

## Impact Of Biomedical Engineering On The Functionality Of Medical Devices In Government Hospitals In Uganda

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### Abstract

**Introduction:** Medical devices play a vital role in the prevention, diagnosis, and treatment of illness and disease, as well as patient rehabilitation. However, a sustainable maintenance of medical devices in government health facilities in the sub-Saharan Africa is still in infancy. In addition, according to the World Health Organisation – it projects that over 50% of medical devices in Low-and-Middle-Income Countries (LMICs) are non-functional, not correctly used, and maintained due to various reasons such as lack of appropriate human resource, especially Biomedical Engineers/Technicians. This study aims to assess the impact of Biomedical Engineers/Technicians on the functional status of medical devices in government hospitals in Uganda.

**Methods:** The study utilised a descriptive survey form. A total of 37 hospitals were observed from the four major regions of Uganda. The hospitals were divided as, where a Biomedical Engineer/Technician is employed and where a Biomedical Engineer/Technician is not employed. 127 participants consented to the study and the medical device status was assessed using the A-F scale recommended by the Ministry of Health.

**Results:** A majority of the hospitals observed were located in the Eastern region (42.7%) followed by Central region (29%). Hospitals with a Biomedical Engineer/Technician represented 79.5% whereas the remaining 20.5% represented without a Biomedical Engineer/Technician. Furthermore, it was observed that hospitals with a Biomedical Engineer/Technician had the highest number of functional medical devices compared to without a Biomedical Engineer/Technician.

**Conclusion:** Employing a Biomedical Engineer/Technician reduces the number of non-functional medical devices in the hospital. This has been corroborated by other studies as well. Therefore, it is recommended to employ many Biomedical Engineers/Technicians in the government hospitals to improve health service delivery.

## 1. Introduction

Medical devices play a vital role in a healthcare system; particularly they are crucial in the prevention, diagnosis, and treatment of illness and disease, as well as patient rehabilitation [1]. The Global Harmonisation Taskforce (GHTF) defines a medical device as an article, instrument, apparatus or machine that is used in the prevention, diagnosis or treatment of illness or disease, or for detecting, measuring, restoring, correcting or modifying the structure or function of the body for some health purpose.

Medical devices are considerable investments and somewhat have high procurement and maintenance cost tight to them. The global medical device market was estimated at US\$ 456.8 billion in 2020 and expected to grow at a rate of 7.7% by 2025 [2]. This implies that technological advancement in health will require a standard system in the procurement and management of medical devices. Otherwise, there will be a disproportionate escalation in the healthcare service delivery.

As such, maintenance of these medical devices play a vital role to keep them effective and safe for their intended use. However, a sustainable maintenance of medical devices in government health facilities in the sub-Saharan Africa is still in infancy. It is worth noting that, malfunctions of medical devices has direct implications on poor health outcomes of patients [3]. In addition, according to the World Health Organisation – it projects that over 50% of medical devices in Low-and-Middle-Income Countries (LMICs) are non-functional, not correctly used, and maintained.

Effective use of medical devices leads to improved quality of healthcare service delivery globally, and particularly in Low-Income Countries such as Uganda. However, the availability of medical devices does not directly translate to improve healthcare service delivery [4]. Lack of functional medical devices has a

devastating effect on the quality of healthcare service delivery in Low-Income Countries and affects the overall healthcare system [4]. It is imperative for a functional medical device in sub-Saharan Africa where there is 24% of the global disease burden, 1% of the global financial resources and 3% of the human resource capacity [5][6].

A systematic literature review in five sub-Saharan African countries indicated that there is neglect in human resource, especially Biomedical Engineers/Technicians to provide maintenance and repair services on medical devices [7]. The same review also revealed that only half of the hospitals assessed had medical device maintenance and repair services [8]. A representative number of medical devices in government hospitals in Uganda are donated or funded by international donors, and or foreign aid. Most of these medical devices are poorly maintained, and or out of service due to various reasons such as; unavailability of spare parts, accessories, consumables, and technical training to maintain the devices [9].

Limited research findings shown that training of Biomedical Technicians was effective in improving the overall medical device functional status in hospitals in Low-Income Countries [10], [11]. In Rwanda, Honduras, and Cambodia, the training model developed by Engineering World Health significantly decreased the non-functional medical devices by 43%, 30%, and 30%, respectively in a period of 2 months in 2015 [10]. Furthermore, the training also improved in the productivity of Biomedical Technicians when compared to Biomedical Technicians that did not undergo the training in Rwanda. This is therefore testament of the impact of Biomedical Engineers/Technicians' on the overall functional status of medical devices in a health facility.

The role of Biomedical Engineers/Technicians in the planning, procurement, and management of medical devices are usually misunderstood and underestimated in the some countries. In fact, Biomedical Engineers/Technicians ensures that medical devices are of good quality, effective for the intended purpose, available, among others [12]. Whenever, these roles are appreciated, medical devices are used safely, and overall health service delivery is improved. Therefore, this study aims to assess the impact of Biomedical Engineers/Technicians on the functional status of medical devices in government hospitals in Uganda

## 2. Methods

This study utilised a descriptive survey form. It assessed the statuses of medical devices in 37 different government hospitals. The government hospitals selected were distributed in the four major regions of Uganda namely; Northern, Eastern, Central, and Western. The hospitals were categorised into two major groups, where a Biomedical Engineer/Technician is

employed, and where a Biomedical Engineer/Technician is not employed.

A total of 127 respondents filled in the survey form with representation from Biomedical Engineers/Technicians and clinicians. The study participants were thoroughly briefed on the purpose of the study. Thereafter, participants gave oral consent to participate in the study. Participant’s sensitive personal data were not collected. They were assigned a generated number to keep it anonymous.

The data collected were observed quantitatively to assess the functional status of medical devices in the government hospitals. The survey tool had a list of selected medical devices such as; Autoclave, Blood pressure machine, Centrifuge, Delivery bed, Glucometer, Otoscope, Oxygen concentrator, Suction machine, Weighing scale, Wheel chair, Pulse oximeter, Patient monitor, Nebulizer, Microscope, Anesthesia unit, Examination couch. These medical devices were assessed based on the Japanese model of Total Quality Management using A – F scale as recommended by the Ministry of Health [13]. Whereby medical device with status “A” were classified as functional whereas medical device of status “B, C, D, E, and F” were classified as non-functional. The table below shows the interpretation of the scale.

Table 1: The A-F scale of the medical device status.

Classification	Interpretation
A	Good working condition and in use
B	Good working condition but not in use
C	In use but needs repair
D	In use but needs replacement
E	Out of use but repairable
F	Out of use, to be disposed of

The data were analysed using Microsoft Excel office 2016. The collected data were cleaned, sorted for completeness and duplications. However, Microsoft Excel office 2016 is not a rich tool for data analysis. This

## 3. Results

A majority of the hospitals of the hospitals observed

is one of the major limitation to this study since outsourcing a Biostatistician or data analysts in the study period was challenging.

were located in the Eastern region (42.7%) followed by Central region (29%) as shown below

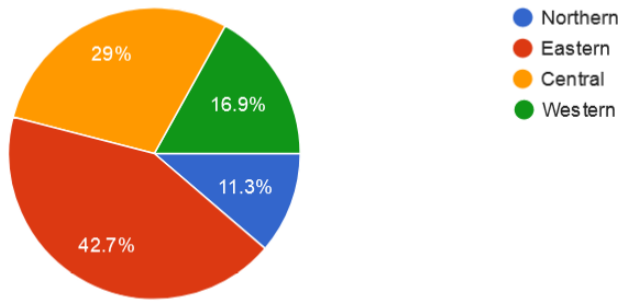
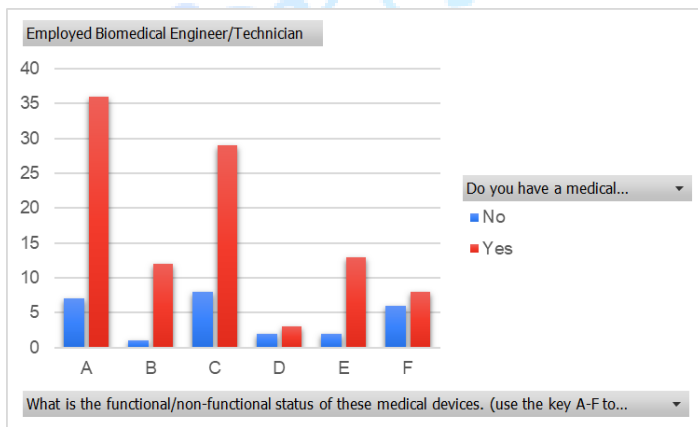


Figure 1: shows the regional distribution of the hospitals assessed.

In these hospitals, majority of it employed Biomedical Engineers/Technicians that represented 79.5% whereas the remaining 20.5% of the hospitals did not employ any Biomedical Engineer/Technician. Conversely, in hospitals that did not employ any Biomedical Engineer/Technician recorded the highest number of non-functional medical devices. In hospitals where a Biomedical Engineer/Technician is employed recorded

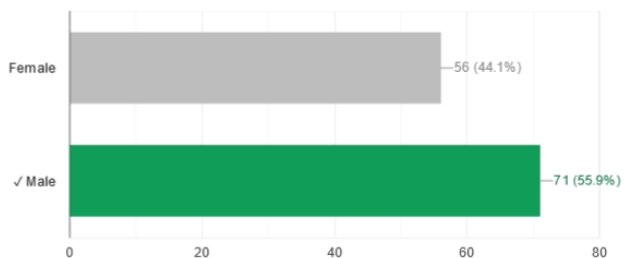
the highest number of functional medical device. However, the hospitals that employed a Biomedical Engineer/Technician also recorded a comparable number of non-functional medical device. The graph below shows comparison of medical device status in hospitals where Biomedical Engineer/Technician is employed versus not employed.



In regards to the individual medical device's status, It was observed that the following revealed the majority of the functional status; examination couch, autoclave, blood pressure machine, delivery bed, and glucometer respectively. On the other hand, medical devices with highest non-functional status included; wheel chair,

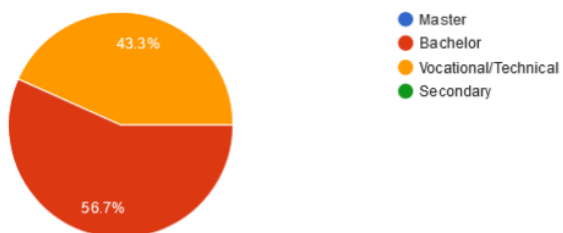
anesthesia unit, microscope, suction machine, otoscope, and centrifuge respectively.

The demographic characteristics of the participants were represented as below. Majority of the participants were male (55.9%). The remaining 44.1% were female.



In addition, the educational level of the participants were indicated in the pie chart below. It was observed

that none of the participant's highest level of education was a master degree or secondary school



#### 4. Discussions

This study evaluated the impact of Biomedical Engineers/Technicians on the functional status of medical device in the government in Uganda. The results from the study revealed that employing a Biomedical Engineer/Technician has an effect of the functional status of medical devices.

The hospitals that employed a Biomedical Engineer/Technician had fewer non-functional medical devices compared to hospitals that did not employ a Biomedical Engineer/Technician. Furthermore, the medical device statuses in hospitals where Biomedical Engineers/Technicians are employed were functional. This included medical devices such as; examination couch, autoclave, blood pressure machine, delivery bed, and glucometer.

This implies that the presence of Biomedical Engineer/Technician provides preventive maintenance and repair services to the medical devices which in turn prolongs their lifespan as well as keeping the medical device running. In hospitals where Biomedical Engineers/Technicians are not employed, even simple fixes to the medical devices are unattended to which with time deteriorates and drastically depreciate the quality of the medical device.

This study is consistent with other studies that indicates deploying a Biomedical Engineer/Technician reduces on the number of non-functional medical devices. For instance, In Rwanda, a training program on Biomedical Technicians enabled them to repair approximately 79% of the medical devices in areas where they were deployed [11]. In addition, another study revealed that deployment of Biomedical Engineers/Technicians resulted in the reduction of non-functional medical devices in the respective hospitals observed [14].

Resource constrain is one of the attributes to non-functional status of medical devices in the government hospitals. In most government hospitals in Uganda, it is usually one or two Biomedical Engineers or Technicians or both managing the entire hospital. As such, there is much workload on them when

compared to the number of medical devices available in the hospitals. Additionally, Biomedical Engineers/Technicians in the Regional Referral Hospitals are obligated to maintain and repair medical devices in the lower health facilities under their catchment area. Each Regional Referral Hospital can have over ten plus catchment health facilities in different other districts. With the little budget line to support the Regional Maintenance Workshop, limited spare parts, limited technical support from the manufacturers, among others, indeed frustrates and overwhelm the Biomedical Engineers/Technicians in the Regional Referral Hospitals.

The limited number of Biomedical Engineers/Technicians absorbed in the government hospitals due to financial sustainability has also attributed to medical device failures. Arguably, there will be no guidance to the procurement, end user training, routine inspection, maintenance and testing of medical devices.

Limitations to this study were majorly faced in the statistical analysis as a less rich tool was used. In addition, the sample number of medical devices were comparably small compared to the number of hospitals assessed. Therefore, it is recommended to conduct another bigger study to mitigate the bias on the sample number.

#### 5. Conclusion

In conclusion, having a Biomedical Engineer/Technician in a government hospital reduces the number of non-functional medical devices by providing simple and complex fixes to the medical devices. Therefore, it is recommendable to absorb many Biomedical Engineers/Technicians in the government hospitals to improve device status which in turn improves the healthcare service delivery.

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