

Enhancing the use of computed tomography and cardiac catheterization angiography in Zambia: A project report on a global extension of medical technology in Japan

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Abstract: Cardiovascular disease (CVD) is one of the leading causes of death in adults in Zambia among the non-communicable diseases. The Government of the Republic of Zambia through the Ministry of Health procured Japanese radiological systems, computed tomography, and angiography for the University Teaching Hospitals (UTHs) – Adult in 2015. However, the operation of these diagnostic systems has not been optimal due to lack of a proper maintenance service plan, lack of competent health professionals, and erratic supply of medical consumables. In this study, we report our experiences of providing intensive training to multidisciplinary healthcare teams of the radiology department at UTHs – Adult from 2017 to 2019 to strengthen the quality management system of the radiological equipment so as to provide effective healthcare services. However, the COVID-19 pandemic has had enormous negative impact on essential healthcare. Long-term support through continuous hands-on training must be provided to establish sustainable healthcare services.

Keywords: diagnostic radiology, quality management, multidisciplinary team, coronary computed tomography angiography, percutaneous coronary intervention

Introduction

Cardiovascular disease (CVD) is one of the leading causes of death in adults in Zambia among the non-communicable diseases (1). Zambia is experiencing a significant increase in non-communicable diseases and their risk factors, along with decreasing incidence of communicable diseases (such as HIV, malaria, and tuberculosis). In 2012, CVD comprised 8% of the total deaths in Zambia (2). Its cultural beliefs and economic factors, such as unhealthy diet, physical inactivity, smoking, and alcohol abuse, increase the risk of CVD (3). Computed tomography (CT) and angiography systems are useful for accurate diagnosis and proper treatment of CVD. With these systems, coronary CT and coronary angiography (CAG) are performed for accurate diagnosis of coronary stenosis, the most common cause of heart attack. Percutaneous coronary angiography (PCI) is performed to treat coronary stenosis whenever required. However, as of 2018, only 13 CT and one angiography systems exist in Zambia (4).

To strengthen the diagnosis and treatment of CVD in

the top referral and teaching hospital, the Government of Zambia, through the Ministry of Health, procured Japanese-made CT and angiography systems for the University Teaching Hospitals (UTHs) – Adult in 2015. However, the operation of these diagnostic systems has not been consistent due to lack of proper maintenance service plan, lack of competent health professionals, and erratic supply of medical consumables. In addition, Japanese companies, due to their poor strategy, have been unsuccessful at marketing high-priced medical consumables in low- and middle-income countries.

Therefore, a number of patients with serious CVD visit neighboring countries (e.g., South Africa and Egypt) for definitive diagnosis and specialist treatment. The government has experienced a large increase in spending on CVD treatment abroad where the Government of Zambia and private Zambians spend not less than \$10,000 USD per treatment (5). The Government of Zambia offers full financial support for patients identified and referred by the Ministry of Health to a medical institution abroad.

To cut down government spending on treatment

abroad and upon the request from UTHs – Adult, the National Center for Global Health and Medicine (NCGM) provided intensive training to multidisciplinary healthcare teams from 2017 to 2019. This study aims to report our experience in order to strengthen the quality management system of the radiological equipment, eventually provide quality health services, and draw lessons to help other low- and middle-income countries facing similar problems.

Approach

This project adopted three pragmatic approaches:

i) Capacity building focusing on a multidisciplinary healthcare team. Instead of traditional training targeted on the physician only, this project provided training in a multidisciplinary team, comprising two medical doctors, three cardiac catheterization laboratory nurses, and six radiologic technologists who went to Japan to acquire proficiency.

ii) Training programs unique to the project. The training program consisted of lectures, observations at the NCGM hospital, factory visits, and hands-on practice with a simulator. The lecture series ran the gamut of diagnostic radiology with the aim of developing the quality management system in the radiology department at UTHs – Adult, such as the standard procedures for coronary and radiation dose control (6), quality assurance (QA), standard procedures for CAG and PCI, and their radiation dose optimization (7,8), medical safety, and infection control (9). Zambian trainees were exposed to advanced diagnostic radiology through factory visits to two medical device manufacturers.

They observed an assembly line for cutting-edge products (*e.g.*, 320 lines of area detector CT and magnetic resonance imaging enabling a 90% reduction of sound during examinations). They also visited a simulation laboratory to practice catheterization techniques on human anatomical models. Additionally, they participated in the use of consumables made in Japan for coronary intervention (*e.g.*, stents, intravascular ultrasound, and diagnostic catheters).

iii) Follow-up training using Japan-made medical devices and consumables. An annual follow-up training was conducted several months after the initial training in

Japan. A multidisciplinary team including a cardiology specialist from Japan visited UTHs – Adult to provide mentorship. Mentoring programs comprised of on-the-job training, question-and-answer sessions, and consultation operations and QA manuals.

Outcomes

The outcomes of this project are summarized below:

i) Zambians performed their first Coronary CT, CAG, and PCI. The UTHs – Adult team successfully performed the first coronary CT in February 2018, and CAG and PCI in November 2019 (second country in Southern Africa after the Republic of South Africa) (10). Table 1 displays a summary of diagnostic CT imaging and cardiac catheterization procedures at UTHs – Adult during and after the project. Remarkably, the number of CT exams increased by 129.6% between 2017 and 2019, reflecting local demands for CT exams at a tertiary-level hospital in Zambia. In the detailed breakdown, no coronary CT studies were conducted in 2019 and 2020, whereas 33 have been conducted in 2018 (from a personal communication of the UTHs annual activity report in 2018-2020). This may be due to unexpected breakdowns of the CT scanner, power failure, and/or an absence of a dedicated 3D workstation to perform coronary CT as in normal clinical setting. To sustain their activities and help confirm diagnosis that allows better visualization, UTHs – Adult is in the process of procuring a high-end workstation.

ii) UTHs – Adult created a quality management system. The UTHs – Adult team has incorporated daily QA data collection tasks into a routine practice to prevent unnecessary breakdowns. The collected daily QA data was analyzed in case of problems.

iii) UTHs – Adult is in the process of concluding a maintenance contract. The UTHs – Adult team has recognized their responsibility in providing medical services to patients without any breakdowns. The team realized the advantage of a sustainable quality control circle and maintenance services. As a consequence, the UTHs – Adult is in the process of concluding a maintenance contract of the CT system.

iv) UTHs – Adult opened new marketing channels. Based on observations in Japan, and handling their

Table 1. The number of computed tomography and cardiac catheterization procedures at the University Teaching Hospitals – Adult in Lusaka

Items	2017	2018	2019	2020 (Jan. to Sep.)
Total Computed Tomography	3,057	5,289	7,018	4,389
Cardiac Catheterization Procedure				
Coronary Angiography	0	0	57	27
Percutaneous Coronary Intervention	0	0	30	10
Pacemaker Insertion	0	0	20	13
Total Cardiac Catheterization Procedure	0	0	107	50

own in the local context, UTHs – Adult healthcare professionals recognized the value of high-quality catheters and consumables high-quality catheters and consumables, enabling the success of coronary interventions. They also realized that the quality is worth the price. Eventually, a distribution channel for Japanese consumables was opened for UTHs – Adult.

Discussion

This project demonstrates the following four main successes: (1) Performance of coronary CT, CAG, and PCI by Zambian trainees; (2) Creation of a quality management system; (3) Conclusion of a maintenance contract; and (4) Opening of new marketing channels for Japan-made products. Points of arguments concerning the achievement are described below:

i) Multidisciplinary team training to promote advanced quality healthcare. The advanced healthcare team requires sustained team effort and its members with various specialty roles identified in a team. The trainees should develop a patient-centered safety culture. These learning strategies substantially contributed to Zambia's first achievements in performing coronary CT, CAG, and PCI in such a short time period (11).

ii) Quality management observation resulting in maintenance agreement. Quality management observation at the NCGM hospital and manufacturing factories aided in implementation of a QA program. A maintenance contract is being concluded, and new channels of marketing were opened. Factory visits by the trainees raised the spirits and confidence of Japanese manufacturers. The Zambian team concluded that a maintenance contract is cost saving in the long-term and extends the life expectancy of the equipment. Through this project, the Japanese manufacturer has come to learn the importance of value-for-money-oriented marketing strategies.

iii) Future perspective for sustainable development. Continuous professional and system development including improved radiation safety is critical for quality health service delivery. In this project, the UTHs – Adult has acquired best clinical practices from the NCGM despite race and ethnic differences. The PCI procedure is specifically associated with high radiation exposure. The possibility of radiation injuries should be explained to the patient (12). Thus, radiation safety measures should be put into practice to limit exposure to as low as reasonably achievable (8). For this purpose, we introduced recently published Japanese guidelines (13) emphasizing three points: a) explanation of possible radiation-induced skin injuries should be provided to the patient while obtaining informed consent before CAG or PCI; b) each institution should develop a protocol based on reference doses used in the institution and monitor radiation dose with dosimetry; and c) if skin exposure dose is estimated to be ≥ 3 Gy, the patient's medical history and subsequent

health should be followed up. These practices are expected to be firmly established at the UTHs – Adult and should extend to the rest of the country.

iv) COVID-19 pandemic has significant negative influence on sustainability. The COVID-19 pandemic has significant negative effects on their activities. Table 1 illustrates the significantly reduced number of CT exams and cardiac catheterization procedures performed in 2020. This is one of the immediate and serious effects of COVID-19. With factories closed and rail transport suspended, this pandemic resulted in a serious shortage of imported medical supplies (*e.g.*, contrast materials and syringes) and their price inflation. Supply chain disruptions and lockdowns in the Republic of South Africa have caused delivery delays and higher freight rates. Additionally, newly opened marketing channels are not yet established. Honoring maintenance contracts requires frequent communication and occasional site visits.

In conclusion, intensive training (focusing on QA) for multidisciplinary healthcare teams of the UTHs – Adult contributes to a better quality management system of the radiological equipment, resulting in greatly improved healthcare services. However, the COVID-19 pandemic has had enormous negative impact on essential healthcare needs. Long-term support through continuous hands-on training must be provided to establish sustainable healthcare services.

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