2018].
[9] Yeole Anjali, Kalbande D. R, Volume: VIII, Issue : IV, April – 2018,Use of Internet of Things(IoT) in Indian Healthcare from Doctor's point of view.
[10] http://www.minitab.com/en-us/
[11] Henry Hsu ,Peter A. Lachenbruch, Paired t Test, Wiely StatsRef,ISBN: 9781118445112| DOI: 10.1002 /9781118445112
[12] Imani R. Salehi, HabibianR, Sadeghi B, Hatamipour K. Comparative study of Measuring Body Temperature by Mercury and Digital Thermometer IJN 2009;21(56):9-16
[13] Evans D,Hodgkinson B,Berry J. Vital signs. The Joanna Briggs Institute for Evidence Based Nursing and Midwifery [online]. 1999[cited on 2011]: 8-9 available from URL http://www.lesionadomedular.com/archivos/almacen/signos%vitales.pdf
[14] Banuchandar J, S Deepa N Tamilarasi, and J Parkavi.,Eye for the visually impaired." International Journal of Modern Engineering Research, 2(2) :368-372
[15] Bayne GC. Vital signs: Are we monitoring the right parameters? Nursing Management 1997 May ; 28(5):74-6