AN EVIDENCE-BASED CURRICULUM FOR BIOMEDICAL TECHNICIAN'S ASSISTANTS IN RESOURCE-POOR SETTINGS

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Abstract

More than half of all medical devices in the developing world are out of service. The lack of working equipment has a devastating effect on healthcare. Based on a recently completed study of several thousand pieces of out-of-service equipment in developing world hospitals, we have shown that most of this equipment can be put back into service using basic knowledge and without importing spare parts. We have developed a Biomedical Technician's Assistant (BTA) curriculum to train secondary school graduates in resource-poor settings to accomplish these repairs. The BTA curriculum aims to provide a sustainable method for local technicians' assistants to repair and maintain medical equipment. The first trial of the curriculum is currently underway in Rwanda.

1 Introduction

Most of the laboratory and medical equipment in resource poor settings is not in service [1]. Unfortunately, the causes of the equipment malfunctions and effective solutions are largely unknown.

Certainly one of the most common causes for a piece of medical equipment to be out of service is the lack of consumables [2], including reagent packs, electrodes and other single use devices. However, a large quantity of out of service equipment does not require consumables. Technician surveys have suggested that a lack of spare parts is the primary cause [2]. If this indeed is the problem, then the solution should be to create a spare parts pool that resource poor hospitals could draw from. However, surveys can only reveal what the participants perceive to be the primary problem, not necessarily what the evidence supports as the problem. In addition, surveys are particularly weak at revealing complex people-machine interactions.

An alternative hypothesis is that medical equipment is out of service because of the lack of trained professionals able to execute the needed repairs or maintenance, usually considered a lack of biomedical engineering technicians or biomedical engineers. If the problem is the lack of professionals, then the solution would be training. Indeed, there are programs that focus on training high school graduates to become biomedical engineering technicians (BMET), where the role of the BMET is often to repair, maintain and manage laboratory and medical equipment in hospitals. Even if this hypothesis is true, there is no data to support the assumption that BMET training is the optimal amount of training for a resource poor setting; perhaps less expensive or less time consuming training is sufficient.

This paper examines the causes of the out-of-service equipment and presents a potential solution.

2 Methods and Results

2.1 Data Collection

Between 2003 and 2008 approximately 100 engineering students, biomedical technicians and engineers spent from two weeks to one month working in a resource poor hospital. For every piece of equipment they discovered to be out of service, or the staff reported as being out of service, they submitted engineering reports. We examined 2849 engineering reports from 60 resource poor hospitals to determine 1) why the equipment was out of service, with particular emphasis on the need for spare parts and 2) what knowledge or skill was required to return the equipment to service, with particular emphasis on the knowledge typically included in BMET training. Of those, 2529 were determined to be laboratory or medical equipment (320 pieces were determined to be non-medical). In other words, 89% of engineering requests in resource poor hospitals are for medical equipment [3].

Of the 2529 pieces, 1821 pieces were repaired. This is a remarkable result. Without the use of imported spare parts and without extraordinary financial resources or specialized

tools, engineering volunteers were able to put 72% of the equipment back into service. This strongly contradicts the hypothesis that most medical equipment repairs require imported spare parts to be returned to service in resource poor settings. Based on the repots from the repaired pieces of equipment, we identified the knowledge and skills required to complete the repair. We found that six domains of knowledge were required to accomplish 99% of the repairs: electrical, mechanical, power supply, plumbing, motors, and installation or user training. [3].

2.2 Curriculum Development

From the evidence we gathered, we prepared a curriculum sufficient to teach the identified skills. The BTA curriculum includes a set of 115 basic skills required frequently in the repair of medical equipment. The skills were classified into 5 knowledge domains: Plumbing, Mechanical, Electrical, Power Supply and Motors. Each general knowledge domain was further specified into Units, of which there are 25. Each skill is classified by its general Knowledge Domain, and further by its Unit. For example, the skill of Descaling is in the Blockages Unit, which is in the Plumbing knowledge domain.

Knowledge Domain	Unit	Skill
Mechanical		
Plumbing	Leaking	Finding holes Cutting tubes Electrical tape Epoxy Superglue Rubber patches Melting tube
	Connections	Clamps Hose barb with clamp Threaded pipe connector
	Seal	Caulk O-rings
	Filters	Cleaning
	Blockages	Routing Cleaning Descaling
Motors		
Power supply		
Electrical		

Table 1: BTA Knowledge Domains, expanded into Units and Skills, within the Plumbing Domain, as an example.

Each module consists of an introduction as to why the skill is necessary, an example of when the skill is used, an exercise to demonstrate essential aspects of the skill, and methods to identify when the skill must be used.

2.3 Curriculum Implementation

The program will span two years: five or six months preparatory work in the hospital prior to the training, five weeks of equipment repair training at a central facility, followed by 18 months of mentored work back in their hospital. To qualify, the trainee must be currently employed at a hospital. In the six months after committing to the program the trainee must complete certain tasks: First, the trainee should conduct a physical inventory of the tools and medical equipment available in the hospital (both broken and in service). The technician will be responsible for locating and buying tools and supplies necessary for the training, with our help, from local sources. The BTA program emphasizes the ability of the hospital to use locally available tools and materials, but some of them may not be familiar to the trainees.

Next, the trainee will have five weeks of classroom work on equipment repair. The equipment repair training would be conducted in a central location. An experienced Biomedical Technician will provide instruction. The technician will be trained using a structured training curriculum. A series of laboratory exercises will be used to teach core skills needed to repair the equipment. After the classroom training, trainees return to their hospitals. During the following eighteen months, they will be give support in their repair efforts. Trainees will be able to access expert advice from around the world via text messaging and the internet. Trainees' performance will also be tracked to insure that they are using the skills they have learned to benefit their hospitals.

After successfully completing the two years of training and supervised hospital work, the trainee will receive a certification in equipment repair. Running a single session each summer, up to 25 people could be trained per year in this program.

2.4 Rwanda

The first trial of the BTA curriculum are currently being implemented in Rwanda. The program will be a partnership between the GE Foundation, Duke University, Engineering World Health, the Rwandan Ministry of Health and the Ministry of Education.

The first class in Rwanda will have 15 trainees, from 15 different hospitals across the country. Subsequent classes will have up to 25 participants. The program's goal is to reach 115 hospitals, at which point we believe the program will be self-sustaining.

3 Conclusions and Discussion

Our data suggests that a graduate of the BTA curriculum could return 66% of the broken medical equipment in their hospital to service independently. The BTA curriculum aims to provide a sustainable solution for the training of qualified medical technicians in the developing world. After the program in Rwanda reaches 115 hospitals, we anticipate that it will be self-sufficient, and at that point, we will expand the program to other developing countries.

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