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STUDY OF THE USE OF MEDICAL LABORATORY APPARATUS IN LOW RESOURCE SETS

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ABSTRACT

This study aimed to demonstrate the efficacy of an intervention strategy comprising ongoing training of medical laboratory equipment users, Biomedical Engineers, and Technicians (BMETs). From January through December of 2017, the Burkina Faso Blood Transfusion Service prospectively examined the status of 312 pieces of medical equipment in several regional blood banks. This group consisted of 170 pieces of equipment mentored by users and BMETs on how to use and maintain all equipment types. Medical equipment that was not participating in the intervention program was compared to 22 other types of medical equipment. Detailed interviews were conducted with twenty-one participants to gain insight into their experiences and the training's impact on their lives.

1. Introduction

Medical technologies have significantly improved treatment outcomes and the quality of healthcare globally in the previous two decades [1, 2]. However, health institutions in Low- and Middle-Income Countries (LMICs) are still struggling to employ medical tech- nologies in service delivery properly. Studies suggest that roughly 40 percent of the medical equipment in health facilities in low-resource settings is out of service [3]. The most commonly noted impediments to health technologies in low-resource locations identified in the literature include lack of replacement parts, shortage of consumables, lack of stable power supply, lack of user training, and lack of technical personnel [4]. The Japanese International Corporation Agency estimated that 20 percent of all equipment failures could be prevented by user training, 60 percent of the equipment failure could be prevented by routine preventive maintenance, whereas only 20 percent are caused by unavoidable system malfunctions [5]. User training enhances the percentage of functional medical equipment in use and minimizes the risk of equipment failure owing to user mistakes and carelessness.

Similarly, preventive maintenance averts possible causes of equipment failure before they inflict any serious damage. For example, dust collection can cause breakdowns in sensing and piping systems putting equipment out of operation. Such equipment failures can be readily avoided by routinely cleaning the equipment, which can be done without any specialized knowledge. Additionally, Engineering World Health [6] tests demonstrated that 70 percent of broken medical equipment in health institutions in LMICS could be fixed using locally accessible spare parts. It has also been observed that 3 percent - 25 percent of the medical equipment found out of service is functioning but not in use due to lack of consumables and user training [7,8]. With evidence-based capacity-building techniques, the quality of medical equipment in low and middle-income nations can be effectively addressed to optimise health service delivery. Current data suggest that successful methods to im- prove the adoption of medical technology in low-resource settings must involve training for users and BMETs to encourage safe use and preventative maintenance of medical laboratory equipment [7-9]. This study explores the impact of an intervention model meant to promote the utilization of medical and laboratory equipment in health facilities in low-resource nations. For more than five years, Knowledge for Change (K4C), a UK registered charity (charity no. 1146911), has placed volunteers from the UK in Burkina Fason hospitals to share knowledge and develop the capacity of health and allied health professionals in Burkina Faso through mentorship. Through its past work, K4C recommended and fought for the first biomedical engineer to be put at the Burkina Faso Blood Transfusion Services (BBTS) in 2018 to boost the utilization of medical laboratory equipment in the or- ganization. In 2018, K4C initiated a project meant to sup- port the work of this biomedical engineer through training and mentorship of medical equipment users to play their part in main- taining medical equipment. This study gives a description of the approach adopted by K4C in this context and the results produced with the purpose of creating evidence to indicate that such approaches can boost the utilization of medical laboratory equipment in low resource situations.

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2. Methodology

Based on Ackers and Ackers-significant Johnson's experience in 2016 [10] and the promotion of the Medical Research Council's 'Complex Interventions [11-13], an action-research study was used to implement the intervention. Beginning in January 2018 and ending in December 2018, a baseline inventory of medical laboratory equipment was taken, followed by an inventory assessment at six months and a year, ongoing mentoring from K4C and UK volunteers, three training courses, and key informant interviews. In Burkina Faso, BBTS is the only organization authorized to collect, test, and distribute blood for transfusion to all of the country's hospitals. Regional blood banks and collection centers make up the backbone of BBTS's blood transfusion services. Medical instruments and single-use medical devices were not included in the baseline assessment, which looked at all of the lab's medical equipment. A/C units have been included because their condition significantly impacts the blood bank equipment's operation. If we use laboratory blood storage as an example, we can see how critical room temperature is to the process. The architect analyzers and other equipment were frequently in good functioning order but were unused owing to a lack of adequate air conditioning in the facility. From a total of 214 pieces of equipment, 140 were selected for inclusion in the intervention group, and users were specifically taught on equipment that belonged to this group. The baseline inventory included 214 pieces of equipment. According to the BBTS administration's perspective and the baseline inventory, this equipment was carefully selected in consultation with the BBTS administration to determine the most valuable and most in-need equipment in blood storage and testing. In the investigation, 12 pieces of equipment could not be discovered during the subsequent evaluation and were therefore omitted from the analysis of data. It was impossible to randomly assign a control group since some equipment was deemed more important than others; hence, randomization was impossible.

Nonetheless, 42 pieces of medical equipment were chosen and included in a second group that was also evaluated utilizing the same data collection procedures for comparison. An action-research intervention using 202 pieces of equipment, including 160 in the intervention group and 42 in the second group, is detailed in this paper. Information gathered by the data collection tool included equipment model, serial number, serial number of the manufacturer, date of manufacture, physical location, serial number, and type of data collection instrument. This information was critical to accurately assessing the status of the equipment during 12 months. The tool is in line with WHO standards for managing medical equipment inventories. Based on their state, medical laboratory equipment was sorted into six subcategories, A-F, as indicated in Table 1. The Ministry of Health's directives for medical equipment inventory taking inspired this classification system. In conjunction with the users and the BBTS biomedical engineer, an independent biomedical engineer collected this data and determined this condition.

Additionally, we performed key informant interviews with 21 participants, including 12 laboratory technologists, 3 laboratory managers, 4 quality officers, and 2 administrators, to determine the impact of the interventions from the perspective of the devices' end-users. All interviewees gave their permission to engage in this study, which the BBTS Executive Director and all participants approved. However, the interviews were not aimed to collect personal information, but rather they were designed to collect specific information about the obstacles of using medical equipment and how a K4C-building model affects the utilization of medical equipment. The Ministry of Health's medical equipment inventory-taking requirements inspired this A – F scale (11).

Table 1 The state of the equipment determines the various equipment groups

Category	Interpretation
A	In use and in good functioning order equipment
B	Equipment that is in good operating order but is not in use
C	Equipment in use but needs repair
D	Equipment in use but needs replacement
E	Equipment out of use but repairable
F	Equipment that is no longer in service and must be replaced

3. Interventions

Co-workers and mentors in BBTS also organized three formal training courses to instruct laboratory technologists and BMETs. BBTS only had one biomedical engineer on staff at the study, but no biomedical technicians were on the team either. Although K4C invited biomedical technicians from the Ministry of Health to participate because they are mandated to assist in managing medical laboratory equipment in BBTS, they declined. As part of K4C's model, professionals from the UK are sent to Burkina Faso to work with local healthcare personnel and mentor them. A clinical engineer, a cold chain specialist, and a long-term (biomedical engineer) volunteer from the United Kingdom were all placed at BBTS during this project, which lasted for the entire duration (1 year). Mentoring local health professionals during this period allowed K4C volunteers to assist ongoing knowledge sharing and translation (usage) and help execute technical skills

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learned during formal training interventions. The team also encouraged the transfer of skills and knowledge among their colleagues at the institution.

The BBTS offices in the capital city hosted all of the training sessions conducted in lecture mode using PowerPoint presentations and problem-based learning. With the help of a facilitator, they were divided into groups of four-six people to discuss a hypothetical or real-world problem (19), learn about healthcare technology management, maintenance, and repair through case-based learning methodology (20), and put their newly acquired skills to the test in hands-on sessions (21). K4C volunteers and local specialists from Burkina Fason biomedical manufacturing enterprises and the College of engineering and technology College School of Biomedical Engineering provided the instruction.

4. Discussion

In contrast to high-income nations, health facilities in low-income countries have limited access to technical support from equipment makers [14-16]. According to this research, a health facility can buy the same equipment from up to 35 different manufacturers. This study shows that LMICs' rules on medical equipment procurement are either poor or non-existent [17, 18]. As a result of the absence of technical support in low-income nations for medical equipment, a wide range of manufacturers are selling the same equipment. According to findings in this research, procurement strategies for medical equipment in low-resource settings should be updated to account for the lack of local technical experience and the lack of access to international producers for support throughout usage.

The absence of user training or installation of medical equipment in low-resource health facilities is also cited as a factor in the low utilization of medical equipment. Our findings demonstrate that in the intervention group, the percentage of medical equipment in good functioning order but not in use grew from 4% to 7%. Compared to the 7 to 21% increase in equipment used in the second group, this was a little divergence. This shows how user training improves medical equipment use in these circumstances. A scarcity of reagents and consumables was blamed for increasing equipment in this category. The manufacturers of medical equipment in Burkina Faso (and other LMICs) tend to give free or low-cost medical equipment to health facilities in exchange for the health facilities signing long-term contracts to buy expensive reagents from the manufacturers. These health organizations sign contracts but cannot use the equipment due to a lack of reagent funds later on in the process. Because of a shortage of reagents, we have seen blood analysis in some BBTS blood banks halted for weeks or even months. According to one of the equipment users, "You can take a whole week when you don't have reagents. If they only last four days, you'll have to wait another week without them, which is our biggest challenge. Procurement and planning also face considerable difficulties due to a lack of legislation and tools for evaluating contracts [9]. Rather than focusing just on the initial purchase price of medical equipment, we advocate for more severe assessment procedures that take into account the long-term expenses of care and donations.

Only one qualified biomedical engineer and no biomedical technicians supported her in managing and maintaining medical equipment in all seven regional blood banks, as indicated by the data. Recruitment and human resource policies at government health facilities are deficient. One technical person can't possibly handle the distance and workload involved.

The University School of Biomedical Engineering graduated 114 biomedical engineers in Burkina Faso in July 2019. However, the Ministry of Health has absorbed these biomedical engineers at a very modest pace. On the other hand, Biomedical engineers were not included in the human resources service plan until 2016 [18]. Implementing partners working with the Ministry of Health and other public health institutions should advocate for the creation and filling of BMET positions. Although they could convince the upper management of BBTS to hire at least one biomedical engineer in 2017, K4C's efforts were insufficient. Additionally, the lack of BMETs demonstrates the importance of educating end-users on using and maintaining their equipment.

Low-resource countries lack BMETs, which means that the medical professionals who use them must be responsible for ensuring that they function properly. Medical equipment management is not included in any Burkina Fason medical, nursing, or laboratory school curricula, as far as we know. Equipment in blood banks and other cutting-edge labs, for example, needs additional training beyond what is provided by the standard curriculum for laboratory personnel. Medical equipment training is scarce for these users, as are the resources available to them from manufacturers, suppliers or the host health institutions. Policies are needed to ensure that health professionals in low-resource countries have access to medical technology training as part of their education and professional development. The Burkina Fason Blood Transfusion Service, for example, is significantly reliant on equipment to work and does not give their professionals or users ongoing Continuing Professional Development in the field of equipment management.

A higher percentage of well-maintained and actively used medical laboratory equipment was found when participants were instructed on its proper use. As a result, 90% of all medical equipment used by intervention patients was used for the entire 12-month trial period. Another way to see the impact is through common quotes from equipment users, such as these: We returned and performed some (preventive) maintenance following the training, and we found that the equipment had not broken down much. Engineers in the laboratory

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As a result of this exercise, I've seen increased awareness. People are paying greater attention to the equipment because they're more aware of it. Engineers in the medical field are becoming more and more proficient. People who have received training have developed an interest in medical laboratory equipment, and I've seen documentation, standard operating procedures, and manuals as a result. I've also seen a record of this. I can now make use of this paperwork." The head of the laboratory.

It is important to highlight that the same users taught in this study were employed in both the intervention and comparison groups. Benefits such as increased motivation and self-assurance in medical equipment management can be applied to all medical equipment, not just that used by the intervention group.

As a result of various people and organizations, medical equipment in low-resource countries is being improved by performing outreach projects to repair broken equipment. Biomedical engineering student volunteer programs [7, 19], externally funded projects like Engineering World Health, and technical teams from the Ministry of Health are just a few examples in Burkina Faso [20-22]. Suppose these programs include extensive user training sessions as part of their operations. In that case, they will have a longer-lasting impact because of the high frequency of medical equipment breakdowns in low-resource health institutions. It's also possible that improvements in equipment conditions last up to two years after skill-building programs have ended [23, 24]. This study's findings are expected to impact BBTS and Burkina Fason policymakers, especially if BBTS and the country's top decision-makers provide further funding and guidance.

4.1 Limitations

All medical equipment, not just that in the intervention group, can benefit by learning about safety precautions and documentation and management best practices taught in the intervention group. This is because the same users trained to operate both groups' equipment also learned these best practices for the second group's equipment. This suggests that the training sessions conducted had a beneficial impact on the condition of the medical laboratory equipment in the second group. There is a good chance that when comparing results from training and control groups, the reported impact on enhancing medical equipment utilization is overstated. The second group cannot be considered a "control." The cost of training and preventive maintenance should be compared to equipment breakdown in future studies.

5. Conclusion

Finally, this study's findings suggest that K4C's strategy of co-learning and mentorship between BBTS users and BMETs successfully increased the use of medical equipment in the system. Medical personnel in low-resource countries should be trained in medical equipment management using this technique, and standardized programs or curricula should be developed. Additionally, medical personnel, including laboratory workers, must receive regular training in the proper use of medical equipment and have this topic included in their training courses.

The curriculum for the study's training classes sought to answer the following questions: (1) How does this equipment work? (2) How is it put to use in day-to-day business? The recommended preventive maintenance actions are listed in question three. (4) What are the most prevalent mistakes, and what can be done to avoid them? If you're using this machine, you'll also want to be aware of the following safety issues: For most medical equipment, these questions are readily available, so identical courses can be produced for a wide range of medical equipment types. The planned training curriculum should be accredited and approved by recognized educational institutions so that participants are issued certificates of completion that contribute to their professional and academic advancements. One of the most important factors encouraging health workers to attend training programs is the desire to put their newly acquired skills and knowledge into action in the real world of practice to improve the quality of medical equipment and provide high-quality care [25-29].

Decisions made during the planning and acquisition of medical equipment will influence the impact of the suggested training approach. This necessitates the creation of national and organizational policies and procedures for the donation, acquisition, and planning of medical equipment. These guidelines should consider the cost of reagents, consumables, user training, technical experience, spare parts, and the variability in manufacturers and suppliers. This might be outlined in an organizational procurement guideline for evaluating procurement bids and contracts. Using the data presented in this research, policymakers in low-resource nations may better train health care workers and BMETs and make better use of medical technology.

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