ISSN 2350-109X
www.indianscholar.co.in

Indian Scholar

An International Multidisciplinary Research e-Journal

MISA MEMBERS OF INTERNATIONAL SCHOOLS' ASSOCIATION

IMPACT OF INTRODUCING MORE RELIABLE WEARABLE SENSORS IN HEALTH CARE MONITORING

Aryak Malhotra
Billabong High International School,
Malad (IN677)

Abstract

This research paper has been written to access the level of Reliability provided by the Wearable Sensors in wellness programs. These tools are often used to track and record a variety of items for different purposes, ranging from monitoring personal hygiene to saving lives, some of which include:

1. Counting steps
2. Monitoring heartbeats
3. Measuring blood oxygen levels
4. Recording body temperatures

The paper also discusses how the future of these healthcare tools can bring about change in our society and how we can further improve it.

Keywords:*RHM (Remote Health Care Monitoring), IoMT (The Internet of Medical Things)*

INTRODUCTION

In recent years, hospitals have invested heavily in state-of-the-art medical technology to ensure the accuracy and reliability of medical equipment and the required level of efficiency. The Internet of Medical Things (IoMT) has played an important role in remote health care monitoring (RHM). IoMT is widely used to collect a patient's data remotely with the help of wearable sensors/devices and store them on a cloud server. IoMT has three main components:

1. device layer (body sensor network (BSN))
2. Fog layer
3. cloud service

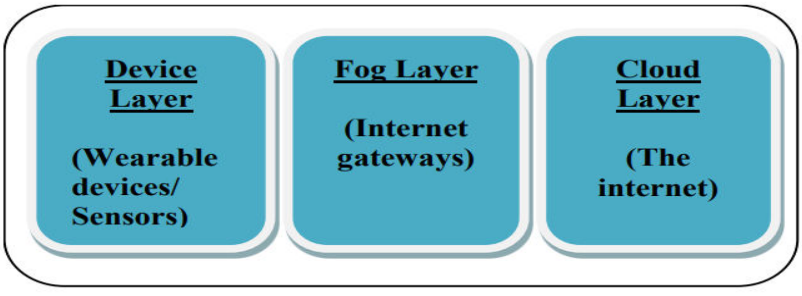

Figure 1. The architecture of IoMT

ISSN 2350-109X
www.indianscholar.co.in

Indian Scholar

An International Multidisciplinary Research e-Journal

The main purpose of the device layer (sensor layer) is to develop effective and accurate sensor technology for collecting different types of health-based data. Communication technology supports network solutions and IoMT system infrastructure. However, communication strategies include Bluetooth, RFID (NFC), WI-FI, IrDA, UWB, and ZIGBEE. In the cloud layer (in the data layer), the data is processed and stored. In addition, the clouds receive patient data for analysis, processing, and storage. Thus, data is available to caregivers. Table 1 shows wearable sensing technologies.

Table 1. Wearable Sensing Technologies

Wearable sensing technologies		
	Sensor type	Example
Line 1	Inertial sensor	Magnetic field sensors, Accelerometer, and Gyroscopes
Line 2	Location sensor	GIS and GPS
Line 3	Physiological sensor	Electrocardiogram (ECG), Electrooculography (EOG), Galvanic skin, and Spirometer
Line 4	Brain activity sensor	Electroencephalogram (EEG)
Line 5	Image sensor	Camera

RHM is a continuous monitoring process of health data, this includes biological monitoring such as heart rate, temperature, and blood pressure, body function monitoring, diet monitoring, medication monitoring, and behavioral monitoring. Health-related data is transmitted wirelessly to both the patient and caregivers through a cloud. Thus, IoMT supports real-time, fast, remote, and reliable diagnoses of several types of diseases and improves the decision-making process. Through this process, large amounts of data are obtained, analyzed, and monitored.
With today's busy lifestyle, most people do not have a standard medical examination. In addition, healthcare costs are rising, and governments are spending more money each year on healthcare services. It is also noteworthy that according to the Indonesian Journal of Electrical Engineering and Computer Science, people in Europe and the United States prefer home-based care to attend hospitals. Therefore, there is an urgent need for remote health care monitoring in real-time to address all of these challenges. Continuous monitoring of patients and the elderly through the use of clothing and nerves has gained considerable attention.

The goal is to provide monitoring of important symptoms such as high blood pressure, temperature, and heart rate that are very important in today's world of health care. According to the World Health Organization (WHO), the number of patients with type 2 diabetes (T2D) is 422 million in 2014. That means 8.5% of adults have diabetes. However, the WHO expects that number will reach 500 million by 2030. Therefore, using RHM may reduce the risk for those most at risk by taking medical data and sending it to caregivers. RHM use includes the following:

1. Diseases management

ISSN 2350-109X
www.indianscholar.co.in
Indian Scholar
An International Multidisciplinary Research e-Journal
MISA MEMBERS OF INTERNATIONAL SCHOOLS' ASSOCIATION

2. Diseases prediction
3. Diseases prognosis
4. Diseases prevention
5. Diagnosing diseases
6. Giving the suitable medications and treatments
7. Rehabilitation

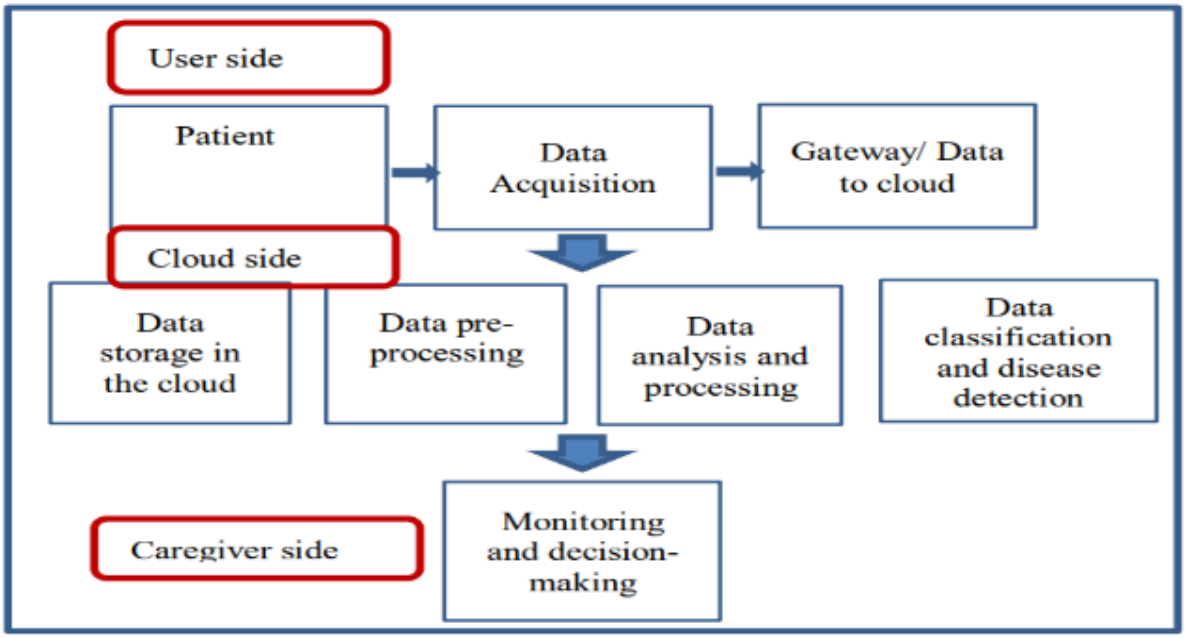

Figure 2. Proposed healthcare monitoring system

Theory

The sophisticated growth of medical technology has greatly improved the health of individuals and society. Improvements have improved survival in the face of illness or injury and significantly improved patient quality of life through improved diagnostics and treatment outcomes. Managing goods and services is one of the key factors in ensuring the continuity of basic and supportive business activities in health care services. The delivery of community health care services is severely affected without the implementation of effective management. Medical assets are an important asset that contributes significantly to the efficiency and quality of health care services. Since medical equipment assists a wide range of resources in the health care sector, representatives of managers, such as medical engineers, must monitor and maintain assets by performing several maintenance tasks throughout the life cycle of the equipment.

Careful handling of medical equipment is essential to ensure that the machine operates under the manufacturer's specifications and ensures the safety of patients and users. Failure of medical equipment may affect the performance of health care services and may result in serious injury to patients and damage to the environment. Bahrain et al. it is summarized in the areas of governance, resources, information bank, service, assessment, education, and quality control. Performance testing is one of the most frequently performed tasks in the entire repair and maintenance phase to determine the true state of medical equipment.

ISSN 2350-109X
www.indianscholar.co.in

Indian Scholar

An International Multidisciplinary Research e-Journal

Performing tests requires knowledge of the characteristics of medical equipment to produce the expected result. The expected outcome will assist health care managers or medical engineers in making important decisions about corrective management procedures to improve the reliability and availability of medical equipment. In addition, certain experimental studies in the Southeast Asian region, particularly in line with the Malaysian standard for managing medical device care, are still lacking. In constructing the current systematic review, the following research questions were discussed:

1. What are the significant parameters required on the medical equipment to be applied for the reliability assessment from the previous studies?
2. How do these parameters applicable to the Malaysian standard practices for managing the maintenance of medical equipment?

Selecting key parameters to be considered to assess the reliability of medical equipment is critical to ensuring quality health care services. In this study, the identification of these important parameters can be applied to a variety of medical devices used in any health facility. In addition, we provide an update on the feasibility of analyzing the reliability of medical equipment using artificial intelligence (AI) and/or machine learning (ML) methods based on these parameters across the health care cycle of the medical device. This research also leads to exposing the gap and youth. The identified parameters will have an impact on the comprehensive strategic management and maintenance of medical equipment, which includes three key components of preventive maintenance (PM), corrective repair (CM), and replacement system (RP). In addition, reliability testing using these parameters may complement and enhance the national standard of medical practice. Based on the research conducted, none of the included studies contributed to these three features and correlated the appropriate parameters and standards. Therefore, the study aimed to identify the essential parameters of medical equipment by conducting systematic reviews of previous studies related to the Malaysian standard of medical equipment repair management.

Materials and Methods:

1) Literature Search

Systematic literature reviews are conducted using published standards, which are PRISMA in evaluating and carefully analyzing articles related to medical equipment testing on the information. In addition, the procedures for inclusion and exclusion of current relevant studies are well documented. The included experimental studies are coded to achieve the purpose of systematic reviews in the study area.

2) Resources

Research related to the testing of medical devices came from two main databases, namely the Web of Science and Scopus. The database covers more than 256 subject areas, including engineering and computer science courses that may enhance comprehension and essay skills. According to Younger, several established databases should be included to improve access to relevant articles in the study area. For this study, additional data selected were PubMed, Science Direct, IEEE Xplore, Emerald, Springer, Medline, and Dimensions.

3) Article Selection

ISSN 2350-109X
www.indianscholar.co.in
Indian Scholar
An International Multidisciplinary Research e-Journal
MISA MEMBERS OF INTERNATIONAL SCHOOLS' ASSOCIATION

This section describes in detail the process of selecting articles. There are three steps to selecting suitable articles, namely, identification, testing, and eligibility.

4) Identification

The identification and selection of appropriate subjects cover four key categories. First, keywords for title areas are identified. Thesaurus, encyclopedia, and previous research have focused on creating relevant keywords. Second, search series algorithms were developed from keywords in January 2020 based on the Science web and Scopus website information features, as shown in Table 2. Next, a few conditions for submission and release were determined to obtain articles from both information sites (See Table 3). These criteria are set because only the latest research articles in the topic area have been downloaded to reduce the chances of inclusion of an unimportant topic. Besides, only English articles were considered for ease of preparation. Later, these two search terms were used in advanced information search. As a result, 183 articles from the Web of Science and 505 articles from Scopus were returned. The same keywords were used in seven other sites, where 64 articles were identified. In addition, the identification of relevant subjects is done through other means, namely websites, organizations, and search quotes. By using the same keywords, 98 indexes were identified, therefore, 852 references contained articles and reports were obtained in the identification phase.

Table 2. The search strings for Web of Science and Scopus databases.

	Database	**Search string**
Line 1	Web of Science	TS = ((“medical equipment*” OR “medical device*” OR “biomedical equipment*”) AND (“performance” OR “reliability” OR “maintenance”) AND (“assessment” OR “predict*” OR “inspect*” OR “priorit*”))
Line 2	Scopus	TITLE-ABS-KEY ((“medical equipment*” OR “medical device*” OR “biomedical equipment*”) AND (“performance” OR “reliability” OR “maintenance”) AND (“assessment” OR “predict*” OR “inspect*” OR “priorit*”))

Table 3. The inclusion and exclusion criteria.

	Criterion	**Eligibility**	**Exclusion**
Line 1	Literature type	Journal (research articles)	Journal (review), book series, book, chapter in a book, conference proceeding
Line 2	Language	English	Non-English
Line 3	Timeline	Between 2000 and 2020	< 2000
Line 4	Subject area	Engineering, Computer Science, Medical Information, Operations and Management	Other than Engineering, Computer Science, Medical Information, Operations and Management

ISSN 2350-109X
www.indianscholar.co.in
Indian Scholar
An International Multidisciplinary Research e-Journal
MISA MEMBERS OF INTERNATIONAL SCHOOLS' ASSOCIATION

Examination 852 Articles and reports are divided into two sections to remove duplication and exclude unrelated subject areas or topics during the evaluation process. There were 38 and 19 duplicate articles in the database and alternatives, respectively. Therefore, these duplicate articles were removed, and the remaining 716 articles and 79 reports continued in the additional review process. Three factors were carefully tested during the test: title, keywords, and abstract. In addition, many considerations were considered in the evaluation of these three factors. First, the general terms of a medical device or medical device or other device included under these general terms are set out in the title and keywords. Second, an indication of the quantitative approach to evaluating the effectiveness of medical devices was presented in the abstract. Therefore, only 85 articles and 21 reports were selected for the next step.

Eligibility This step involves reviewing the full text of the essay to ensure that 85 research articles and 21 reports are eligible for compilation and review. The important content of the articles was thoroughly reviewed to ensure that the conditions for installation and removal were met. Important factors such as research objective, input parameters, methodology, expected outcome, and desired outcomes were carefully evaluated. Later, 69 articles and 21 reports were excluded due to the lack of a multidisciplinary approach to evaluating the effectiveness of medical devices and not experimental studies. In addition, two important articles based on manual search are included. Therefore, a total of the remaining 16 topics were included in this study, as shown in Figure 3.

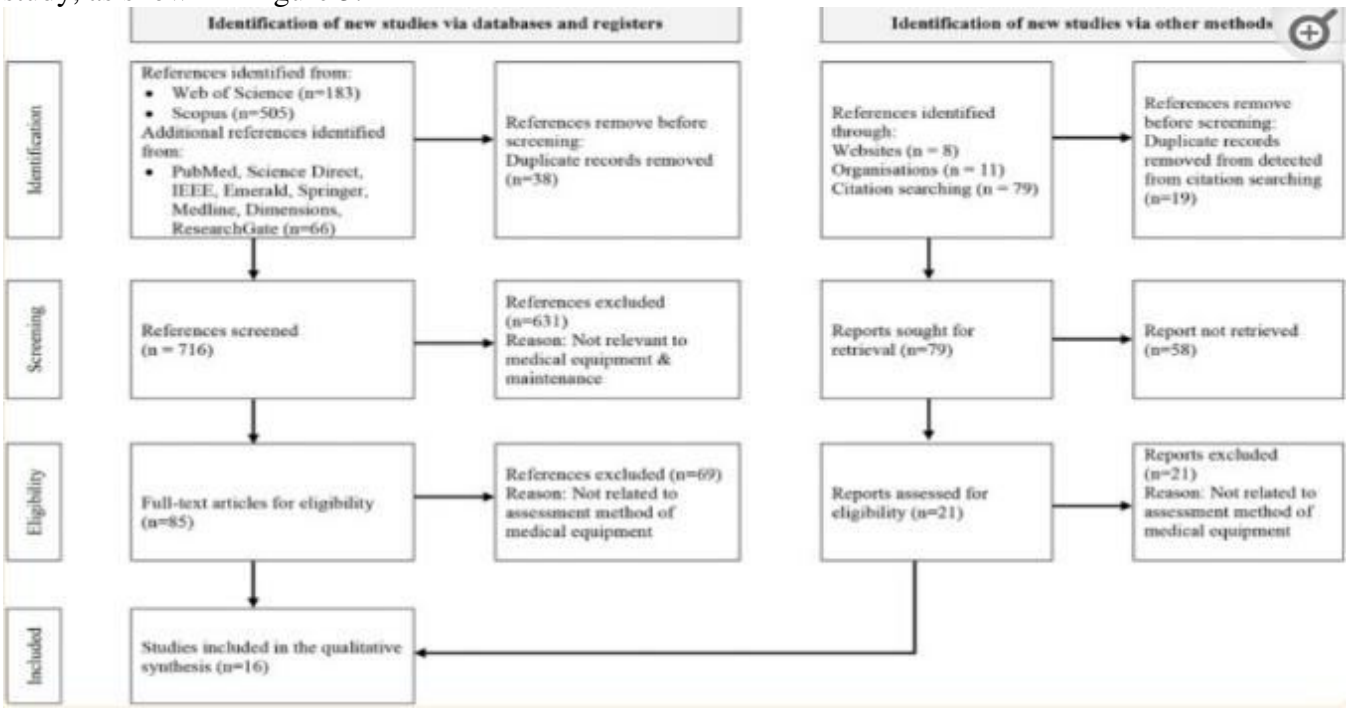

Figure 3. PRISMA flow chart of the study adapted from Page et al

Quality Checking and Data Release A quality analysis method were used to evaluate the remaining articles. The first, second, and sixth authors conducted a quality assessment of selected articles. Articles are divided into upper, middle, and lower levels that reflect purpose, input parameters, performance, output, and desired results. The texts must be of the highest

quality and be agreed upon by all the authors. The compilation of extracted information was done by the first, second, and sixth authors and was compiled into an organized table. The third, fourth, and fifth authors then analyzed all the data included. Combined data was categorized using theme analysis. Following Active Medical Device Maintenance Management developed by the Department of Standards, Malaysia, the prescribed categories were associated with features. The result of the division of input elements was discussed intelligently among the authors. Any disagreements or disagreements were resolved amicably until the agreement of the reviewers.

RESULT

As a large number of medical equipment and most of the functions are used in health facilities, the equipment will be properly monitored and maintained to maintain operational and safety standards. However, maintenance management can be challenging if a health care provider encounters a few problems with inadequate staffing and available resources, such as replacement parts and finances. According to the World Health Organization (WHO), initial costs, and operating costs are two categories of resources needed to maintain medical equipment. Cordova et al. added that the cost of care represents a large portion of the entire health system which requires 15-60% of the total operating costs. Improper care may affect performance and safety which has had a significant impact on spending on health facilities. Wu et al. proved that good maintenance management within 2 years improves the availability of medical equipment and reduces operating costs by more than $ 1 million.

The computer invention program greatly assists health care management in managing care tools and services. Using the right method for large-scale data processing produces useful clues that can assist medical engineers in developing corrective planning strategies and continuous action. The identification of the process of medical equipment is important to produce important indicators. Based on the analysis from the included articles, conditional exemptions have been referred to in previous publications, data collection and output, expert judgment using survey, input based on customer needs, and adaptability to international norms and national guidelines.

DISCUSSION

The first consideration that is important in improving the performance appraisal of medical equipment is to determine the appropriate input parameters. However, no single method can be used for all input parameters. The selection of input parameters must be the same and apply to the expected output. According to Mahfoud et al., the results of medical equipment tests are associated with care strategies. Availability of existing data that includes information on medical equipment and care history is one of the factors in selecting appropriate input parameters. Differences in the input parameters used can be processed to produce the same output.

The second consideration is a high-quality processing method based on thousands of medical equipment data. As mentioned earlier, many scientific methods are developed that can be used to calculate input data and ultimately produce the expected result for experimental purposes. However, the use of ML strategy is considered to be the best option compared to conventional strategies. This is due to the ability of the ML algorithm to assess the accuracy of high-output predictions using accurate and important input data.

The results obtained from the studies made by Badnjevic et al. And Kovacevic et al. Showed that the generated output achieved above 89% accuracy whereas Random Forest and Decision Tree

reached around 99% of accuracy in predicting both selected medical equipment performance. Therefore, both authors concluded that improved supervision, quality, and safety in managing medical equipment maintenance could be achieved which eventually optimized the cost of maintenance. However, the ML techniques utilized in both studies were developed based on only one type of medical equipment. Consideration of applying to various types of medical equipment would be more practical to be utilized in healthcare facility management. This is because various types of medical equipment have different functionality and required specific assessment to ensure their reliability being used in healthcare services.

CONCLUSION

In the IoMT era, remote health care (RHM) monitoring represents the future of the health careindustry. Importantly, to improve the quality of human life, the vital signs of the human body suchas glucose levels can be detected. Worldwide, the number of diabetic patients is growing steadily leading to additional challenges in the health care community. Therefore, benefiting from the latest developments and trends ininformation and communication technology (i.e. IoT) is important. The proposed review study has compiledIoMT - remote health monitoring for diabetic patients. In addition, the challenges that go hand in handwith future styles are discussed and highlighted.

REFERENCES

1. Badnjević A, Gurbeta L, Bošković D, Džemić Z. *Measurement in medicine–Past, present, future. Folia Medica Fac Medicinae Uni Saraeviensis*. (2015) . http://foliamedica.mf.unsa.ba/index.php/FM/article/view/38 [Google Scholar]
2. S. Gupta, et al., ―Technologies in Health Care Domain: A Systematic Review,‖ International Journal of e-Collaboration (IJeC), vol. 16, no. 1, pp. 33-44,
3. Kavrakov D. *Asset vs. Facility Management – Spot the Difference Comparative Analysis of Professional Identity and Functions. Euro FM Insights*. (2016).https://www.bgfma.bg/content/uploads/2016/01/AMvsFM_FMInsights_DK.pdf
4. Ismail S, Hussein B, Hajj-Hassan M, Nehme H, Khachfe H. A holistic approach for forecasting medical equipment risks using monte carlo simulation. *Int J Adv Life Sci.* (2018) http://www.iariajournals.org/life_sciences/lifsci_v10_n12_2018_paged.pdf [Google Scholar]
5. *A review of internet of medical things (IoMT) – based remote health monitoring through wearable sensors: a case study fordiabetic patients.* (2020). https://pdfs.semanticscholar.org/5f4d/b83c5f95673ae6c6a0f0622c4f939c20344d.pdf
6. *A Systematic Review of Medical Equipment Reliability Assessment in Improving the Quality of Healthcare Services.* (2021). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8503610/