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# Evaluating The Use Of Iot For Healthcare Providers In Treating Elderly NCD Patients In Malaysia

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***Abstract : Noncommunicable Diseases (NCDs) are one of the major health challenges, which has caused global concern due to their magnitude and high social cost. Industry 4.0 will significantly bring in IoT in the healthcare sector in an age of great growth in connected devices (up to 100 billion by 2030). The COVID-19 pandemic further accentuates the importance of using IoT in healthcare settings for both the providers and NCD patients due to controlled movements and enforced self-isolation throughout the world including Malaysia. In this regard, the improvement of "connected devices" has had a remarkable effect upon the entire healthcare sector and has been noticeably appreciated in "remote clinical monitoring", "chronic disease management", "preventive care", and "assisted living" for senior NCD patients. This study intends to interpret the significance of IoT in connection with wearable technologies and digital healthcare. The study discusses several benefits of IoT like reducing cost, rising profits for the healthcare service providers in Malaysia, a higher level of success and productivity, and precision of "health monitoring and treatment systems". The insights of this study will help the elderly NCD patients' community and healthcare providers to recognise the significance of IoT Enabled Health Monitoring and Assistive Systems due to their significant contribution to improving healthcare in the country in the long run.***

***Keywords: IoT, Healthcare, NCD Patients, Malaysia***

## 1. INTRODUCTION

Before the introduction of the Internet of Things (IoT) technologies in healthcare, patients' interactions with doctors were often limited to clinic visits, text, or telecommunications. Doctors then were not able to monitor patients' health continuously and this was affecting the overall treatment outcome. To address this clinical concern, researchers are shifting towards the use of IoT-enabled medical devices to support physicians in continuous and real-time health monitoring of patients by collecting key health parameters ("2020 Growth", 2020).

Health Information Technology (HIT) associated with the current main information technology is being used in health information management and facilitates health information exchange ensuring the safety of information among the patients, healthcare sector staff and healthcare service givers across the "computerised system" of diverse connected devices.

Lately, the application of IoT-enabled technologies in remote monitoring, telemedicine, disease diagnosis, connected clinical trials, and disease surveillance for the management of infectious diseases such as COVID-19, has led to a sudden surge in demand for IoT-enabled medical devices ("2020 Growth", 2020). According to the same report, it is estimated that "by 2020, the amount of USD 117 billion will be contributed by the IoT enabled development in the healthcare sector".

Noncommunicable Diseases (NCDs) are one of the major health challenges, which has caused global concern due to their magnitude and high social cost (Mendis, Davis, & Norrving, 2015). The four major groups, cardiovascular disease (CVD), cancer, diabetes, and chronic respiratory diseases together have caused about 70% of deaths worldwide (WHO, 2017).

In 2010, approximately 106 million people aged 60 years and older were living with Type 2 diabetes (T2DM) which is one of the common NCDs worldwide, and it is projected to increase to approximately up to 200 million by the year 2030 (Sazlina et al., 2014). According to these researchers, this enhances the risk of CVDs that might not be primarily due to age-related changes but is attributable to the age-associated diseases as a result of increased obesity, physical inactivity, glucose intolerance, hypertension and dyslipidemia. Furthermore, the reported principal cause of death among the elderly in Malaysia in 2008 was coronary heart disease for both sexes (DOSM, 2010).

The number of elderly Malaysian patients who require unique care and support by the year 2020 and beyond has a clear discrepancy with the number of healthcare staff and physicians with suitable training to give such care presage. Developments in public health and nutrition, along with advancements in medicine have subsidized longer life-expectancy in this country (Poi et al, 2004). It may be viewed that for elders to remain at their own house is the secure location for them to reduce health risks. However, as people age, it causes several physiological changes that impact not only our "physical outlook" but also weakens the health condition. This leads the body to experience "health disorders such as eyesight problems, hearing problems, body joint problems, memory losses and so on" (Balamurugan & Ramathirtham, 2012). The most important thing for these aging people is to continuously check their health condition and take rapid action if an urgent illness is felt.

Therefore, the main idea of this study is to explore the significance to monitor elderly people's health conditions and particularly that of NCD patients through the advancement of IoT-enabled applications. The use of IoT systems can help to create a bridge between community medical practitioners and their NCD patients in Malaysia.

## 2. LITERATURE REVIEW

### *Elderly NCD Patients*

Non-communicable diseases (NCDs) may be "of long duration chronic diseases that slowly progressed non-infectious in nature and cannot be transferred from one person to another" (Samsudin, Abdullah & Applanaidu, 2016, p.743). According to these researchers, the major burden of NCDs in Malaysia is blood pressure which is a risk factor for cardiovascular diseases, diabetes mellitus, cancer and mental illness and these NCDs have shown a rising an alarming trend. The Ministry of Health Malaysia (MOH) reports that 17 million (60.7 percent) Malaysians live with at least one NCD and almost 15 percent of Malaysians aged above 30 suffers from diabetes mellitus and 42.6 percent have hypertension (MOH, 2010). The increase in the prevalence of NCDs influences society in many ways which include higher utilisation of health services. The World Organization (WHO) reports that NCDs to be the top cause of mortality in the world. They cause more than 36 million deaths each year, of which almost 80% are from low and middle-income countries (WHO, 2010). As in the South-East Asia Region (SEAR), 55% of the estimated total death in 2008 were caused by NCDs. The rate is believed to upsurge over the next decade(WHO, 2011). The elderly are vulnerable to chronic health problems, including NCDs (Sazlina, Zaiton, Afiah & Hayati, 2012). They are among the high-risk group of having NCDs due to poor disease resistance, the ongoing effect of lifestyle, poor diet and less physical activities. By 2020, people aged 60 and over in Malaysia are projected to be 9.7 percent of the total population.

***Technology supports the delivery of integrated care***

The World Health Organization estimates that Non-Communicable Diseases kill 40 million people each year, equivalent to 70% of all deaths globally and each year, 15 million people die from an NCD between the ages of 30 and 69 years (WHO, 2020). The inbuilt sensors of smartphones can be used to monitor the patients with chronic diseases such as diabetes, heart problem, hypertonia, or for measuring the various health-related vital signs (like blood pressure and obesity) – which can be then transmitted to a central server through the mobile wireless network for further processing. The "m-Health" trend, which uses mobile devices and associated technology for health interventions, offers an unprecedented opportunity to transform the health services available to people across the globe (Marzolini, 2020).

The improvement of "connected devices" has had a remarkable effect on the whole healthcare sector. Moreover, it has been remarkably appreciated in, remote clinical monitoring, chronic disease management, preventive care, and assisted living for elderly people. Therefore, reports show that "the total value of the IoT health care devices such as wearables like smartwatches market is expected to reach $40 billion in 2018" (Jovanov, 2019, p.4295).

Internet-connected devices have been presented to patients such as elderly NCD patients in different ways (see Figure 1). The variety of the sensors can be associated with the nature of the stimuli that they respond to. For example, there are few big physiological symptoms like a heartbeat, blood pressure, or body movements. Moreover, this sensor can be also placed on the body parts or things adjacent to our body, such as "clothing, subcutaneous implant, wearable devices such as smartwatch and glasses" (Deloitte, 2018, n.p.).


**Figure 1:** The Future of Digital Health (Karthik, 2017)

NCDs are the leading cause of death, although preventive actions can be taken. For example, the World Health Organization (WHO, 2020) writes that 80% of premature cardiovascular diseases, strokes and diabetes can be prevented. According to Kristoffersson & Lindén (2020), first, this can be accomplished by reducing the risk factors related to the way we live

our lives, i.e., reduce the consumption of tobacco, alcohol and unhealthy food and by increasing our physical activity (PA) level. Second, we can react to and take action when warning signals, such as raised blood pressure (BP), blood glucose (BG) and cholesterol, arise. Wearable sensors and E-health systems play an important role in health trend monitoring. Table 1 presents the List of NCDs and related wearable IoT healthcare devices to monitor elderly patients.

**Table1:** List of NCDs and related wearable IoT healthcare devices

| **Categories** | **NCDs** | **Risk** | **Wearable IoT Healthcare devices** | **Measures** |
|---|---|---|---|---|
| Non-modifiable | Hypertension or high BP | Cardiovascular, brain and kidney diseases | Photoplethysmography (PPG) and diameter pulse wave (DPV) on the wrist (Li, Y., Li, S., Song, Shao, Yang & Deng, 2019) | -PPG on the wrist and fingertip (Wannenburg, & Malekian, 2015) or from an ECG signal (Simjanoska, Gjoreski, Gams & Madevska Bogdanova, 2018; Simjanoska, Kochev, Tanevski, Bogdanova, Papa, & Eftimov, 2020)<br>- Indirect measure of BP through pulse wave velocity (PWV) (Jovanov, 2019). |
| | Arrhythmia | -Stroke, heart failure and cardiac arrest (nhlbi, 2020) | -Portable ECG monitor (Susič & Stanič, 2016) | -Heart rate variability (HRV) |
| | Asthma/ Chronic Obstructive Pulmonary Disease (COPD) | Respiratory problems | -Wearable acoustic sensor | -Detect wheezing |
| | Diabetes | Heart disease, stroke, kidney damage, nerve damage | -Non-invasive: light, a clip on the earlobe, smart contact lenses and sweat patches exist (Young, 2007) | -Measuring BG. |
| Modifiable | Overeating | -Diet and overweight/obesity (Kristoffersson, & Lindén, 2020) | -Piezoelectric sensor in a necklace<br>-Accelerometer and respiratory plethysmographies (RIPs) (Kristoffersson, & Lindén, 2020). | -Monitor food intake<br>-Detect hand movements and swallow apneas<br>-ECG, BP, BG and muscular activity |

Source: Put together by the authors of this study

## 3. IOT ENABLED HEALTHCARE

Newswire (2016) mentioned that "the healthcare industry is poised to be driven by the high innovative connected health technologies which consist of IoT, applications, services and solutions". The main purpose of "digital health" is to mainly lessen the expenditures and remarkably develop medical services. Along with this eventually to make the "IoT enabled healthcare applications" are more realistic and viable. The IoT empowered care related to health is being delineated with the help of mainly two improvements: firstly, wearable technology and secondly, digital healthcare. Wood (2016, n.p.) mentioned that "by leveraging the wearable devices in IoT, it delivers a range of health products and services from telemedicine to self-diagnosis and monitoring which results in reduce cost and becomes a major influence of driving the insurance company for IoT adoption". Ma et al (2015, n.p.) also mentioned that "the IoT enabled healthcare should deliver the core values that not only to benefit patients but also drive the entire healthcare industry to form an organism of health services".

Figure 2 shows the conceptual IoT enabled healthcare. Based on this figure the connected objects ("Things") apply logic to sense the information. Then gather the health data ("Data") of elderly NCD patients ("People"). Afterward, transmit it to the private/public cloud. Lastly, the data gathered will be synthesized ("Process") to generate meaningful health information ("Data"). Meaningful information related to the health will be presented ("Process") to medical staff ("People") in either report format or checking GUI.

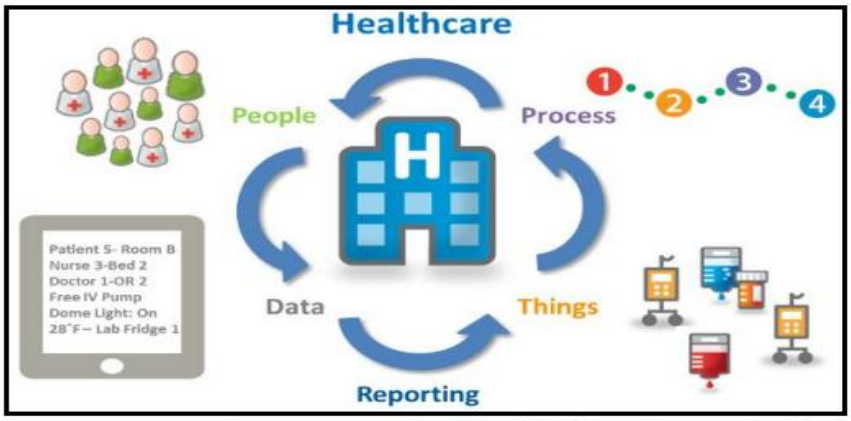


**Figure 2:** The idea related to IoT enabled healthcare (Hossain & Ghulam, 2016)

***Healthcare Innovation Using IoT***

The main objective of using IoT for health information exchange is to integrate the communications systems in the healthcare environment. Hence, it is possible to have full control of and provide access from one system to other linked systems and establish ubiquitous communication and computing for the purpose of defining a new generation of assistance in health service (Ahmadian, Nejad, & Khajouei, 2015). The practical advantages in the design of the Internet of Things (IoT) technologies include the ability to encourage the development of the smart systems to support and improve the processes related to biomedical and healthcare that is essential for the elderly NCD patients. For these patients, IoT can help to monitor the elderly patients for physiological parameters in real-time for early detection of clinical deterioration, automatic people identification and tracking through biomedical devices in smart hospitals, and drug-patient associations (Catarinucci et al., 2015).

Figure 3 illustrates how this technological innovation in healthcare will appear in a typical IoT process in practice in smart hospitals. A patient with an emergency case will have a

wearable device that detects the nearest emergency department in a hospital to deliver the required services. The emergency department when detecting an elderly NCD patient within an emergency case links the ambulance care to send the care services. The ambulance care will have detection that, when arrived, links the bio-bank of patient information to a secure cloud, which stores their electronic health record vitals and lab results, as well as medical and prescription histories. This process can assist health medical staff to know the elderly NCD patient's status in a fast, easy, and effective way (Hamdan, 2018).

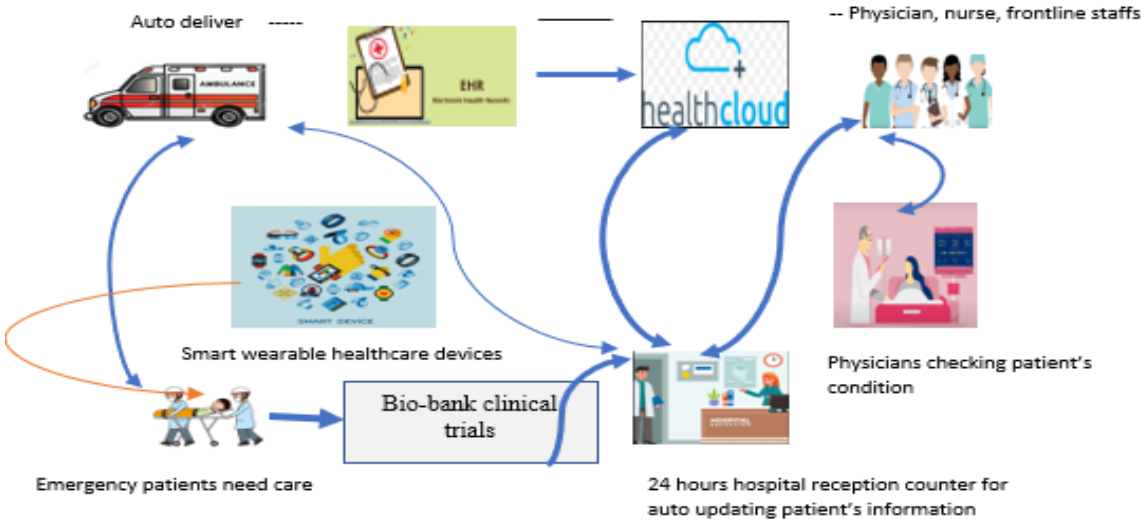


**Figure 3:** An illustration of innovation in healthcare in a typical IoT process in a smart hospital (Adapted from Hamdan, 2018)

## 4. SIGNIFICANCE OF USING IOT FOR THE ELDERLY NCD PATIENTS' HEALTHCARE

Healthcare/medical sectors around the world make use of the evolving IoT. As these have the prospect for getting close to most people, especially the elderly NCD patients group, the crucial effect is on health checking, when the symptoms are mainly silent. In such circumstances, quick diagnosis may help prevention procedures and also reduce the chances of chronic illnesses or mortality. In short, bigger IoT integration seems "desirable, particularly because the global health system is clearly moving toward health care at home" (Islam et al., 2014, p.29).

Figure 4 depicts various uses of IoT, particularly for healthcare. There is a scattered node-set where each node may function jointly with other elements. For example, telemedicine, nurse, doctors, ambulance, and so on.

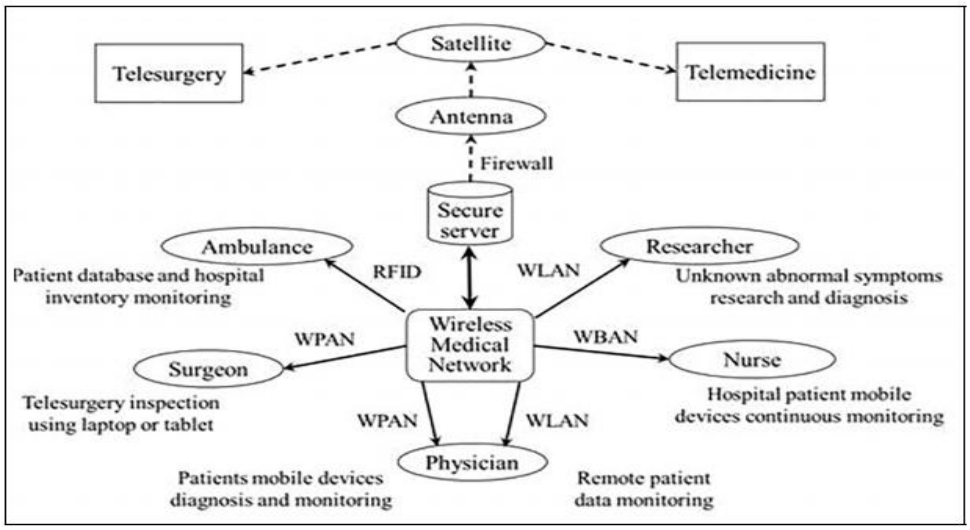


**Figure 4:** IoT apps related to healthcare (Bedón-Molina, Lopez, & Derpich, 2020)

There may be a wide variety of applications for hospitals' patient control through monitoring and control systems. According to Bedón-Molina, Lopez, & Derpich (2020), there are different networks such as wireless local area network (WLAN), wireless personal area network (WPAN), wireless body area network (WBAN), radio-frequency identification (RFID), assist in automated identification, and electronic device data capturing.

Dimitrov (2016) reports that by 2020, "20% of the IoT market will be on the Internet of medical things (IoMT) and that another 20% will be directly or indirectly related to health, well-being, and Ambient Assisted Living(AAL). Thus, the health sector would have 40% of the market" (p.158). Similarly, Nicolescu, Huth, Radanliev and De Roure (2018) argue that Industry 4.0 will significantly impact IoT on healthcare scenarios in an age of great growth in connected devices (estimated up to 100 billion by 2030).

The progress of "IoT enabled medical devices and equipment, and treatments" in the medical sectors will ultimately help to reduce cost and bring large profits for health service providers. Moreover, "IoT will also help to develop effectiveness, efficiency, and accuracy of health monitoring and treatment systems" (Islam et al., 2014, p.27). Hence, IoT can benefits, "the patients particularly for the elderly NCD patients to experience the affordable high quality of healthiness caring, monitoring and treatment services" (p.28).

IoT has formed prospects for generating proper "computerised systems". Therefore, the application of IoT will lessen the "human intervention into the physical world and practical life". This is especially required to drastically develop the quality, productivity, precision and cost in the industries and ultimately create merits for people particularly the elderly NCD patient community.

## 5. CONCLUSION

This study highlighted the elderly group not only because its proportion to the population has been increasing over time but also due to the fact that the probability to be diagnosed with longstanding illnesses that include NCDs has also swelled with age. In such circumstances, the application of IoT has immense prospects for treating elderly NCD patients in a technologically developed county like Malaysia. The insights of this study will help the elderly community and healthcare providers to recognise the significance of using IoT for healthcare in the long run.

Undoubtedly, an advanced level of readiness is expected among the healthcare providers to implement changes for optimal benefits for treating elderly patients. Besides, the awareness of the use and benefits of IoT devices such as smartphones and smartwatches for monitoring the NCDs need to be transmitted throughout the society and community as a whole through campaigns that could help to monitor elderly healthcare in a timely manner. Lastly, the COVID-19 pandemic also accentuates the importance of using IoT for healthcare for both the providers and NCD patients due to controlled movements and enforced self-isolation throughout the world including Malaysia.

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