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Economic Commission for Africa

Policy Brief

Building biomedical engineering capacity for improved health-care outcomes in Africa

Summary

African countries heavily rely on the import of medical devices and foreign expertise to install and maintain medical devices. Based on a three-year pilot project[1] undertaken by the Economic Commission for Africa (ECA) in Ethiopia, Kenya, Malawi, Uganda and Zambia, this policy brief recommends three policy actions that can be used to mobilize universities to build biomedical engineering skills, entrepreneurial mindset and innovative capacity in order to meet the continent's health-care needs. The recommendations are: support and promote biomedical engineering training in institutions of higher learning; inspire biomedical innovations among students and researchers through the establishment of competitions and awards; and use of public procurement contracts as a tool for technological learning and commercialization.

Introduction

Innovations in medical[2] devices have played a major role in enhancing the diagnosis of diseases, treatment of illnesses, rehabilitation of the injured, comfort of patients and mobility of persons with disabilities, and performance of complicated operations. Simple medical devices, such as thermometers and microscopes, have been at the forefront of the fight against malaria, while more sophisticated equipment, such as X-Ray machines, are important in the fight against tuberculosis. The advances in medical devices have reduced the time and costs of detecting tuberculosis,[3] increased access to rapid HIV testing kits[4] and are eliminating the use of harmful chemicals through increased use of digital X-rays.

To meet the growing need for improved health care, African countries are estimated to have spent about $3.2 billion, about 3 per cent of total health-care expenditure, in 2010[5] on imports of medical devices. Most of these imported medical devices were designed for use in developed countries. Some of the support infrastructure and skills needed to maintain and appropriately

1 The project, which is entitled "Engineering Capacity for Improved Healthcare Outcome in Africa" involves nine universities in Ethiopia, Kenya, Malawi, Uganda and Zambia and eight partner support institutions in Africa, Europe and the United States of America.

2 The terms medical and biomedical devises are used interchangeably

3 Manunank Shah and others, "Comparison of laboratory costs of rapid molecular tests and conventional diagnostics for detection of tuberculosis and drug-resistant tuberculosis in South Africa", *BMC Infectious Diseases*, Issue 12, pp. 352. Available from http://www.biomedcentral.com/1471-2334/13/352.

4 United States, Food and Drug Administration, "First rapid home-use HIV kit approved for self-testing", Consumer Update Section, 3 July 2012, Available from http://www.fda.gov/forconsumers/consumerupdates/ucm310545.htm.

5 Espicom Business Intelligence, African Medical Device Market 2012 Fact Book, http://www.espicom.com/african-medical-market-fact-book, Business Monitor International (2012).

use these medical devices are lacking or inadequate. According to a study on hospital inventory in sixteen countries made during the period 1996 to 2010,6 about 30 per cent and 39 per cent of medical devices in Nigeria and Ethiopia, respectively, are out of service, largely due to inappropriate use, lack of maintenance and poor infrastructure.

For instance, the Nyanza General Hospital imported brachytherapy equipment for cancer treatments at a cost of 30 million Kenya shilling (K Sh) ($340,000) in 1998. The equipment was installed in 2002, but by the end of that year, it was reported to have "broken down". The hospital finally raised the one million K Sh needed for the pre-payment to have engineers sent in to inspect it in 2006. When the equipment was inspected in October 2008, the engineers found nothing wrong with it, saying that it had not been operated properly.[7] This incident highlights the urgent need for skilled human resources if complex medical devices are to be effectively deployed to improve health care in Africa.

Defining a medical device

A medical device is broadly defined as "an instrument, apparatus, implement, machine, contrivance, implant, in vitro reagent, or other similar or related article, including a component part, or accessory which is:

- recognized in the official National Formulary, or the United States Pharmacopoeia, or any supplement to them,
- intended for use in the diagnosis of disease or other conditions, or in the cure, mitigation, treatment, or prevention of disease, in man or other animals, or
- intended to affect the structure or any function of the body of man or other animals, and which does not achieve its primary intended purposes through chemical action within or on the body of man or other animals and which is not dependent upon being metabolized for the achievement of any of its primary intended purposes."[8]

Strategies and policy actions employed

Encouraging and supporting universities to develop human resource for medical devices

In order to deploy the diverse medical devices needed to deliver improved health care, a host of skills is required, ranging from, for example, basic electrical/electronic engineering, life sciences, computer science and support social sciences to specialized skills, such as those related to material science, artificial intelligence and genomics. Current initiatives in Africa are primarily focused on building technical skills to improve maintenance and repair.

A more comprehensive approach to skill training and development of capable biomedical engineering manpower is encouraging and supporting universities in efforts to develop and implement biomedical engineering (BME) programmes. These programmes cover, among other things, a wide range of engineering, medical, software programming and entrepreneurship courses; they are specifically designed to develop a broad base of requisite skills in designing, installing, commissioning, maintaining, decommissioning and safely disposing biomedical devices.

For instance, with the support of ECA, a generic BME curriculum has been developed. The curriculum has already been adopted by three universities to quickly develop their BME programmes. In addition, the Commission has also started to promote BME as a core field of study and industrial development. The promotion efforts have spurred increased cooperation among universities and industrial partners and with governments. One such partnership in

6 L. Perry and R. Malkin, "Effectiveness of medical equipment donations to improve health systems: how much medical equipment is broken in the developing world?", Med Bio Eng Comput , vol. 49, Issue 7 (20 May 2011) pp.719-722.

7 Cosmas Butuny, "Sorry state of cancer treatment", Daily Nation, 10 January 2009.

Available from www.nation.co.ke/News/-/1056/513126/-/u18wl2/-/index.html.

8 United States, Food and Drug Administration, "What is a medical device", FDA basic questions.

Available from www.fda.gov/aboutfda/transparency/basics/ucm211822.htm.

Uganda has enabled the entire class of BME at Makerere University to obtain access to state-of-the-art facilities at the Uganda Industrial Research Institute. Governments, with their greater national influence and resources, could ensure that BME programmes are adequately funded and supported by key partners.

Promoting innovation awards among researchers and students

Incentives help stimulate research and innovation among different players by encouraging competition and recognizing achievements. In the case of biomedical devices, competitions and awards could be tailored to deal with specific targeted population sectors, such as childern or persons with disablities, diseases, such as HIV/AIDS, tuberculosis or malaria, and technologies, such as genomics or 3D printing. As examples, the ECA International Design Competition and the Innovator Summer School awards have successfully generated 21 concepts and 53 ideas, respectively, over the last two years. Inspired and encouraged by these competitions and awards, at least two student teams have pursued their innovative concepts further and one team is offering its service to at least three hospitals in Uganda. As such, special attention should be paid to young people and to the formation of multidisciplinary teams. In general, awards recognize the value of innovative ideas and promote competition among researchers and firms, which, in turn, drives innovation.

Inclusion of public procurement as tools for promoting innovation

Government procurement contracts are a major source of technological learning, as well as being a means for inspiring innovation. Firstly, suppliers of complex medical devices, such as an electron microscopes or magnetic resonance imaging, should be required to train as many interested technicians, researchers and students in their installation, proper user and maintenance. Second, joint ventures and industrial alliances among international suppliers and domestic firms should be encouraged. Third, some contracts should be reserved for domestic investment promotion or domestic producers or service providers. Finally, some contracts could be used to stimulate the development of novel medical devices and support services to meet domestic challenges or requirements. All these avenues present ways in which procurement could be used to promote national technological learning and innovation.

For instance, human capital development was made part of the public procurement of a medical devices agreement between the Government of Uganda and the Government of the Netherlands. Under the agreement, the Netherlands provided Kyambogo University with funding, equipped a biomedical engineering training laboratory, and supported training of selected members of staff in course development and delivery. The first class of the course graduated in 2013. The class notably had successfully repaired equipment previously written off by engineers from the Ministry of Health at three referral hospitals in the country. This case proves that procurement could serve as an opportunity for learning and human capital development.

Challenges

African universities face many challenges that have an impact on effective delivery of BME programmes. Some of the key challenges that specifically affect BME programmes are as follows:

1. Limited numbers of lecturers with qualifications in BME. As a new field, there are few lecturers that can effectively teach BME courses. In Uganda, two of the senior medical devices engineers at the Ministry of Health teach BME at both Kyambogo University and Makerere University due to limited numbers of lecturers
2. Lack of facilities. The basic laboratories for training BME engineers are inadequate due to limited funding.
3. Lack of infrastructure that encourages research and innovation. Facilities where students can undertake design and rapid prototyping, multi-disciplinary platforms for tackling challenges, such as seminars, and

technology transfer offices and incubators are either lacking or still emerging

4. Weak links between medical and engineering professionals and between universities and industry. BME students are required to spend time in hospitals to learn not only about medical devices, but also about the "culture" of hospitals and medical professionals and identify challenges.

Policy recommendations

There are many ways in which governments and development partners can support universities to develop the necessary skills needed to install, maintain and upgrade, as well as to design and produce, medical devices. Below are three main policies recommendations for meeting this goal:

- Encourage universities to develop biomedical engineering graduate and post-graduate programmes in close collaboration with hospitals and industrial partners. This should include support to train lecturers and researchers BME.
- Design awards and competitions to drive biomedical device innovation and entrepreneurship. Such awards may require engineering students and researchers to form teams with professionals in the field of medicine, among others, to encourage the establishment of multidisciplinary teams capable of bringing products to market.
- Carefully utilize procurement contracts as tools for technological learning and for facilitating innovation and entrepreneurship. These could also serve as platforms for building the capacity of lecturers, researchers and entrepreneurs, as well as for improving facilities.

These policy measures may support the current efforts to build an indigenous pool of human capital that has the entrepreneurial mindset and requisite skills to effectuate the deployment and management of medical devices.

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