

The potential role of IFMBE in improving the state of medical equipment in developing countries

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Abstract— In developing countries medical equipment is often non-functional. Well known reasons for that are donations of already broken equipment and lack of spare parts and consumables. It is to be expected that current *state of the art* medical equipment is even less suitable for donation, given the way they are designed to function under conditions that are hard to find in rural areas in low resource countries. The key to start solving these problems lies in improving technical education at all levels in these countries.

This paper explores how the IFMBE can work together with several other institutions (WHO, local professional organizations, non-profit organizations, Ministries of Health and Education,...) to train and sustain a competent technical workforce that can do maintenance, repair, and design of biomedical equipment using locally available materials and knowledge.

Keywords— Developing countries, education, sustainability, BMET

INTRODUCTION

Functioning, available medical equipment is a huge challenge faced by health systems in Africa with studies suggesting that at least 40% [1] of medical equipment is out of service, with many studies citing 50-80% [2]. In high-income countries by comparison, less than 1% of medical equipment is out of service.

Up to 80% of the medical equipment in many Sub-Saharan countries is donated or funded by foreign sources [3], and 70-90% of donated equipment is never operationalized [4].

The availability of appropriately trained staff to manage, maintain and repair equipment is limited across sub-Saharan Africa [5]. The first global survey of Biomedical Engineering (BME) teaching units identified only 19 teaching units in sub-Saharan Africa [6]. Only ~35% of Sub-Saharan countries have a registered Professional Association of BMEs which are often under-resourced [7]. In low resource settings, the role of such bodies is particularly relevant to, for example, exchange experiences, expertise and materials and to advocate for the profession with the Ministry of Health. The lack of budgets, processes and regulations at national level are factors that could be influenced by professional associations as well.

There are several reasons for the current state of medical equipment in developing countries. In this article we would like to highlight three and link them to potential solutions within the reach of the International Federation of Medical and Biological Engineers (IFMBE);

1. Inadequate Human Resources/insufficient training for users and maintenance staff
2. Lack of service, spare parts, consumables and accessories
3. Poor equipment lifecycle management



1. INADEQUATE HUMAN RESOURCES

Inadequate human resources is a broad topic. We consider three different levels of Human Resources influencing the state of medical equipment:

- A) Users; the lack of trained users: most medical equipment breaks down due to user errors
- B) Maintainers; the lack of trained maintenance staff
- C) Trainers; lack of trainers teaching maintainers how to maintain, repair equipment and train users

A. User training

User training is one of the tasks of the Biomedical engineering professional in the hospital. In tender procedures user training performed by the manufacturer should be required by the buyer, but as mentioned earlier, most medical equipment present in low-resource settings does not follow routine tender procedures (e.g. donations). Therefore the BioMedical Equipment Technicians (BMETs) should take this responsibility in collaboration with the different hospital Head of Departments (e.g. head of Nursing). This is one of the reasons we need trained/qualified technicians.

B. Training of maintenance staff

Most developing countries face a shortage of qualified maintenance staff in their health facilities. Often medical equipment specific tasks are performed by polyvalent technicians (electricians, mechanics, etc) without appropriate training. Less than half of the sub-Saharan African countries offers biomedical technology training.

Several organizations have taken initiative to increase to number of accredited BMET trainings, for example AmaltheaTrust.org.uk in Uganda, EWH.org in Rwanda, Honduras, Cambodia and Rwanda, and THET.org in Zambia. Finding a partner college or university, writing and implementing a curriculum, creating a lab with equipment is all within reach. However, for sustainability local BME trainers are a crucial factor to success.

The organisations mentioned earlier are building up a significant amount of experience that should be used for further expansion of similar programmes around the world. IFMBE could play a role in encouraging and enabling this work.

C. Training of trainers

When working on the creation of BMET programs in developing countries one of the first things that need to be created and financed is a solid train the trainer program. As long as no qualified trainers are present in the country, the BMET department will depend on foreign expertise and often charity.

Here lies a major task for the IFMBE. It is the professional organization for biomedical engineers worldwide. The teachers for this new generation of teachers will in general be BMEs on a MSc or PhD level and members of the IFMBE. They can be located via and supported by the various groups and divisions within the IFMBE. For the federation being involved is also an investment in its future, those trained will be the future members members.

To create a sustainable and structural improvement of the educational system in developing countries, a technical curriculum should be offered at secondary school (e.g. the

BTA skill curriculum from R. Malkin [8]), followed by options to follow BMET diploma programmes, and BSc/MSc in Clinical Engineering.

2. LACK OF SPARE PARTS, CONSUMABLES AND ACCESSORIES

The lack of an appropriate service structure is a limiting factor in many developing countries. Even qualified technicians can not execute proper equipment maintenance and repair without a service infrastructure. The latest equipment can hardly be serviced without a service engineer trained by the manufacturer, the supply chain of spare parts, consumables and accessories is sometime non-existent.

We suggest a two way approach to tackle this issue; for the shorter term improvement of service logistics and for the long term the development of locally designed and manufactured sustainable medical equipment and consumables.

A. Improve service logistics through professional associations

Manufacturers need to be convinced to improve their service network ('world wide warranty'). Professional associations play a significant role in forcing local agents to improve their service channels, meaning timely access to spare-parts, service contracts for reasonable fees, presence of qualified service engineers and reliability in general. IFMBE can play a role in the strengthening of biomedical professional associations to empower them to fight for change.

Besides this bottom-up-approach it could be interesting to see if IFMBE, in collaboration with e.g. the WHO could invite the main medical equipment manufacturers to discuss this issue on a global level. This top-down-approach could for example focus on the creation of consumable factories in low and middle-income countries.

B. Encourage local development of medical equipment

25, even 15 years ago electronic systems were designed with PCB's, dual in line IC's from the 7400 and 4000 series, and transistors and resistors that you could pick up by hand. When something was broken you could consult the schematics, isolate the malfunctioning component and replace it. Nowadays we have SMD components that are so small that you have to use special equipment to handle them, most of the logic is hidden in custom made chips and firmware for embedded micro-controllers. It has made systems more reliable, but the only way to 'repair' things is by replacing them. Add to that that in many cases equipment is not what the company makes the money on, it is the consumables. Designed in such a way that you really can only use them once. This, however, assumes a short supply line

of consumables, spare parts, and even a technician from the company on stand-by.

Moreover modern equipment often communicates with the outside world (e.g. the EHR system) by way of WiFi or ethernet, not the phone system that is the preferred network in rural areas in the developing world.

Thus it is necessary to encourage developing countries to design their own equipment, appropriate to the local needs, climate and skill levels, that can be produced locally, is safe, repairable/reusable, and either does not require consumables or only ones that can also be produced locally.

Referring to the educational structure in Chapter 1, it would be appropriate to encourage innovation from secondary school level onwards. Development of medical equipment fits better in University level than on BMET diploma level, so entrepreneurship and design should be topics well embedded in the BSc/MSc curricula proposed.

3. LIFE CYCLE MANAGEMENT

Life cycle management and preventive maintenance is important and can very well be executed also in a low resource setting[9]. Due to the lack of structure, budgets and qualified technical staff, today there is a great need for expertise and implementation of Healthcare Technology Management (HTM) structure, HTM should be taught at both BMET diploma level and BSc/MSc levels and should be part of Continuous Professional Development under the wings of the professional associations. The IFMBE and especially the Clinical Engineering Division has the knowledge required.

CONCLUSIONS

Given that state of the art equipment in the developed world will probably not function in low resource environments it is necessary that knowledge to produce sustainable biomedical equipment and consumables locally.

There are many places where the IFMBE could help develop that knowledge and skill base. Its constitution allows and even advocates to support programs to:

- support train the trainer programs in BME with experts, expertise and e.g. travel grants for teachers
- help countries to enhance the secondary school curriculum with more technical/BMET skills like BTA
- help set up BME BSc/MSc courses in local universities with focus on entrepreneurship and innovation/design
- provide scholarships (preferably for local universities)

- help set up BMET diploma courses in local colleges with a focus on hands-on maintenance and repair through collaboration with THET, EWH, Amalthea Trust and other expert group.
- help professional associations with technical and practical expertise and interactions with local governments. Provide assistance for continuous professional development with e.g. travel grants.

To achieve these long term goals, the IFMBE should in coordination with the WHO interact with Ministries of Health and Education to strengthen the entire chain from secondary school to BME departments at universities, to Continuous Professional Development.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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